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16. KEY

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1	1	HK Ananda	HK Ananda	10/3/94	S1-57	DC Board			S1-57	3	
1	1	Safety SH Baker	SH Baker	10/3/94	R3-08	MN Islam			R3-08	3	
		Env.									
1	1	KG Carothers	KG Carothers	9/30/94	R1-51						
1	1	S Jenkins	S Jenkins	9/30/94	R1-51						

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Unreviewed Safety Question-Evaluation Form (sheet 1 of 3)

USQ Tracking Number: TF-94-0276

AREA: (Circle Those That Apply) EAST WEST

FACILITY: (Circle Those That Apply) 242-A DST SST LERF AGING

WASTE EQUIPMENT DESCRIPTION: This includes modification to Tank 241-AN-107 for installation of the mixer pump assembly, caustic addition system, camera system, and densitometers.

REFERENCE DOCUMENT: (Circle Those That Apply)

ECN No._____ PCA No._____ WORK PKG No._____ OTHER(Specify) * *See Refs in Safety Basis

TITLE: Safety Basis for the 241-AN-107 Mixer Pump Installation and Caustic Addition

1. Does the PROPOSED CHANGE or DISCOVERY increase the probability of occurrence of an accident previously evaluated in the AUTHORIZATION BASIS documentation?
No X Yes/Maybe___

Basis: Two previous mixer pump installations and operations have been performed for 101-SY and 102-AP. The rigorous safety assessment (LA-UR--92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101*, March 1994) in support of 101-SY has produced results favorable for the safe operation of mixer pumps in hydrogen generating "watch-list" tanks. The 107-AN mixer pump is very similar to the pumps installed in 101-SY and 102-AP only not as large. Tank 107-AN is not a watch-list tank, however the addition of caustic is new. The analyses are addressed in chapter 4.0 of the safety basis (see WHC-SD-WM-HIE-003) for the various hazards and the affect that this activity will have on them. The results indicate that the risks associated with the installation and operation of the mixer pump and caustic addition are within the acceptable boundaries of the safety envelope.

2. Does the PROPOSED CHANGE or DISCOVERY increase the consequences of an accident previously evaluated in the AUTHORIZATION BASIS documentation?
No X Yes/Maybe___

Basis: As stated above and in the Safety Basis, WHC-SD-WM-HIE-003, no increases in the consequences of an accident will occur.

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Unreviewed Safety Question Evaluation Form (sheet 2 of 3)

REFERENCE ITEM #: TF-94-0276

3. Does the PROPOSED CHANGE or DISCOVERY increase the probability of occurrence of a malfunction of ITS EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?
No_X_ Yes/Maybe___

Basis: The operational controls will prevent direct jet discharge at full pump speed to the thermocouple tree probe as stated in the Safety Basis (see WHC-SD-WM-HIE-003). There are no other anticipated effects on any other equipment that will increase the probability of malfunction.

4. Does the PROPOSED CHANGE or DISCOVERY increase the consequences of a malfunction of ITS EQUIPMENT previously evaluated in the AUTHORIZATION BASIS documentation?
No_X_ Yes/Maybe___

Basis: No increase in the consequences from a malfunction of Tank 107-AN equipment is anticipated (see Safety Basis, WHC-SD-WM-HIE-003).

5. Does the PROPOSED CHANGE or DISCOVERY create the possibility of an accident of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?
No_X_ Yes/Maybe___

Basis: (See Safety Basis, WHC-SD-WM-HIE-003). There are no new accidents that would have any consequences anticipated.

6. Does the PROPOSED CHANGE or DISCOVERY create the possibility of a malfunction of ITS EQUIPMENT of a different type than any previously evaluated in the AUTHORIZATION BASIS documentation?
No_X_ Yes/Maybe___

Basis: With the operational controls and equipment interlocks as discussed in the Safety Basis (WHC-SD-WM-HIE-003), there are no new and/or different types of malfunctions expected to occur.

7. Does the PROPOSED CHANGE or DISCOVERY reduce the margin of safety as defined in the basis for any Technical Specification/Operational Safety Requirement?
No_X_ Yes/Maybe___

Basis: As stated in chapter 5.1 of the Safety Basis (WHC-SD-WM-HIE-003), the installation, operation, and removal of the mixer pump and supporting equipment does not reduce any margin of safety as defined in the safety documentation for the DSTs.

Unreviewed Safety Question Evaluation Form (sheet 3 of 3)

REFERENCE ITEM #: TF-94-0276

8. Does the PROPOSED CHANGE or DISCOVERY require a new or revised Technical Safety Requirement/ Operational Safety Requirement?

No X Yes/Maybe ____

Basis: There are no additional TSRs/OSRs required or anticipated for this operation (see Safety Basis, WHC-SD-WM-HIE-003).

USQE #1 Leland G. Coleman
Print Name
Leland G. Coleman 9/27/94
Signature Date

USQE #2 Eric E. Oscarson
Print Name
Eric E. Oscarson 9/27/94
Signature Date

PRC REVIEW

Meeting #: _____ Date _____

PRC Chairman Concurrence: _____ _____

Signature Date

RELEASE AUTHORIZATION

Document Number:	WHC-SD-WM-HIE-003, REV 0
Document Title:	Safety Basis for the 241-AN-107 Mixer Pump Installation and Caustic Addition
Release Date:	October 5, 1994

* * * * * * * * * * * * * *

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

* * * * * * * * * * * * * *

WHC Information Release Administration Specialist:

Kara Broz
(Signature)

October 5, 1994
(Date)

A-6001-400 (07/94) WEF256

SUPPORTING DOCUMENT

1. Total Pages 82

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APPROVED FOR PUBLIC RELEASE	Signature: Rick J. Van Vleet
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7. Abstract

This safety Basis was prepared to determine whether or not the proposed activities of installing a 75 HP jet mixer pump and the addition of approximately 50,000 gallons of 19 M (50:50 wt %) aqueous caustic are within the safety envelope as described by Tank Farms (chapter six of WHC-SD-WM-ISB-001, Rev 0). The safety basis covers the components, structures and systems for the caustic addition and mixer pump installation. These include: installation of the mixer pump and monitoring equipment; operation of the mixer pump, process monitoring equipment and caustic addition; the pump stand, caustic addition skid, the electrical skid, the video camera system and the two densitometers. Also covered is the removal and decontamination of the mixer pump and process monitoring system. Authority for this safety basis is WHC-IP-0842 (Waste Tank Administration). Section 15.9, Rev 2 (Unreviewed Safety Questions) of WHC-IP-0842 requires that an evaluation be performed for all physical modifications.

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SAFETY BASIS FOR THE 241-AN-107 MIXER PUMP INSTALLATION AND CAUSTIC ADDITION

Prepared for

Westinghouse Hanford Company

by

WASTREN, INC.

September 27, 1994

TABLE OF CONTENTS

1.0 INTRODUCTION 1
- 1.1 Purpose 1
- 1.2 Scope 1
- 1.3 History 2
- 1.4 Summary of Results 3

2.0 DESCRIPTION OF EQUIPMENT 4
- 2.1 Mixer Pump and Ancillary Equipment 4
- 2.2 Caustic Addition Skid 4
- 2.3 Electrical Skid 5
- 2.4 Pump Stand 6
- 2.5 Tank 107-AN, Components, and Waste Contents 6
  - 2.5.1 Tank 107-AN 6
  - 2.5.2 Thermocouple tree probe 7
  - 2.5.3 Air Lift Circulators (ALCs) 7
  - 2.5.4 ALC horizontal restraints 7
  - 2.5.5 Camera System 8
  - 2.5.6 Enraf-Nonius 854 ATG densitometer 8
  - 2.5.7 Tank 107-AN waste profile 9

3.0 OPERATING PROCEDURES 11
- 3.1 ATarm Response/Abnormal Operating Procedures 11
- 3.2 Standard Operating Procedures 11

4.0 HAZARDS IDENTIFICATION 12
- 4.1 Hazards Grid and Supporting Documents 12
- 4.2 Hazard Analyses - Extrinsic 17
  - 4.2.1 Seismic 17
  - 4.2.2 Wind/tornado 17
  - 4.2.3 Lightning/thunderstorm 18
- 4.3 Hazard Analyses - Containment Barriers 19
  - 4.3.1 Primary tank pressurization 19
  - 4.3.2 Ground release (spill) 19
  - 4.3.3 Primary tank leakage 19
  - 4.3.4 Hydrostatic load/specific gravity 20
  - 4.3.5 Heat loading 20
    - 4.3.5.1 Heat loading from the caustic addition . . . 20
    - 4.3.5.2 Heat loading from mixer pump operation . . . 21
  - 4.3.6 Corrosion 22
  - 4.3.7 Descaling of the walls 23
  - 4.3.8 Impact of mixer pump on tank internals 24
  - 4.3.9 Dropped object 25
  - 4.3.10 Internal missiles 26
  - 4.3.11 Tank Level 26
  - 4.3.12 Dome Loading 26
- 4.4 Hazard Analyses - Uncontrolled Chemical Reactions 27
  - 4.4.1 Criticality 27

4.4.2 Solids precipitation from caustic addition 28
4.4.3 Accumulation of flammable gases - Ammonia Evolution . . 29
4.5 Hazard Analysis - Industrial and Radiological 30
4.5.1 Occupational radiation exposure 30
4.5.2 Occupational exposure to toxic gases 31
4.5.2.1 Ammonia 31
4.5.3 Occupational exposure to caustic 32

5.0 CONTROLS AND MITIGATING FEATURES 33
5.1 TSR/OSR Considerations 34

6.0 CONCLUSIONS AND RECOMMENDATIONS 34

7.0 REFERENCES 35

TABLES

Table 2-1: Tank 107-AN Supernatant Waste Properties 10
Table 4-1: Hazard Analysis Grid 13
Table 4-2: Ammonia 32
Table 4-3: Caustic (Sodium Hydroxide) 33

APPENDIX

Appendix A: Mixer Pump Installation and Caustic Addition SEL 38

ATTACHMENTS

Attachment 1: Conceptual Operating Procedures Att.-1

1.0 INTRODUCTION

Analytic data reported for November 1984 samples indicate that waste tank 241-AN-107 (107-AN) is out of operating specifications relative to the free hydroxide ion (OH^-) concentration (Not synonymous with pH.). The OH^- concentration is below the range specified to prevent stress-corrosion cracking (SCC). Since the progress of SCC is difficult to detect, bringing the tank contents back into conformity with the operating specifications is vitally important to prevent the degradation of the safety class "1" tank walls; which mitigate the potential environmental risks. To bring the OH^- concentration back into the acceptable operating range (>0.30 molar (M)), caustic (sodium hydroxide) must be added. The target concentration for the tank contents is 0.5 M. However, the operating specification upper bound for free hydroxide (<10 M) cannot be exceeded during the caustic addition; which may occur locally without a mixer pump installation and operation to mix the caustic as it is added. The mixer pump operation will uniformly distribute caustic into the waste; reaching the operating specification concentration that minimizes the potential for SCC. The proposed caustic addition process and equipment are described in I.M. 7C240-92-072, *Action Plan for Adding Caustic to Tank 241-AN-107*.

Appendix A contains the Safety Equipment List (SEL) for this project. Based upon this safety basis and the application of the procedure for assigning safety class contained in WHC-CM-4-46, there were no systems or equipment that are classified as safety class 1 or 2.

1.1 Purpose

This safety assessment is prepared by *WASTREN, Inc.*, for Westinghouse Hanford Company's Tank Farm Safety Analysis and Engineering group to determine whether or not the proposed activities of installing a 75 hp rotating submersible mixer pump, and the addition and mixing of approximately 49,520 gallons of 19 M (50:50 wt.%) aqueous caustic solution into tank 107-AN are bounded within the existing "safety envelope" as described in the accepted Tank Farms authorization basis documents, including Chapter 6 of WHC-SD-WM-ISB-001, Rev. 0, *Hanford Site Tank Farm Facilities Interim Safety Basis*. Additionally, this assessment will determine if any new LCOs or IOSRs will be required outside of those stated in the accepted authorization basis. The outcome of this assessment will illustrate that the risks associated with implementation of the proposed activities are thoroughly addressed and adequately described in the authorization basis, or that additional analyses and direct DOE authorization will be required for the proposed activities. This Safety Evaluation was started and accomplished using WHC-IP-0842, *Waste Tank Project Administration*, Procedure 15.9, "Unreviewed Safety Question" Rev. 2, which required a USQ Evaluation for facility modifications.

1.2 Scope

The scope of this safety assessment includes identifying and describing the structures, systems and components for tank 107-AN, for

the installation and operation of the mixer pump, and for the caustic injection. Upon identification of these structures, systems, and components, an evaluation will be made that identifies the associated hazards corresponding to each facet of the proposed activities which include: installation of the mixer pump and process monitoring equipment; operation of the mixer pump, process monitoring equipment and caustic addition; and removal and decontamination of the mixer pump and process monitoring systems. Hazards analysis will be conducted to include evaluation of equipment failures due directly to the installation, operation and removal of the mixer pump, as well as other previously identified hazards (WHC-SD-WM-ISB-001, Rev.0) which may be exacerbated by the operation of the mixer pump and caustic addition. Those hazards identified which are not addressed in the authorization basis documents will require unique evaluations and cleared information release requests when substantiated by the engineering and laboratory studies conducted in direct support of this project.

1.3 History

Stress-corrosion cracking proceeds as fine cracks that progress through the material while the metal surface remains virtually unscarred. It is the most intense form of localized corrosion and failure may ensue rapidly after its onset. SCC occurs by the simultaneous presence of tensile stressors and chemical corrosive environments after an indeterminate incubation period; its progress upon initiation is rapid. Tank surfaces which are under tensile stress and are in contact with liquid or sludge waste appear to be the most vulnerable regions. In the double shell tanks the knuckle region should be more sensitive to the effects of SCC (the reader is referred to the topical report, Proposed Corrosion Assessment of Hanford Site Waste Storage Tanks in Support of Interim Safety Basis, 5.3.4).

Stress-corrosion cracking is known to occur in A537 carbon steel, the material of the tank walls. Specifically, when some of the Savannah River Site tanks were found to be leaking (September 8, 1960) the follow-up analysis indicated that SCC was at fault (Poe, 1974). As many as 68 Hanford Site single shell tanks are suspected of leakage, and SCC is implicated as the major fault mode. This may be due in part to the original wastes being transferred to the single shell tanks in an "uninhibited" or too acidic state.

No double shell tanks are known to leak at present. Apparently, this is due to the fact that the welds in the double shell tanks were thermally stress-relieved and the chemical composition of the waste was properly conditioned to prevent potential SCC. The major chemical species preventing SCC are NO_3^-, NO_2^-, and OH^-; provided that they are maintained in the proper molar (M) concentrations and contact the tank wall surfaces. The specification states that for DSTs with temperature $\leq$ 212 °F and NO_3^- > 3.0 M, the OH^- concentrations shall be $\geq$ 0.3M, and the combined OH^- and NO_2^- concentrations be $\geq$ 1.2 M (WHC-SD-WM-OSR-016, *Double Shell Tank Interim Operational Safety Requirements*, Rev. 0, Table B-5.17-1).

The waste in tank 107-AN has been out of OH^- specification for nearly ten years. Analytic results reported in February 1985 (I.L., Herting to Bratzel, February 1985) from November 1984 samples revealed an OH^- concentration at < 0.04 M. Subsequent sampling in March 1986 (I.L., Bratzel to Appel, December 1986) reported the OH^- at < 0.05 M, and the most recent analysis of samples taken in February 1993 (I.M. 12110-PCL93-042, *Tank 107-AN Caustic Demand*, May 1993) indicate OH^- concentration of < 0.02 M.

Pacific Northwest Laboratory (I.M., Reynolds to Dunford, February 1988) conducted a study to determine the SCC potential of tank 107-AN in 1987 utilizing electrochemical potential testing (corrosion probe) on actual waste samples and waste simulants on A537 carbon steel. The results indicated that the general corrosion rate was within the design specifications of < 0.001 inch per year, but that the measured electrochemical potential fell within the range where SCC could occur.

In May 1990 tank 107-AN was identified as an "unresolved anomaly" after inquiry by DOE-RL. Questions concerning potential safety issues of waste management facilities led to the assignment of Priority Level "3" for tank 107-AN mitigation within the Waste Tank Safety Program using criteria provided by the DOE High-Level Radioactive Waste Tanks Task Force. Funding to mitigate the insufficient OH^- concentration was forthcoming in FY 1993 and included in the Draft FY 1994 Five-Year Plan.

1.4 Summary of Results

Two previous mixer pump installations and operations have been performed for 101-SY and 102-AP. The rigorous safety assessment (LA-UR--92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101*, March 1994) in support of 101-SY has produced results favorable for the safe operation of mixer pumps in hydrogen generating "watch-list" tanks; within the appropriate limitations. The mixer pumps used in 101-SY and 102-AP are essentially identical to the one proposed for 107-AN, with the latter being a 75 hp model as opposed to the 150 hp models (The reader is also referred to *USQ Screening and Safety Evaluation for Mixer Pump in Tank 241-AP-102*, 15-93-MXRPMP-102-AP, February 1993).

The previous studies and results would indicate that 107-AN proposed activities are well defined. This is mostly true, however, there are slight differences in the methods of installation and operation of the mixer pump assembly. The 107-AN mixer pump will be installed on a pump "stand" rather than a stiffened riser, and the waste environment is slightly different. The addition of the caustic may have adverse impacts on either the pump or the waste, or both. The following descriptions and hazard identification and analyses support the conclusion that the existing documentation and the risks described therein adequately address the proposed activities; the USQ Evaluation is favorable (all "no" answers); the mixer pump installation, operation and caustic addition is not an "Unreviewed Safety Question".

2.0 DESCRIPTION OF EQUIPMENT

2.1 Mixer Pump and Ancillary Equipment

The planned mixer pump is a Hazleton 5N SSB, Model No. 360-75-1800(R), operating at a total flow of 950 gallon per minute (gpm) at a total dynamic head of 115.5 feet. The 75-hp pump has two opposing nozzles with the exit streams parallel to the tank floor. The pump exit nozzles are diametrically opposed and will create two directly opposed, submerged liquid jets. These liquid jets will cause the mixing of the waste material. The mixer pump will be rotated by a rotational motor which provides the pump the ability to rotate through 190°. This more than provides for full 360° coverage through the opposing discharge nozzles. Limit switches prevent the mixer pump from rotating to a point where damage could result to the flex-hose assemblies. The pump will be installed in Riser WST-RIS-126G, at approximately three feet from the tank centerline, and will be supported by a pump support column made of 10 inch diameter Schedule 40 pipe, with attached exterior lines for caustic injection and water flush of the suction inlet screen and discharge nozzle throat. Ultrasonic transducers and a density monitor will also be installed on the pump support column. The centerline of the pump nozzles will be nine inches above the tank floor and the pump intake is six feet above the discharge. The mixer pump assembly weighs approximately 7,800 pounds. The arrangement of the pump, pump support column, and caustic injection flush lines is shown in drawings H-2-85264, *Assembly - Mixer Pump - Caustic Addition Tank 107-AN*.

The pump will not be rotated continuously during operation, but will operate at a specified angle for a specified period, and will then be rotated to successive angles. WHC-SD-WM-ER-219, *Mixing Test Report for Tank 107-AN Caustic Addition Project* by Chang, S.C., recommends operating for one hour at each index angle, except in a 10° exclusion zone centered on the thermocouple tree probe (5° on each side) in which pumping would not be allowed. Further analysis which refined the results found in WHC-SD-WM-ER-219 were completed in WHC-SD-WM-ANAL-018, *Structural Evaluation of Tank 241-AN-107 Internal Components For Caustic Addition Mixing Operations*. The conclusions recommend that during mixing pump operation, when either of the nozzles is within the 10-deg. exclusion zone, the jet exit velocity should be between 32 and 49 ft/sec (0-deg. impingement) and 49 and 75 ft/sec (2.5-deg. impingement) so that the probe does not experience resonance or contact the riser during mixing pump operations. Outside the 10-deg. exclusion zone the pump can operate at the maximum nozzle exit velocity of 96 ft/sec and at a minimum of 70 and 74 ft/sec for 5- and 7-deg. impingement angles, respectively.

2.2 Caustic Addition Skid

The planned caustic addition skid is about four feet wide by eight feet long, and will support and protect the caustic injection pump, control valves, and piping. The skid structure consists of support elements, a drain pan, and a roof. The drain pan is constructed of 18

gauge or thicker 304 L stainless steel, with a slope of ¼ inch per foot. The minimum containment volume of the pan is 120 gallons. The roof over the skid will be sloped, with a minimum height of at least seven feet above the drain pan. The skid is designed to be capable of withstanding 70 mile per hour winds and will be anchored on a 6 inch thick concrete pad measuring 5.5 feet wide by 9 feet long.

The injection pump is a Robbins & Meyers, Moyno progressing cavity positive displacement pump with a 480 V, 3 phase, 60 hertz motor. It is rated at 15 gpm at 50 psi head, when pumping a caustic solution with a 1.5 specific gravity and fluid viscosity of 25 Centipoise. The pump system and skid also includes a motor speed control unit, vibration isolation for rotating equipment, and pump instrumentation. Pump instrumentation includes but is not limited to flowmeter, totalizer, chart recorder, temperature sensor, alarms, pressure detector, and leak detectors. WHC-SD-WM-RD-031, Rev. 0, *Tank 107-AN Caustic Addition Pump Skid Requirements*, gives additional details on the design and assembly data for the pump and skid.

The skid will be located outside the tank farm fence and south of the electrical skid. A 19 molar (50:50 wt%) sodium hydroxide caustic additive will be transported to the area by tanker trucks. Each tanker truck will contain about 4,000 gallons of caustic. The tanker truck will either be connected directly to tank 107-AN via the caustic addition skid or will pump to a doubly-enclosed transport trailer that will serve as a temporary storage tank for feeding the caustic addition skid. The temporary storage tank will be located at the south end 241-AN tank farm parking lot adjacent to the caustic addition skid. The injection pump will transfer the caustic directly from the temporary storage tank to the mixer pump through a heat traced, two inch flexible hose.

2.3 Electrical Skid

Power control circuit breakers and interlocks for the mixer pump, the caustic injection pump and associated instrumentation will be provided from an electrical skid. The electrical skid will be located southwest of Tank 107-AN, outside the tank farm fence adjacent to the caustic addition skid. The electrical skid will be an air conditioned, metal building and platform approximately 10 feet wide by 16 feet long by 10 feet high. The skid will be bolted to a 6 inch thick concrete pad measuring 12.5 feet wide by 21.5 feet long.

The 480 Volt, 3 phase, 60 hertz electrical power will be provided to the electrical skid from Motor Control Center MCC-241-AN-271. On the skid, this power will be routed through circuit breakers and transformers as required to provide power and protective shutdowns to the mixer pump variable speed drive and controls, caustic addition pump and controls, camera system controls, monitoring instrumentation, and auxiliary services such as convenience outlets and skid air conditioning. Power for the mixer pump will be routed to pump pit 241-AN-07A through three conduits which will be buried at approximately 2.5

feet deep. The conduit will be identified by a covering of wood boards and yellow plastic which will be labeled with the words "Caution Buried Electrical Cables." Drawing H-2-85259 Rev. 0, *Electrical - Caustic Addition Project*, gives arrangement and installation details for the electrical skid.

2.4 Pump Stand

The mixer pump will rest on the pump stand that has been fabricated for installation in the Tank 107-AN pump pit, riser WST-RIS-126G (42 inch riser). The pump stand is approximately 10 inches tall and consists of angle iron and steel plate support bracing. The mixer pump stand will be Hilti bolted into place, leveled, and then grouted onto the pump pit floor. The pump stand weighs 500 pounds. The arrangement of the pump stand is shown in H-2-85261, *Pump Stand - Caustic Mixer Pump - Tank 107-AN*.

2.5 Tank 107-AN, Components, and Waste Contents

2.5.1 Tank 107-AN

Tank 107-AN is located in the 241-AN Tank Farm in the 200 East Area; and is one of five DST Farms located in the 200 East Area. 241-AN Tank Farm contains seven DSTs whose mission is to receive liquid wastes from the 242-A Evaporator and various other facilities. As such, the tank bottoms are design to accommodate slurry solids (The reader is referred to section 3.0 of WHC-SD-MW-ISB-001, Vol. 2, Rev. 0 for more complete descriptions, specifications, schematics and diagrams.).

Tank 107-AN is a double shell underground waste storage tank with components suspended into the tank and supported from the tank dome. The tank is 75 feet in diameter, constructed of ASTM A 537 Class 1 material and is designed to store a maximum of 1.14 million gallons (with specific gravity of 1.7). Tank 107-AN is unique in the 241-AN Tank Farm by the fact that it contains eighty risers which in turn support 21 air-lift circulators (ALCs). The mixer pump will be installed in riser WST-RIS-126G. This riser is located three feet from the tank centerline and has a diameter of 42 inches.

In-tank components include a safety class IOSR thermocouple tree probe, 21 safety class 4 (SC4) air-lift circulators (ALCs) with associated SC4 ALC horizontal restraints, two densitometers and an in-tank remote television camera. The densitometers and camera are to be added to support the mixer pump operations.

<u>Specifications</u> for tanks in the 241-AN Tank Farm are as follows (WHC-SD-WM-ES-284 Rev. 0, *Double Shell Tank Ventilation Upgrades (and other selected ventilation systems)*):

Maximum pressure = 60 inches water

Maximum vacuum = 6 inches water
Maximum tank wall temperature = 200 °F
Tank construction material = ASTM A 537 Class 1

Waste characteristics:

Temperature = 350 °F maximum entering tank, 200 °F maximum in storage
Heat generation rate = 100,000 BTU/hr/tank maximum
pH = 8 - 14
Specific gravity = 2.0 maximum

Primary Ventilation Requirements:

Maximum ventilation = 1000 scfm (total of seven tanks)

Annulus Ventilation Requirements:

Maximum ventilation = 6125 scfm (total of seven tanks)

2.5.2 Thermocouple tree probe

The thermocouple tree probe is a 55 foot long, two inch diameter Schedule 40 carbon steel (ASTM A-106 Grade B) pipe. The thermocouple tree probe has external threads at the location of the riser flange and the end of the thermocouple tree probe is 1 foot above the floor of the tank. It is installed through riser WST-RIS-106G (a four inch Schedule 40 pipe) at a radial distance of 20 feet from the center of the tank.

2.5.3 Air Lift Circulators (ALCs)

The ALCs consist primarily of six inch Schedule 40 and Schedule 80 carbon steel (ASTM A-106, Grade B) pipe with either a 17 foot or 22 foot length of 30 inch Schedule 10 carbon steel (ASTM A-285, Grade C) pipe at the bottom of the ALCs. There are a total of 21 ALCs of which 4 have a 17 foot length of 30 inch diameter steel pipe at the bottom and 17 have a 22 foot length. Seven of the ALCs are approximately evenly spaced around the tank center and are located at a radius of approximately 14½ feet from the tank center. The remainder are also approximately evenly spaced around the tank center, but are located on a 27¼ foot radius from the tank center. The ends of the ALCs are 2½ feet above the tank floor.

2.5.4 ALC horizontal restraints

The ALC horizontal restraints consist of ASTM A-36 carbon steel weldments of structural members and a baseplate. There are three restraints equally positioned around each ALC at a radial clearance of ½ inch and the base plates are welded to the tank floor.

2.5.5 Camera System

The Tank 107-AN camera system will be installed through riser WST-RIS-111G (a 12 inch riser). The remote controls and display will be located in the electrical control skid. Local controls will be located in an electrical cabinet near riser WST-RIS-111G.

The in-tank camera system assembly consists of a single frame with a remotely controllable camera (including zoom, iris, and focus capabilities), remotely controllable pan-and-tilt mechanism, remotely controllable lights, dry gas distribution lines, radiation shielding plates, riser flange mating plate, and assembly lifting bail. The shielding plate, upper junction box, and upper flange plate are welded to a 103 inch long schedule 80, 304 stainless steel pipe that is 3.5 inches O.D. with 0.30 inch wall thickness. This pipe contains the electrical wiring and purge gas lines. A lower flange welded to the end of the pipe bolts to a J-box body made of schedule 80, 304 stainless steel that is 6.625 inches O.D. with a 0.43 inch thick wall. The pan and tilt mechanism and camera assembly are bolted to the bottom of the J-box.

The camera is an R. J. Electronics RCS-521 color TV stainless steel incased camera mounted above a lighting array consisting of four 250 watt sealed beam quartz halogen lamps. The camera will be capable of full tank monitoring and will have a video grid display which allows for measuring the thermocouple tree probe deflection during mixer operations. The total penetration from the top of the tank is between 160 and 170 inches. The total weight below the top flange where the camera is attached to the tank is 263.7 pounds.

2.5.6 Enraf-Nonius 854 ATG densitometer

The Enraf-Nonius Model 854 Advanced Technology Gauge (ATG) is a level and density measuring instrument with optional remote control and data acquisition capabilities. The instrument is used primarily in the petroleum and chemical industries for product inventory control. The model purchased for the AN-107 Caustic Addition program is Factory Mutual approved as explosion proof for Class I, Division 1, Groups B, C and D hazardous locations.

The 854 ATG uses a displacer (AKA plumb bob) of known weight and volume, along with the riser mounted mechanical and electronic apparatus needed to raise and lower it, and to make measurements. The effective density of the displacer must be greater than the maximum expected density of the fluid being measured so it will sink. The displacer is suspended on a thin wire wound on a take-up drum in a sealed housing. The drum is coupled to a precision load cell in the attached, isolated electronics housing. Density is calculated by accurately measuring the apparent weight of the

displacer when it is fully immersed in the fluid. The gauge is also capable of measuring three levels; normally air-to-surface, oil-to-water and tank bottom. The levels are detected by an abrupt decrease in the wire tension.

2.5.7 Tank 107-AN waste profile

The majority of 107-AN waste originates from 470,000 gallons of concentrated complexant (CC) waste transferred from 102-AN in June 1983 and 640,000 gallons of CC waste transferred from 102-AZ in October 1983 (RHO-RE-SR-14, October 1983, *Inventory and Status by Tank*). The waste was transferred onto an existing 11,000 gallon heel. Tank 107-AN has been inactive (no waste transfers or additions) since November 1983 (WHC-SD-WM-ISB, Rev. 0, Appendix F-11). The tank has lost a small amount of liquid volume beginning shortly after March 1985 and continuing through the present, apparently due to evaporative losses; further concentrating the CC waste (the supernatant liquid volume). Over its operating life, 134,000 gallons of sludge solids have settled or precipitated out of solution to the bottom of the tank.

The CC waste is produced by evaporating dilute wastes containing organic complexants such as n-hydroxyethyl ethylenediaminetricetic acid (HEDTA), ethylenediaminetetraacetic acid (EDTA), and nitrilotriacetic acid (NTA). Evaporation of dilute complexant waste is controlled to minimize solids precipitation and keep the concentrated product fluid. The sample data used was obtained from a "bottle on string" sample collected February 7, 1993, to test the 930,000 gallons of complexant concentrate supernatant liquid, and the heel layer (sludge solids).

This sampling effort produced three supernatant samples and two sludge samples. The sludge samples did not contain enough solid material (<10% solids) to provide results representative of the sludge heel. The three supernatant samples conform to WHC-SD-CP-QAPP-001, *Analytic Chemistry Services Laboratories Quality Assurance Plan*; laboratory procedure LA-211-102 was followed for free hydroxide in solution. Table 2-1, Tank 107-AN Supernatant Waste Properties, presents the highest value (maximum column) of the three samples for each analyte, the total for the tank based upon the maximum, the average of the three samples and the tank total based upon the average values.

Table 2-1: Tank 107-AN Supernatant Waste Properties				
Analysis	Maximum (M)	Total (kg)	Average (M)	Total (kg)
Density, g/ml	1.41	n/a	1.40	n/a
DSC exotherm, J/g	704	3.49E+12 J	683	3.36E+12 J
wt.% H_2O (TGA)	49.6	n/a	49.5	n/a
wt.% H_2O, oven drying	55.0	n/a	54.8	n/a
pH	11.9	n/a	11.9	n/a
OH^- by titration	<0.02	<1.20E+03	<0.02	<1.20E+03
Cl^- by IC	0.10	1.25E+04	0.09	1.12E+04
NO_2^- by IC	1.30	2.11E+05	1.07	1.73E+05
NO_3^- by IC	4.10	8.95E+05	3.83	8.37E+05
PO_4^{3-} by IC	0.006	2.01E+03	0.005	1.67E+03
SO_4^{2-} by IC	0.17	5.74E+04	0.14	4.73E+04
CO_3^{2-} by TIC	1.43	3.02E+05	1.25	2.64E+05
Al by ICP	0.046	4.37E+03	0.045	4.28E+03
Fe by ICP	0.027	5.32E+03	0.027	5.32E+03
K by ICP	0.066	9.06E+03	0.054	7.41E+03
Na by ICP	8.83	7.15E+05	8.65	7.00E+05
S by ICP	0.09	1.10E+04	0.08	9.01E+03
TOC, g/L	44.8	1.58E+05	42.9	1.51E+05
Anion/Cation ratio	1.06	n/a	1.04	n/a
Mass balance, wt.%	101.5	n/a	101.2	n/a
U, μg/ml	92.3	3.25E+02	83.3	2.71E+02
Total alpha, μCi/ml	1.09	3.84E+03 Ci	1.06	3.73E+03 Ci
Total Beta, μCi/ml	634	2.23E+06 Ci	556	1.96E+06 Ci
^{137}Cs, μci/ml	302	1.06E+06 Ci	253	8.91E+05 Ci
$^{239/240}Pu$, μCi/ml	0.035	1.23E+02 Ci	0.034	1.20E+02 Ci
^{241}Am, μCi/ml	0.66	2.32E+03 Ci	0.63	2.22E+03 Ci
^{237}Np, μCi/ml	0.0009	3.17E+00 Ci	<0.0006	<2.11E+00 Ci
^{90}Sr, μCi/ml	98.7	3.47E+05 Ci	93.0	3.27E+05 Ci

3.0 OPERATING PROCEDURES

The operating procedures reviewed for this safety evaluation are conceptual procedures which have been prepared to provide an operating envelope for the 241-AN-107 Caustic Addition process (see Attachment 1). The evaluation of these conceptual procedures should not be interpreted as an endorsement of the final operating procedures, however, if the final procedures are bounded by these conceptual procedures then a USQ Screening should be sufficient to verify compliance with the requirements contained in the safety basis for this tank farm.

3.1 Alarm Response/Abnormal Operating Procedures

The procedure outlines for the alarm response/abnormal operating procedures identify six (6) separate procedures which will be prepared in detail prior to operation of the caustic addition system. These procedures include: (1) General Power Failure; (2) Tank Farms ARM Alarm; (3) Water Utility/Flush Water Line Failure; (4) Caustic Addition Skid Failure; (5) Mixer Pump Rotational Motor Failure/Overtravel; and (6) Mixer Pump Failure/Operational Interlocks. The General Power Failure procedure will describe the actions which will be taken if electrical power is lost. The safety considerations are that the system will fail or shut down into a safe configuration. The ARM Alarm procedure will describe how the ARM will shut down the mixer pump and caustic addition pump, which is a safe configuration. The loss of flush water would have no immediate safety concerns, but would require a shutdown of the mixer pump to prevent clogging of the inlet screen or nozzles.

The Caustic Addition Skid Failure procedure will describe the responses to leaks, pump failure, or any alarms associated with failures of caustic addition skid systems. The only hazard involved with the skid is the spill of caustic onto the ground in the event of a line leak. The consequences of a leak of caustic are considered to be relatively minor and are well within the safety basis of the tank farms. The operating procedure covering Mixer Pump Rotational Motor Failure/Overtravel will describe the operator actions in the event of either type of rotational motor failure. In the event of overtravel the mixer pump will automatically shutdown into a safe mode. If indexing capability is lost the pump can still be operated with no safety concerns. The final operating procedure in this section is the Mixer Pump Failure/Operational Interlocks. There are a number of automatic interlocks on the mixer pump which will all shut the pump down. In each case, if the mixer pump shuts down the caustic addition pump will also automatically shut down. With the pumps shut down there are no safety concerns.

3.2 Standard Operating Procedures

There will be at least three standard operating procedures for the Operation of the 241-AN-107 Mixer Pump: (1) Initial Mixing; (2) Caustic Addition; and (3) Waste Recirculation. The Initial Mixing operating procedure will be developed to define how the mixer pump will be

evaluated to determine the optimum pump operating speed to support uniform mixing and minimize wear on the mixer pump and thermocouple tree probe. There were no inherently hazardous conditions identified for this initial mixing phase, therefore, this operation is within the authorization basis of the tank farms.

Both the Caustic Addition and Waste Recirculation operating procedures require the determination of the optimum mixer pump operating conditions (as per the Initial Mixing procedure) prior to implementation. Use of the Waste Recirculation procedure will introduce no additional hazards to the tank or its contents, since it only specifies how to mix the tank contents with the mixer pump. The Caustic Addition procedure will describe the process of operating the mixer pump and the addition of caustic to the waste in the tank. The only hazard associated with the operation of the mixer pump and the addition of caustic is the case where the mixer pump is shut down and caustic continues to be injected. If this were to happen then there might be local high caustic concentrations and an accelerated reaction with the waste. Since the operation of the caustic addition pump is interlocked with the operation of the mixer pump, there should be only a very remote potential for caustic injection without mixing. Consequently, the use of these conceptual operating procedures is not considered to introduce any new or increased hazards which are not within the authorization basis for the tank farms.

4.0 HAZARDS IDENTIFICATION

4.1 Hazards Grid and Supporting Documents

Table 4-1, Hazard Analysis Grid, below lists the hazards, their unique applicability to the proposed activities, and references as extracted from WHC-SD-WM-ISB-001, REV. 0, Section 3.4, *Double Shell Tank Hazards and Safety Bases*. The table provides a "road map" of the existing generic hazards covered by WHC-SD-WM-ISB-001. Hazards are evaluated relative to the uniqueness of the proposed activities and tank 107-AN. When a hazard identified on the table is adequately covered by the existing authorization bases, and is not potentially exacerbated by the proposed activities it is not addressed further (see below). Hazards with direct unique applicability to the proposed activities are evaluated further in their own subsection of section 4.0, *Hazards Identification*. Any new potential hazards (outside of WHC-SD-WM-ISB-001) are given individual attention if warranted and not adequately addressed in the generic hazard topics in WHC-SD-WM-ISB-001.

Table 4-1: Hazard Analysis Grid			
HAZARD	APPL.	DOCUMENTS	COMMENTS
EXTRINSIC HAZARDS			
Seismic	Yes	SD-WM-SAR-016, Rev.1, Section 9.4, Table 9-1	See section 4.2.1 below.
Wind/Tornado	Yes	SD-WM-SAR-106, Rev.1, Section 9.4, Table 9-1	See section 4.2.2 below.
Lightning/Thunderstorm	Yes	SD-WM-SAR-016, Rev.1, Section 9.4, Table 9-1	See section 4.2.3 below.
Freezing Weather	No	SD-WM-SAR-016, Rev.1, Section 9.4, Table 9-1	Caustic addition system does not increase risk or consequence over previous analysis.
Loss of Power	No	WHC-SD-WM-SEL-026, 2-5.12, Table 2-5.1 DOE/RL-90-29, Rev.0, Section 6.4.4	Caustic addition system does not increase risk or consequence over previous analysis.
Loss of Steam Supply	No	WHC-SD-WM-SEL-026, Rev.0, Table 2-5.1, 2-5.14	Caustic addition system does not increase risk or consequence over previous analysis.
Loss of Raw Water	No	WHC-SD-WM-SEL-026, Rev.0, Table 2-5.1, 2-5.13	Caustic addition system does not increase risk or consequence over previous analysis.
Loss of Compressed Air	No	WHC-SD-WM-SEL-026, Rev.0, Table 2-5.1, 2-5.11	Caustic addition system does not increase risk or consequence over previous analysis.
Loss of ALCs	No	WHC-SD-WM-SEL-026, Rev.0, Table 2-5.1.1	Caustic addition system does not increase risk or consequence over previous analysis.
Loss of Heat Trace Sensing	No	WHC-SD-WM-SEL-026, Rev.0, Table 2-5.1	Caustic addition system does not increase risk or consequence over previous analysis.
Loss of CASS	No	WHC-SD-WM-SEL-026, Rev.0, Table 2-5.10.2	Caustic addition system does not increase risk or consequence over previous analysis.
Loss of Radiological Monitoring	No	WHC-SD-WM-OSR-016, Rev.0, LCO 3.4.2 WHC-SD-WM-OSR-004, Rev.0, LCO 3.4.2, B 3.4.2 WHC-SD-WM-SEL-026, Rev.0, 205.8.4, 2-5.8.5, 2-5.8.6, 2-5.9.3, 2-5.9.5	Caustic addition system does not increase risk or consequence over previous analysis.

Table 4-1: Hazard Analysis Grid			
HAZARD	APPL.	DOCUMENTS	COMMENTS
Fire Safety	No	DOE/RL-90-39, Rev.0, Section 6.3	Caustic addition does not increase risks or consequences over previous analysis. See section 4.4.3 for Ammonia generation.
CONTAINMENT BARRIER			
Breach of Primary Tank Confinement	No	WHC-SD-WM-OSR-016, Rev.0, LCO 3.4.1, SR 3.4.1, 3.4.1.2, B 3.4.1 OSD-T-151-00007, Rev.H-5, 7.3.1.A&B, 7.3.1.C, 7.3.1.E, 7.3.2	Analyzed under "Primary Tank Leakage," see section 4.3.3 below.
Primary Ventilation Failure	No	WHC-SD-WM-SAR-052 WHC-SD-WM-SAR-016, Rev.1, Table 9-4, LCO 3.4.3, B 3.4.3 WHC-SD-WM-OSR-004, Rev.0, LCO 3.4.3, B 3.4.3 OSD-T-151-00007, Rev. H-5, 7.3.1.D WHC-SD-WM-SEL-026, Rev.0, Table 2-4.2, 2-5.3	Caustic addition system does not increase risk or consequence over previous analysis.
Primary Tank Pressurization	Yes	WHC-SD-WM-OSR-016, Rev.0, SL 2.4, B 2.4, B 3.3.1 WHC-SD-WM-SAR-016, Rev.1, 9.5 OSD-T-151-00007, Rev.H-5, 7.2.5	See section 4.3.1 below.
Ground Release	Yes	SD-WM-SAR-016, Rev.1, 9.2.1.4, Tables 9-4, 9-7 & 9-8 WHC-SD-WM-SEL-026, Rev.0, pg.2-22, Appendix 6 DOE/RL-90-39, Rev.0, 9.2.1, 9.2.4, 9.2.5	See section 4.3.2 below.
Primary Tank Leakage	Yes	WHC-SD-WM-OSR-016, Rev.0, LCO 3.5.1, SR 3.5.1.1, B 3.5.1 OSD-T-151-00007, Rev.H.5, 7.2.9 WHC-SD-WM-SEL-026, Rev.0, 2-5.5.2, 2-5.6.2	See section 4.3.3 below.
Secondary Tank Leakage	No	WHC-SD-WM-OSR-016, Rev.0, LCO 3.5.2, B 3.5.2, AC5.21, B 5.23 WHC-SD-WM-OSR-004, Rev.0, LCO 3.5.2, B 3.5.2	Caustic addition system does not increase risk or consequence over previous analysis.
Level	Yes	WHC-SD-WM-OSR-016, Rev.0, SL 2.1, LCO 3.1.1, LCO 3.1.2, B 2.1 OSD-T-151-00007, Rev.H-5, 7.2.2	Caustic addition system does increase the chance of overfill, however the additional inventory anticipated is within the safety limits (see section 4.3.11 below).
Hydrostatic Load/Specific Gravity	Yes	WHC-SD-WM-OSR-016, Rev.0, AC 5.20, B 5.20 OSD-T-151-00007, Rev.H-5, 7.2.5 WHC-SD-WM-SEL-026, Rev.0, 2-5, 5.2	See section 4.3.4 below.

Table 4-1: Hazard Analysis Grid

HAZARD	APPL.	DOCUMENTS	COMMENTS
Bottom/Uplift Buckling	No	WHC-SD-WM-OSR-016, Rev.0, SL 2.3, B 2.3, LCO 3.3.1, 3.3.2, B 3.3.1, 3.3.2 OSD-T-151-00007, Rev.H-5, 7.2.2.b,c, 7.2.5.c	Caustic addition system does not increase risk or consequence over previous analysis.
Heat Loading	Yes	SD-WM-SAR-016, Rev.1, 9.4 WHC-SD-WM-OSR, Rev.0, AC 5.19, B 5.19 OSD-T-151-00007, Rev.H-5, 7.2.8	See section 4.3.5 below.
Temperature	No	WHC-SD-WM-OSR-016, Rev.0, AC 5.28, B 5.28 ISB Heat-up Cool Down Topical OSD-T-151-00007, Rev. H-5, 7.2.6, 7.2.7 WHC-SD-WM-SEL-026, Rev.0, 2-5, 5-1, 2-5.6.1	Analyzed under Heat Loading, see section 4.3.5 below.
Corrosion	Yes	WHC-SD-WM-OSR-016, Rev.0, AC 5.1.7, B 5.17, Table B 5.17-1, parts A&B OSD-T-151-00007, Rev.H-5, 7.2.1 a,b,c	See section 4.3.6 below.
General & Multiple Loads	No	RHO-C-17 DOE/RL-90-39, Rev.0	Caustic addition system does not increase risk or consequence over previous analysis.
Impact of Mixer Pump on Tank Internals	Yes	15-93-MXRPMP-102-AP	See section 4.3.8 below.
Dropped Objects	Yes	SD-HS-SAR-010, Revs. 1&2, Table 9-2 SD-WM-SAR-016, Rev.1, Table 9-2	See section 4.3.9 below.
Dome Loading	Yes	WHC-SD-WM-OSR-016, Rev.0, AC 5.22, B 5.22 WHC-SD-WM-OSR-004, Rev.0, AC 5.22, B 5.22 SD-HS-SAR-010, Rev.3, Table 5-4 OSD-T-00007, Rev.H-5, 7.2.4 OSD-T-151-00017, Rev.D-0, 17.2.5 WHC-SD-WM-ISB-001, Rev. 0	Tank dome loading is increased due to the addition of the mixer assembly, pump stand, and instrumentation, however, it does not increase risk or consequence over previous analysis. See section 4.3.12
Dome Collapse	No	SD-WM-SAR-016, Rev.1, Table 9-3	Caustic addition system does not increase risk or consequence over previous analysis
Internal Missiles	Yes	LA-UR-92-3196	See section 4.3.10 below.
Waste Transfer Hazards	No	SD-WM-SAR-016, Rev.1, Table 9-2, 11.7 WHC-SD-WM-OSR-016, Rev.0, LCO 3.6.1, 3.6.2, 3.6.3 WHC-SD-WM-OSR-004, Rev.0, LCO 3.6.1, B 3.6.1, LCO 3.6.2, B 3.6.2, LCO 3.6.3, B 3.6.3 OSD-T-151-00007, Rev.H-5, 7.2.10 WHC-SD-WM-SEL-026, Rev.0, Table 2-4.2, 2-5.2.1	Caustic addition system does not increase risk or consequence over previous analysis..

Table 4-1: Hazard Analysis Grid			
HAZARD	APPL.	DOCUMENTS	COMMENTS
Toxicological Contamination	Yes	DOE/RL-90-39, Rev.0, 6.4.3	See sections 4.5.2 and 4.5.3 below.
UNCONTROLLED CHEMICAL REACTIONS			
Criticality	Yes	ISB Criticality Topical CPS-T-149-000101 SD-SQA-CSA-20108, Rev.0 (Criticality Safety Analysis Report) WHC-SD-WM-OSR-016, Rev.0, AC-5.12, B.12, Table B5.12-1 WHC-SD-WM-SEL-026, Rev.0	See section 4.4.1 below.
Waste Compatibility	No	WHC-SD-WM-OSR-016, Rev.0, AC 5.18 WHC-SD-WM-OSR-004, Rev.0, AC-5.18	Waste transfer is not a part of caustic addition system activities.
Accumulation of Flammable Gases	Yes	WHC-SD-WM-OSR-016, Rev.0, AC 5.29, B 5.29	See section 4.4.3 below.
Organic Burn	No	ISB Topical OSD-T-151-00007, Rev.H-5, 7.2.1.D	Tank 107-AN is not a "watch list" tank and TOC concentration is below levels of concern because of the high water content of the waste.
INDUSTRIAL & RADIOLOGICAL HAZARDS			
Occupational Exposure due to Waste Transfer	No	SD-WM-SAR-016, Rev.1, Table 9-2 WHC-SD-WM-OSR-016, Rev.0, LCO 3.6.3	Waste transfer is not part of the caustic addition system activities.
Occupational Radiation Exposure	Yes	WHC-SD-WM-OSR-016, Rev.0, AC 5.13 WHC-SD-WM-OSR-004, Rev.0, AC 5.13	See section 4.5.1 below.
Industrial Accidents	No	SD-WM-SAR-016, Rev.1, Table 9-2	Caustic addition system does not increase risk or consequence over previous analysis.
Occupational Exposure to Toxic Gases	Yes	LA-UR-92-3196, App. AB and M	See section 4.5.2 below.

4.2 Hazard Analyses - Extrinsic

4.2.1 Seismic

Seismic analysis of the mixer pump assembly is necessary to the extent of showing that an earthquake will not cause damage to the tank. The critical loading on the mixer pump due to a seismic event is bending stress at the connection of the cantilevered pump support column to the mixer pump mounting flange (the assumption made in USQ Screening and Safety Evaluation 15-93-MXRPMP-102-AP, Section 3.5, for a mixer pump of very similar configuration and larger size). The evaluation presented in section 4.3.9, Dropped Object, concludes that ultimate failure of the pump support column and its resultant impact on the tank bottom will not cause damage to the tank bottom. Therefore, even if a seismic event fails the pump support column, there is no increased risk of releasing material from the tank. A further seismic evaluation is covered in WHC-SD-WM-DA-148 (Draft), *Mixer Pump Seismic Analysis*. This document states that the bending and shear stresses during seismic loading will be under the allowable limits.

During construction or decommissioning, an earthquake may provide the initiating event for a dropped mixer pump (see Section 4.3.9). An earthquake may also cause loss of electric power to the system, but this loss will stop caustic injection and mixing, thus returning the tank to its previous undisturbed state. This will not cause a situation or condition which is outside the existing safety envelope. Seismic effects on tank internals (the thermocouple tree probe, ALCs, and ALC restraints) are included in the flow stress analysis discussed in Section 4.3.8.

4.2.2 Wind/tornado

The caustic and electric skids are designed and will be procured and installed to withstand a 70 mph wind storm. Should higher winds occur, the loss of the caustic addition or electrical skid would not result in increased risk or consequences of release of material from the tank. Other major components are installed inside below-ground riser pits or in a conduit trench. Thus, operation of the system after installation will not increase the risk or consequences of releasing material from the tank.

A tornado would almost certainly damage one or both skids, and/or cause a loss of electric power to the system. Damage to the injection skid could cause a spill or leakage of caustic (see Section 4.3.2), but will also stop caustic injection and in-tank mixing. This will not cause a situation or condition which is outside the existing safety envelope.

During construction or decommissioning, a sudden windstorm or tornado may provide the initiating event for a dropped mixer pump (or other object). Micro weather patterns in this area may

allow a sudden windstorm to occur at a critical time with little warning. The dropped object hazard is discussed in section 4.3.9.

A windstorm may also cause loss of electric power to the system, but this loss will stop caustic injection and mixing. This will not cause a situation or condition which is outside the existing safety envelope.

WHC-SD-WM-ISB-001, Rev. 0, Volume 1, Section 3.4.I, page 3-104, gives several operating constraints developed for the 101-SY mitigation pump installation, and states that "All 101-SY Mitigation Test controls are generally accepted and regarded as ISB Requirements." The requirement that "Pump installation, operation, [and] removal [shall be] stopped when wind > 15 mph," is directly applicable only to the 101-SY Tank; however, it might be prudent to terminate 107-AN mixer pump installation or removal operations if there is a potential for high winds. Application of this criteria will remove any potential for equipment or personnel casualty due to wind or tornado during installation and recovery of the pump.

4.2.3 Lightning/thunderstorm

A direct lightning strike would probably damage the electrical skid or caustic pump skid, but such damage (or associated system shutdown) cannot cause a release of radioactive or hazardous material. Damage to the injection skid could cause a spill or leakage of caustic (see Section 4.3.2), but will also stop caustic injection. This will not cause a situation or condition which is outside the existing safety envelope.

WHC-SD-WM-ISB-001, Rev. 0, Volume 1, Section 3.4.I, page 3-104, gives several operating constraints developed for the 101-SY mitigation pump installation, and states that "All 101-SY Mitigation Test controls are generally accepted and regarded as ISB Requirements." One requirement in this section is that "Pump operation [shall be] precluded during thunderstorm." Application of this requirement during installation or recovery of the mixer pump will remove any potential for equipment or personnel casualty due to lightning or thunderstorm. Since the tank is not a watch list tank, and since the head of the 107-AN pump will be located below the cover blocks inside the pump pit, a direct lightning strike to the pump during mixing operations causing ignition of flammable material inside the tank is not considered creditable.

During insertion or removal of the pump, a weather watch shall be maintained. If lightning is present in an 80.5-km (50-mile) radius around the AN tank farm where the activity is being performed, the tank will be placed in a safe shutdown condition.

4.3 Hazard Analyses - Containment Barriers

4.3.1 Primary tank pressurization

The ammonia generation rate is discussed in Section 4.4.3, and is shown to be lessened by mixing and caustic addition. The operation of the mixer pump and the caustic addition will add to the existing heat load of the tank (see section 4.3.5). Using the most conservative calculations, the liquid waste temperature may rise no more than 1° F during the caustic injection (see section 4.3.5.1 and 4.3.5.2 below), this will increase the vapor pressure of water in the waste and increase the evaporation rate. The increase in temperature and associated vapor pressure increase is minimal, and well within the tank specifications.

4.3.2 Ground release (spill)

Spills and pipe leaks of the caustic solution (which is non-radioactive) are anticipated and the consequences unremarkable. The sources of potential caustic spills are at the tanker truck and caustic skid locations. The caustic may be pumped at a maximum of 15 gallons per minute at 50 psig. Leaks in the hoses transporting the caustic are another potential contamination source. Existing spill containment procedures, Hazardous Work Permits (HWPs) and Radiological Work Permits (RWPs), and WHC-SD-WM-HSP-002, Rev. 0, *Tank Farm Health and Safety Plan*, adequately address these potential occurrences. During the pre- pump installation and installation activities potential radiological contamination release to the ground is possible. Decontamination efforts during the removal of the pump may also result in contamination. The magnitude of these potential releases is small and well within the established acceptable risk criteria. The work plan and procedures will contain contingencies to readily mitigate or resolve these potential problems.

4.3.3 Primary tank leakage

The intent of the proposed activities is to minimize the probability of primary tank leakage by adjusting the OH^- molar concentration into the range which reduces the likelihood of stress-crack corrosion; retaining the tank wall integrity. Although the purpose of the caustic addition is to minimize SCC, the pump installation and operation may have adverse effects on the tank walls and dome. Sections 4.3.6, *Corrosion*, 4.3.7, *Descaling of the Walls*, 4.3.8, *Impact of the Mixer Pump on Tank Internals*, 4.3.9, *Dropped Object*, and 4.3.10, *Internal Missiles*, address potential fault modes which could impact tank integrity.

There have been some indications that stress corrosion cracking may already have occurred. The two indications were the decrease in tank level and the "malfunctioning" of the annulus continuous air monitor on 107-AN. Upon investigation it was found

that the alarming of the continuous air monitors was directly attributed to the presence of radon. If the liner was leaking, the conductivity meters would also alarm and this has not been the case. In addition, video inspection of the annulus in two separate areas has not revealed any indications of stress corrosion cracking. These investigations indicate that the 107-AN primary tank integrity has not been compromised at this time.

4.3.4 Hydrostatic load/specific gravity

The present plan calls for 49,520 gallons of 19 M caustic (SG = 1.5) to be added to the tank. This does not increase the existing total load of 1,062,600 gallons or the specific gravity (SG) beyond the recognized "safety envelope" (1,140,000 gallons, SG = 1.7).

4.3.5 Heat loading

Chemical reactions can potentially liberate large amounts of heat. The addition of the 49,520 gallons of 50:50 wt.% caustic and the operation of the 75 hp mixer pump will add heat to the tank system. This heat addition may result in exceeding tank operating specifications or in the case of the caustic addition, potentially create conditions, which with other lost safety contingencies could increase the probability of a tank bump. The potential heat addition to the tank contents by both new heat sources is not anticipated to increase the tank waste temperature by more that 0.6 °F per day (assuming the addition of one truck load of caustic per day) and is described below.

4.3.5.1 Heat loading from the caustic addition

49,520 gallons of 19 M Caustic are scheduled to be added to the tank supernate in Phase A operations. Since 4,000 gallons will be added during each caustic injection, the evaluation for caustic heat liberation will be for 4,000 gallons only. The caustic injection pump maximum flow is rated at 15 gallons per minute. Reaching the full anticipated temperature capacity will not be rapid. For the following calculations the specific heat (C_p) and specific gravity (SG) for water were used. This is a conservative assumption since this will yield temperature change values slightly higher than using SG = 1.4 of the supernate.

To calculate the expected temperature rise:

1) Determine the total amount of energy liberated from the heat of dissociation of the caustic solution assuming:

- The diluting system is composed of only water;

- All liberated energy is absorbed into the liquid waste fraction, only; and
- No energy losses from the liquid waste occur.

Then:

$$\Delta H = \Delta G \times k$$

where:

ΔG = 3.22 kcal/mole (Lange's Handbook of Chemistry)
k = moles of NaOH added
= (19 moles/L)*(4000 gal)*(3.785 L/gal)
= 2.88E+05 moles

therefore:

ΔH = 9.27E+05 kcal : Using 1 BTU = 3.968 kcal
= 2.34E+05 BTUs

2) Calculate the temperature increase associated with perfect absorption of ΔH by 9.34E+05 gallons liquid waste:

$$\Delta T = \frac{\Delta H}{m \times C_p} = \frac{\Delta H}{V_{gal} \times \frac{8.33\ Lb_m}{gal} \times SG \times C_p}$$

where:

ΔH = heat input = 2.34E+05 BTU
SG = 1.0
C_p = specific heat of water = 1.0 BTU/lb_m-°F
V_{gal} = Volume of supernate = 9.34E+05 gal

ΔT = 3.0E-02 °F

4.3.5.2 Heat loading from mixer pump operation

Heating due to pump operation may be estimated as follows:

The maximum energy output from the pump is

$$\Delta H = 75hp = 190{,}800 \frac{BTU}{hr} = 4.58x10^6 \frac{BTU}{day}$$

To find the maximum temperature increase per day, assume that:

- The pump is operated continuously and at maximum capacity.
- There is no heat loss to the ventilation system or conduction through the tank wall.
- The constant pressure specific heat C_p is that of water.
- The supernatant is the only part of the waste being heated, so that the waste volume is 9.34×10^5 gallons. This is conservative and will bound the case assuming both supernate and solids.

For these values again using the equation,

$$\Delta T = \frac{\Delta H}{(m)\,(C_p)} = \frac{\Delta H}{V_{gal} \times 8.33 \frac{Lb_m}{gal} \times SG \times C_p}$$

and ΔT equals 5.89E-01 °F/day.

4.3.6 Corrosion

LA-UR-92-3196, *A Safety Assessment for Proposed Pump Mixing Operations to Mitigate Episodic Gas Releases in Tank 241-SY-101*, section 4.5.6.1, provides a discussion of mixing effects on corrosion and erosion of the tank liner in tank 101-SY. It states that the waste will not be abrasive due to small particle size. WHC-SD-WM-ER-219 uses a waste simulant with a log normal peak particle diameter of 3 to 5 micron, and states that this "is nearly identical to the tank waste." Thus the combination of small particle size and low jet velocity (see below) indicate that erosion will not control the loss of liner thickness during mixer pump operation.

The process of caustic addition and mixing is expected to reduce tank corrosion due to SCC (since that is the project's purpose). For general corrosion, mixing should have no effect,

and caustic addition should reduce corrosion rate, thus reducing the likelihood of leaks. Studies conducted by PNL (I.M. Reynolds to Dunford) with actual tank waste indicate that the tank wall corrosion rate is < 0.001 inches per year, which is below the design specification.

4.3.7 Descaling of the walls

LA-UR-92-3196, section 4.5.6.2, shows that one potential leak path is through a fault in the primary tank sealed only with saltcake. To reduce the possibility of leakage due to descaling the walls during mixing pump operation, the 101-SY mixing pump will be operated to limit the jet velocity near the tank wall (specifically, limited to a velocity of five feet/second at five feet from the tank wall). This limit will also apply to mixing operations in tank 107-AN.

USQ Screening and Safety Evaluation 15-93-MXRPMP-102-AP, section 3.2.2, provides equations giving the velocity as a function of distance from the nozzle for a circular free jet in a stagnant medium, for both turbulent and laminar flow.

For turbulent flow, the equation is:

$$v = v_0\left(\frac{0.6D}{x}\right)$$

For laminar flow, the equation is:

$$v = v_0\left(\frac{1.44}{x+0.6D}\right)$$

WHC-SD-WM-ER-219 provides a similar equation for turbulent jet flow as follows:

$$v = \frac{0.96v_0}{0.15\frac{x}{D}+0.29}$$

where:

D = nozzle diameter, 1.5 inches
v_0 = nozzle discharge velocity, 96.2 ft/sec for 1,060 gpm flow (Service factor = 1.15)
x = jet length, 29.5 feet since the pump is located 3 feet off center of a 75-foot diameter tank.

For these values, the turbulent flow equation from USQ Screening and Safety Evaluation 15-93-MXRPMP-102-AP, yield v = 0.245 feet/second. The laminar flow equation (15-93-MXRPMP-102-AP) yields v = 4.68 feet/second. The equation from WHC-SD-WM-ER-219 yields v = 2.386 feet/second. All of these values are below 5 feet/second, and the jet is thus within the safety envelope calculated for the 101-SY pump.

4.3.8 Impact of mixer pump on tank internals

During the operation of the mixer pump, all of the internal components located within the jet flow path, will be subjected to jet loads. A structural analysis of in-tank components was performed to check the adequacy of the internal equipment for jet impingement loads and reported in WHC-SD-WM-ANAL-018, Rev. 0. The thermocouple tree probe, the ALC, and the ALC restraints were analyzed for normal and extreme loading conditions. Normal loading conditions for the in-tank equipment include the dead weight of the components and fluid drag loads induced on the equipment by fluid circulating during pump operation. Extreme loading conditions include waste sloshing and the design basis earthquake. The thermocouple tree probe was also analyzed for fatigue damage due to flow induced vibration and vortex shedding since it will be subject to cyclic loads caused by startup, shutdown, operation, and rotation of the mixing pump.

The static stresses in the thermocouple tree probe, fully submerged in the waste meet the allowable limits for normal pump loading conditions of 10.45, 4.40, 2.20 and 2.0 lbf concentrated load at the end of the thermocouple tree (0-, 2.5-, 5-, and 7-degree nozzle jet offset impingement angles respectively). The maximum allowable deflection under normal pump operations, based on American Institute of Steel Construction (AISC) criteria, is 60 inches at the free end of the thermocouple probe (TCP) or 14.3 inches at the surface of the waste. The stresses and deflections, based on the AISC criteria, are valid only for flow induced vibrations outside the resonance frequency bands.

The results shown in WHC-SD-WM-ANAL-018 of the analysis of flow-induced vibration of the TCP indicates that at 2.5- (contacts riser) or 5- and 7-deg. (does not contact riser) impingement angles, the TCP should not experience resonance "lock-in." However, at 0-deg. (contacts riser) impingement angle, the TCP may be excited in the third mode of vibration. The fatigue analysis

indicates that, when the TCP remains outside the resonance "lock-in" frequency bands, the TCP can withstand many years of pump operations. Within the third resonance "lock-in" band, the total mixing pump run time for the 0-deg. impingement angle is 245 hours during which time the TCP could accumulate 1.0×10^6 cycles before the TCP fails in fatigue. The flow-induced vibration analysis for the TCP was based on a maximum projected nozzle velocity of 96 ft/sec.

The thermocouple probe was found to be structurally adequate for the pump-induced hydraulic loads predicted by Chang (1993) under the following recommended conditions.

- The nozzle jet is excluded from a 10-degree sector around the TCP (5-degree jet impingement angle).

- The nozzle jet is at the vertical position of 9 inches from the bottom of the tank.

- During mixing pump operation, when either of the nozzles is within the 10-deg. exclusion zone, the jet exit velocity should be between 32 and 49 ft/sec (0-deg. impingement) and 49 and 75 ft/sec (2.5-deg. impingement) so that the probe does not experience resonance or contact the riser during mixing pump operations. Outside the 10-deg. exclusion zone the pump can operate at the maximum nozzle exit velocity of 96 ft/sec and at a minimum of 70 and 74 ft/sec for 5- and 7-deg. impingement angles, respectively.

- During the transit period, the time to reach steady-state should be short and pass through the first and second mode resonant bands quickly.

The ALCs and their horizontal restraints were analyzed in WHC-SD-WM-ANAL-018, Rev. 0, and it was determined that they are structurally adequate for the normal operating loads predicted and for the extreme load condition. Their fatigue life is predicted to be greater than 20 years. The in-tank camera system will not be affected by mixer pump operations since it is located above the surface of the liquid.

The densitometers will not be effected by the operation of the pump since they will be retracted during pumping operations

4.3.9 Dropped object

During installation of the pump, there is a possibility of dropping the pump assembly. If the pump is dropped while orientated vertically over the riser, the first contact would be the pump flange contacting the pump stand. If the stand or flange fails, the pump would contact the top of the riser which must also fail if the pump were to contact the bottom of the tank. Multiple

failures of the flange, stand and pump housing and riser would have to occur to incur damage to the tank liner.

As further mitigation the lift is being treated as a critical lift. The procedures will duplicate those utilized during the pump run-in trials of August 1993 and will comply with DOE-RL-92-86, Hoisting an Rigging Procedures.

USQ Screening and Safety Evaluation 15-93-MXRPMP-102-AP, section 3.5, and LA-UR-92-3196 discuss the failure of the pump support column, allowing the mixer pump to drop to the tank bottom. Both references show that this impact will not cause damage to the tank bottom. Since the caustic addition mixer pump weighs less than these pumps and the AN-107 mixer pump is being installed in the same location with respect to the tank, the analyses in 15-93-MXRPMP-102-AP and LA-UR-92-3196 cover mixer pump operation for this casualty.

4.3.10 Internal missiles

USQ Screening and Safety Evaluation 15-93-MXRPMP-102-AP and LA-UR-92-3196 both contain extensive analyses of failures that could cause high energy fragments inside tanks 102-AP and 101-SY, and conclude that these failures will not cause release of material or breach of the primary tank. These analyses cover the caustic addition mixing pump, since:

1) The pump is physically the same as those in tanks 101-SY and 102-AP, and thus would be susceptible to the same failure modes and equipment.

2) The pump is operating at half the energy as those in 101-SY and 102-AP (75 hp vs. 150 hp), and thus has less energy available to propel missiles.

4.3.11 Tank Level

The addition of 49,520 gallons of 19 M caustic will not exceed the 1,140,000 gallon capacity of Tank 107-AN. The current inventory is 1,066,000 gallons and the space available is 74,000 gallons (see WHC-EP-0182-68).

4.3.12 Dome Loading

The weight of the mixer pump assembly, pump stand, camera system, and ancillary equipment will total less than 10,000 pounds on the dome of the tank. The electrical and caustic addition skids will be located in an area off of the tank dome. WHC-SD-WM-ISB-001 states that the live load design of the DSTs is 40 pounds per square foot uniform loading with 50 tons concentrated load at the apex of the dome (worst case). Standing Order 94-13, Rev.4,

July 8, 1994, requires that prior to initiation of any project, a corrected analysis of the tank loading must be established to insure that dome loading for the double-shell tanks will be within design limits.

4.4 Hazard Analyses - Uncontrolled Chemical Reactions

4.4.1 Criticality

The most current waste analysis for 107-AN contains a maximum supernatant concentration of 0.035 μCi/ml for ^{239}Pu (see section 2.5.7). Using this maximum supernatant concentration, up to 2 kg (Specific activity ^{239}Pu = 2.27 E+9 Bq/g) of fissile material may be present (assuming 930,000 gallons of supernatant waste). The concentrations of ^{239}Pu in sludge may be estimated from a Rockwell International Internal Letter No. 65453-85-053 titled, *Characterization of Complexant Concentrate Solids from Tanks 107-AN, 102-AN, and 101-AY.* Using a reported concentration value for ^{239}Pu of 0.312 μCi/g, a maximum of 4.5 kg of plutonium would be present in the 107-AN sludge (assuming 134,000 gallons). The current recommended inventory for Tank 107-AN based on this reference and the 1993 supernate samples is 6.5 kg, with 2 kg in the supernatant liquid and 4.5 kg in the sludge. Estimated sludge and supernatant concentrations are 8.9E-03 g/L and 5.6E-04 g/L respectively. This 6.5 kg inventory estimate is well below the 50 kg criticality prevention specification. This alone does not necessarily preclude potential criticality.

Three conditions must be satisfied for criticality to occur:

1) A minimum critical mass must be present

2) There must be sufficient concentration of fissile material present

3) The geometry of the fissile material must be favorable.

The ^{239}Pu minimum critical mass is approximately 520 g, the minimum plutonium concentration must be 2.6 g/L, the solids/Pu mass ratio must be less than 476, the neutronic velocities must be optimal for the fission cross-sections of the fissile materials, and the shape of the material optimum to prevent neutron leakage and maximize neutron reflection to optimize the conditions necessary for criticality. The tank is also hostile for criticality by being in an "over" moderated state. Only the critical mass requirement is met for 107-AN. Additionally, the tank waste contains materials which poison or absorb neutrons, further limiting criticality. A few of these common tank waste materials are uranium, iron, manganese, chromium, nickel in the solid fraction and aluminum, sodium, and nitrate in the liquid

fraction. The mass ratio of the soluble neutron poisons to fissile material for each entity is within the subcritical range.

Assuming the maximum value for the solid fraction of 4.5 kg implies a concentration of 0.009 g/L, well below the minimum concentration required for criticality. The sole remaining uncertainty exists as to whether or not the action of the mixer pump and addition of the caustic would change any of the above parameters in favor of criticality. The operation of the mixer pump should only redistribute any settled solids into the liquid fraction of the waste and thereby further reduce the fissile material concentration of the solids.

4.4.2 Solids precipitation from caustic addition

Laboratory studies (I.M. 12110-PCL93-043 and I.M. 12110-PCL93-100) have been performed to ascertain whether any undesired solid precipitation may occur from the caustic addition. Three unfavorable results which could hypothetically occur would be:

1) A large amount of solids could precipitate out of solution over the course of the waste mixing and potentially clog the pump intakes; or

2) Radionuclide solubilities could be seriously affected which could either increase the amount of fissile material in the solids or could substantially increase the heat generation rate of the solids--potentially impacting temperature LCOs; or

3) Chemical reactivities may ensue, and if so, do they adversely affect the waste environment.

Microscopic analysis indicate that the average precipitate is 1-2 microns in diameter (I.M. 1211-PCL93-100). The pump specifications state that the pump could move solids up to 2 inches in diameter. The precipitation has been demonstrate to occur slowly, and may not settle at all during the mixing operation; remaining suspended in the slurry as a result of the pumping action (950 gallons per minute).

Solubility studies and precipitate analyses have shown that the total alpha concentration of the supernate decreases by up to 11% (I.M. 12110-PCL93-043) (The solid precipitate is enriched in fissile content.). This does not pose any additional criticality potential, because the maximum assumed fissile solid content is 0.02 g/L, two orders-of-magnitude below the LCO, and the precipitate is greatly enriched in manganese, a neutron absorber.

The fact that the precipitate is enriched in manganese (Mn), does not imply that a reactivity problem exist. The wt.% Mn is

0.538. Regardless of the chemical form of Mn, chemical reactivity will not merit additional concern.

4.4.3 Accumulation of flammable gases - Ammonia Evolution

Ammonia concentrations potentially present a two fold problem:

1) Ammonia vapors are highly toxic; and

2) Ammonia, although considered a NFPA flammable gas (LEL for Ammonia = 15 vol%), is not readily flammable (requires a large heat input), but may represent an explosion hazard in confined spaces and will support combustion; this possibly can create a flammable environment in the presence of other flammable gases which are below the lower explosion limit for the ammonia free mixture.

Concentrations of ammonia at 13,000 ppm have been measured during 101-SY "gas release events" (GRE). This suggests that the potential for ammonia evolution from waste solution in other tanks may also occur. It has been queried as to whether during mixer pump operations and caustic addition, significant ammonia will evolve from solution. The primary mechanism for release would come from the ammonia trapped in the sludge at the lower region of the tank. When the mixer pump is initially turned on, the mixing would mix the sludge into the supernate and the ammonia would be released. Although a continuing release of ammonia above OSHA occupational exposure limits is considered unlikely, it would be prudent to implement some measure of control during initial mixer operations until the ammonia in the supernate and sludge has been adequately mixed and an equilibrium of ammonia production and release established. It is recommended that the requirements for monitoring and respiratory protection of WHC-SD-WM-HSP-002, *Health and Safety Plan*, Rev. 1B, be imposed to ensure worker safety during initial start-up of the mixing operations and until the resulting released gases are sampled and it is demonstrated that ammonia levels are below OSHA limits. A significant release of ammonia does not appear to be probable for 107-AN, for the following reasons:

1) 107-AN does not experience GRE for any gas or vapors.

2) Ammonia most likely exists as dissolved free ammonia NH_3 or as ammonium hydroxide (NH_4OH);

3) The addition of caustic to the waste solution should increase the concentration of ammonium hydroxide by scavenging free ammonia and any ammonium ions in solution.

4) Ammonia has a vapor pressure in aqueous solutions of 400 mmHg @ 45° C and 1 atm (at the slightly negative pressure of the tank environment, the vapor pressure would be slightly higher). The tank waste supernatant solution is more representative of a brine and the entire system much more complex. Competing chemical modalities for ammonia and ammonium compounds, coupled with the free ammonia propensity to form hydroxides and salts suggests that the ammonia vapor pressure in tank waste supernatant would be less. With the high vapor pressure of ammonia and its specific gravity of 0.59 concentrations should readily be measurable in either the tank dome space or in the ventilation system prior to stack discharge (analytic sensitivities are well below the exposure limits).

5) The even temperature profile that exists in AN-107 suggests that the supernate is evenly mixed. There is no layer or crust to trap the gases as exists in some tanks. The approximately 80 inch layer of sludge that exists at the bottom of the tank could possibly contain some ammonia that would be released when mixer operations begin.

Three "watch list" tanks share a common ventilation system with 107-AN. As such, another concern which is addressed is the possibility of reaching the LEL of a mixture of H_2 and ammonia if the tanks 103-, 104-, and 105-AN were to simultaneous undergo a GRE and back vent hydrogen gas and ammonia into the vapor space of 107-AN (Additional gases may also be present which could act as oxidizers and fuels: nitrous oxide, methane and an unknown plethora of hydrocarbons).

Although these tanks are known to undergo GREs, they occur much less frequently and are much reduced in overall magnitude compared with 101-SY surface level changes, pressure increases and hydrogen gas concentration (The reader is referred to tables 1 & 2 of *Evaluation of 241-AN Tank Farm Flammable Gas Behavior*, WHC-EP-0717, D.A. Reynolds, January 1994).

4.5 Hazard Analysis - Industrial and Radiological

4.5.1 Occupational radiation exposure

Potential radiation exposure or radioactive intakes are excepted (and accepted) risks whenever working with radioactive materials. The overriding principle governing the potential for incurring risks from ionizing radiation is "as low as reasonably achievable" (ALARA). To ensure that exposures and intakes are kept to a minimum, ALARA fundamentals are engineered into any job plan. The WHC Radiological Control Manual (WHC-CM-1-6) and the WHC ALARA Program Manual (WHC-CM-4-11) provide the guidance

necessary to ensure that ALARA is an integral part of any operation performed on the Hanford Site. Several pre-existing radiological work permits (RWPs) cover the routine tank farm operations. Since the installation of the mixer pump and associated equipment are non-routine, special RWPs may be required to provide additional limitations for these specific jobs. All aspects including the riser shielding plug and pump decontamination are adequately addressed in previous analyses.

4.5.2 Occupational exposure to toxic gases

Chemical species characterization, particularly of volatile organic compounds is not well characterized, or understood in Hanford waste tanks. Specific exposure criteria for substances with potential toxicological implications is not established at Hanford. Routine operations will be conducted using the guidelines contained in WHC-SD-WM-HSP-002, Rev.0, July 1993, to ensure compliance with WHC procedures, DOE Orders, 29 CFR 1910 (OSHA) and WISHA.

For unusual occurrences, it has been decided that ERPG-3 or IDLH will be the governing on-site exposure criteria, and ERPG-1 or the PEL-STEL will be the governing off-site criteria. Evaluating (with field measurements) these concentrations requires specific knowledge of the substance(s) of immediate concern. To address the organic exposure concerns, an approach has been adopted which measures hydrocarbons non-specifically and provides for a nominal 1 ppm exposure limit during normal operations. Minimizing exposure through ALARA principles predominate the philosophies throughout the development of the specific work plans and procedures for the proposed tasks.

4.5.2.1 Ammonia

Ammonia (NH_3) is a very highly corrosive and toxic gas which is usually encountered in industry as a liquid gas contained under moderate pressures. Because it is usually stored as a liquid under pressure, it is readily dispersable when depressurized and poses an acute exposure hazard. Ammonia is listed in 40 CFR 302.4, *List of Hazardous Substances and Reportable Quantities*, and is also listed in 40 CFR 355, Appendix A, *List of Extremely Hazardous Substances and Their Threshold Planning Quantities*. 40 CFR 302.4 and 40 CFR 355, Appendix A provide provisions to inform the local communities of potentially harmful inventories of hazardous substances stored by industry and for the industry and the community to work cooperatively to develop plans for emergencies when inventories exceed the "threshold planning quantity." It is impossible, at present, to characterize a precise inventory of ammonia in Hanford waste tanks and precautions are merited on "watch list" tanks experiencing GREs.

The ammonia generation for Hanford waste tanks is not well understood, but appears to be associated with gas release events (LA-UR-92-3196). Tanks which experience GREs are on "watch lists," so that tank encroachments are well planned and appropriate precautions exercised. Tank 107-AN is not on a "watch list," and does not experience GREs. Table 4-2 lists some important physical properties and regulatory information regarding ammonia.

Table 4-2: Ammonia

CAS #	7664-41-7
Mol. wt.	17.0
Vapor Density	0.59 @ 0 C
Vapor pressure in solution	400 mmHg @ 45 C
LEL	15%
Solubility @ 1 atm.	34%
Reportable Quantity	100 lbs
Threshold Planning Quantity	500 lbs
OSHA PEL 8-Hr (n/a)	35 ppm (27 mg/m^3) STEL
NIOSH IDLH	500 ppm (385 mg/m^3)
ERPG-1	25 ppm (18 mg/m^3)
ERPG-2	200 ppm (153 mg/m^3)
ERPG-3	1000 ppm (769 mg/m^3)

Ammonia is a colorless irritant gas, with an acrid odor. The odor threshold is in the range of 5 to 53 ppm, beginning well below exposure limits (providing early warning properties). It attacks the mucous membranes and upper bronchiole passages of the respiratory system; particularly sensitive are the eyes. Severe exposures can lead to death through pulmonary edema.

For the reasons described in Section 4.4.3, the ammonia generation due to caustic addition should not evolve enough ammonia vapor to exceed the existing accepted risk levels encountered for occupational exposure.

4.5.3 Occupational exposure to caustic

Caustic solutions can be very corrosive. This is why sodium hydroxide is on the list contained in 40 CFR 302.4 as a hazardous substance. A 19 M aqueous sodium hydroxide is very corrosive and as such presents an acute contact and respiratory hazard (as aerosol). This means that the caustic must not come into direct contact with skin, mucous membranes (and eyes) and respiratory

epithelium. This contact precipitates burning and eventual severe scarring of the exposed regions. The anti-inflammatory responses to the caustic assault causes the majority of the symptomologies.

The physical characteristic that the caustic is a dissolved solid without vapor pressure in solution greatly reduces the exposure risks when utilizing caustic solutions. This means that without direct contact with the solution or without a mechanical means (natural or anthropogenic) to produce an aerosol, exposures cannot occur. It is this fact that excludes sodium hydroxide from 40 CFR 355 App A, which require specific emergency planning when inventories exceed established thresholds (water will evaporate from solution while the solid sodium hydroxide remains).

Some physical properties and exposure limits are presented in Table 4-3 below.

Table 4-3: Caustic (Sodium Hydroxide)	
CAS #	1310-73-2
Mol. wt.	40.0
SG (of the solid)	2.13
Solubility	111%
Strength	19 M (50:50 wt.)
Amount	4000 gallons
Reportable quantity	1000 lbs
OSHA PEL 8-Hr (n/a)	2 mg/m^3 C
NIOSH IDLH	250 mg/m^3
ERPG-1*	2 mg/m^3
ERPG-2*	40 mg/m^3
ERPG-3*	100 mg/m^3

* ERPG values are "draft" only, and are used by DOE and various contractor organizations for planning purposes (ERPGs for sodium hydroxide may be inappropriate based on physical properties and routes of exposure.).

5.0 CONTROLS AND MITIGATING FEATURES

There are interlocks required on the mixer pump which will automatically shut the caustic addition pump down in the event of mechanical or electrical failure of the mixer pump. This is required because of the uncertainty of the affect of adding caustic directly with no mixing occurring. The localized heating that may occur has not been analyzed. The interlocks assure that this

will not take place. With both the mixer pump and the caustic addition pump shut down, there are no safety concerns.

Operating procedures and automatic indexing control will prevent the mixing pump jet from discharging within the thermocouple tree probe 10° area of exclusion at full pump speed. The thermocouple tree will also be monitored by the in-tank camera and remote monitor that is equipped with a grid to determine deflection of the tree during mixer pump operations. These features and actions will prevent possible fatigue of the thermocouple tree probe.

5.1 TSR/OSR Considerations

The installation, operation, and removal of the mixer pump and supporting equipment does not reduce any margin of safety previously analyzed in safety documentation and is adequately covered under existing technical safety requirements/operational safety requirements (TSRs/OSRs). There is presently no anticipated changes or additions to existing TSRs/OSRs anticipated.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The descriptions and hazard identification and analyses support the results that the existing documentation and the risks described adequately address the proposed activities and are within the present safety envelope. Previous reviews and analyses of mixer pump installations and operations within the Tank Farms have provided similar favorable results. The operations and activities that are unique to this particular mixing pump and caustic addition installation and operation have been analyzed and addressed in this evaluation and present no further risk than has been bounded by the present safety envelope.

The USQ Evaluation is favorable (all "no" answers); the mixer pump installation, operation and caustic addition is not an "Unreviewed Safety Question".

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Appendix A: Mixer Pump Installation and Caustic Addition SEL

A1.0 INTRODUCTION A-1
A1.1 Background A-1
A1.2 Purpose and scope A-1
A1.3 Basis of analysis A-2

A2.0 METHODOLOGY A-2
A2.1 Safety classification criteria A-2
A2.2 Safety system classification methodology A-3

A3.0 GENERAL PROJECT DESCRIPTION A-3
A3.1 Mixer pump assembly and pump pit A-3
A3.2 Caustic injection pump and skid A-4
A3.3 Electrical skid A-4
A3.4 Camera system A-4
A3.5 Enraf densitometer A-5

TABLE A-1: TANK CAMERA ASSEMBLY SEL A-6
TABLE A-2: CAUSTIC ADDITION SEL A-7
TABLE A-3: MIXER PUMP ASSEMBLY SEL A-11
TABLE A-4: DENSITOMETER SEL A-14
TABLE A-5: ELECTRICAL SKID SEL A-15

FIGURE A2-1: METHODOLOGY A-3

A1.0 INTRODUCTION

A1.1 Background

Analytical studies prepared for the 241-AN-107, (107-AN), waste tank indicate that the free hydroxide ion (OH^-) concentration is not within the operating parameters as specified by OSD-T-151-00007, "Operating Specifications for 241-AN, AP, AW, AY, AZ, and SY Tank Farms." The acceptable operating range of the OH^- concentration (>0.30 M) is required in order to prevent stress-corrosion cracking (SCC). The susceptible component for the waste tank is the primary tank wall, a safety class "1" item in accordance with WHC-SD-WM-SEL-026, Double Shell Tank Interim Safety Equipment List, Table G-1.

This temporary process is to include the addition of approximately 49,520 gallons of 19 M aqueous caustic (sodium hydroxide) solution into tank 107-AN. This will raise the OH^- concentration to within operating parameters thus minimizing the potential for environmental risks. Homogeneous mixing of the caustic solution will be accomplished with the installation of a 75 HP rotating submersible mixer pump and a 15 GPM positive displacement caustic addition pump. Visual monitoring of the mixing operations will be provided through the installation of a video camera system, and a pair of densitometers will be employed to monitor the degree of mixing.

Components that are not identified in Table A-1 of this document, but comprise part of the mixing pump installation and caustic addition process, were determined to be nonsafety class 4.

A1.2 Purpose and scope

The purpose of this safety equipment list (SEL) is to provide safety classifications of items (systems, structures, equipment, components, and parts) that provide a safety function and are to be used within the 107-AN mixer pump installation and caustic addition project.

The list of those systems and equipment items that were considered in this safety classification process are identified in Table A-1 of this document.

The pertinent documents that address safety classification are:

1. WHC-CM-1-3, Management Requirements and Procedures, Section MRP 5.46, "*Safety Classification of Systems, Components, and Structures*" (WHC 1991a).

2. WHC-CM-4-46, Assigning Safety Classes to Systems, Structures, and Components, Section 9.0, "*Safety Analysis Manual*" (7/25/94).

A1.3 Basis of analysis

The safety classification of an item is based upon the safety function it performs as well as the consequences if it fails. This was determined through the review of the following:

1. Engineering Drawings

   a. H-2-85259 sheets 1 through 19

   b. ECN 702912 sheets 1 through 39

   c. A14343-201

   d. A14343-501

   e. H-2-85261

   f. H-2-85264

   g. Manufacturer provided drawings where WHC drawings were unavailable

2. Engineering judgement and other pertinent references listed within the body of this report.

A2.0 METHODOLOGY

This chapter describes the criteria and methodology that were used to develop the SEL safety classifications.

A2.1 Safety classification criteria

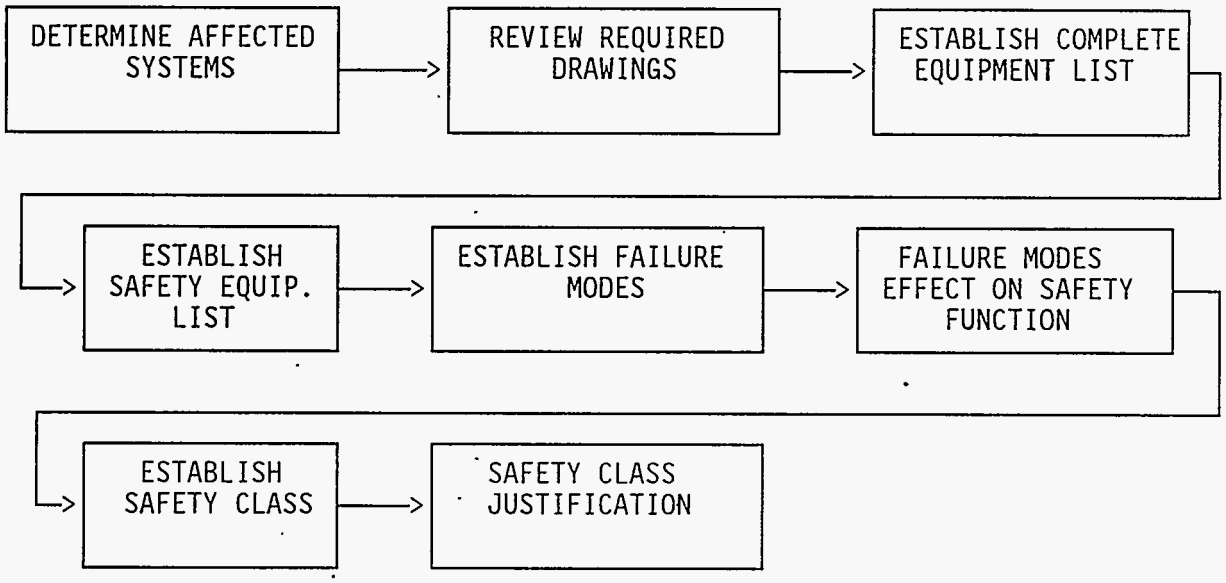
The 107-AN mixer pump installation and caustic addition systems and equipment are classified on the basis of the safety function they perform and the consequences of their failure to perform that safety function in relation to *Safety Classification of Systems, Components, and Structures* (WHC 1991a).

If more than one possible scenario could be developed for a system, the scenario with the worst case consequence was used to determine the safety class. Predominant scenarios involved in this process were a seismic event resulting in major structural and system damage, and mechanical and/or electrical failure of equipment resulting in the inability of the equipment to perform its safety function. For all safety class analyses, it was assumed that no operator action occured.

A2.2 Safety system classification methodology

Figure A2-1 illustrates the logic path used to determine the safety classifications of the 107-AN mixer pump installation and caustic addition.

FIGURE A2-1: METHODOLOGY



A3.0 GENERAL PROJECT DESCRIPTION

A3.1 Mixer pump assembly and pump pit

The mixer pump is a 75 horsepower Hazelton model 5N SSB. The maximum flow rate of the pump is 950 gallons per minute at a discharge pressure of 115.5 feet of head. The submerged pump has two opposing nozzles with exit streams parallel to the tank bottom that will produce mixing within the waste material. The pump assembly will be installed in riser WST-RIS-126G, at approximately three feet from the tank centerline.

The pump will not be rotated continuously during mixing operations, but will be operated at a specific angle for a specified period of time. This rotation will be accomplished via a 1 horsepower, 1200 RPM rotation motor. The rotation motor will, through gearing, rotate the mixer pump through 166° which will provide 332° of coverage. The rotation motor and gearing will be installed on the pump adaptor flange within the pump pit.

Two limit switches will be installed on the index gearing in the pump pit. The limit switches will prevent excessive mixer pump rotation during mixer pump operations which could result in failure, beneath the pump flange, of the flexible hose containing caustic solution.

Power terminal box, TB-2, will be installed in the pump pit. This will provide 480 VAC to the mixer pump motor via DS-AN-001. Instrumentation terminal box, TB-1, will also be installed in the pump pit. This will provide power terminal blocks for the mixer pump monitoring elements. These elements, which monitor vibration, motor stator temperature, motor moisture, and unbalanced column loads, are included as part of the pump assembly.

A3.2 Caustic injection pump and skid

The injection pump is a positive displacement pump with a 480 V, 3 phase, 60 hertz motor. It has a rating of 15 gpm at 50 PSI, when pumping a caustic solution with a 1.5 specific gravity and a fluid viscosity of 25 Centipoise. The pump system and skid also includes a motor speed control unit, vibration isolation for rotating equipment, and pump instrumentation. Pump instrumentation includes, but is not limited to; flowmeter, temperature sensor, pressure detector, leak detector, and alarms.

The skid supports and protects the caustic injection pump, control valves, and piping. The skid structure consists of support elements, a drain pan, and a roof.

A3.3 Electrical skid

Power, controls, circuit breakers, and interlocks for the mixer pump, the caustic injection pump, and associated instrumentation will be provided from the electrical skid.

Monitoring instrumentation will allow the operator the ability to monitor the following data; pump motor cavity moisture, pump motor stator winding temperature, pump motor vibration, and pump column unbalanced loads.

A3.4 Camera system

The in-tank assembly will consist of a single frame with a remotely controllable camera, remotely controllable pan-and-tilt unit, and remotely controllable lights. The camera will be capable of full tank monitoring. The video camera display will have a grid which will allow the operator to measure the deflection of the thermocouple tree during mixer pump operations.

The thermocouple tree probe is a 55 foot long, two inch diameter Schedule 40 carbon steel (ASTM A-106 Grade B) pipe and is listed as an IOSR safety class item in accordance with WHC-SD-WM-SEL-026, Rev. 1. The thermocouple tree probe has external threads at the location of the riser flange and the end of the thermocouple tree probe is 1 foot above the floor of the tank. It is installed through riser WST-RIS-106G at a radial

distance of 20 feet from the center of the tank.

Camera system controls are located both locally and remotely. The local controls will be contained in a cabinet near riser WST-RIS-111G. The remote controls, video monitors, and video tape recorders will be located in the electrical control skid.

A3.5 Enraf densitometer

Two Enraf-Nonius Model 854 Advanced Technology Gauges will be utilized as density measuring devices. The densitometers will be used to measure the mixing effectiveness of the mixing pump by measuring the density of the waste and sludge within the tank in order to define areas of possible stratification. The output of the equipment will be monitored in the 241-AN-271 Instrument building.

TABLE A-1: TANK CAMERA ASSEMBLY SEL

IDENTIFICATION	SAFETY FUNCTION	SAFETY CLASS	SAFETY CLASS JUSTIFICATION
SYSTEM: TANK CAMERA ASSEMBLY STRUCTURE: EQUIPMENT: COMPONENT:	FULL TANK MONITORING AS WELL AS MEASURING THERMOCOUPLE TREE PROBE DEFLECTION DURING MIXER OPERATIONS	3	FAILURE OF ANY EQUIPMENT LISTED BELOW WOULD REQUIRE BREAKING CONTAINMENT IN ORDER TO REPAIR/REPLACE THE EQUIPMENT. THIS COULD POSSIBLY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS. WHC-CM-4-46 TABLE 1 CRITERION 3

THE ITEMS THAT ARE BEING SAFETY CLASSIFIED BELOW ARE EQUIPMENT/COMPONENTS OF THE SYSTEM SHOWN ABOVE

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
RCS-521 COLOR TV CAMERA NO DRAWING	FULL TANK MONITORING AND VIDEO GRID DISPLAY TO ALLOW FOR THERMOCOUPLE TREE PROBE DEFLECTION MEASUREMENT DURING MIXER OPERATIONS	MECHANICAL/ELECTRICAL FAILURE	CAMERA WOULD NEED TO BE REPAIRED/REPLACED	REPAIR/REPLACEMENT MAY REQUIRE BREAKING CONTAINMENT LEADING TO POSSIBLY EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
PTE-300 PAN AND TILT NO DRAWING	MANEUVERING OF RCS-521 COLOR TV CAMERA	MECHANICAL/ELECTRICAL FAILURE	REPAIR/REPLACEMENT COULD BE REQUIRED	REPAIR/REPLACEMENT MAY REQUIRE BREAKING CONTAINMENT LEADING TO POSSIBLY EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
LIGHTING ARRAY NO DRAWING	PROVIDE VISUAL ILLUMINATION OF TANK OPERATIONS	MECHANICAL/ELECTRICAL FAILURE	REPAIR/REPLACEMENT COULD BE REQUIRED	REPAIR/REPLACEMENT MAY REQUIRE BREAKING CONTAINMENT LEADING TO POSSIBLY EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3

TABLE A-2: CAUSTIC ADDITION SEL

IDENTIFICATION	SAFETY FUNCTION	SAFETY CLASS	SAFETY CLASS JUSTIFICATION
SYSTEM: CAUSTIC ADDITION STRUCTURE: EQUIPMENT: COMPONENT:	PROVIDE INJECTION OF A SOLUTION OF SODIUM HYDROXIDE TO TANK 107-AN TO RAISE FREE OH ION CONCENTRATION	3	FAILURE OF ANY CAUSTIC SKID EQUIPMENT DUE TO SEISMIC EVENTS, MECHANICAL OR ELECTRICAL FAILURE WOULD REQUIRE REPAIR OR REPLACEMENT OF THE EQUIPMENT. CAUSTIC SOLUTION CLEANUP WOULD ALSO BE REQUIRED. THERE EXISTS THE POSSIBILITY FOR THE EXCEEDING OF ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6

THE ITEMS THAT ARE BEING SAFETY CLASSIFIED BELOW ARE EQUIPMENT/COMPONENTS FOR THE SYSTEM SHOWN ABOVE

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
MOYNO POSITIVE DISPLACEMENT PUMP B10 DRAWING A14343-501	PROVIDE CONTROL OF CAUSTIC SODIUM HYDROXIDE SOLUTION FLOW TO TANK 107-AN	PUMP FAILURE DUE TO MECHANICAL FAILURE	PUMP CASING FAILURE RESULTING IN THE RELEASE OF CAUSTIC SOLUTION TO THE CAUSTIC SKID	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
150 GALLON FLUSH TANK DRAWING A14343-20	WATER FLUSH SOURCE FOR CAUSTIC LINE TO PREVENT FOULING OF COMPONENTS	FAILURE OF TANK DUE TO SEISMIC EVENT	TANK CONTENTS SPILL INTO CAUSTIC SKID DRAIN PAN	NO SIGNIFICANT IMPORTANCE TO SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
10 GALLON DRAIN TANK • ISOLATION VALVE 86-105 DRAWING A14343-501	PROVIDE CAUSTIC LINE DRAIN CAPABILITY	FAILURE OF FULL DRAIN TANK DUE TO SEISMIC EVENT	DRAIN TANK CONTENTS WOULD BE DISCHARGED INTO CAUSTIC SKID DRAIN PAN	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
CAUSTIC SKID PIPING DRAWING A14343-501	PRIMARY CONTAINMENT OF SODIUM HYDROXIDE SOLUTION	FAILURE OF PIPING DUE TO SEISMIC EVENT OR MECHANICAL FAILURE	INABILITY TO PROVIDE CAUSTIC CONTAINMENT. CAUSTIC WOULD BE DISCHARGED INTO CAUSTIC SKID DRAIN PAN UNTIL CAUSTIC PUMP SHUTDOWN DUE TO LOW PRESSURE	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
FEMALE QUICK-DISCONNECT VALVE 1673AN-0200/1775D-0200 DRAWING A14343-501	PROVIDE QUICK RELEASE CAPABILITY OF FLEXIBLE LINE TO PUMP PIT	DAMAGE TO VALVE DUE TO SEISMIC EVENT OR MECHANICAL FAILURE	CAUSTIC SOLUTION DISCHARGED INTO CAUSTIC SKID DRAIN PAN	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
MALE QUICK-DISCONNECT VALVE 1673AN-0200/1775D-0200 DRAWING A14343-501	PROVIDE QUICK RELEASE CAPABILITY OF FLEXIBLE LINE TO PUMP PIT	DAMAGE TO VALVE DUE TO SEISMIC EVENT OR MECHANICAL FAILURE	CAUSTIC SOLUTION DISCHARGED INTO CAUSTIC SKID DRAIN PAN	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
BALL VALVES 86-103 THRU 86-108 DRAWING A14343-501	PROVIDE MANUAL ISOLATION OF CAUSTIC PIPING LINE	VALVES FAIL IN OPEN POSITION DUE TO MECHANICAL FAILURE	INABILITY TO ISOLATE LEAK WHICH COULD LEAD TO RELEASE OF CAUSTIC ONTO CAUSTIC SKID DRAIN PAN OR SOIL	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
PRESSURE SAFETY VALVE 71S DRAWING A14343-501	PROVIDE OVER PRESSURIZATION PROTECTION	FAILS SHUT DURING OVER PRESSURE EVENT DUE TO MECHANICAL FAILURE	INABILITY TO RELIEVE SYSTEM PRESSURE WHICH MAY RESULT IN BURSTING OF CHEMICAL TRANSFER HOSE OR FITTINGS TO PUMP PIT	REPAIR/REPLACEMENT AND/OR CLEANUP OF HOSE AND/OR VALVE MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
TEMPERATURE TRANSMITTER 577906-U2 1/2" DRAWING A14343-501	MONITOR CAUSTIC TEMPERATURE	FAILS TO INDICATE LOW CAUSTIC TEMPERATURE	SOLIDIFICATION OF CAUSTIC SOLUTION LEADS TO CLOGGING OF CAUSTIC LINES	MAY REQUIRE BREAKING SYSTEM BOUNDARIES IN ORDER TO CLEANUP WHC-CM-4-46 TABLE 1 CRITERION 6	3
PRESSURE DETECTOR 2279S DRAWING A14343-501	MONITOR CAUSTIC PUMP DISCHARGE PRESSURE	MECHANICAL/ ELECTRICAL FAILURE PREVENTS ABILITY OF DETECTOR TO ACCURATELY DETECT CAUSTIC PRESSURE	INABILITY TO INITIATE AUTOMATIC SHUTDOWN DUE TO HIGH OR LOW PRESSURE	LINE RUPTURE/LEAK AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
PRESSURE GAUGES 1279 DRAWING A14343-501	PROVIDE VISUAL DISPLAY OF PUMP SUCTION AND DISCHARGE PRESSURES	MECHANICAL/ ELECTRICAL FAILURE PREVENTS ABILITY TO MONITOR SYSTEM PRESSURE CHANGES	INABILITY TO VERIFY CORRECT OPERATING PRESSURE	LOSS HAS NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
FLOWMETER AM115AG-AB1-LSA-S2AHA DRAWING A14343-501	PROVIDE CAUSTIC FLOWRATE SIGNAL OUTPUT	MECHANICAL/ ELECTRICAL FAILURE PREVENTING ACCURATE DISPLAY OR COMPLETE LOSS OF INDICATION OF CAUSTIC FLOW	MIXING OPERATIONS WOULD BE REQUIRED TO CEASE IN ORDER TO REPLACE FLOWMETER	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
DRIP PAN DRAWING A14343-201	304SS, 202 GALLON PAN USED TO CONTAIN UNPLANNED RELEASES OF CAUSTIC SOLUTION WITHIN THE CAUSTIC SKID	DRAIN PAN DRAIN VALVE FAILS IN OPEN POSITION	VALVE FAILURE WOULD RESULT IN RELEASE OF CAUSTIC ONTO SOIL	CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
CHEMICAL TRANSFER HOSES 2 INCH CROSS-LINKED POLYETHYLENE HOSE, HEAT TRACED, WRAPPED IN INSULATION AND INSTALLED WITHIN A 10 mil POLYETHYLENE SLEEVE. • 2 INCH, 304SS, PIPING • BALL VALVE NO DRAWING	USED FOR PRIMARY CONTAINMENT OF CAUSTIC SOLUTION FROM TANKER TO CAUSTIC SKID AND FROM CAUSTIC SKID TO MIXER PUMP FLANGE	FAILURE DUE TO LEAK OR RUPTURE	CAUSTIC SOLUTION IS DISCHARGED ONTO SOIL	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
HEAT TRACING NO DRAWING	120 VAC, SELF REGULATING TO POWER DENSITY OF 15 WATTS PER LINEAR FOOT TO HEAT CAUSTIC LINES TO PREVENT FREEZING	ELECTRICAL FAILURE PREVENTING HEATING OF CAUSTIC LINES	SOLIDIFICATION OF CAUSTIC SOLUTION LEADS TO CLOGGING OF CAUSTIC LINES	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3
FLOAT SWITCH L4 DRAWING A14343-501	LEAK DETECTION IN CAUSTIC SKID DRIP PAN	MECHANICAL/ ELECTRICAL FAILURE PREVENTING LEAK DETECTION CAPABILITY	CAUSTIC LINE LEAK COULD POSSIBLY NOT BE DETECTED UNTIL LOW PRESSURE SIGNAL STOPS THE CAUSTIC FLOW OR DRIP PAN OVERFLOWS ONTO SOIL	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3

TABLE A-3: MIXER PUMP ASSEMBLY SEL

IDENTIFICATION	SAFETY FUNCTION	SAFETY CLASS	SAFETY CLASS JUSTIFICATION
SYSTEM: MIXER PUMP ASSEMBLY STRUCTURE: EQUIPMENT: COMPONENT:	PROVIDE HOMOGENOUS MIXING OF CAUSTIC AND WASTE	3	FAILURE OF BELOW EQUIPMENT MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3

THE ITEMS THAT ARE BEING SAFETY CLASSIFIED BELOW ARE EQUIPMENT/COMPONENTS FOR THE SYSTEM SHOWN ABOVE

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
MIXER PUMP STAND DRAWING H-2-85261 SH 1	PROVIDE MIXER PUMP INSTALLATION SUPPORT	FAILURE DUE TO SEISMIC EVENT OR MECHANICAL FAILURE	MIXER PUMP ASSEMBLY FALLS BREAKING CONTAINMENT SEAL	DUE TO A NEGATIVE PRESSURE, MINOR RELEASE TO PUMP PIT IS POSTULATED, ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS MAY BE EXCEEDED DURING REPAIR WHC-CM-4-46 TABLE 1 CRITERION 3	3
MIXER PUMP 360-75-1800(R) • MOISTURE ELEMENT F-050 • LOAD CELL USB-2K • TEMPERATURE ELEMENT SERIES 78S • VIBRATION ELEMENT M99-3 DRAWING H-2-85259 SH 14	PROVIDE HOMOGENOUS MIXING OF CAUSTIC AND WASTE DETECTS MOISTURE IN MOTOR MONITOR UNBALANCED FORCES CREATED BY NOZZLE IMBALANCE MONITOR MOTOR TEMPERATURE MONITOR VIBRATION IN MOTOR/PUMP	STOPS FUNCTIONING " " "	UNABLE TO DETECT MOISTURE IN MOTOR RESULTING IN MOTOR FAILURE UNABLE TO DETECT NOZZLE IMBALANCE UNABLE TO DETECT EXCESSIVE TEMPERATURE IN MOTOR RESULTING IN MOTOR FAILURE UNABLE TO DETECT EXCESSIVE VIBRATION WHICH COULD LEAD TO PREMATURE BEARING WEAR	REPAIR/REPLACEMENT MAY LEAD TO EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS " " " WHC-CM-4-46 TABLE 1 CRITERION 3	3 " " " "

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
ROTATION MOTOR AND ASSOCIATED SWITCHING EQUIPMENT FC145TC DRAWING H-2-85259 SH 14	ROTATE MIXER PUMP TO ALLOW FOR HOMOGENEOUS MIXING	MANUAL MODE: JOG SWITCH FAILS IN ON POSITION	EXCESSIVE ROTATION COULD RESULT IN DAMAGE TO ELECTRICAL POWER AND INSTRUMENT CABLING OR SHEARING OF THE FLEX HOSE, DISCHARGING CAUSTIC INTO TANK	REPAIR/REPLACEMENT MAY LEAD TO EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
POSITION RESOLVER SAC-RL100-M11 DRAWING H-2-85259 SH 14	REPORTS RELATIVE POSITION OF ROTATING ASSEMBLY TO POSITION CONTROLLER	INACCURATE POSITION INDICATION	PUMPING PROCESS MAY PROCEED INTO EXCLUSION ZONE RESULTING IN FATIGUE/STRESS AND POSSIBLE FAILURE OF THERMOCOUPLE TREE PROBE	REPAIR OF THERMOCOUPLE TREE PROBE MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
LIMIT SWITCHES 802T-ASP DRAWING H-2-85259 SH 14	PREVENT EXCESSIVE PUMP ASSEMBLY ROTATION	FAILURE TO PREVENT EXCESSIVE ROTATION WITH ROTATION MOTOR IN AUTOMATIC MODE	EXCESSIVE ROTATION COULD RESULT IN DAMAGE TO ELECTRIC POWER AND INSTRUMENT CABLES OR FAILURE OF FLEX HOSE RESULTING IN RELEASE OF CAUSTIC DIRECTLY TO TANK	REPAIR/REPLACEMENT MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
CHECK VALVES 232-T-2PP DRAWING H-2-85264 SH 2	PREVENT BACKFLOW OF WASTE MATERIAL INTO CAUSTIC LINE	VALVE FAILS OPEN VALVE FAILS SHUT	NO EFFECT DUE TO REDUNDANCY SYSTEM SHUTS DOWN DUE TO OVERPRESSURIZATION	HAS NO EFFECT ON SYSTEM SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
COLUMN PIPE DRAWING H-2-85264 SH 2	CONTAINS AND PROVIDES DRY ENVIRONMENT FROM WASTE MATERIAL FOR PUMP MOTOR ELECTRICAL CABLING	FAILURE DUE TO SEISMIC EVENT	FAILURE COULD RESULT IN A DROPPED PUMP ASSEMBLY	REPAIR/RETRIEVAL MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
FLEXIBLE HOSES 402H DRAWING H-2-85264 SH 1	1.5 INCH, STAINLESS STEEL HOSE USED TO: 1. DELIVER CAUSTIC SOLUTION FROM BOTTOM OF RISER TO CAUSTIC ADDITION TUBING ON COLUMN PIPE 2. WATER FLUSH LINE	FAILURE DUE TO EXCESSIVE ROTATION	RELEASE OF CAUSTIC DIRECTLY TO TANK CAUSING LOCALIZED CONCENTRATION OF CAUSTIC SOLUTION UNTIL PUMP SHUT DOWN DUE TO LOW PRESSURE OR VISUAL OBSERVATION FROM VIDEO CAMERA DISPLAY	LOCALIZED CONCENTRATION OF CAUSTIC WOULD BE TRANSITORY AND WOULD DISPERSE QUICKLY. REPAIR/REPLACEMENT MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
PUMP PIT ELECTRICAL SUPPORTS • POWER AND INSTRUMENT RACK • CABLE SUPPORT SWING ARM DRAWING H-2-85259 SH 9	PROVIDES INSTALLATION SUPPORT TO ELECTRICAL TERMINAL BOXES AND CABLING	DAMAGE DUE TO SEISMIC EVENT OR MECHANICAL FAILURE	FAILURE OF CABLE SUPPORT SWING ARM MAY RESULT IN DAMAGE TO ELECTRICAL POWER AND INSTRUMENT CABLING	NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
CHEMICAL TRANSFER HOSE CONNECTION ASSEMBLY • MALE NOZZLE H-2-90185-2 • PIPE • REDUCER • JUMPER DRAWING H-2-85264 SH 1	PROVIDES CONTAINMENT OF CAUSTIC SOLUTION FROM TOP OF PUMP ADAPTOR FLANGE TO CAUSTIC LINE TUBING WITHIN TANK	FAILURE DUE TO SEISMIC EVENT OR MECHANICAL FAILURE	CAUSTIC SPILL WITHIN PUMP PIT WHICH WOULD DRAIN INTO TANK	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 6	3

TABLE A-4: DENSITOMETER SEL

IDENTIFICATION	SAFETY FUNCTION	SAFETY CLASS	SAFETY CLASS JUSTIFICATION
SYSTEM: DENSITOMETER ASSEMBLY LOCATED WITHIN RISER PIT STRUCTURE: EQUIPMENT: COMPONENT:	MEASURE THE DENSITY OF THE LIQUID AND SLUDGE WASTES WITHIN TANK 107-AN	3	FAILURE OF THE SYSTEM OR ITS EQUIPMENT WOULD REQUIRE REPAIR OR REPLACEMENT. THIS MAY LEAD TO EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIAL DUE TO THE FACT THAT CONTAINMENT BARRIER MAY BE REQUIRED TO BE BROKEN WHC-CM-4-46 TABLE 1 CRITERION 3

THE ITEMS THAT ARE BEING SAFETY CLASSIFIED BELOW ARE EQUIPMENT/COMPONENTS FOR THE SYSTEM SHOWN ABOVE

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
DENSITOMETER ENRAF MODEL 854 NO DRAWING	MEASURE THE DENSITY OF THE LIQUID AND SLUDGE WASTES IN TANK 107-AN TO DETERMINE PRESENCE OF STRATIFICATION	MECHANICAL/ ELECTRICAL FAILURE PREVENTING DENSITY MEASUREMENT	REPAIR/REPLACEMENT COULD BE REQUIRED	REPAIR/REPLACEMENT MAY LEAD TO EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3

TABLE A-5: ELECTRICAL SKID SEL

IDENTIFICATION	SAFETY FUNCTION	SAFETY CLASS	SAFETY CLASS JUSTIFICATION
SYSTEM: ELECTRICAL SKID STRUCTURE: EQUIPMENT: COMPONENT:	PROVIDE POWER CONTROL CIRCUIT BREAKERS AND INTERLOCKS FOR THE MIXER PUMP, THE CAUSTIC INJECTION PUMP, AND ASSOCIATED INSTRUMENTATION	3	SUPPLIES ELECTRICAL POWER TO OPERATE MIXER PUMP , CAUSTIC ADDITION PUMP, AND ASSOCIATED EQUIPMENT AND INTERLOCKS. FAILURE OF KEY EQUIPMENT REQUIRING THE NEED TO BE REPAIRED OR REPLACED MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3

THE ITEMS THAT ARE BEING SAFETY CLASSIFIED BELOW ARE EQUIPMENT/COMPONENTS FOR THE SYSTEM SHOWN ABOVE

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
AIR CONDITIONER XHA173D DRAWING ECN 700439 SH19	PROVIDE HEATING AND COOLING TO ELECTRICAL SKID	MECHANICAL/ ELECTRICAL FAILURE	FAILURE MAY RESULT IN EXTREME TEMPERATURES CAUSING COMPONENT FAILURE	SYSTEM WILL SHUT DOWN INTO A SAFE MODE OF OPERATION, NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
MIXER PUMP VARIABLE SPEED DRIVE VSD-AN-001 DRAWING ECN 700439 SH 5	PROVIDE VARIABLE SPEED OPERATIONS OF MIXER PUMP WITHIN EXCLUSION ZONE	MECHANICAL/ ELECTRICAL FAILURE PREVENTING OPERATION	VSD FAILURE WOULD RESULT IN THE CEASING OF MIXING OPERATION AND CAUSTIC ADDITION DUE TO INTERLOCKS	FAILURE HAS NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
PANELBOARD DP-AN-004 DRAWING ECN 700439 SH 5	PROVIDE 480 VAC ELECTRICAL POWER TO: MIXER PUMP VSD, ROTATION MOTOR STARTER, EMERGENCY MOTOR STARTER, TBX-AN-1C, TB2, MIXER PUMP MOTOR, ROTATION MOTOR, AND CAUSTIC SKID MOTOR CONTROLLER	MECHANICAL/ ELECTRICAL FAILURE	LOSS OF POWER TO ALL EQUIPMENT, RESULTS IN SHUTDOWN OF ALL SYSTEMS	SAFE SHUTDOWN RESULTS, NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
PANELBOARD DP-AN-005 DRAWING ECN 700439 SH 5	PROVIDE 120/240 VAC ELECTRICAL POWER TO: TB-2A, TB-1A, ANNUNCIATORS, TB-1, AND TBX-AN-2C	MECHANICAL/ ELECTRICAL FAILURE	LOSS OF MIXER PUMP MONITORING CAPABILITY	LOSS OF SAFETY MONITORING ABILITY WOULD ALLOW MIXER PUMP TO FAIL IN A VARIETY OF WAYS, REPAIR/REPLACEMENT OF MIXER PUMP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
TRANSFORMER TX-AN-001 DRAWING ECN 700439 SH 8	STEP DOWN ELECTRIC POWER FROM 240/480 VAC TO 120/240 VAC TO SUPPLY DP-AN-005	MECHANICAL/ ELECTRICAL FAILURE	LOSS OF MIXER PUMP MONITORING CAPABILITY	WOULD ALLOW MIXER PUMP TO FAIL IN A VARIETY OF WAYS, REPAIR/REPLACEMENT MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
CAUSTIC SKID MOTOR DISCONNECT SWITCH DP-AN-003 DRAWING ECN 700439 SH 8	PROVIDE ELECTRIC POWER DISCONNECT CAPABILITY OF CAUSTIC SKID MOTOR	MECHANICAL/ ELECTRICAL FAILURE	LOSS OF POWER TO CAUSTIC SKID MOTOR RESULTING IN LOSS OF CAUSTIC ADDITION	FAILURE HAS NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
MIXER PUMP EMERGENCY MOTOR STARTER EMS-AN-001 DRAWING ECN 700439 SH 5	PROVIDES EMERGENCY START CAPABILITY TO MIXER PUMP MOTOR, WOULD NEED TO BE JUMPERED IN THE EVENT OF EMERGENCY	MECHANICAL/ ELECTRICAL FAILURE	FAILURE WOULD PREVENT EMERGENCY START OF MIXER PUMP IN EVENT OF VSD FAILURE	FAILURE WOULD PREVENT MIXER PUMP OPERATIONS, LEAVING SYSTEM IN SAFE SHUTDOWN MODE, NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
INSTRUMENTATION TERMINAL BOX TBX-AN-2C DRAWING H-2-85259 SH 14	PROVIDES TERMINAL BLOCKS FOR MIXER PUMP SAFETY MONITORING INSTRUMENTATION	MECHANICAL/ ELECTRICAL FAILURE	LOSS OF MIXER PUMP MONITORING ABILITY	LOSS OF SAFETY MONITORING FOR MIXER PUMP COULD ALLOW MIXER PUMP TO FAIL IN A VARIETY OF WAYS, REPAIR/REPLACEMENT MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
POWER TERMINAL BOX TBX-AN-3C DRAWING H-2-85259 SH 14	SUPPLIES POWER TO DP-AN-004 IN ELECTRICAL POWER SKID	LOSS OF POWER	LOSS OF POWER TO EMERGENCY STOP LOGIC WILL SHUTDOWN MIXER PUMP AND CEASE CAUSTIC ADDITION OPERATIONS	SHUTDOWN IS TO SAFE CONDITION, NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
POWER TERMINAL BOX TBX-AN-1C DRAWING H-2-85259 SH 14	PROVIDES POWER TERMINAL BLOCKS FOR MIXER PUMP	MECHANICAL/ ELECTRICAL FAILURE	FAILURE WILL RESULT IN CEASING OF MIXING AND CAUSTIC ADDITION OPERATIONS DUE TO INTERLOCKS	FAILURE HAS NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
MIXER PUMP EMERGENCY STOP VSD-AN-001 DRAWING ECN 700439 SH 5	PROVIDES EMERGENCY STOP CAPABILITY TO MIXER PUMP	MECHANICAL/ ELECTRICAL FAILURE	LOSS OF POWER TO EMERGENCY STOP LOGIC WILL SHUT DOWN MIXER PUMP AND CEASE CAUSTIC ADDITION DUE TO INTERLOCKS	SHUTDOWN IS TO SAFE MODE, NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-CM-4-46 TABLE 1 CRITERION 25	4
MIXER PUMP POSITION CONTROLLER, PRESSURE, RADIATION, AND LEAK MONITORING TB-2A DRAWING ECN 700439 SH 8	INDICATE ACTUAL POSITION OF ROTATING ASSEMBLY AND PROVIDE LOGIC TO REVERSING STARTER, PRESSURE, RADIATION, AND LEAK MONITORING	MECHANICAL/ ELECTRICAL FAILURE	ERRONEOUS INDICATION OF INDEXING OF MIXER PUMP ASSEMBLY MAY LEAD TO POSSIBLE DAMAGE TO THERMOCOUPLE TREE PROBE	REPAIR/REPLACEMENT OF THERMOCOUPLE TREE PROBE MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
MIXER PUMP INSTRUMENT ENCLOSURE ASSEMBLY TB-1A DRAWING ECN 700439 SH 8	ENCLOSURE FOR MIXER PUMP INSTRUMENT TRANSMITTERS AND POWER SUPPLY	MECHANICAL/ ELECTRICAL FAILURE	LOSS OF MIXER PUMP MONITORING ABILITY	LOSS OF SAFETY MONITORING FOR MIXER PUMP COULD ALLOW MIXER PUMP TO FAIL IN A VARIETY OF WAYS, REPAIR/REPLACEMENT MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3
ANNUNCIATORS • ANN-001 • ANN-002 DRAWING H-2-85259 SH 11	PROVIDE VISUAL AND AUDIBLE SIGNALS TO INDICATE TROUBLE CONDITION	MECHANICAL/ ELECTRICAL FAILURE	LOSS OF VISUAL AND AUDIBLE PROBLEM INDICATION	FAILURE WILL HAVE NO EFFECT ON SAFETY, HEALTH, OR ENVIRONMENTAL PROTECTION WHC-4-46 TABLE 1 CRITERION 25	4
ELECTRIC POWER INTERFACES AND ASSOCIATED CABLING • CAMERA POWER • CAMERA CONTROL • CAMERA INSTRUMENTATION • CAUSTIC SKID INSTRUMENTATION • CAUSTIC SKID 120 VAC • CAUSTIC SKID 2 HP MOTOR DRAWING H-2-85259 SH 4	PROVIDE ELECTRIC POWER AND ELECTRIC POWER CONNECTIONS TO LISTED EQUIPMENT	MECHANICAL/ELECTRICAL FAILURE	FAILURE RESULTING IN LOSS OF CAUSTIC ADDITION SYSTEM MONITORING ABILITY WHICH MAY LEAD TO AN OVERPRESSURIZATION EVENT BURSTING THE CAUSTIC LINE	REPAIR/REPLACEMENT AND/OR CLEANUP MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR TOXIC MATERIALS WHC-4-46 TABLE 1 CRITERION 6	3

ITEM IDENTIFICATION	SAFETY FUNCTION	ITEM FAILURE MODE	ITEM'S FAILURE EFFECT ON SYSTEM/ STRUCTURE/ EQUIPMENT/ COMPONENT SAFETY FUNCTION	ITEM SAFETY CLASSIFICATION JUSTIFICATION	ITEM SAFETY CLASS
POWER TERMINAL BOX TB-2 DRAWING H-2-85259 SH 14	SUPPLIES POWER TO MIXER PUMP	MECHANICAL/ ELECTRICAL FAILURE	FAILURE WILL PREVENT MIXER PUMP OPERATIONS	REPAIR/REPLACEMENT WILL REQUIRE LIFTING PUMP PIT COVER, THIS MAY RESULT IN EXCEEDING ALARA PRINCIPLES FOR RADIOACTIVE MATERIALS WHC-CM-4-46 TABLE 1 CRITERION 3	3

Attachment 1: Conceptual Operating Procedures

Westinghouse
Hanford Company

Internal
Memo

From: Waste Tank Plant Engineering WTPE-94-046
Phone: 373-6365 R1-51
Date: July 13, 1994
Subject: DRAFT OPERATING PROCEDURES FOR CAUSTIC ADDITION TO TANK 241-AN-107

To: R. J. Van Vleet H4-63

cc: W. R. Ash S2-24
K. G. Carothers R1-51 KGC
D. B. Cole R3-27
K. O. Fein H4-63
E. C. Heubach H4-63
S. Jenkins R1-51
G. A. Leshikar S2-24
G. P. Paintner S2-24
R. E. Parazin R1-51
G. R. Sawtelle H4-63
K. A. White R2-70
RER:SJ File/LB

The waste stored in Tank 241-AN-107 does not meet tank farm composition operating specifications for hydroxide ion (OH^-) concentration. In order to increase the hydroxide ion concentration, 19 M (50 wt%) sodium hydroxide (caustic) will be added to AN-107 and mixed into the waste. The purpose of this memorandum is to outline the conceptual operating procedures for the caustic addition process. Final operating procedures for the caustic addition have not been written. The attached procedures are drafts only and are subject to change.

Samantha Jenkins

Samantha Jenkins
Rotational Engineer

sj:sbg

Attachment

Table of Contents

GENERAL PROCESS DESCRIPTION 3

2.0 EQUIPMENT DESCRIPTION 3
2.1 CAUSTIC DELIVERY TRUCK 3
2.1.1 Location 3
2.1.2 Description 3
2.1.3 Point of Contact 3
2.2 TEMPORARY STORAGE TANK 3
2.2.1 Location 3
2.2.2 Description 4
2.2.3 Point of Contact 4
2.3 CAUSTIC ADDITION SKID 4
2.3.1 Location 4
2.3.2 Description 4
2.3.3 Point of Contact 4
2.4 MIXER PUMP ASSEMBLY 4
2.4.1 Location 4
2.4.2 Description 5
2.5 ELECTRICAL CONTROL SKID 5
2.5.1 Location 5
2.5.2 Description 5
2.5.3 Point of Contact 6
2.6 CAMERA SYSTEM 6
2.6.1 Location 6
2.6.2 Description 6
2.6.3 Point of Contact 6
2.7 MIXING EFFECTIVENESS INSTRUMENTATION 6
2.7.1 Location 6
2.7.2 Description 7
2.7.3 Point of Contact 7

3.0 ALARM RESPONSE/ABNORMAL OPERATING PROCEDURES . . . 7
3.1 GENERAL POWER FAILURE 7
3.1.1 Description 7
3.1.2 Automatic Response 7
3.1.3 Operator Response 7
3.1.4 Basis 7
3.2 TANK FARMS ARM ALARM 8
3.2.1 Description 8
3.2.2 Automatic Response 8
3.2.3 Operator Response 8
3.2.4 Basis 8
3.3 WATER UTILITY/FLUSH WATER LINE FAILURE . . . 8
3.3.1 Description 8
3.3.2 Automatic Response 8
3.3.3 Operator Response 8
3.3.4 Basis 8

Table of Contents (cont.)

3.4 CAUSTIC ADDITION SKID FAILURE 9
3.4.1 Description 9
3.4.2 Automatic Response 9
3.4.3 Operator Response 9
3.4.4 Basis 9
3.5 MIXER PUMP ROTATIONAL MOTOR FAILURE/OVERTRAVEL 10
3.5.1 Description 10
3.5.2 Automatic Response 10
3.5.3 Operator Response 10
3.5.4 Basis 10
3.6 MIXER PUMP FAILURE/OPERATIONAL INTERLOCKS . . 10
3.6.1 Description 10
3.6.2 Automatic Response 10
3.6.3 Operator Response 11
3.6.4 Basis 11

4.0 STANDARD OPERATING PROCEDURES 11
4.1 OPERATION OF 241-AN-107 MIXER PUMP--INITIAL MIXING 11
4.2 OPERATION OF 241-AN-107 MIXER PUMP--CAUSTIC ADDITION 12
4.3 OPERATION OF 241-AN-107 MIXER PUMP--WASTE. RECIRCULATION 13
4.4 POINT OF CONTACT 14

1.0 GENERAL PROCESS DESCRIPTION

The purpose of the caustic addition activity is to raise the hydroxide ion concentration of Tank 241-AN-107 waste to a level that meets tank farm operating specifications. This will be accomplished by adding 19 M sodium hydroxide (caustic) to the contents of the tank by way of an in-tank mixer pump.

The system design is to deliver caustic to 241-AN Tank Farm with a delivery truck. The caustic will be pumped to a temporary storage tank, out to a metering caustic injection skid, then out to the mixer pump where it will be mixed into the waste by the action of the mixer pump turbulent jets.

2.0 EQUIPMENT DESCRIPTION

The caustic addition system includes all components required to add the caustic to the tank in a controlled manner and adequately evaluate the effectiveness of the process.

2.1 CAUSTIC DELIVERY TRUCK

2.1.1 Location

The Caustic Delivery Truck will be a vendor supplied transport vehicle periodically located at the 241-AN Tank Farm parking lot.

2.1.2 Description

The caustic delivery truck will be used to bring the caustic to the addition site. The caustic container will be doubly enclosed; if the caustic is to be delivered in cold weather, the annulus space between the two enclosures can be filled with hot water to keep the caustic at an acceptable temperature.

2.1.3 Point of Contact

For information regarding the Caustic Delivery Truck contact Samantha Jenkins (373-6365).

2.2 TEMPORARY STORAGE TANK

2.2.1 Location

The temporary storage tank will be located at the south end of 241-AN Tank Farm parking lot adjacent to the caustic addition skid.

2.2.2 Description

The caustic will be pumped from the delivery truck to the temporary storage tank. The temporary storage tank will be a doubly-enclosed transport vehicle trailer leased from a commercial chemical supplier/transportation company. The truck will not be required to be present throughout the entire operation. The caustic addition skid will be fed form the storage tank.

2.2.3 Point of Contact

For information regarding the temporary storage tank contact Samantha Jenkins (373-6365).

2.3 CAUSTIC ADDITION SKID (drawing H-2-85347)

2.3.1 Location

The caustic addition skid will be located directly to the south of the electrical control skid (south of the existing 241-AN instrument building).

2.3.2 Description

The caustic addition skid will be installed on a 9′ X 5.5′ concrete pad. The caustic injection skid consists of a skid mounted metering pump and monitoring system. The caustic metering pump will discharge caustic solution to the mixer pump at a known flow rate while the monitoring system will track the quantity of caustic solution added over a given period of time. The caustic metering pump will be controlled form the electrical control skid.

The caustic addition skid has annunciators for drain-pan leak detection, caustic flow high/low temperature, and caustic flow high/low pressure that alarm in the electrical control skid. A local beacon light will also activate.

2.3.3 Point of Contact

For information regarding the caustic delivery skid contact Billy Ash (373-1074) or Greg Leshikar (373-4434).

2.4 MIXER PUMP ASSEMBLY (drawing H-2-85261, H-2-85264 CVI #22528)

2.4.1 Location

The mixer pump will be located in the central pump pit of Tank 241-AN-107; it will be installed in Riser 11A (42" riser).

2.4.2 Description

The mixer pump is a 75 horsepower Hazelton Model 5N SSB. The maximum flow rate of the pump is 950 gallons per minute, at a discharge pressure of 115.5 feet. The pump assembly is approximately 50 feet long with opposing discharge nozzles approximately 1 foot above the tank bottom (in the sludge layer). The pump intake will be located approximately 6 feet above the discharge nozzles (in the supernate layer).

Instrumentation measuring vibration, windage temperature, motor moisture, and unbalanced column loads are included as part of the pump assembly.

A variable speed drive will be used to control the pump, this gives the operator the ability to operate the mixer pump motor over its entire speed envelope. The variable speed drive can be run manually or can be programmed to run through a given sequence automatically.

The mixer pump will be rotated by a rotational motor. The rotational motor allows the pump the ability to rotate through 190° which provides 360° of coverage through the opposing discharge nozzles. The mixer pump will rest on a pump stand, as opposed to being rigidly attached to the riser. The stand will be grouted onto the pump pit floor then Hilte bolted into place.

2.4.3 Point of Contact

For information regarding the caustic delivery skid contact Billy Ash (373-1074), Greg Leshikar (373-4434) or Greg Paintner (373-2472).

2.5 ELECTRICAL CONTROL SKID (drawing H-2-85259 sh. 1-19)

2.5.1 Location

The electrical control skid will be located directly south of the existing 241-AN instrument building.

2.5.2 Description

The electrical control skid will be installed on a 12.5′ X 21.5′ concrete pad. The skid consists of a building containing the equipment necessary to run and monitor the mixer pump. The control equipment will include the mixer pump controls (see Section 2.4), camera system controls (see Section 2.6), and the caustic addition skid controls (see Section 2.3). The monitoring instruments will allow the operator the ability to monitor the following data; pump motor cavity moisture, pump stator winding temperature; pump column vibration; pump column tension/compression; pump

rotational position and caustic addition flow rate. Deflection of the thermocouple tree in Riser 4 will be monitored with the camera system.

2.5.3 Point of Contact

For information regarding the electrical control skid contact Greg Paintner (373-2472).

2.6 CAMERA SYSTEM

2.6.1 Location

In-tank components of the camera system will be deployed through Riser 7B (12" riser). The remote controls and display will be located in the electrical control skid.

2.6.2 Description

A complete color S-VHS video camera system will be installed in Tank 241-AN-107. The in-tank assembly will consist of a single frame with a remotely controllable camera, remotely controllable pan-and-tilt unit, remotely controllable lights, drying gad distribution lines, radiation shielding plates, riser flange mating plate, and assembly lifting bail. The frame and all mounting hardware will be stainless steel. The camera will be capable of full tank monitoring. The video camera display will have a grid which will allow the operator to measure the deflection of the thermocouple tree.

The camera lens will have remotely controlled zoom, iris, and focus capability. The camera housing shall be attached to a pan-and-tilt unit which allows full 360° horizontal viewing. The pan-and-tilt unit shall rotate vertically through 120° (90° down, 30° up).

Camera system controls are located both locally and remotely. The local controls will be contained in a cabinet near the riser (Riser 7B). The remote controls, video monitors, and video tape recorders will be located in the electrical control skid.

2.6.3 Point of Contact

For information regarding the camera system contact Tom Pedersen (373-3414).

2.7 MIXING EFFECTIVENESS INSTRUMENTATION

2.7.1 Location

Densitometers will be installed in two separate risers. Ultrasonic transducers and a density monitor will be installed on the column of the mixer pump. The IR monitor is a fully self-contained transportable system. An IR temperature monitor will be used in the tank annulus. The instrument consoles for the densitometers and ultrasonic transducers will be located in the existing 241-AN instrument building.

2.7.2 Description

The mixing effectiveness instrumentation will consist of two ENRAF densitometers deployed in separate risers, an IR temperature monitor periodically deployed in the tank annulus, and sludge measurement devices. The ultrasonic instruments may provide useful data for evaluating mixing effectiveness, but their primary function is to demonstrate applicability for future double-shell tank retrieval. Except for the sludge measurement devices, the final design of these equipment systems has not been completed.

2.7.3 Point of Contact

For information regarding the mixing effectiveness instrumentation contact J. D. Martin (376-1949) or Kelly Carothers (373-4556). The contact for the ultrasonic instruments is R. L. Hand (373-3053).

3.0 ALARM RESPONSE/ABNORMAL OPERATING PROCEDURES

Alarm response/abnormal operating procedures have not been written yet. The following procedure outlines are strictly rough drafts that represent current thinking and are subject to change.

3.1 GENERAL POWER FAILURE

3.1.1 Description

This procedure describes actions to be taken if the electrical utility is lost.

3.1.2 Automatic Response

In the event of a power failure, any caustic addition system equipment that is operating will stop.

3.1.3 Operator Response

If the mixer pump was operating at the time of power failure then the running switch for the pump shall be turned to the off position.

3.1.4 Basis

A power failure should not harm any of the caustic addition equipment. There is no safety concern regarding any of the caustic addition equipment under zero power conditions.

3.2 TANK FARMS ARM ALARM

3.2.1 Description

This procedure describes actions to be taken if a 241-AN Area Radiation Monitor alarms. (Probably won't be necessary due to planned ARM removals).

3.2.2 Automatic Response

In the event of an 241-AN ARM alarm, the mixer pump is interlocked to shutdown. The caustic addition pump is interlocked to shutdown when the mixer pump shuts down.

3.2.3 Operator Response

Leave area immediately, proceed to staging area.

3.2.4 Basis

An ARM alarm represents the presence of a radiation dose rate above acceptable levels. Leaving the shutdown caustic addition equipment does not represent a safety concern.

3.3 WATER UTILITY/FLUSH WATER LINE FAILURE

3.3.1 Description

This procedure describes actions to be taken if the water utility is lost or if the flush water line is found to be leaking either internally in the central pump pit or externally.

3.3.2 Automatic Response

None for an external leak. Internal to the control pump pit a leak detection element is interlocked to the caustic addition skid to shut the system down automatically and activate an alarm.

3.3.3 Operator Response

Shutdown the caustic addition skid if operating and flush the caustic delivery line. Shutdown the mixer pump if operating, inform operations manager.

3.3.4 Basis

Low/No flush water line pressure means that the pump inlet filter and jet nozzles cannot be properly flushed. The pump can run under these conditions but only per the direction of the responsible engineering organization.

3.4 CAUSTIC ADDITION SKID FAILURE

3.4.1 Description

This procedure describes actions to be taken if the caustic addition line is found to be leaking (either internally in the central pump pit or externally); the caustic addition skid pump fails; or any of the caustic addition skid annunciators alarm.

3.4.2 Automatic Response

Local caustic addition skid annunciator alarms. Central pump pit leak detection element interlock with caustic addition skid.

3.4.3 Operator Response

In the caustic addition line is found to be severed or leaking, shutdown the caustic addition skid if operating. A caustic leak in the central pump pit will automatically shut down the caustic addition skid when the leak detection interlock is activated. Report the spill to the on-duty operations manager and await directions.

If the caustic addition skid pump has failed, report to the on-duty operations manager and contact the responsible engineering organization for guidance.

If the caustic addition skid high or low temperature annunciators alarm (30° F-180° F), shutdown the skid and report to the on-duty operations manager.

If the caustic addition high pressure or low pressure annunciators alarm, shutdown the skid. Check all valves to make sure they are in the proper position. Check the caustic addition line for signs of any leakage or damage. If the vales are correctly aligned for the caustic addition line has failed then contact the on-duty shift manager for direction.

If the drain-pan leak detection annunciator alarms, shutdown the skid and report to the on-duty operations manager.

3.4.4 Basis

The only caustic addition skid pump interlock is tied to the operation of the mixer pump, the caustic addition pump cannot run unless the mixer pump is running. This is to prevent the addition of caustic into the tank waste without proper mixing, The only other hazard involved with the skid is the spill of caustic onto the ground in the event of a line leak. The amount of caustic leaked to the ground would be relatively small.

Due to the non-interlocking nature of the skid annunciators, the operator is responsible for taking action in the event of a problem. The action that should be taken in the event of a problem is to shut the skid down and notify the shift manager. Shutting the sid down leaves it in a safe state.

3.5 MIXER PUMP ROTATIONAL MOTOR FAILURE/OVERTRAVEL

3.5.1 Description

This procedure describes actions to be taken in the event of a rotational motor failure, or if the rotational motor overtravel interlock is tripped.

3.5.2 Automatic Response

If the rotational motor fails, the mixer pump will lose indexing capabilities.

If the rotational motor overtravels, the mixer pump will shutdown.

3.5.3 Operator Response

If the rotational motor fails, the operator can allow the mixer pump to operate at its current index angle, then shut the mixer pump down when the specified operating time is up.

If the rotational motor overtravel interlock is tripped, the operator shall contact the shift manager and responsible engineering organization for guidance.

3.5.4 Basis

The mixer pump can be operated without the rotational motor with no safety concerns.

3.6 MIXER PUMP FAILURE/OPERATIONAL INTERLOCKS

3.6.1 Description

This procedure describes actions to be taken in the event of a mixer pump failure, or the engagement of the mixer pump interlocks (cavity moisture, stator temperature, pump column vibration, pump column tension, or pump column compression).

3.6.2 Automatic Response

In the event of a mixer pump failure or shutdown both the rotational motor and the caustic addition skid motor are interlocked to shutdown also.

If moisture is detected in the pump motor cavity, the pump automatically shuts down.

If the pump stator winding temperature reaches 150° F, the pump automatically shuts down.

If the pump vibration reaches 65 in/s, the pump automatically shuts down.

If the pump column tension reaches -100 lbs, the pump automatically shuts down.

If the pump column compression reaches 100 lbs, the pump automatically shuts down.

3.6.3 Operator Response

In the event of a mixer pump failure or interlocking, contact the shift manager for guidance.

3.6.4 Basis

If the mixer pump interlocks are tripped that means there is a problem with the pump that can cause the pump permanent damage. Under those circumstances the pump should not be operated. The interlock set points were set in accordance with vendor information in order to keep from approaching the design limits of the pump.

4.0 STANDARD OPERATING PROCEDURES

Operating procedures for the caustic addition system have not been written yet. The following procedure outlines are strictly rough drafts that represent current thinking and are subject to change.

4.1 OPERATION OF 241-AN-107 MIXER PUMP--INITIAL MIXING

The basic idea of this procedure is to operate the mixer pump at progressively higher speeds until a speed is found that will support uniform mixing. This is to be done prior to adding caustic in order to determine a speed that will effectively mix

the tank waste while minimizing the wear and tear on the mixer pump and thermocouple tree.

1. Make sure all monitoring instruments at the electrical control skid, including the video display are powered-up and functioning properly.

2. Perform site inspection to verify that the flush water line is properly attached and unbroken.

3. Record a baseline set of data for all instrumentation.

4. Prior to starting the pump verify that the video display is functioning properly and the thermocouple tree can be clearly seen. Once the pup is started the video display must be monitored to verify the thermocouple tree does not undergo excessive deflection.

5. Start the mixer pump and adjust the variable speed drive until the pump is running at the selected speed (initially 400 RPM). Rotate the mixer pump until it is at the specified index (initially 7 degrees past the thermocouple tree). Note the time when the pump is rotated into place.

6. After on hour rotate the mixer pump 10 degrees while maintaining the same pump speed.

7. Repeat step 6 until the entire tank floor has been swept (excluding the 14 degree exclusion zone for the thermocouple tree).

8. Stop the mixer pump and record data from the instruments that require a quiescent flow field in the tank (sludge weights and densitometers).

9. Evaluate the data to determine if it's necessary to continue. If uniform mixing has been reached, do not increase the pump speed.

10. Increase the pump speed to the next specified amount (400, 700, 1000, 1200, 1400, 1600, and 1700 RPM) and repeat steps 3 through 9 until the minimum pump speed that will support uniformity is found.

11. When a suitable speed has been found, perform a water flush of the mixer pump inlet screen and injection nozzles, then shut the mixer pump down.

12. Verify all instruments are still functioning properly.

13. Record a set of data from all the instrumentation for comparison against the baseline.

14. Shutdown all unnecessary equipment.

4.2 OPERATION OF 241-AN-107 MIXER PUMP--CAUSTIC ADDITION

The basic idea of this procedure is to operate the 241-AN-107 caustic addition system under normal conditions. This procedure should not be performed until a suitable speed and time of operation for the mixer pump has been determined.

1. Make sure all monitoring instruments at the electrical control skid and caustic addition skid, including the video display, are powered-up and functioning properly.

2. Perform site inspection to verify that the caustic addition and flush water lines are properly attached and unbroken.

3. Record a baseline set of data for all instrumentation.

4. Prior to starting the pump verify that the video display is functioning properly and the thermocouple tree can clearly be seen. Once the pump is started, the video display must be monitored to verify the thermocouple tree does not undergo excessive deflection.

5. Start the mixer pump and adjust the variable speed drive until the pump is running at the selected speed. Rotate the mixer pump until it is at the specified index (initially 7 degrees past the thermocouple tree). Note the time when the pump is rotated into place.

6. Start the caustic addition pump and adjust the pump speed to deliver caustic at the speed selected flow rate.

7. After one hour, rotate the mixer pump 10 degrees while maintaining the same pump speed.

8. Repeat step 7 until entire tank floor has been swept (excluding the 14 degree exclusion zone for the thermocouple tree).

9. Reverse the direction of rotation of the mixer pump and repeat steps 7 and 8.

9a. Repeat step 9 until the specified volume of caustic has been added or the specified mixing time has been reached.

10. Perform a water flush of the caustic addition line.

11. Shut down caustic addition skid.

12. Perform a water flush of the pump inlet screen and injection nozzles. Then shut down the mixer pump.

13. Verify all instruments are still functioning properly.

14. Record a set of data from all the instrumentation for comparison against the baseline.

15. Shutdown all unnecessary equipment.

4.3 OPERATION OF 241-AN-107 MIXER PUMP--WASTE RECIRCULATION

This procedure details the operation of the 241-AN-107 mixer pump in order to mix the tank waste. This procedure is to be used only after a suitable speed and time of operation has been determined for the mixer pump. This procedure can be performed before or after adding caustic.

1. Make sure all monitoring instruments at the electrical control skid, including the video display, are powered-up and functioning properly.

2. Perform site inspection to verify that the flush water line is properly attached and unbroken.

3. Record a baseline set of data for all instrumentation.

4. Prior to starting the pump, verify that the video display is functioning properly and the thermocouple tree can be clearly seen. Once the pump is started, the video display must be monitored to verify the thermocouple tree does not undergo excessive deflection.

5. Start the mixer pump and adjust the variable speed drive until the pump is running at the selected speed. Rotate the mixer pump until it is at the specified index (initially 7 degrees past the thermocouple tree). Note the time when the pump is rotated into place.

6. After one hour rotate the mixer pump 10 degrees while maintaining the same pump speed.

7. Repeat step 6, reversing the rotational direction each time the entire tank floor has been swept (excluding the 14 degree exclusion zone for the thermocouple tree), until the specified mixing time has been reached.

8. Perform a water flush of the mixer pump inlet screen and injection nozzles, then shut the pump down.

9. Verify all instruments are still functioning properly.

10. Record a set of data from all the instrumentation for comparison against the baseline.

11. Shutdown all unnecessary equipment.

4.4 POINT OF CONTACT

For information regarding operating procedures for the 241-AN-107 caustic addition system contact Ray Parazin (373-1847 or Samantha Jenkins (373-6365).

For information regarding operating procedures for the 241-AN-107 camera system contact Tom Pedersen (373-3414).

For information regarding operating procedures for the 241-AN-107 densitometers contact J. D. Martin (376-1949).

For information regarding operating procedures for the 241-AN-107 ultrasonic instruments contact R. L. Hand (373-3053).

For information regarding operating procedures for the 241-AN-107 sludge measurement devices refer to Tank Farm Standard Operating Procedure TBD .