CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

VOLUME 4

Revision 20
August 2017
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## DOCUMENTED SAFETY ANALYSIS

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<td>Revised to include Type I/II Waste Tank Chemical Cleaning including resolution of the PISA against F-Tank Farm Type I Waste Tank Chemical Cleaning process</td>
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| 15   | 9/2013   | All Chapters      | - Incorporated CRFs: HLW-CRF-12008, HLW-CRF-12009, HLW-CRF-12011, HLW-CRF-12012, HLW-CRF-12013, HLW-CRF-13002, HLW-CRF-13004, HLW-CRF-13005, HLW-CRF-13007
|      |          |                   | - Updated Minimum Staff requirements for Control Room Manager
|      |          |                   | - Deleted the H-Area Tank Farm – Chemical Addition System
|      |          |                   | - Clarified requirements for the Chemical Inventory Control Program and Table 3.3-5
|      |          |                   | - Updated Table 3.4-1 for revised max ventilation flow values
|      |          |                   | - Added a degraded flow aspect for the Transfer Facility Ventilation Systems
|      |          |                   | - Revised the following Programs: Configuration Management, Structural Integrity, WAC, Prohibited Operations, Tank Fill Limit
|      |          |                   | - Modified operability statements and actions associated with transfer facility cell covers
<p>|      |          |                   | - Clarified installed/portable diesel generator requirements |</p>
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| 16   | 6/2014| ES, 1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 13, 14, 16, 18, 18 | ➢ Incorporated CRFs: HLW-CRF-14002, HLW-CRF-14003, HLW-CRF-14005, HLW-CRF-14006  
➢ Aligned Sub-Section titles to match DOE-STD-3009 where appropriate  
➢ Updated References  
➢ Clarified Unmitigated/Mitigated Progressions, Source Term derivations  
➢ Clarified Aerosolization events  
➢ Updated Table 5.9-1 for Administrative Controls  
➢ Added Waste Tank Overheating scenario for waste tank annulus  
➢ Deleted Waste Box Control Program  
➢ Revised Static Waste Tank Overheating scenario to Not Credible  
➢ Modified Process Area and Mode Applicabilities for jetting of sump  
➢ Added new Conditions to facilitate maintenance during cell cover removal in pump pits and ventilated diversion boxes  
➢ Updated list of external sources of liquid radioactive waste to the CSTF  
➢ Revised verification methodology to conform to current Manual 2S requirements  
➢ Made changes for resolution of PISA PI-2014-0001 |
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➤ Updated to new SRS Site Characteristics and Program Descriptions (SCPD) document  
➤ Added sub headings to Chapter 3  
➤ Modified to recognize consolidation of 242-1F and 241-74F Control Rooms  
➤ Removed Mechanical Cleaning for Type IV waste tanks  
➤ Updated References  
➤ Modified/clarified actions and supporting text for Event Response and Severe Weather Response  
➤ Changed the Preventive Maintenance Program to the Nuclear Maintenance Management Program  
➤ Updated portions of DSA Chapter 5 for TSR Methodology Manual Rev. 6 changes  
➤ Modified Requirements Section in DSA Chapters 1 and 7-17 for consistent approach  
➤ Added Prohibited Operation and clarified information regarding fuel powered vehicles/equipment (other than diesel powered) used within Building 299-H  
➤ Added isolation requirements to consider system “non-continuous makeup capability” (electrical or mechanical isolation shall contain two independent means of isolation)  
➤ Added information about accounting for analytical uncertainty  
➤ Updated Low-Rem transfer criteria for Type IV waste tanks  
➤ Modified Pump Run Program and Salt Dissolution/Interstitial Liquid Removal Program |
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| 18   | 3/2016 | ES, 2, 3, 4, 5, 6 | - Incorporated CRFs: HLW-CRF-15006, HLW-CRF-15007, HLW-CRF-15008, HLW-CRF-15009  
- Updated text associated with Tank 16 to recognize tank has been filled with grout  
- Updated Chapter 3 to recognize new Trapped Gas Release CHA  
- Revised text to recognize pump speed evaluation of the Transfer Control Program  
- Modified waste tank primary and annulus volumes based on changes to inputs  
- Defined terms “settled sludge” and “slurried sludge” per new input  
- Created new “Controls for Waste Tanks Undergoing Planned Gas Release Activities” subsection  
- Revised “Waste Tank Quiescent Time Program” subsection |
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| 19   | 6/2016 | ES, 1, 2, 3, 4, 5, 6, 18 | - Incorporated CRFs: HLW-CRF-16001, HLW-CRF-16002  
  - Updated text associated with Tank 12 to recognize the tank has been closed and backfilled with grout.  
  - Modified text to recognize permitted time delay relays for alarms associated with Conductivity Probes.  
  - Revised text for clarifications associated with issues identified in the Extent of Condition review for the Waste Tank Siphon PISA.  
  - Revised text to address changes made to the Mercury Management Program and addition of new controls (Evaporator Mercury Monitoring LCO). Added new Evaporator Modes. This change resolves PISA PI-2015-0001.  
  - Updated References.  
  - Added discussion pertaining to the Tank 50 to Z-Area events in the NPH DBA Sections of Chapter 3.  
  - Added safety function for Very Slow Generation Tanks when receiving a steam jetted transfer. Modified LCO 3.8.1 for applicability of Very Slow Generation Tanks during receipt of a steam jetted transfer.  
  - Modified LCO 3.7.4 (Valve Box, Drain Valve Box, and HPFP Leak Detection Instruments) and created new LCO 3.7.14 (Valve Box, Drain Valve Box, and HPFP Level) to address residual waste levels.  
  - Revised basis discussion for restoring ventilation on pump tanks to account for the presence of the pump tank passive vent and dissolved hydrogen release from a steam jetted transfer from a source less than or equal to 1,200 gallons. |
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<td>Modified the status of the 242-16F Evaporator such that it is an “Inactive Location” per the DSA/TSR (does not require additional hazard/accident analysis).</td>
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<td>Modified the status of Valve Box 15/16 such that it is an “Inactive Location” per the DSA/TSR (does not require additional hazard/accident analysis).</td>
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<td>Updated ventilation system setpoints (and references) for closure of PISA PI-2016-0010 (Errors Associated with Waste Tank Purge Ventilation System “Degraded” Flow Calculation and Setpoints) and associated ESS (U-ESS-H-00012).</td>
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<td>Updated Work Product Disclaimer at the beginning of each DSA chapter to the new Disclaimer for AECOM N&amp;E Technical Services, LLC.</td>
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<td>Clarified discussion pertaining to radiological versus chemical consequences and added new reference report (G-ESR-H-00232).</td>
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<td>Modified “non-waste” transfer definition/criteria with respect to chemical EGs.</td>
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<td>Clarified DSA use of radiolytic hydrogen generation rate for Type IV tanks.</td>
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<td>Added clarifying discussion to the Valve Box Explosion sub-DBA recognizing that a deflagration could occur for the Tank 40 VB and Tank 51 VB (when the waste material is ESP Sludge Slurry), but that the progression for this DBA (explosion with follow-on spill) is assumed to not occur for mitigated analysis and no consequences are attributed to a VB explosion.</td>
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<td>Modified reported “Tank 50” type consequence from the LPDT Cell explosion to the Tank 50 VB explosion.</td>
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<td>Added bases justifying why no change is necessary for “required setpoints” for ventilation flow related to in-leakage allowances permitted by Level 4 duct class.</td>
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CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 7
RADIOLOGICAL PROTECTION

Revision 20
August 2017
DISCLAIMER

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ACRONYMS AND ABBREVIATIONS

ALARA  As Low As Reasonably Achievable
ARM    Area Radiation Monitor
CSTF   Concentration, Storage, and Transfer Facilities
DOE    Department of Energy
GET    General Employee Training
LW     Liquid Waste
RBA    Radiological Buffer Area
RCO    Radiological Control Operations
RWP    Radiological Work Permit
RWT    Radiological Worker Training
S/RID  Standards/Requirements Identification Document
SRR    Savannah River Remediation LLC
SRS    Savannah River Site
TLD    Thermoluminescent Dosimeter
7.0 RADIOLOGICAL PROTECTION

7.1 INTRODUCTION

7.1.1 OBJECTIVE

This chapter provides information on the Savannah River Site (SRS) Radiological Protection Program, which maintains the radiological safety in the Concentration, Storage, and Transfer Facilities (CSTF).

7.1.2 SCOPE

The scope of this chapter includes the following:

- Description of the radiological protection organization that supports CSTF
- Information regarding methods, systems, management organization, and policy implemented at CSTF to ensure radiation exposure is kept As Low As Reasonably Achievable (ALARA)
- Description of the elements of site training programs that maintain radiological safety for CSTF personnel
- Description of sampling and monitoring of potential releases of radioactive material to offsite
- Information on the administrative program for maintaining records of radiation sources, releases of radioactive material and occupational exposures at the CSTF

Procedure Manual 5Q describes the SRS Radiological Protection program as it applies to the entire site (Ref. 1). This chapter of the CSTF Documented Safety Analysis describes the interfaces between the CSTF and the site and business unit-level programs.
7.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 2) states the codes, standards, and regulations governing the policies and program elements of the Radiological Protection Program (e.g., S/RID Functional Area 11). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 3). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
7.3 RADIOLOGICAL PROTECTION PROGRAM AND ORGANIZATION

This section provides information on the SRS Radiological Protection Program and organization applicable to CSTF.

7.3.1 RADIOLOGICAL PROTECTION PROGRAM

A description of the components of the Radiological Protection Program at SRS and CSTF is contained in the following subsections. Included are descriptions of the program organization, program objectives, equipment, instrumentation, facilities, administrative controls, training, review and audits, and inspection and testing of equipment.

7.3.1.1 Program Organization

The Radiological Protection Program consists of a stand-alone radiological controls program for Liquid Waste (LW) which implements procedures and requirements established by a central, site-wide, Radiological Program group. The Radiological Program group is the responsible consulting authority within SRS for radiological protection of site personnel and the public. This department is responsible for awareness, analysis, and advice to other departments on hazards incident to the handling, use of, and exposure to, radioactive materials. The Radiological Program group is also consulted for guidance in radiological protection of LW employees, equipment, and the environment. Responsibility for radiological safety at LW rests with departmental line organizations.

7.3.1.2 Program Objectives

The Radiological Protection Program objectives are as follows:

- Maintain radiation exposures ALARA and prevent or limit contamination to personnel
- Minimize internal assimilation of radioactive material, consistent with maintaining total dose ALARA
- Minimize contamination of facilities
- Minimize the release of radioactive material to the environment
- Train exempt and nonexempt Radcon personnel in radiological work
- Maintain and provide quality assurance/control on the various procedures and the equipment to ensure proper implementation of Radcon programs and operations
- Measure and record personnel radiation dose
- Provide support for emergency response activities
- Interface with other site safety organizations (Industrial Hygiene and Employee Safety) to ensure consistent program implementation

Details of the Radiological Protection Program objectives are provided in Procedure Manual 5Q (Ref. 1).
7.3.2 CONCENTRATION, STORAGE, AND TRANSFER FACILITIES PROGRAM AND OBJECTIVES

Implementation of the Radiological Protection Program at the CSTF is the responsibility of the Liquid Waste Safety and Health Manager. The Liquid Waste Safety and Health Manager is part of the Liquid Waste organization that reports to the Liquid Waste contractor President.

Radiological Control Operations (RCO) personnel assigned to CSTF report to the Liquid Waste Safety and Health Manager. A sufficient level of RCO staff is maintained at CSTF and at the LW level to ensure that the goals of the Radiological Program are maintained. Personnel associated with the Radiological Program must have a combination of education, experience, and training in order to perform their duties (Procedure Manual 5Q, Ref. 1). The managers of the Radiological Program are involved directly in the training and qualification of RCO inspectors and First Line Managers.

General responsibilities of RCO personnel at CSTF include the following:

- Ensure that radiological operations of the facilities are conducted in accordance with plant policies and procedures
- Provide recommendations, advice and guidance concerning radiological safety
- Ensure that environmental protection is effective
- Maintain records to assist in the general program to maintain personnel exposure within ALARA guidelines

Generic job descriptions and responsibilities for the various RCO positions are provided in Procedure Manual 5Q (Ref. 1).
7.4 AS LOW AS REASONABLY ACHIEVABLE POLICY AND PROGRAM

7.4.1 AS LOW AS REASONABLY ACHIEVABLE POLICY CONSIDERATIONS

It is the policy of the LW contractor for SRS to maintain radiological exposures to levels that are ALARA. The design criteria for ALARA considerations at CSTF were contained in federal documents that existed during the 1975-83 design phase, including the following:


The design external radiological dose, based on these criteria, was less than 1 roentgen equivalent man effective dose equivalent per year. Construction of the facility incorporated shielding design that provides for this dose rate. Implementing direction for ALARA design includes Radiation Technical Standards DPSTS-RH-02, and the Basic Data Report, DPSP 80-1038, Part 11.

Since design completion, DOE has provided requirements and guidance on ALARA programs. These documents are listed in the S/RID (Ref. 2). The requirements of these documents will be implemented at the CSTF via SCD-6, Procedure Manual 5Q, lower tier procedures, and other site procedures and manuals (Ref. 4, 1).

7.4.2 ASSOCIATED RADIOLOGICAL GOALS

Commitment to ALARA is required by Procedure Manual 5Q for all levels of employees (Ref. 1). The President of the LW contractor, through the Site ALARA Committee, establishes the radiological performance goals. The Site ALARA Committee, with representatives from line organizations, technical organizations, and the Radiological Program, makes recommendations to management to improve ALARA operations. The purpose, organization, and function of committees responsible for radiation safety, including the charter of responsibilities, scope of reviews, qualification, and education requirements for members, are stated in the ALARA Manual (SCD-6, Ref. 4).

ALARA reviews are performed for CSTF radiological design changes, modifications, and operation and maintenance procedures per requirements of Procedure Manual 5Q (Ref. 1). Periodic reviews of performance against exposure goals ensure that ALARA is considered in all facets of work at the CSTF. The CSTF ALARA Coordinator coordinates efforts to limit total exposures to less than the allowable goal.
7.5 RADIOLOGICAL PROTECTION TRAINING

The education and training of employees is essential to the success of any Radiological Protection Program. The educational program includes information on considerations in minimizing exposure, radiation health effects, and dose limits. The appropriate level of radiological training is provided to each worker in the facility, as well as to RCO personnel. Procedure Manual 5Q specifies the requirements for training and the frequency of training for all employees onsite (Ref. 1). The site maintains training records for each person who enters a radiological area.

Personnel, who may routinely enter a Controlled Area and encounter radiological barriers and radiological postings, must receive General Employee Radiological Training. Successful completion of this training is required prior to potential occupational radiation exposure and is given as part of all SRS employee General Employee Training (GET) and Consolidated Annual Training. Workers whose job assignments require access to Radiological Buffer Areas (RBAs) shall complete DOE standardized core Radiological Worker Training (RWT) before being permitted to enter these areas without a qualified escort.

GET, RWT and Radiological Control Technician training are administered as sitewide programs. These training programs are detailed in Procedure Manual 5Q (and Procedure Manual 4B) and are implemented directly at the CSTF (Ref. 1, 5).
7.6 RADIATION EXPOSURE CONTROL

Radiation exposure in nuclear facilities is carefully controlled to prevent or minimize any radiation-induced health effects. Administrative dose limits, good radiological practices, dosimetry programs, and respiratory protection equipment applicable to controlling radiation exposure are detailed in Procedure Manual 5Q and are implemented directly at the CSTF (Ref. 1).
7.7 RADIOLOGICAL MONITORING

At the CSTF, routine and special radiological monitoring determines area radiation exposure rates, contamination levels (surface, internal, liquid, airborne, and soil), and monitors personnel for external contamination. Installed or portable samplers and radiation detector/indicators are used to perform this monitoring. Procedure Manual 5Q1.7 provides additional information on specific types of monitors and systems (Ref. 14). As required by Procedure Manual 5Q1.2 the CSTF has developed a Facility Annual Review of Monitoring Systems jointly with Radiological Protection (Ref. 15). This plan considers criteria for the protection of both radiation and non-radiation workers.

At the CSTF, personnel are monitored for external exposure by use of external dosimetry. Radiological Protection provides dosimetry and maintains technical responsibility for the program. The technical basis for the external dosimetry program can be found in the External Dosimetry Technical Basis Manual (Ref. 11).

In addition to external monitoring, personnel are also monitored for internal dose which is accomplished by the air sampling/monitoring and bioassay sampling programs. These two programs make up a large part of the internal dosimetry program. Detecting and assessing intakes of radioactive materials in the workplace help verify and validate the administrative controls and physical confinement features of the CSTF. The technical basis for the internal dosimetry program can be found in the Internal Dosimetry Technical Basis Manual (Ref. 12). Also, the technical basis and the additional information for the air sampling and monitoring program can be found in the Workplace Air Monitoring Technical Basis Manual (Ref. 13).

The radiological environmental monitoring program consists of two major activities: 1) effluent monitoring, and 2) environmental surveillance. LW retains the overall responsibility and ownership of CSTF radiological effluents.

These programs are detailed in Procedure Manual 3Q1, and are implemented by Procedure Manual 3Q (Ref. 7, 8).
7.8 RADIOLOGICAL CONTROL OPERATIONS AND HEALTH PHYSICS
FACILITIES, EQUIPMENT, AND INSTRUMENTATION

This section provides a brief description of the radiological protection facilities, including facilities for radioactivity analyses, decontamination, and the storage and issue of protective clothing and respiratory protection equipment. This section also describes the following radiological protection equipment and instrumentation:

- Portable and laboratory equipment and instrumentation for performing radiation and contamination surveys
- Airborne radioactivity monitoring and sampling
- Area radiation monitoring
- Effluent monitoring
- Personnel monitoring during normal operation, anticipated operational occurrences, and accident conditions at CSTF

7.8.1 FACILITIES

The Radiological Protection group has offices and laboratories throughout the site. The LW RCO group maintains offices, laboratories, and change rooms in CSTF, as needed.

Protective clothing is available at local contamination area access points, as required. Change facilities are provided for those areas where, and when, personnel traffic warrants. Such facilities consist of clothing storage, count rate meter stations, automatic portal monitors, and other radiological support equipment storage, as appropriate for the job in progress. Storage facilities are provided for additional protective clothing, materials and equipment, respiratory protective equipment, portable instruments, and other miscellaneous radiological control supplies at the facility entry points.

Personnel decontamination stations are also available. The control rooms throughout the CSTF are provided with remote alarms of some Area Radiation Monitors (ARMs) and Stack Air Sampling and Monitoring Systems.

7.8.2 RADIOLOGICAL MONITORING EQUIPMENT

7.8.2.1 Laboratory Instrumentation

Laboratory instruments located in the RCO counting rooms allow the measurement of radioactive material present in samples. Typical samples include contamination survey smears, air sample filter papers, and liquid samples. CSTF laboratory instrumentation includes counters for beta-gamma and alpha emitting samples. Analytical services are provided for isotopic identification of samples using a gamma pulse height analysis system on an as-needed basis.
7.8.2.2 Whole Body Counting Instrumentation

Personnel are monitored in whole body counters at intervals established by procedures or by specific request of the Radiological Program group. The group provides analysis and radionuclide characterization for whole body counts.

New employees, who previously worked in radiological areas at other installations, are required to have a background whole body count. SRS employees involved in incidents at the SRS requiring whole body and chest counts, and selected individuals based on work history are also scheduled for a whole body or chest count prior to termination. The whole body counters are used to count new, current, and terminating employees, as well as selected subcontractors and visitors. The whole body counter provides a quick measurement of gamma-emitting fission products and activation products that may have been assimilated by SRS workers.

7.8.2.3 Portable Survey Instrumentation

Portable survey instrumentation includes radiation survey instruments, monitors for survey of personnel at specified radiological boundaries, equipment used to obtain air samples, laboratory and counting room instruments, and special monitors and instruments for specific jobs. Procedure Manual 5Q1.3 (and Procedure Manual S12) contains the details and operating instructions of the various portable radiological survey instrumentation used at CSTF (Ref. 16, 17). Sensitivities, bases for use, and specifications for common portable survey instruments are found in the Radiation Monitoring Equipment Technical Basis Manual (Ref. 9).

7.8.2.4 Personnel Monitoring Instruments

Monitoring of personnel radiation exposure includes the use of Thermoluminescent Dosimeters (TLDs), electronic personnel dosimeters, and portable survey instrumentation. Personnel wear the applicable dosimeter(s), as posted, or as specified by RCO instructions. The TLDs are analyzed quarterly and/or when circumstances warrant. This provides the official record of personnel external exposure to beta-gamma and neutron radiation. The results of body scans and bioassays are used to determine radiation exposure due to internal contamination.

Personnel exit survey instrumentation for radioactive contamination detection consists of count rate meters and automatic portal monitors.

7.8.2.5 Calibration

Portable radiation survey instruments and personnel monitoring equipment are calibrated and controlled in accordance with the requirements of Procedure Manual 5Q (Ref. 1).

7.8.3 INSTALLED SAMPLING AND MONITORING EQUIPMENT

The following paragraphs briefly describe the sampling and monitoring equipment installed in CSTF. Chapter 2 provides the design details and locations of the sampling and monitoring equipment.
### 7.8.3.1 Workplace Air Sampling Equipment

Within the CSTF, air sampling and/or monitoring systems are installed at locations that have the potential for airborne radioactive particulates. Air samplers collect airborne radioactive particulates by continuously pulling a sample of air through a filter sample media. Air sampling systems are designed to collect representative samples which are used to quantify the amount of radioactive material in air that may result in personnel exposures. The sample media can also be used to determine the type of radioactive material and its source.

### 7.8.3.2 Stack Air Sampling and Monitoring Systems

Stack Air Sampling and Monitoring Systems are installed on exhaust streams from each waste tank to minimize the potential of radioactive releases to the environment from exceeding established limits. An increase in exhaust radioactivity levels can indicate the failure of the ventilation treatment system or a primary to annulus tank leak. Stack Air Sampling and Monitoring Systems are also installed on the exhaust stream from some process area enclosures and structures (see Chapter 2).

Stack Air Sampling and Monitoring Systems collect airborne radioactive particulates by continuously pulling a sample of air through filter sample media (i.e., glass fiber, membrane). Systems that have installed radiation detectors continuously monitor particulates collected on filter media for beta gamma radioactivity. For systems that do not have installed radiation detectors, RCO perform surveys on filter media at a frequency which is based on the potential for loading the HEPA filter and the planned work or work in progress. Elevated levels of radioactivity on filter media will alarm in the associated control room for those systems with installed detectors. For systems without detectors, RCO will notify the control room if radioactivity reaches or exceeds action levels based on the performed surveys.

### 7.8.3.3 Area Radiation Monitors

ARMs are located throughout the CSTF to warn personnel of elevated radiation levels. ARMs operate independently of each other and are usually connected to the alarm system located in each control room. Each monitor is equipped with an audiovisual alarm to annunciate in, or near, the monitored area (see Chapter 2).

### 7.8.3.4 Effluent Monitors

Effluent monitoring instrumentation is discussed in Chapter 2.

### 7.8.3.5 Access Control

Personnel access control is maintained for each radiological area in accordance with the requirements of Procedure Manual 5Q (Ref. 1). Physical controls to prevent inadvertent or unauthorized access to High and Very High Radiation Areas are maintained in accordance with Procedure Manual 5Q.
7.8.4 ADMINISTRATIVE CONTROL PROVISIONS

The Radiological Protection Program objectives are implemented at CSTF through a hierarchy of control measures, either individually or in combination, as follows:

- Engineering Controls - shielding, design, remote manipulations, ventilation, containment devices (glove bags, sleeves, and huts)
- Administrative Controls - dose limits and monitoring, access control, work planning and control, postings, procedures
- Personal Protective Equipment (respirator, protective clothing)
- Effective training and employee communication

Procedure Manual 5Q sets forth the practices for the conduct of radiological protection activities at SRS (Ref. 1). The requirements and administrative controls of Procedure Manual 5Q are fully implemented at CSTF. These controls include administrative dose limits, surveys, establishing RBAs, monitoring, work planning and controls, and training.

Administrative Control Limits for radiation doses and exposure to radioactive material are established at numerical levels that are more stringent than regulatory limits. This is done to administratively control and help reduce individual and collective radiation doses. These control levels are multi-tiered, with increasing levels of authority required to approve higher Administrative Control Limits.

Planned special exposures (non-emergency) that would result in an individual exceeding any exposure guide or limit are allowed in highly unusual situations where alternatives that would avoid exceeding limits are unavailable or impractical. The planned special exposure limits are not the same as the emergency exposure limits. The administrative controls and approvals required for the planned special and emergency exposures are specified in Procedure Manual 5Q (Ref. 1).

To ensure that radiation and contamination control programs are adequately protecting both occupational workers and visitors, a dosimetry program has been established at CSTF. The Radiological Protection program provides a primary means of measuring external radiation exposure and maintaining a permanent radiation history file for employees at SRS. Activities associated with the dosimetry program (both internal and external) are maintained in accordance with the requirements of Procedure Manual 5Q (Ref. 1).

Control of radioactive contamination is achieved by means of engineering and administrative controls, worker performance to contain contamination at the source, reducing existing areas of contamination, and promptly decontaminating areas that become contaminated.

Radiological postings alert personnel to the presence of radiation and radioactive materials and aid them in minimizing exposures and preventing the spread of contamination. Entrance points to areas of ongoing work activities controlled for radiological purposes state basic entry requirements, such as dosimetry, Radiological Work Permit (RWP), and respirator required. Entrances or access points to a High Radiation or Very High Radiation Areas have physical controls to prevent inadvertent or unauthorized entry. These physical access controls are defined in Procedure Manual 5Q (Ref. 1).
At the CSTF, the RWP is the primary administrative mechanism used to establish radiological controls for work activities in radiological areas, or for handling radioactive materials. The RWP informs workers of area radiological conditions and entry requirements, and provides a method to relate worker exposure to specific work activities.

RBAs for CSTF have been defined and established, and the RWP program is fully implemented. Details required to perform radiological work and to develop and approve radiation work permits are contained in the Procedure Manual 5Q (Ref. 1).

Details of the requirements, implementation plans, and procedures for administrative controls, protective equipment and radiological training are provided in Procedure Manual 5Q and in the Radiological Program implementing procedures (Ref. 1).

### 7.8.5 RESPIRATORY PROTECTION

It is a site policy to protect employees from exposure to airborne radioactive contaminants by using facilities and equipment with physical barriers, and other safeguards incorporated into their design. When engineered controls are not feasible, or while they are being initiated, protection is provided through a combination of administrative controls and approved respiratory devices.

Additional information on the respiratory protection program is addressed in Procedure Manual 4Q (Ref. 10).
7.9 RADIOLOGICAL PROTECTION RECORD KEEPING

Procedure Manual 5Q describes the process for preparing and distributing required reports concerning radiation exposures (Ref. 1). It also describes a method by which personnel radiation exposure information may be released by the Radiological Program. In addition, Procedure Manual 5Q requires the establishment of a radiological records management program. This program ensures that auditable records and reports are controlled through the stages of creation, distribution, use, arrangement, storage, retrieval, media conversion (if applicable), and disposition.
7.10 OCCUPATIONAL RADIATION EXPOSURES

Radiological design utilizes shielding at the CSTF to limit dose rates in areas that may be routinely occupied by personnel. Chapters 2 and 4 provide the details of radiological protection design features. Chapter 3 contains the details of estimated exposures during analyzed accidents.

LW establishes annual goals for occupational radiological exposures in consultation with the ALARA Committee. These goals are set for both individual and collective exposures. Annual Administrative Control guidelines are set at, or below, SRS Administrative Guidelines. These Guides and Limits are not knowingly exceeded without prior appropriate approvals. The level of approval required for the RWP controlling the task that will result in exceeding the Guides or Limits depends on the magnitude of the planned exposure. Procedure Manual 5Q provides the details of the documentation and approval required for planned departure from the Administrative Control Guides and Limits (Ref. 1).
7.11 REFERENCES


6. Deleted


CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 8
HAZARDOUS MATERIAL PROTECTION

Revision 20
August 2017
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### ACRONYMS AND ABBREVIATIONS

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<td>As Low As Practicable</td>
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<td>CFR</td>
<td>Code of Federal Regulations</td>
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<td>CSTF</td>
<td>Concentration, Storage, and Transfer Facilities</td>
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8.0 HAZARDOUS MATERIAL PROTECTION

8.1 INTRODUCTION

8.1.1 OBJECTIVE

This chapter provides information on the Savannah River Site (SRS) Industrial Hygiene (IH) program and the program requirements that maintain IH safety at the Concentration, Storage, and Transfer Facilities (CSTF).

8.1.2 SCOPE

This chapter provides an overall description of the IH policy and programs in effect at the CSTF, which are designed to maintain each employee's personal work environment at a safe level of exposure to chemical, physical and biological agents. These programs apply a hierarchy of controls used by the IH program, including the following:

- Substitution of a less hazardous process or agent
- Engineering control measures (changes in process, ventilation, isolation/enclosure of the process)
- Work Practices and Procedures (Standard Operating Procedures, Limited Access)
- Personal Protective Equipment (PPE) (respirators, chemical protective clothing)
- Administrative Controls (employee rotation)
8.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 1) states the codes, standards, and regulations governing the hazardous material protection policies and program elements for the IH Program (e.g., S/RID Functional Area 19). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 2). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
8.3 INDUSTRIAL HYGIENE ORGANIZATION

The Site occupational health objective of providing a place and condition of employment that is free from, or protected against, recognized hazards is achieved through a professional, comprehensive IH program. This is based on management commitment and employee involvement, worksite analysis, hazard identification, program review, hazard prevention and control, safety and health training, and program assessment (Procedure Manual 1-01, Ref. 3).

The organizational elements and associated responsibilities outlined in this section provide the framework by which the site IH policy is implemented within CSTF. This section lists the major elements of the site IH program that ensure its implementation at the CSTF.

8.3.1 OVERALL ORGANIZATION

The Site IH program is managed by the Management and Operations (M&O) contractor.

IH staff positions, responsibilities, qualifications, and training are addressed in Procedure Manual 4Q (Ref. 4). Field and support staffs for the CSTF are addressed below.

8.3.1.1 CSTF Industrial Hygiene Staff

Industrial hygienists at CSTF are part of the Safety and Health Project Services organization. A sufficient number of industrial hygienists are maintained at CSTF and SRS to support CSTF IH programs and to ensure that goals are met for support of other Site organizations. The industrial hygienists’ responsibilities at CSTF include occupational health assessments (e.g., walk-throughs) and management of assigned IH technicians. The industrial hygienist is also responsible for coordinating and evaluating the results of the IH sampling programs and for assisting in day-to-day IH activities.

Facility Line Supervision is ultimately responsible for each employee's health and safety. Supervision must ensure the following:

- Employees are trained on the potential hazards of the job and on the proper use of control measures to perform the job safely.
- Unsafe acts or work conditions that may cause injury or damage to health are corrected.
- A high level of orderliness and housekeeping is maintained.
- Employees adhere to appropriate rules and procedures.

In the Occupational Health Program, the IH group provides CSTF with assistance on technical matters relating to IH and program development. Occupational health programs comply with prescribed Department of Energy (DOE) standards or with SRS Occupational Health and Safety Guidelines provided in Procedure Manual 4Q (Ref. 4). Each employee is responsible for knowing and following the control measures applicable to each job, minimizing exposures, and for being aware of the potential hazards before a job starts.
8.3.1.2 Industrial Hygiene Staff Qualifications

The IH staff is qualified in accordance with the requirements of Procedure Manual 4Q (Ref. 4). The IH staff is trained in anticipating, recognizing, evaluating, and controlling hazardous exposures. Industrial hygienists maintain “state of the art” cognizance and competence in IH science through continual training, professional education and/or certification. The training (core, continued, and refresher) is provided according to the assigned tasks and level of responsibilities. The Industrial Hygiene Training Program Description (Ref. 14) provides the details of training requirements for the IH staff.

8.3.1.3 Training

Employees at SRS are provided with IH-related training so that the employees can adequately and safely perform work assignments. For those personnel assigned by management, the Site Training Department, with the assistance of the Safety and Health Department (SHD), provides employees with initial and refresher training on lasers, hearing conservation, heat stress, respiratory protection, and hazard communication, as well as specific protective requirements for hazardous chemicals at the facility, as listed on Material Safety Data Sheets (MSDSs).
8.4 THE AS LOW AS PRACTICABLE POLICY AND PROGRAM

As Low As Practicable (ALAP) concepts, primarily related to known carcinogens, are integrated into the IH program. The purpose of the program is to prevent occupational illnesses and preserve the health of SRS employees while striving to go beyond minimal compliance with DOE Orders and DOE-prescribed SHD standards. Procedure Manual 4Q describes the IH policy and aspects of the IH program (Ref. 4).

8.4.1 INDUSTRIAL HYGIENE PROGRAM

8.4.1.1 Program Policy

The site IH program, which includes the hazardous material protection program, is managed by the M&O contractor and implemented through Procedure Manual 4Q (Ref. 4). Procedure Manual 4Q satisfies the program requirements of 10 Code of Federal Regulations (CFR) 851 (Ref. 5). The purpose of the IH program is to address identification, evaluation, and control of chemical, physical, and biological hazards within the workplace.

8.4.1.2 Program Elements

Procedure Manual 4Q provides comprehensive direction for the following IH program elements described in this chapter (Ref. 4):

- Integrated exposure assessment
- Hazard prevention and control
- Special program requirements
- Control of occupational exposure
- Training and documentation
- Respiratory protection
- Record keeping

These program elements, as well as occupational chemical exposures, are described in Procedure Manual 4Q (Ref. 4). Only the implementing steps required in the CSTF are discussed here.

It should be noted that since the major portion of the wastes handled and stored at the CSTF are radioactive, most of the handling and storage activities are performed under the Radiological Protection Program (see Chapter 7). For the most part, the protective procedures and equipment specified by the Radiological Protection Program provide hazardous materials protection to the workers also. Handling and storage of a few nonradioactive hazardous process materials, such as nitric acid, oxalic acids, sodium chromate, and sodium hydroxide are performed under the IH and Employee Safety programs, implemented by Procedure Manuals 4Q and 8Q, respectively (Ref. 4, 6).
8.4.1.3 Special Program Requirements

The M&O and Liquid Waste (LW) contractors implement DOE/Occupational Safety and Health Administration (OSHA) special control programs to maintain occupational exposures ALAP. Hazardous material exposure control is addressed in Section 8.6.

The IH program also establishes operating requirements for laboratory and workbench hoods and local exhaust systems used in controlling the emission of nonradiological particulates, gases, vapors, mists and fumes. The requirements address the following areas (Procedure Manual 4Q, Ref. 4):

- Design of laboratory hoods and local exhaust systems
- Design control velocities for laboratory hoods and local exhaust systems
- Laboratory hood or local exhaust system variance request

Determination of ventilation stack discharge heights for waste tanks and transfer facilities, necessary to ensure adequate dispersion of potential chemical vapors, is determined by Engineering and Industrial Hygiene.

These programs are addressed within the IH program. Where feasible, engineering controls are the primary method used to minimize worker exposure and to prevent releases into the work environment (Procedure Manual 4Q, Ref. 4).

8.4.1.4 Program Implementation

The IH program is implemented through Procedure Manual 4Q (Ref. 4). The IH program planning document is utilized as a planning guide in determining the IH programs, responsibilities, lines of authority, available resources, and priorities.

8.4.1.5 Program Implementation Oversight

The IH program specifies surveillance, control, cognizance, and oversight requirements for CSTF employees and organizations assigned to, or involved in, program implementation oversight positions or activities. Facility managers are responsible for implementing and complying with all elements of the IH program deemed applicable by site management (Procedure Manual 4Q, Ref. 4).

The CSTF self-assessment program is described in Chapter 17.

Internal and external Quality Assurance (QA) audits are performed in accordance with the requirements in Procedure Manual 1Q (Ref. 7). The CSTF QA program is addressed in Chapter 14.
8.5 HAZARDOUS MATERIAL TRAINING

The IH training criteria, which includes hazardous material protection training, specifies IH training requirements for site personnel and subcontractors.

On-shift training and equipment and systems status are covered in Chapter 11. Chapter 12 describes the development, maintenance, and modification of CSTF training programs.

Training records satisfy the requirements relating to records management listed in Section 8.9.

8.5.1 INDUSTRIAL HYGIENE STAFF

8.5.1.1 General Requirements

The IH program defines educational and training criteria for anticipating, recognizing, evaluating, and controlling hazards for CSTF employees assigned to, or involved in, IH staff positions or activities (Procedure Manual 4Q, Ref. 4).

8.5.1.2 Department of Energy Industrial Hygiene Support Training Requirements

Personnel supporting implementation of the IH program in the field (including management, IH staff, and employees) are trained in anticipating, recognizing, evaluating, and controlling hazards. DOE-mandated training objectives are integrated into site training programs, as appropriate, for each level of qualification for IH field staff assigned to CSTF (Procedure Manual 4Q, Ref. 4).

8.5.2 LIQUID WASTE PERSONNEL AND SUBCONTRACTORS

The IH program also identifies general occupational health training requirements that must be met by all site employees, organizations, and other site personnel (Procedure Manual 4Q, Ref. 4). The following sections describe the guidance and requirements provided for hazardous material training of CSTF personnel and subcontractors.

8.5.2.1 General Requirements

Each CSTF employee, having an exposure potential to a toxic chemical or harmful physical agent, receives instruction on operations that may lead to exposure, the potential health effects of the hazard, the content of applicable standards or procedures, and required control measures (i.e., engineering controls, administrative controls such as Safe Work Permits, and/or protective equipment). Training and information dissemination are commensurate with the duties, workplace assignment and responsibilities of the employee. These are discussed in Procedure Manual 4Q (Ref. 4).

8.5.2.2 Training Frequencies

Training and retraining frequencies are listed in Procedure Manual 4B (Ref. 8). Area-specific training for new or transferred employees is provided at the initial assignment to any department (Procedure Manual 4Q, Ref. 4).
8.5.2.3 Training Topics

The following site-level training topics associated with hazardous material protection are presented at SRS in the courses/format indicated (Procedure Manual 4Q, Ref. 4):

- **Respiratory protection**: Section 8.6.6 addresses respiratory protection training and the associated training courses.

- **Employee monitoring and medical exposure records**: The consolidated annual training conducted for all site personnel provides a review of DOE policy concerning employee monitoring.

- **Chemical hazards**: Section 8.10 addresses hazard communication training and the associated training courses.

- **Carcinogenic, reproductive, or developmental hazards**: Area-specific training is provided for each chemical present in the workplace that is identified in Procedure Manual 4Q as a potential carcinogenic, reproductive, or developmental hazard (Ref. 4).

- **Asbestos control**: Asbestos control training is provided for SRS employees who may be required to conduct activities that can cause an exposure to asbestos-containing materials. Additional training is provided for asbestos work crew supervisors.
8.6 HAZARDOUS MATERIAL EXPOSURE CONTROL

8.6.1 HAZARDOUS MATERIAL IDENTIFICATION PROGRAM

The hazardous material identification program, referred to as the Hazard Assessment program, is administered as a site-level program and is described in Procedure Manual 4Q (Ref. 4). Chemical hazards resulting from postulated accidents, such as fires and explosions, are identified and quantified in the hazard and accident analyses in Chapter 3.

8.6.2 WORKPLACE SURVEYS

Workplace surveys are performed by the area industrial hygienist (or a designee) under the conditions specified in Procedure Manual 4Q (Ref. 4), Industrial Hygiene Survey Procedures, Procedure Manual 4Q1.1 (Ref. 12) and Radiation Monitoring Procedures, Procedure Manual 5Q1.2 (Ref. 13).

8.6.3 DELETED

8.6.4 ADMINISTRATIVE LIMITS

Facility-specific administrative control levels and exposure limits are established in accordance with Procedure Manual 4Q (Ref. 4).

8.6.5 MEDICAL DEPARTMENT INDUSTRIAL HYGIENE RESPONSIBILITIES

Programmatic responsibilities specified in the IH program for the Medical Department are specified in Procedure Manual 4Q (Ref. 4).

8.6.6 RESPIRATORY PROTECTION

It is Site policy to protect employees from exposure to atmospheric contaminants (radioactive or non-radioactive) by using facilities and equipment with safeguards incorporated into their design. When effective engineering controls are not feasible, or while they are being initiated, protection is provided through the use of approved respiratory devices.

The Respiratory Protection Program Administrator has overall responsibility and authority for the Respiratory Protection Program (Ref. 9). An evaluation of the program is performed and documented periodically.

Engineering controls are the preferred method to protect employees from exposure to airborne contaminants, both radioactive and nonradioactive, within the workplace. PPE is the method of last resort. PPE, such as respirators, is only used during the time period necessary to install engineered controls, evaluate controls, or repair controls. They are also applied in work situations where engineered controls are not feasible and in emergencies. Respiratory protection requirements are controlled by specific procedures. Respiratory protection is discussed in the Procedure Manual 4Q (Ref. 4).
8.7 HAZARDOUS MATERIAL MONITORING

This section describes the hazardous material monitoring and control programs conducted inside, and outside, the boundaries of the facility. Records associated with the hazardous material monitoring and control programs satisfy the requirements relating to records management listed in Section 8.9.

8.7.1 HAZARDOUS MATERIAL MONITORING

Air monitoring for determining chemical exposures of facility personnel is addressed in Section 8.7.2. Medical Department responsibilities concerning hazardous material monitoring are discussed in Procedure Manual 4Q (Ref. 4). Water released from the CSTF is monitored at the Effluent Treatment Project before release through permitted outfalls (Procedure Manual 3Q, Ref. 10). Any specific hazards, such as leaks from the chromate-treated cooling water in the CSTF, are treated as process wastes, and recovery plans are prepared with the direct involvement of the Radiological Control Operations and IH staffs. Information addressing other aspects of hazardous material monitoring, such as facility installed monitoring equipment and associated equipment locations, is provided in Chapter 2.

8.7.2 AIR MONITORING

This section describes the airborne hazardous material sampling and monitoring programs conducted inside, and outside, the boundaries of the facility. Air monitoring is performed primarily for airborne radioactive contamination and is discussed in Chapter 7.

8.7.2.1 Air Monitoring in the Workplace

The IH program specifies requirements for workplace air sampling and data analysis.

Chapter 2 addresses air monitoring equipment selection, locations, instrumentation, and alarms used for radiological protection. General guidance and requirements for air monitoring are discussed in Procedure Manual 4Q (Ref. 4).

8.7.2.2 Air Monitoring Outside of the Facility

Airborne hazardous material sampling and monitoring programs conducted outside the boundaries of the facility are the responsibility of the M&O contractor in support of permit compliance records (Procedure Manual 3Q, Ref. 10).

Chapter 1 describes meteorology of the CSTF and general site.

8.7.3 HAZARD PREVENTION AND CONTROL

8.7.3.1 Site Program

The IH program establishes guidance for identifying and recommending effective engineering, work practices, and administrative controls to reduce employee exposure to occupational hazards (Procedure Manual 4Q, Ref. 4). This hazard prevention and control process is associated with
the hazard assessment process described in Section 8.6. This is a sitewide program and is discussed in Procedure Manual 4Q (Ref. 4).

8.7.3.2 **Hazard Prevention and Control Measures for Existing Operations**

The area industrial hygienist reviews work practices, maintenance records, and historical employee exposure records and, based on the results of these reviews, transmits any recommendations to the responsible facility manager for minimizing or eliminating employee occupational exposures. The facility manager implements engineering or administrative controls, as recommended, for work areas or process activities that represent potential exposure to workers (Procedure Manual 4Q, Ref. 4).
8.8 HAZARDOUS MATERIAL PROTECTION INSTRUMENTATION

Other than the instrumentation for radiological protection monitoring (referenced in Section 8.7 and discussed in Chapter 7), there is no special installed monitoring instrumentation for specific hazardous materials at the CSTF. Portable instruments for periodic hazardous material sampling are used and maintained by the IH technicians (see Section 8.3.1.1). Specialized sampling and analytical instruments are available from other site locations if they are required.
8.9 HAZARDOUS MATERIAL PROTECTION RECORD KEEPING

The records requirements within the IH program are discussed in Procedure Manual 4Q (Ref. 4). CSTF complies with the IH record control requirements as defined in the Records Inventory and Disposition Schedule.

8.9.1 DOCUMENT CONTROL OF PLANS AND PROCEDURES

Procedure Manual 4Q defines the plans and procedures that make up the IH program, including those governing operations involving hazardous materials (Ref. 4). These plans and procedures and their implementation are described in ESH-IHS-942350 (Ref. 11).

By a formally controlled process, IH plans and procedures (including changes) are reviewed for adequacy, approved for release by authorized personnel, and distributed to, and used at, the locations where hazardous materials are used, processed, or stored. This process includes the following activities:

- Site review activities
- Document control activities
- QA activities

These elements of the IH plans and procedures process are described in the following chapters:

- Chapter 12 presents the program for developing, maintaining, and modifying procedures.
- Chapter 14 describes the CSTF QA program.
- Chapter 17 addresses the document control program implemented at CSTF.
8.10  HAZARD COMMUNICATION PROGRAM

Within its special program requirements, the IH program establishes the SRS hazard communication program. This program implements the provisions of the OSHA hazard communication standard for communicating chemical hazards to employees at SRS and applies to chemicals known to be present in the workplace. This is a sitewide program and is specified in Procedure Manual 13B (Ref. 15).

8.10.1 MATERIAL SAFETY DATA SHEETS

Site rules require that all employees have access to MSDSs for the products they are required to use. MSDSs are readily available on the site network and at various locations. The CSTF Chemical Coordinator maintains one copy of the MSDS binders in each Facility Control Room and one copy in the Chemical Coordinator’s office. The location of department MSDS binders and identification of the departmental chemical coordinator are displayed on posters throughout CSTF work areas (Procedure Manual 13B, Ref. 15).

As MSDSs are obtained for chemicals currently used at SRS, they are reviewed for completeness, assigned a tracking number, and incorporated into the sitewide chemical listing (Procedure Manual 13B, Ref. 15).

8.10.2 INFORMATION AND TRAINING

The M&O contractor provides employees with information and training on hazardous chemicals in their work area at the time of their initial assignment, whenever a new hazard is introduced into the workplace, for non-routine tasks, and periodically, thereafter. This training consists of two programs supplemented by area-specific training: 1) employees who have been determined by line management to have a low potential for hazardous chemical exposure in the workplace attend basic hazard communication training for office/administrative personnel, and 2) employees who have a significant potential for exposure attend basic hazard communication training for operations personnel (Procedure Manual 13B, Ref. 15).
8.11 OCCUPATIONAL CHEMICAL EXPOSURES

Exposure assessments are performed at CSTF, reviewed annually, and updated as needed in accordance with the requirements of Procedure Manual 4Q (Ref. 4). The results of the assessments are used to maintain exposures ALAP by validating or improving hazard controls, to extend the same controls to employees in similar exposure groups, to support application of appropriate medical surveillance decisions, to monitor employee exposure, and to demonstrate compliance with regulations. If surveys indicate unusual levels of hazardous chemicals, engineering actions are taken to remove them or to provide protection from them.
8.12 REFERENCES


14. Industrial Hygiene Training Program Description. PROGIHP PDES 0001 04, Savannah River Site, Aiken, SC.

CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 9
RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

Revision 20
August 2017
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# ACRONYMS AND ABBREVIATIONS

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<td>ARP</td>
<td>Actinide Removal Process</td>
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<td>CSTF</td>
<td>Concentration, Storage, and Transfer Facilities</td>
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<td>DWPF</td>
<td>Defense Waste Processing Facility</td>
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<td>ESP</td>
<td>Extended Sludge Processing</td>
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<td>ETP</td>
<td>Effluent Treatment Project</td>
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<td>High-Efficiency Particulate Air</td>
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<td>Investigation Derived Waste</td>
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<td>LLW</td>
<td>Low Level Waste</td>
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<td>M&amp;O</td>
<td>Management and Operations</td>
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<td>Modular Caustic Side Solvent Extraction Unit</td>
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<td>SRNL</td>
<td>Savannah River National Laboratory</td>
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<td>TSD</td>
<td>Treatment, Storage, and Disposal</td>
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9.0 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT

9.1 INTRODUCTION

9.1.1 OBJECTIVE

This chapter provides information on the Savannah River Site (SRS) Radioactive and Hazardous Waste Management program that maintains safety for the management of radioactive and hazardous waste at the Concentration, Storage, and Transfer Facilities (CSTF).

9.1.2 SCOPE

This chapter addresses the origin and destination of the radioactive and hazardous waste streams that are dealt with at CSTF, as well as, any special activities and treatments that are applied.

Since the majority of the material handling done at CSTF involves either radioactive wastes or hazardous wastes, the organization described in Chapter 17 presents the organization for both radioactive and hazardous waste management.
9.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 1) states the codes, standards, and regulations governing the Radioactive and Hazardous Waste Management program (e.g., S/RID Functional Area 16). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 2). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
9.3 RADIOACTIVE AND HAZARDOUS WASTE MANAGEMENT PROGRAM AND ORGANIZATION

Since the major portion of the waste streams handled and stored at CSTF are radioactive, most of the handling and storing activities are performed under the Radiological Protection Program, implemented by Procedure Manual 5Q (Ref. 3). The protective procedures and equipment specified by the Radiological Protection Program also provide hazardous materials protection to the workers. Handling and storage of a few nonradioactive hazardous materials, such as nitric acid, oxalic acid, and sodium hydroxide, are performed under the Industrial Hygiene and Employee Safety programs, implemented by References 4 and 5, respectively.

9.3.1 CONCENTRATION, STORAGE, AND TRANSFER FACILITIES SOLID WASTE CERTIFICATION PROGRAM

As a generator of solid Low Level Waste (LLW) and Low Level Mixed Waste, the CSTF, management is responsible for minimizing the generation of waste and for providing solid waste generation forecasts to the Management and Operations (M&O) Contractor, which is responsible for the Treatment, Storage, and Disposal (TSD) Facility for LLW at SRS. CSTF management is also responsible for the following:

- Characterizing waste streams as required (Procedure Manual 1S, Ref. 6)
- Complying with requirements and criteria of the TSD facility
- Establishing auditable programs, as required (Ref. 6)
- Submitting waste certification plans for review and evaluation, as required (Ref. 6)
- Submitting requests for deviations from the requirements, as applicable (Ref. 6)

A Waste Certification Plan documents the organizations responsible for certification and packaging of solid radioactive wastes for onsite and offsite disposal (Procedure Manual 1S) (Ref. 7, 6). The Waste Certification Plan also specifies the training required; how the waste streams are generated, processed, and packaged; describes waste isotopic and analytical characterization; and defines the CSTF waste reduction program. Quality Assurance requirements and assessment of waste handling activities are also included.

9.3.2 ORGANIZATIONAL STRUCTURE

As noted in the introduction, the organization that manages the receipt, storage, and disposition of radioactive and hazardous waste at the CSTF is described in Section 17.3 for management of the day-to-day operations.
9.4 RADIOACTIVE AND HAZARDOUS WASTE STREAMS AND SOURCES

9.4.1 RADIOACTIVE WASTE

CSTF receives, transfers, and stores SRS liquid high level radioactive waste streams. Most of the High Level Waste (HLW) is produced from reactor fuel reprocessing. This HLW produces high levels of decay heat and external radiation due to high fission product concentrations, and contains high concentrations of transuranic radionuclides. The CSTF storage and treatment facilities are regulated under the Resource Conservation and Recovery Act and South Carolina regulations as wastewater treatment systems, subject to the Clean Water Act (Ref. 8). Liquid high level radioactive wastes are treated as process materials and are discussed in Chapter 2.

This section deals with gaseous, liquid, and solid radioactive wastes generated, or disposed of, at the CSTF in the process of performing its mission.

Gaseous waste handled at the CSTF consists primarily of very small amounts of tritium present in stored process waste, radon/thoron and fission product gases in the waste, and non-radioactive hydrogen and oxygen from radiolytic decomposition of water contained in the HLW being stored or transferred. The gaseous waste gradually collects in the vapor spaces of the HLW storage tanks and is removed by the tank ventilation systems after being passed through High-Efficiency Particulate Air (HEPA) filters.

9.4.1.1 Liquid Radioactive Waste Influents

Liquid radioactive waste to be stored and processed by the F-Area and H-Area tank farms is received from the following external sources:

- Fuel reprocessing facility (H-Canyon)
- Savannah River National Laboratory (SRNL)
- Reactor Areas
- Defense Waste Processing Facility (DWPF)
- Effluent Treatment Project (ETP) (concentrate)
- Central Laboratory

All waste streams being transferred into or through, the F-Area and H-Area transfer facilities for storage or processing must meet the CSTF Waste Acceptance Criteria (WAC). The originating facility prepares a Waste Compliance Plan, which verifies that the waste stream being shipped or transferred meets the CSTF WAC. Several transfers may be covered under one plan, provided the waste stream compositions are similar.

Liquid radioactive waste is also generated within the CSTF from the following:

- Waste Transfer Systems (flushing)
- Sludge washing
- Salt processing
- 299-H Waste Management Maintenance (decontamination)

Liquid radioactive waste is generated by H-Canyon during the recovery and purification segment of the reprocessing operation. At present, most of the reprocessing is dedicated to recovering stored and aged fissionable materials from the SRS or from other Department of Energy facilities. This waste is transferred to the CSTF via waste headers.

Small amounts of liquid waste generated by the SRNL (radioactive samples, laboratory wastes) and the Reactor Areas (disassembly basin water waste) are transported to the separations areas or CSTF by tank trailers or approved transport shipping casks. The waste is determined to be in compliance with the CSTF WAC prior to being transferred to the CSTF waste tanks.

Aqueous liquid waste, Melter Offgas System liquid waste, Actinide Removal Process (ARP) filtrate, and miscellaneous flush waters from the DWPF are returned to the CSTF. ARP filtrate consists of clarified salt solution fed to the Modular Caustic Side Solvent Extraction Unit (MCU) and concentrate sodium wash filtrate transferred to Tank 50.

Concentrate from the ETP evaporator that does not meet Saltstone Facility criteria and is returned to the CSTF.

These waste streams are concentrated by evaporation and stored in CSTF until ready for further processing.

9.4.1.2 Wastewater Streams (Effluents)

Sources of wastewater include the following:

- CSTF evaporator overheads
- Storm water to F-Area and H-Area retention basins
- Diverted cooling water from F-Area and H-Area cooling water basins
- Investigation Derived Wastes (IDW) from various SRS groundwater monitoring wells

Collected liquid IDW wastes are trucked to the ETP influent collection tanks and added to the stored influent, in accordance with WSRC-RP-94-1227 (Ref. 9).

These are transferred to the wastewater collection tanks in the ETP, where they are treated by a series of process units to remove any radioactivity, metal ions, or organics. After confirmation by sampling and analysis to verify that the products meet permitted quality, the water is released to Upper Three Runs Creek via National Pollutant Discharge Elimination System outfall H-016.

Evaporator overheads constitute about 90% of the CSTF liquid effluents. The other minor contributors are rainwater (less than 10%), which collects in various dikes (for Radiological Control Areas and chemical tanks), and the tank farm leak detection catch tank and IDW (less than 1%).
9.4.2 MIXED AND HAZARDOUS WASTE STREAMS

Only a very small quantity of mixed and hazardous wastes are generated at CSTF, largely because of effective programs in place to minimize the amounts generated. Before the maximum permitted quantity of stored waste accumulates at a designated storage area in the CSTF, it is sent to the TSD facility for recycling or disposal.

Procedures require that the amounts of mixed and hazardous waste expected and the amount received at the TSD facility are reported periodically; therefore, management actions can be taken to reduce the quantities in accordance with waste reduction and minimization programs specified in Procedure Manual 1S (Ref. 6).

The mixed and hazardous waste is managed in accordance with the requirements of Procedure Manual 3Q (Ref. 10) and Procedure Manual 1S (Ref. 6).

9.4.3 SOLID WASTE STREAMS

9.4.3.1 Solid Radioactive Waste

Solid radioactive waste is generated at the CSTF by process activities carried out in support of normal treatment operations. These activities result in the collection of radioactive contaminated solid waste, such as tools or contaminated job control waste generated during work performed by personnel in controlled areas. This waste is termed LLW.

9.4.3.2 Low Level Waste

LLW is radioactive waste that is not HLW, transuranic waste, spent nuclear fuel, byproduct material (as defined in Section 11e. (2) of the Atomic Energy Act, as amended), or naturally occurring radioactive material. LLW contaminated with HLW supernate is the largest volume of LLW originating from CSTF. This waste stream is easily identified by its high-energy gamma signature. Another waste stream, sludge, is identified by the alpha signature. Characterization of these waste streams is performed in accordance with References 11, 12, 13, 14.

Solid waste generated by process operations are packaged and disposed of in accordance with the requirements of Procedure Manual 1S (Ref. 6).

The origin of the CSTF LLW is discussed below.

9.4.3.3 Job Control Waste

Job control waste is generated during work performed by personnel in controlled areas. It consists of discarded protective clothing, gloves, shoe covers, plastic sheets, cellulose wipes, etc. It is packaged, and disposed of, in accordance with the requirements of Procedure Manual 1S (Ref. 6).
9.4.3.4 Ventilation Filters

Roughing and HEPA filters are extensively used in the ventilation and offgas systems in the CSTF. They are packaged, and disposed of, in accordance with the requirements of Procedure Manual 1S (Ref. 6).

9.4.3.5 Failed Process Equipment

Major process vessels have a life expectancy of approximately 20 years, based upon design criteria and SRS equipment histories. All of these are replaceable, as are the connecting piping and instruments. Large failed process equipment is dispositioned by one of the following methods: 1) decontaminated to the extent practicable and repaired; 2) size reduced and disposed of via current available options; or 3) stored as spare equipment for future evaluation. Procedure Manual 5Q and Chapter 16 discuss planning and procedural requirements for this decontamination and disposal work (Ref. 3).

9.4.3.6 Excavated Material

Excavated material is normally contaminated similar to job waste. Excavated material contamination can also occur due to leaks in underground waste transfer piping or waste tanks.

9.4.3.7 Packaging

LLW, consisting primarily of job waste (contamination control, filters, etc.), is characterized, packaged, and disposed of, in accordance with the requirements of Procedure Manual 1S (Ref. 6).

Records of volume, isotopic content, and estimated curie content for each shipment are maintained by the existing radioactive Waste Information Tracking System.

9.4.3.8 Waste Incidental to Reprocessing Evaluation

Waste incidental to reprocessing refers to a process for identifying waste streams that would otherwise be considered HLW due to their sources of generation or concentration, but can be managed in accordance with the DOE requirements for transuranic or LLW, if the citation or evaluation requirements for waste incidental to reprocessing are met (Ref. 16). The determination as to whether the waste meets citation or evaluation requirements is performed in accordance with Reference 15. Waste Incidental to Reprocessing is characterized, packaged and disposed of, in accordance with the requirements of Procedure Manual 1S (Ref. 6).

9.4.3.9 Characteristics, Concentration, and Volume of Solid Waste

All waste is characterized, as required, by Procedure Manual 1S (Ref. 6). The waste generation and shipment is forecast, as required, by Procedure Manual 1S. Any variance to the shipment forecast is analyzed and the shipment forecast is updated according to the requirements of Procedure Manual 1S.
9.5 REFERENCES

15. Waste Incidental to Reprocessing Citation Determination. Q-CIT-G-00001.
CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 10
INITIAL TESTING, IN-SERVICE SURVEILLANCE AND MAINTENANCE

Revision 20
August 2017
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10.0 INITIAL TESTING, IN-SERVICE SURVEILLANCE, AND MAINTENANCE

10.1 INTRODUCTION

10.1.1 OBJECTIVE

This chapter provides information on the Savannah River Site (SRS) programs under which initial testing, in-service surveillance, and maintenance activities are performed and the program requirements that govern these activities in the Concentration, Storage, and Transfer Facilities (CSTF).

10.1.2 SCOPE

This chapter provides a description of the initial testing, in-service surveillance, and maintenance programs established by Liquid Waste (LW) and describes the interfaces between the CSTF and the site level programs.

The scope of this chapter includes the following:

- Facility initial testing program
- Facility in-service surveillance program
- Planned, predictive, preventive, and corrective facility maintenance programs

In those cases where policies, programs, and practices important to safe operation are described in detail in other site documents, the information is summarized in this chapter and the documents are referenced.
10.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 1) states the codes, standards, and regulations governing initial testing, in-service surveillance, maintenance policies, and program elements (e.g., S/RID Functional Areas 9 and 10). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 2). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
10.3 INITIAL TESTING PROGRAM

This section summarizes the following test programs that ensure the operability of a facility or Structures, Systems, and Components (SSCs) in a facility:

- Pre-operational testing for initial startup
- Post-modification testing

Section 10.3.1 contains descriptions of the initial startup of a facility/process or restart testing of a facility/process following a major modification. Section 10.3.2 covers testing following modifications to a SSC and its related return-to-service requirements. This program can also be used to perform pre-operational testing following a major modification. Sections 10.4 and 10.5 describe the in-service surveillance and post-maintenance testing, respectively.

Procedure Manual 1Q, (Procedure 11.1) defines responsibilities for planning, performing and documenting tests (Ref. 7).

Procedure Manual E7 (Procedures 2.26 and 5.40) establishes the criteria for functional acceptance by testing of SRS facilities and process computer software (Ref. 9). Off-line testing of process software is performed by Procedure Manual E7, Procedure 5.40 (Ref. 9).

Site programs on testing which are defined in Procedure Manual 1Q (Procedure 11.1) and Procedure Manual 5E, are implemented in the Procedure Manual S4 (Ref. 7, 6).

10.3.1 TESTING OF FACILITY MODIFICATIONS

Procedure Manual 12Q establishes a formalized process for the startup/restart of nuclear facilities and processes (called nuclear activity startups) at SRS and provides procedures for the uniform conduct of Readiness Self-Assessments (RSAs), Operational Readiness Reviews (ORRs) and Readiness Assessments (RAs) (Ref. 3). Procedures in Procedure Manual 12Q identify the activities required to accomplish nuclear activity startups based on a graded approach (Ref. 3).

Procedure Manual 5E describes the requirements for an initial startup of a facility or the restart testing program to establish uniformity and consistency in developing and implementing the test program activities (Ref. 5). The scope of Procedure Manual 5E includes the startup/restart-testing activities of a facility from the completion of construction through the ORR (Ref. 5). Various phases of startup that would be applied to new or substantially modified facilities in the CSTF are described in Procedure Manual 5E (Ref. 5).

10.3.2 TESTING OF EQUIPMENT MODIFICATIONS

Procedure Manual E7 (Procedure 1.02) establishes responsibilities and activities for the configuration management process for controlling changes to SSCs and their associated documentation at SRS facilities (Ref. 9). Section 17.4.2 provides more details on configuration management. Among the configuration management requirements are requirements for modifying the configuration of a system and the subsequent testing of that modification prior to release for operation.
Procedure Manual S4 describes the program utilized to perform testing of modifications prior to release for operation (Ref. 6). This manual describes the LW test program, test procedure preparation, conduct of testing, and required qualification of test personnel. This test program methodology is also applied to facility restart activities.

10.3.3 ADEQUACY OF TESTING ACTIVITIES

Several elements of the initial testing, post-modification testing, in-service surveillance, and maintenance programs ensure that CSTF facilities are managed safely from the standpoint of testing facility equipment prior to facility startup and prior to use of the equipment following maintenance or modifications. These program elements are described in other sections of this chapter, as indicated in the following paragraphs.

As discussed in Section 10.3.1, Procedure Manual 5E defines the requirements for testing equipment prior to startup/restart of a facility (Ref. 5). Procedure Manual 5E provides detailed descriptions of the different programmatic areas considered, the responsibilities of organizations involved, and training and qualification requirements for personnel involved in the startup/restart process (Ref. 5).

Section 10.3.2 discusses modification of a system or a piece of equipment. Procedure Manual E7 (Procedure 1.02) describes the detailed requirements in place to control the configuration of SRS SSCs (Ref. 9). Chapter 4 identifies safety-related SSCs in the CSTF that require configuration management.

Surveillance testing of SSCs and testing following routine maintenance is discussed in Sections 10.4 and 10.5, respectively. These sections also discuss training and qualification of personnel, responsibilities of personnel, and the SRS guidance governing these testing programs.

10.3.4 STARTUP TESTING ACTIVITIES

Startup activities are conducted in accordance with the requirements of the Quality Assurance Program (QAP) described in Procedure Manual 1Q (Ref. 7). Details of the activities, including responsibilities, test plan, test procedures, control of testing, documentation of test results, tracking test deficiencies, and qualification of test personnel are described in Procedure Manuals 5E and S4 (Ref. 5, 6).
10.4 IN-SERVICE SURVEILLANCE PROGRAM

In-service surveillance and inspections at the CSTF are performed in accordance with Procedure Manuals S4 and 1Q (Ref. 6, 7). These require periodic inspections, ranging from management walkthroughs to detailed facility inspections, to ensure that proper conditions are maintained to support safe and reliable facility operations. This section addresses implementation of the requirements of Procedure Manual 1Y in the CSTF (Ref. 8).

10.4.1 PROVISIONS FOR TESTING AND CALIBRATIONS

Surveillance, inspection, and testing activities verify that the equipment needed for the safe and reliable facility operation performs within the required limits and that the functional tests of the installed equipment and/or systems are conducted and documented as part of the surveillance program. Abnormalities found during these surveillances are reported immediately to management. The effectiveness of the maintenance surveillance program is evaluated, periodically, by facility management and the results of the evaluations are used to identify any necessary program improvements.

Procedure Manual 1Q provides the program requirements and responsibilities for planning, performing, and documenting CSTF tests (Ref. 7). Consistent with the above-stated requirements, Procedure Manual 1Q specifies the type and extent of test controls to be applied to systems, subsystems, components, and items, based on the functional classification assigned to it (Ref. 7). The SSCs covered in the Surveillance Inspection program are identified in Chapter 4. The surveillance testing and calibration of Technical Safety Requirements (TSRs) related components are identified in the TSRs. Management of the surveillance test program is discussed in Procedure Manual S4 (Ref. 6).

10.4.2 CONTROL AND CALIBRATION OF MEASURING AND TEST EQUIPMENT

Section 10.5.5 discusses the control and calibration of Measuring and Test Equipment (M&TE), as well as, Installed Process Instrumentation (IPI). The requirements of Procedure Manual 1Q also apply to M&TE and IPI used for in-service surveillance, and are detailed in Procedure Manual 1Q, Procedures QAP 12-1 and 12-2 (Ref. 7).

10.4.3 TRENDING OF SURVEILLANCE TEST RESULTS

Trending data is acquired as part of the maintenance surveillance program for long-term performance evaluations. Section 10.5.6 discusses trending of historical data obtained from various sources, including surveillance tests. The guidelines described in that section also apply to trending of surveillance test data for various uses in improving the maintenance program.

10.4.4 PROGRAMMATIC REVIEW

Procedure Manual 1Y states that inspections, audits, reviews, investigations, and self-assessments are necessary for an effective maintenance program (Ref. 8). It recommends that senior managers periodically review and assess elements of the maintenance program to assist line managers and supervisors in identifying and correcting program deficiencies.
Section 17.4 discusses formal self-assessment and facility programmatic review processes in more detail.

Procedure Manual 1Q provides guidance for conducting inspections, including In-Service Inspections (ISIs), of specified SSCs (Ref. 7). An ISI is an inspection performed on operable equipment to verify that characteristics of an item remain in compliance with specified requirements. The cognizant technical function and cognizant quality function for a particular facility are responsible for evaluating the processes, activities and items for which they are responsible and for establishing the level, extent, and acceptance criteria for inspections. The basis for the assignment, level, and intensity of inspections is directly related to functional classifications or design document requirements.

The ISI program at CSTF facilities is called the Structural Integrity (SI) program. This program provides for the conduct of ISI of critical SSCs and their supports. The critical SSCs covered in the SI program are identified in Chapter 4. The surveillance testing and calibration of TSR related components are identified in the TSRs. SI is a process to determine those inspections or measurements that need to be performed on the SSCs to ensure that they will perform their intended design functions under operational and accident conditions. This program provides reasonable assurance that the evidence of structural or functional degradation during services is detected to permit corrective action before the function of the SSC is compromised. The SI program is also a predictive maintenance activity that complements the overall Nuclear Maintenance Management Program (NMMP). Procedure Manual S4 defines the requirements and responsibilities for initiating, preparing, reviewing, approving, issuing, and controlling SI datasheets, as well as, reporting and trending the resultant information (Ref. 6).

ISIs are planned by the organization performing the inspection and are approved by the Design Authority and the cognizant quality function.

10.4.5 TRAINING OF SURVEILLANCE TESTING PERSONNEL

Section 12.4 discusses training of maintenance personnel. The requirements of Procedure Manual 4B described in that section also apply to training conducted for in-service surveillance personnel (Ref. 4).
10.5 MAINTENANCE PROGRAM

The NMMP Description Document is the single site document that identifies the policies, programs, procedures, and processes that provide the requirements for planning and executing maintenance activities to ensure SSCs are maintained and operated within the approved safety basis for each division and facility (Ref. 11). Maintenance activities at CSTF are conducted in accordance with Procedure Manual 1Y (Ref. 8), which provides implementing procedures for sitewide consistency and is controlled by the NMMP. The maintenance facilities and equipment are described in Chapter 2. This section addresses the CSTF implementation of the requirements in Procedure Manual 1Y (Ref. 8), as described in the NMMP Description Document (Ref. 11).

10.5.1 MAINTENANCE ORGANIZATION AND ADMINISTRATION

The organization and administration of the maintenance function ensures that a high level of performance in maintenance is achieved through effective implementation and control of maintenance activities. This goal is achieved primarily by establishing written policies, procedures, standards for maintenance, and by periodically observing and assessing performance.

Procedure Manuals 1Y and S4 establish the requirements and responsibilities for the maintenance organization and administration of the LW maintenance program (Ref. 8, 6). It is a primary responsibility of Maintenance Management to ensure the implementation of site and business unit policies that affect the maintenance organization. Maintenance organization procedures support contractor management and facility maintenance policies. Procedure Manual 1Y defines the responsibilities for implementing these policies, including the responsibilities of maintenance personnel (Ref. 8). Maintenance personnel must clearly understand their authority, responsibility, accountability, and interfaces with other groups. Procedures or other definitive documents specify policies that are used to guide maintenance organization activities. These documents also specify the types of controls necessary to implement maintenance policies.

Procedure Manuals 1Y and S4 describe the CSTF maintenance program and state the organization, responsibilities, interface, and qualification requirements of the CSTF maintenance department (Ref. 8, 6). The CSTF Maintenance organization provides support to the Closure Project Manager and Operations Manager (see Section 17.3.2). The CSTF Maintenance organization provides the following:

- Various aspects of maintenance of CSTF facilities and ensuring that the training and qualification program adequately supports the requirements of the department, the site, and the DOE
- Maintaining CSTF in a safe, quality, cost effective manner; ensuring compliance with site programs, industry standards, and applicable DOE Orders consistent with LW Mission Statements
- Monitoring and ensuring that maintenance activities comply with the TSRs, existing procedures, applicable regulations, policies, and programs
The Work Control System provides the programmatic method of work control within CSTF (Ref. 8).

10.5.2 TRAINING AND QUALIFICATION OF MAINTENANCE PERSONNEL

Maintenance managers are responsible for helping to select high-quality personnel for maintenance responsibilities. These managers are involved in defining entry-level criteria and in screening new personnel. A maintenance training and qualification program is required by Procedure Manual 4B to develop and maintain the knowledge and skills needed by maintenance personnel to effectively perform maintenance activities (Ref. 4). Maintenance managers are directly involved in training maintenance personnel.

The site training organization implements maintenance training programs that meet the intent of established industrial guidelines and that address specific company and facility needs. These programs are supported and guided by the maintenance organization.

On-the-Job Training (OJT) is a formal part of the maintenance-training program. Section 12.4 provides further information regarding OJT, training program development, and requirements.

10.5.3 MAINTENANCE FACILITIES, EQUIPMENT, AND TOOLS

Adequate maintenance facilities and equipment are available to support the entire range of facility operations and maintenance training activities. To determine the adequacy of maintenance facilities, equipment, and tools, assessments of the maintenance facilities are performed in accordance with the requirements of SCD-4 (Ref. 10).

10.5.4 POST-MAINTENANCE TESTING

Post-maintenance testing is performed to verify that components and systems are capable of performing their intended function when returned to service following maintenance and to ensure that the original deficiency is corrected and that no others are created. A post-maintenance test is performed after selected corrective maintenance activities and after some preventive maintenance activities. The test performed is commensurate with the maintenance work performed and the importance of the equipment to safe and reliable operations. The post-maintenance testing program includes the following (Ref. 8):

- Determining post-maintenance test requirements
- Determining the scope of post-maintenance testing to ensure that appropriate levels of testing are applied to facility equipment and that redundant testing is minimized
- Tracking the status of equipment that has undergone maintenance to ensure that all testing is completed prior to the equipment being returned to service
- Conducting proper post-maintenance tests, documenting the results, and verifying that the resulting data meet acceptance criteria
Test requirements and acceptance criteria are obtained from the following sources (Procedure Manual 1Y, Ref. 8):

- Plant modification traveler
- Temporary modification package
- Selected maintenance activities and post-maintenance tests
- Maintenance history
- Vendor manuals
- Facility operations
- Cognizant technical function and other sources

Procedure Manual 1Q requires that a program be established to control post-maintenance testing, particularly for cases where more than one group is involved in the testing (Ref. 7). At CSTF, Facility Operations is responsible for maintaining the status of incomplete, post-maintenance testing and for coordinating post-maintenance testing performance. The operations organization reviews the completed post-maintenance test results and approves the Work Order to document the satisfactory completion of the maintenance/modification work.

10.5.5 CONTROL AND CALIBRATION OF MEASURING AND TEST EQUIPMENT

Procedure Manual 1Q requires that a program for the control and calibration of M&TE should be instituted to ensure the accurate performance of facility instrumentation and equipment for testing, calibration, and repairs (Ref. 7). M&TE includes all devices or systems used to inspect, test, calibrate, measure, or troubleshoot in order to control or acquire data for verifying the conformance of an instrument or piece of equipment to specified requirements. M&TE is calibrated and controlled in accordance with the requirements of Procedure Manual 1Q (Ref. 7).

10.5.6 MAINTENANCE HISTORY AND TRENDING

An equipment repair history and trending program has been established for selected equipment and is maintained to provide historical information for maintenance planning and to support the maintenance and performance trending analysis of facility systems and components (Procedure Manual 1Y, Ref. 8). The equipment repair history is used to support maintenance activities, upgrade maintenance programs, optimize equipment performance, and improve equipment reliability. The equipment history program allows the retrieval of information on equipment maintenance and performance in order to improve facility reliability. This data, combined with operating experience at similar facilities, operating logs and records, and facility performance monitoring data, are used in analyzing trends and failures in equipment performance and in making adjustments to the maintenance program.

Maintenance trending, the process used to evaluate recurring maintenance problems and to propose corrective actions for maintenance-related problems, is applied to selected equipment to ensure that a systematic analysis methodology is used to determine and correct root causes of problems, unplanned events and occurrences related to maintenance activities.
Procedure Manual 1Y describes the Maintenance History program used at CSTF for the collection of maintenance documentation and data, for generation of historical information to support maintenance work planning, and for the trending of systems and components (Ref. 8).
10.6 REFERENCES


CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 11
OPERATIONAL SAFETY

Revision 20
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11.0 OPERATIONAL SAFETY

11.1 INTRODUCTION

11.1.1 OBJECTIVE

This chapter provides information on the Savannah River Site (SRS) Conduct of Operations and Fire Protection programs and the program requirements that maintain operational safety at the Concentration, Storage, and Transfer Facilities (CSTF).

11.1.2 SCOPE

This chapter discusses general aspects of operational safety and fire protection. It specifically focuses on the bases of operations programs specified by Department of Energy (DOE) Order 422.1, as implemented in the CSTF (Ref. 1). Fire Protection is implemented by Procedure Manual 2Q (Ref. 11) as specified in DOE Order 420.1C (Ref. 18).

The scope of this chapter includes the following:

- Identification of aspects of the Conduct of Operations program
- Integrated summary of the main features of the Conduct of Operations program
- Description of the Fire Protection Program

When required information is provided in another chapter of this Documented Safety Analysis (DSA), that chapter is referenced to limit repetition. In those cases where policies, programs, and practices important to safe operation are described in detail in other site documents, the salient features are summarized for inclusion in this chapter and the documents are referenced.

This chapter of the CSTF DSA describes the interfaces between the site and business unit-level operational safety programs and those for the CSTF.
11.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 2) states the codes, standards, and regulations governing the operational safety policies and program elements of the Conduct of Operations program (e.g., S/RID Functional Area 9) and Fire Protection program (Functional Areas 12 and 18). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 3). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
11.3 CONDUCT OF OPERATIONS

In accordance with DOE Order 422.1, a Conduct of Operations program has been established to enhance the safe operation of its facilities at the SRS (Ref. 1). Conduct of Operations requirements apply to the programs and functions of SRS operations that may have an impact on the safety of the public, environment, and site personnel (Procedure Manual 2S [Ref. 4]).

Conduct of Operations is defined here as the minimum acceptable level of performance expected of operations and support personnel required to maintain safe operations. These activities may vary widely, from the performance of a chemical analysis of ground water samples to the processing of High Level Waste for transfer to the Defense Waste Processing Facility. Regardless of the degree of complexity, the same quality level of performance is expected. Conduct of Operations also requires a commitment to continuous improvement.

The site Conduct of Operations program is implemented at CSTF through Procedure Manual 2S (Ref. 4). Procedure Manual 2S describes the methods for implementing the program requirements. The CSTF applies these detailed requirements directly to the Conduct of Operations training. Implementing instructions are generally given through Standing Orders, Shift Orders, and logbooks.

11.3.1 SHIFT ROUTINES AND OPERATING PRACTICES

The Conduct of Operations program specifies the shift routines and operating practices that apply to operations and support personnel at CSTF. The program includes standards for professional conduct, good watch standing practices, equipment monitoring, and management responsibilities that are fundamental to operating a facility. Operations personnel respond to instrument indications and alarms until such indications and alarms are proven to be false. The Shift Manager/First Line Manager/Control Room Manager is promptly notified of changes in facility status, abnormalities, or difficulties encountered in performing assigned tasks. Operators are trained to shut down the process using approved procedures if system parameters for trips or safety systems exceed their actuation setpoint and automatic actuation does not occur.

11.3.1.1 Facility Operating Practices

The Shift Manager/First Line Manager/Control Room Manager directs the overall operation of the assigned facility.

Operators complete surveillance rounds for systems within their assigned watch station on specified frequencies. Each round is of sufficient detail to ensure that the status of equipment is known. Operators also ensure that standby equipment is fully operational. Operators take appropriate action to correct or report deficiencies noted during rounds. Management ensures that appropriate corrective action has been initiated for each abnormal condition noted in round sheets and/or logbooks. A record or indication of the current operational status of major equipment is maintained within the appropriate control room area.

Operations personnel must follow good radiological protection practices and must also minimize exposure to chemicals, electromagnetic fields, toxic materials, and other personnel hazards. As
part of the As Low As Reasonably Achievable program, operations management personnel periodically review exposure trends of operations personnel under their supervision (Ref. 5).

11.3.1.2 Resetting of Alarms or Protective Devices

Personnel do not modify alarm, interlock, or equipment-operating setpoints unless such action is specifically authorized by approved operating procedures or work orders. Protective devices (e.g., circuit breakers, fuses) are not reset except in accordance with guidelines established in Procedure Manual 2S (Ref. 4). Control Area (CA) alarms are verbally announced by Control Room Operators (CROs) before acknowledgment and appropriate actions are taken to address the cause of the alarm and clear alarm conditions. Alarm status is addressed in Section 11.3.5. Control of alarm setpoints is specified in Procedure Manual S4, Procedure ENG.26 (Ref. 16). Facility restoration plans address recovery of protective device actuation (interlocks) for major systems and components.

11.3.1.3 Key Control

To facilitate control over keys that are used in day-to-day operations, a key accountability log is in place. Key accountability is maintained by conducting routine inventories.

11.3.1.4 Overtime

General overtime guidelines are provided for operations and support personnel. Additional restrictions for overtime control and ensuring personnel are alert and fit for duty are specified in Procedure Manual S16 (Ref. 7).

11.3.2 CONTROL AREA ACTIVITIES

Procedure Manual 2S establishes guidelines and requirements for performance of CA activities to ensure that CA activities are conducted in a business-like manner and that distractions, such as nonessential personnel traffic, are minimized (Ref. 4). The guidelines and requirements apply to facility operations, support personnel, and to activities conducted in the continuously manned CAs of the facilities.

11.3.2.1 Control Area Identification and Access

CAs in the CSTF are located at 241-18F, 241-2H, and 241-28H (refer to Chapter 2 for control room functions). As part of the F-Area Tank Farm control room consolidation project, control room functions historically performed using the 241-18F Control Room will be transitioned to the 241-2H Control Room. A skid mounted Mobile Waste Removal Control Center or Electrical Equipment Skid, which is designed to be movable from one tank to another, supports waste removal operations in the CSTF and may serve as a CA. The CAs are clearly identified by signs and entry requirements are posted at the entrances. Only designated personnel may grant entry to a CA. During periods of abnormal or emergency operations, the Shift Manager/First Line Manager/Control Room Manager normally directs nonessential personnel to exit the CA.

CA activities are performed in a disciplined, formal, business-like, and professional manner. Only activities essential to supporting operation and activities authorized by management are
conducted. Facility business is conducted in a manner that neither distracts on-duty control personnel nor compromises the professional atmosphere of the CA.

11.3.2.2 Monitoring Control Panels and Ancillary Duties

Operators monitor control panel indications and alarms in accordance with CA round sheet requirements and upon assuming duties for the assigned watchstation. Emphasis is placed on closely monitoring and trending control panel data to detect problem situations early and take prompt action to determine the cause of, and correct, abnormalities.

Secondary duties include the installation of lockouts, completion and review of operating procedures, required reading, coordination of maintenance and surveillance activities for equipment, and maintaining status boards and logs. This administrative workload is minimized for CROs by providing a separate workstation for CA support.

11.3.2.3 Operation of Control Area Equipment

Only operations and support personnel specifically authorized by facility procedures operate control room equipment. When trainees operate this equipment, they are supervised and controlled by the qualified operator who is responsible for the performance of the operation.

11.3.3 COMMUNICATIONS

Procedure Manual 2S provides guidance and requirements for communications within the facility during normal, abnormal, and/or emergency conditions, including guidance and requirements for both individuals sending communications and individuals receiving communications (Ref. 4).

11.3.4 CONTROL OF ON-SHIFT TRAINING

The Conduct of Operations program specifies requirements for control of on-shift training by facility personnel. On-shift training is the portion of a qualification program where the trainee receives as much hands-on experience as possible in the work environment. The requirements apply to operations personnel training and qualifications performed in the facility as part of the shift or normal work routine.

The On-shift Training Program is developed and approved and the training is documented in accordance with the requirements of the Conduct of Operations program, Procedure Manual 2S (Ref. 4) and Procedure Manual 4B (Ref. 8).

11.3.5 CONTROL OF EQUIPMENT AND SYSTEM STATUS

To satisfy design bases and operational limits, the proper component, equipment, and system configurations are established and maintained. The Conduct of Operations program (Procedure Manual 2S) provides instructions for system alignments, locking of components, authorization to remove or restore equipment to service, documentation of equipment deficiencies, and the use and maintenance of facility status board(s) (Ref. 4).
These requirements apply to facility operations and support personnel responsible for administrative controls, procedures, and requirements that govern equipment and system status. This program applies to safety related Structures, Systems, and Components (SSCs), essential support SSCs, and to other SSCs designated by management.

11.3.6 LOCKOUTS AND TAGOUTS

The use of lockouts and tagouts for the purpose of hazardous energy control is implemented at CSTF in accordance with requirements specified in Procedure Manual 8Q (Ref. 9).

11.3.7 VERIFICATION

Verification is performed in those cases where a reasonable potential exists for component mispositioning or where the consequence of error is great. The application of the program is dependent upon the safety and operations considerations of each process, system, or facility. Those systems or components that require verification are designated by the facility in facility procedures or Standing Orders.

Verifications involving hazardous energy control are performed in accordance with requirements specified in Procedure Manual 8Q (Ref. 9).

11.3.8 LOGKEEPING

The requirements for establishing and maintaining operating logs for key operations positions are specified to fully record the data necessary to provide an accurate history of facility conditions. Operating logs provide a system for ensuring that pertinent information is passed from one shift to the next, allows the history of a key position to be reviewed in event reconstruction, and supports trending analysis.

Operations Management identifies the personnel to make entries into the shift operating log and provide guidance to define the scope of information to be maintained in each shift operating log. Personnel making entries in operating logs fully document all data necessary to provide an accurate shift history. The types of information that should be recorded in operating logs are delineated in Procedure Manual 2S (Ref. 4).

11.3.9 OPERATIONS TURNOVER

The facility shift turnover process ensures that relief personnel are provided with the knowledge required to accomplish their shift assignment responsibilities. Procedure Manual 2S (Ref. 4) provides details on conducting an orderly and accurate transfer of information regarding the overall status of the facility at shift turnover and specifies shift turnover checklists and shift turnover responsibilities.

11.3.10 OPERATIONAL ASPECTS OF FACILITY UNIQUE PROCESSES

Operational monitoring of CSTF-unique data and parameters ensures that parameters are properly maintained. Monitoring parameters is important to verifying the system operation in accordance with the design expectations. In order to enhance proper process control of systems,
operations personnel must have an understanding of CSTF processes and must effectively coordinate operations activities with Liquid Waste Engineering.

Facility Managers are responsible for ensuring that all operations-specific responsibilities are defined through approved operations procedures and that specific process training is appropriately addressed. The managers shall also ensure that process requirements within the facility are properly identified and implemented.

11.3.11 REQUIRED READING

The Required Reading program is a method for ensuring that individuals are kept informed of important information to enhance their ability to perform their job assignment effectively. Procedure Manual 2S provides the guidance and requirements for documentation, responsibilities, and the reading material that can be included in the Required Reading program (Ref. 4).

11.3.12 TIMELY ORDERS TO OPERATORS

Shift Orders are issued to communicate short-term information and administrative instructions to shift personnel. Information, such as special operations, increased frequency in monitoring certain parameters, classification of administrative instructions, etc., is conveyed in Shift Orders.

Standing Orders are issued to communicate long-term information and administrative instructions to shift personnel. Procedure Manual 2S provides the guidance and requirements for the approval, issuance and maintenance of both Standing Orders and Shift Orders (Ref. 4). Standing Orders and Shift Orders are not to be used in lieu of approved operating procedures or as a means to circumvent necessary procedure changes. If the Standing or Shift Orders cannot be followed or completed as written, they should be revised only after approval by the issuing authority or designated alternate.

11.3.13 OPERATOR AID POSTINGS

The operator aid program describes the requesting, authorization, documentation, placing, and reviewing process used to ensure that operator aids are current, complete, and necessary.

Operators frequently make use of information, such as tables or graphs of tank volumes and chemical concentrations. All such information must be controlled to ensure that the information is the latest revision. Procedure Manual 2S describes the requesting, authorization, documentation, placing, and reviewing required to ensure that operator aids are current, complete, and necessary (Ref. 4).

11.3.14 EQUIPMENT AND PIPING LABELING

The equipment and piping labeling program provides the general guidelines required to establish and maintain a standardized and consistent labeling program for permanent identification of plant equipment, valves, instruments, and piping. Procedure Manual 2S provides additional guidance and requirements for labeling requests, temporary label approval and installation, label specifications, label ordering, label installation, and program maintenance (Ref. 4).
Labeling of piping, containers, and vessels containing hazardous materials for the purpose of hazard communication is in accordance with the Occupational Safety and Health Administration requirements specified in Procedure Manual 3B (Ref. 10).
11.4 FIRE PROTECTION

The SRS Fire Protection Program is established in Procedure Manual 2Q (Ref. 11). In addition the CSTF supplements this manual with the Fire Protection Program Plan (Ref. 12).

11.4.1 FIRE HAZARDS

The specific fire hazard analyses for the CSTF are contained in References 19 and 20. These references analyzed the CSTF to ensure the objectives of DOE Orders for fire protection are met. These comprehensive assessments included facility structures within the CSTF boundaries. The structures included the waste storage tanks, evaporators, diversion boxes (DBs), pump pits (PPs), control rooms, and ancillary facilities. From this process, any identified deficiencies are tracked to closure by the CSTF to ensure compliance with applicable requirements.

In addition to the fire hazard analyses, the main fire protection issues of interest from Chapter 3 associated with potential combustible or explosive loading in proximity to hazardous materials are described in the following sections.

11.4.1.1 Waste Tanks

The waste tanks contain supernate, salt solution, or sludge which can generate hydrogen via radiolysis and other methods described in Chapter 3. The flammable vapor concentrations are maintained at safe levels by following the requirements of Chapter 3.

11.4.1.2 Transfer Facilities

The transfer facilities (e.g., DBs, valve boxes [VBs], pump tanks, PPs) are mainly located below grade and are adequately separated from nearby facilities. The transfer facilities contain some combustible material; however, combustible material loading is controlled through the Fire Protection Program. Flammable vapors may accumulate during and following waste transfer activities and present an explosion hazard, but these concentrations are maintained at safe levels by following the requirements of Chapter 3.

11.4.1.3 Evaporators

The primary fire hazard of the 242-16H and 242-25H Evaporator structures consists of potential hydrogen buildup. The flammable vapor concentrations are maintained at safe levels by following the requirements of Chapter 3. The 242-16H and 242-25H Evaporator Cells contain some combustible material; however, combustible material loading is controlled through the Fire Protection Program. The 242-F, 242-16F, and 242-H Evaporators currently contain minimal waste and perform no processes; thus, there is minimal potential for a fire to affect hazardous materials.

11.4.1.4 299-H/ARP/MCU

Risk from fires in the Waste Management Maintenance Facility (299-H), Actinide Removal Process (ARP) (241-96H), and Modular Caustic Side Solvent Extraction Unit (MCU) (241-278H) is sufficiently managed due to implementation of the Fire Protection Program.
11.4.2 FIRE PROTECTION PROGRAM AND ORGANIZATION

11.4.2.1 Fire Protection Program

CSTF follows the Fire Protection Program as described in Procedure Manual 2Q (Ref. 11).

The objectives of the Fire Protection Program are:

- Minimize the potential for occurrence of a fire or related event.
- Minimize the potential for a fire that causes an unacceptable onsite or offsite release of hazardous or radiological material will threaten the health and safety of employees, the public, or the environment.
- Minimize the potential for unacceptable interruption of vital DOE programs as a result of fire and related hazards.
- Minimize the potential for property losses from a fire and related events exceeding defined limits established by DOE.
- Minimize the potential for fire damage to critical process controls and safety class systems, structures, and components as documented by appropriate safety analysis.
- Implement a comprehensive fire safety and emergency response program to protect works commensurate with the nature of the work that is performed.
- Meeting or exceeding applicable building code and National Fire Protection Association (NFPA) Codes and Standards unless explicit written relief has been granted by the Authority Having Jurisdiction.

The policy of the Fire Protection Program is a commitment to supporting a level of fire protection and fire suppression capability sufficient to minimize losses from fire and related hazards consistent with the best class of protected property in private industry (“highly protected risk” or “improved risk”).

11.4.2.1.1 CONTROL OF IGNITION SOURCES

Restrictions on the use of ignition sources, such as cutting, welding, and grinding activities in the CSTF, are provided through a Hot Work permit program. This program requires a pre-work inspection of the work site, an issuance of a control permit, and the establishment of a fire watch/patrol before, during, and after, work has been completed.

11.4.2.1.2 FIRE WATCHES AND PATROLS

Fire watches/patrols are instituted as required by procedure or whenever it is necessary to maintain an adequate level of fire safety within a designated area (e.g., fire protection systems removed from service or an unusual hazardous operation, having potential for a fire, is ongoing). Personnel performing fire watch/patrol duties are trained and qualified in accordance with Procedure Manual 2Q (Ref. 11). Fire Watch/Fire Patrol activities are performed in accordance with Procedure Manual 2Q (Ref. 11).
11.4.2.2 Fire Protection Organization

The Fire Protection Organization consists of personnel from each of the three main contractors at SRS. The Management and Operations (M&O) Contractor is responsible for management of the Fire Department, SRS Operations Center (SRSOC), Emergency Operations Center (EOC), and Maintenance Organization. The LW Contractor is responsible for operation of the CSTF. The SRS security contractor is responsible for security.

11.4.2.2.1 SRR CST OPERATIONS

The Facility Manager has overall management responsibility for the implementation of the Fire Protection Program Plan within the CSTF. Responsible positions in Operations include the following:

- Facility Manager
- Facility Support Manager
- Facility Shift Manager
- Facility Fire Protection Coordinator
- First Line Manager
- Control Room Manager
- Work Control Manager
- Chemical Coordinator
- Facility Operators

Duties and areas of responsibility for each position are provided in detail in Reference 12.

The Facility Engineering Manager has responsibility for the establishment of the CSTF Fire Protection Program, including the following:

- Approve facility design modifications to the CSTF
- Perform engineering and Fire Protection System reviews of design modifications to identify necessary changes to operating, control, and/or surveillance procedures
- Develop and implement configuration control procedures

11.4.2.2.2 ENGINEERING PROCESSES ORGANIZATION

Oversight of the site Fire Protection Program and self-assessment program ensures that facilities meet the requirements of DOE Orders. Self-assessments are performed by facility personnel per SCD-4 (Ref. 15).
11.4.2.2.3 SRS FIRE DEPARTMENT AND SRSOC/EOC

The SRS Fire Department is responsible for the following:

- Emergency response activities
- Submitting an annual fire loss summary to DOE
- Developing and updating the facility pre-fire plans

These are discussed in Procedure Manual 2Q (Ref. 11). More detail on the SRS Fire Department can be found in Section 11.4.4.1.

Centralized emergency support facilities, such as SRSOC (manned at all times) and EOC (partially staffed during an Operational Emergency and fully staffed during an emergency classification of Alert or higher) are discussed in SCD-7 (Ref. 6).

11.4.2.2.4 MAINTENANCE

The M&O Maintenance Organization provides fire protection maintenance to the CSTF.

11.4.2.2.5 SUPPORT ORGANIZATIONS

The Electrical and Instrumentation Maintenance, Radiological Control Operations (RCO), and SRS security contractor organizations provide emergency response support at the fire scene, as needed by the Incident Scene Coordinator, Shift Manager/First Line Manager/Control Room Manager, or Area Emergency Coordinator.
11.4.3 COMBUSTIBLE LOADING CONTROL

Procedure Manual 2Q (Ref. 11), Procedure 5.5 establishes requirements for managing the combustible control limits within the facilities at SRS. As structured, it differentiates materials into three categories:

- Use and handling
- Storage and Staging
- Flammable/combustible liquids, compressed gases and aerosol products, which are covered by Procedure Manual 2Q, Procedure 5.2 (Ref. 11)

The use and handling requirements are goal driven. The intent is to minimize the accumulation of transient combustibles, use harder-to-ignite materials where alternatives exist, and limit the potential for waste ignition.

Storage of transient combustibles is limited to those areas designated by the Fire Protection Engineer (FPE). The FPE sets the limits on the permissible types and quantities of transient combustible materials to be stored.

Procedure Manual 2Q (Ref. 11), Procedure 5.2 establishes requirements for handling, transfer, and use separate from those requirements related to storage. It establishes specific quantitative limits for flammable liquids, combustible liquids, flammable gases and aerosol containers based on the buildings occupancy and protective features.

Administrative controls (e.g., Standing Orders and procedures) have been established to ensure that conditions within the facilities are maintained consistent with the objectives of the Fire Protection Program.
11.4.4 FIRE FIGHTING CAPABILITIES

SRS employees are trained to notify the SRS Fire Department in the event of a fire alarm and to use fire extinguishers to contain incipient fires consistent with their capabilities. The CSTF Incident Scene Coordinator is the point of contact for the Fire Department and is the operations representative for coordination of activities at the fire scene. The Incident Scene Coordinator ensures that Fire Department personnel are directed to the fire scene and assists them during their fire suppression efforts (Ref. 12).

11.4.4.1 SRS Fire Department

The SRS Fire Department is the primary firefighting organization for the site. The department responds with sufficient emergency equipment to ensure suppression of fire at an affected facility. The Fire Department Captain directs fire-fighting activities at the fire scene with support from the Incident Scene Coordinator.

The SRS Fire Department maintains fire stations at strategic locations and the fire control preplans for each facility where required, which provide necessary information in fighting a fire.

The SRS Fire Department has three fire stations on-site. Each station and the equipment available for the fire department response to a fire in the CSTF is described and analyzed within Reference 17. This document establishes the minimum number and types of response personnel and apparatus, predicted maximum acceptable response times, and the use of the SRS Fire Department All-Call system and mutual aid for additional resources.

The CSTF area-specific fire control preplans are used to reduce decision time and improve decision quality. During an actual fire, the preplans serve as a fire fighting attack outline and provide information and quick reference for Fire Department personnel. Preplans include information on the following:

- Radioactive, combustible, flammable, and chemical hazards present in each building
- Major equipment, electrical feeds, Fire Protection Systems, and access and egress routes
- Communication and ventilation systems
- General instructions and building plan drawings

11.4.4.2 Control Room Operator

On receipt of a fire alarm in the Facility Control Room, the CRO initiates the area fire response procedure. The operator notifies the building occupants and the Incident Scene Coordinator by voice announcements over the Public Address System.

11.4.4.3 Radiological Control

If a fire is in a Radiological Buffer Area (RBA), or if RCO personnel are needed at a fire event, the Shift Manager/First Line Manager/Control Room Manager will notify RCO. Designated, on-shift RCO personnel respond to the Fire Command Post for fires that might involve an RBA
or toxic materials. Under direction of the Incident Scene Coordinator, RCO personnel are responsible for establishing appropriate RBA and contamination control boundaries and providing guidance on protective clothing and the handling of radioactive materials.

11.4.4.4 **SRS Security Contractor**

Designated, on-shift security personnel respond to the fire and establish crowd and traffic control, as directed. SRS security contractor personnel or facility personnel are prepared to support immediate Fire Department entry into the area.

11.4.4.5 **Facility Personnel**

Non-fire fighting personnel evacuate the fire area in accordance with area fire response procedures. If warranted, personnel are evacuated from the area to designated rally points.

Each SRS employee receives fire protection training through the Site General Employee Training program. The training program includes the following:

- Basic fire theory
- Identification of class A, B, C, and D fires
- Reporting a fire
- Emergency evacuation routes and rally points
- Review of portable fire extinguisher use
- Good housekeeping practices
- Proper marking of hazardous material

Trained facility personnel may respond to suppress the fire in its incipient stage and provide support to the Fire Department, if directed. All other personnel are notified of the fire and have been trained to evacuate, as directed by the emergency evacuation procedures.
11.4.5 FIRE FIGHTING READINESS ASSURANCE

11.4.5.1 Fire Prevention Inspection Program

11.4.5.1.1 FACILITY INSPECTIONS

Regular facility fire safety inspections are conducted in accordance with Procedure Manual 2Q procedures (Ref. 11). At a minimum, these include periodic inspections of portable extinguishers, storage of combustibles, exits and exit accesses, and general housekeeping (Ref. 12).

11.4.5.1.2 TESTING AND SURVEILLANCE

Regular fire protection inspections and surveillance testing, as required by NFPA standards and S/RID Functional Area 12 “Fire Protection”, are conducted and the results of surveillance testing are documented.

11.4.5.1.3 FIRE PROTECTION IMPAIRMENTS AND COMPENSATORY ACTIONS

CSTF has implemented procedures to control impairments to Fire Protection Systems. Impairments are controlled, documented, and compensatory actions are instituted in accordance with Procedure Manual 2Q procedures (Ref. 11).

11.4.5.2 Types and Frequencies of Safety Drills and Exercises

CSTF participates in fire drills conducted in conjunction with the Fire Department on a routine basis in accordance with the requirements of the site Fire Protection Program.

11.4.5.3 Record Keeping Requirements

Records generated in compliance with Procedure Manual 2Q are managed with Procedure Manual 1B, MRP 3.31 (Ref. 14).
11.5 REFERENCES


6. SRS Emergency Plan. SCD-7


13. Deleted


CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 12
PROCEDURES AND TRAINING

Revision 20
August 2017
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<td>Emergency Operating Procedure</td>
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12.0 PROCEDURES AND TRAINING

12.1 INTRODUCTION

12.1.1 OBJECTIVE

The objective of this chapter is to provide information on the processes and requirements by which technical procedures and training are developed, verified, and validated at the Concentration, Storage, and Transfer Facilities (CSTF).

12.1.2 SCOPE

This chapter discusses the processes by which the technical content of procedures and training are developed, verified, and validated at the CSTF. In addition, procedures and training elements have been developed to keep the processes current through the use of feedback and continuous improvement, and these are summarized. These processes ensure that the facilities are operated and maintained by personnel who are qualified and competent to carry out their job responsibilities.

Procedure Manual 4B describes the site-level training program (Ref. 1). This chapter describes the application of the site- and division-level programs by the CSTF.
12.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 2) states the codes, standards, and regulations governing the procedures and training elements (e.g., S/RID Functional Area 4). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 3). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
12.3 PROCEDURE PROGRAM

12.3.1 DEVELOPMENT OF PROCEDURES

Procedure Manual 2S provides guidance on preparation, validation, verification, and administration of technical and response procedures (Ref. 4). Procedure Manual S25 provides additional guidance on the required content and format of technical procedures (Ref. 5). Technical procedures include Standard Operating Procedures, Standard Operating Manuals, maintenance, testing, surveillance, and periodic procedures. In addition, Procedure Manual 2S provides specific format guidance on Abnormal Operating Procedures (AOPs), Emergency Operating Procedures (EOPs) and Alarm Response Procedures (ARPs) (Ref. 4). Procedure Manual 1B governs the generation of program-specific administrative procedures that define the communication and coordination activities necessary to carry out the facility's technical programs (Ref. 6). The CSTF procedures are developed to comply with these guiding documents.

The emergency plan-related procedures, such as Emergency Preparedness Administrative, Implementing and Program Procedures, are distinct from ARPs, EOPs, and AOPs and are developed and controlled in accordance with the requirements of Procedure Manual 2S and SCD-7 (Ref. 4, 7).

Startup Test Program procedures are developed and controlled in accordance with Procedure Manual 5E and Procedure Manual S4, and are discussed in Chapter 10 (Ref. 8, 9).

12.3.2 MAINTENANCE OF PROCEDURES

Procedure Manual 2S provides guidance regarding the maintenance and control of procedures to ensure proper dissemination and utilization of facility procedures (Ref. 4). Procedures that are controlled documents and records are handled according to the quality assurance requirements described in Chapter 14.

Prior to issuance of approved procedures, the procedure owner and Training and Procedures Department determine the effective or implementation date of the procedure, based on the need for training, the timetable for completion, and the urgency (safety considerations) associated with the changes made to the procedure. Identified training is implemented via the operating experience program by way of required reading, shift briefing, qualification briefing, classroom, or On-the-Job Training (OJT).
12.4 TRAINING PROGRAM

12.4.1 TRAINING PROGRAM DESCRIPTION

Successful completion of a prescribed training program is required for CSTF Operations, Maintenance, support staff, and technical staff personnel, as applicable to the position. This program includes the training and qualification requirements that prescribe: 1) basic indoctrination in General Employee Training and Facility Training, and 2) applicable specific job-related training to fully qualify each employee to perform the assigned work. Evidence that the employee is qualified to perform the work in a competent and safe manner is a prerequisite for performing the assigned work independently. Department of Energy (DOE) Order 426.2 establishes the requirements for training and qualification of contractor and subcontractor personnel for Savannah River Site (SRS) (Ref. 10). These requirements ensure only properly qualified and competent personnel are assigned to positions that have a functional impact on CSTF safety and operation.

Performance Based Training (PBT) is used to establish the training programs at the CSTF (Ref. 1). PBT is a systematic approach to the development and implementation of training in a technical environment that consists of five phases. The first four phases (Analysis, Design, Development, and Implementation) are sequential. The output of one phase feeds the next phase in the sequence. The fifth phase (Evaluation) is applied throughout the training process.

Line management is ultimately responsible for the indoctrination and training of personnel. Line management ensures that personnel receive the necessary indoctrination and training to fulfill the requirements of their assigned positions. The LW Training Department is responsible for leading and managing the analysis, design, development, implementation and revision of training, as well as assuring line management that requirements are met.

12.4.2 PROGRAM OBJECTIVES

The training program for CSTF personnel ensures that trained personnel have the knowledge and skills to operate and maintain the equipment and facilities in a safe and efficient manner. These objectives are achieved through the development and implementation of a comprehensive training program that is administered by the LW Training Department with the support of management at all levels.

12.4.3 TRAINING CURRICULUM

The general curriculum is designed to provide the training necessary to familiarize the trainee with basic departmental functions, practices, requirements, and the job specific requirements. The selection, training, qualification, and records requirements for CSTF personnel are specified in Procedure Manual 4B (Ref. 1). Detailed training and qualification requirements are specified in the Training Program Description (TPD) for CSTF operations, maintenance, support staff, and technical staff personnel, as applicable to the position. These TPDs are developed for each CSTF department and are approved by the responsible Line Manager as required by Procedure Manual 4B (Ref. 1). The combination of education, experience, and training ensures that the employee possesses the knowledge, skills, and abilities to support actions and decisions during normal and off-normal conditions that will result in safe and efficient facility operation.
Personnel regularly assigned to the SRS areas are also required to be trained in general topics to a level of understanding commensurate with their assignments (Ref. 1). This training is denoted as General Employee Radiological Training (GERT). In addition to GERT, CSTF personnel who are required to have routine access to controlled areas (such as Radiological Buffer Areas) are required to complete Radiological Worker Training. Additionally, operations personnel receive extensive training in AOPs and EOPs.

The requirements of the various training programs within CSTF are described in the applicable TPDs.

12.4.3.1 Development of Training

The technical content of CSTF training programs is developed, reviewed and approved in accordance with Procedure Manual 4B (Ref. 1). Training developed using these guidelines applies to various aspects of CSTF operations, including conduct of normal, abnormal, and emergency operations. This manual establishes a systematic process for the training program, including analysis of training requirements, design of training, development of training materials, instructor training and qualifications, implementation of training, and OJT.

12.4.3.2 Maintenance and Modifications of Training

CSTF training and training materials are updated as needed to ensure that training programs reflect actual plant conditions and current procedures. This is discussed in greater detail in Procedure Manual 4B (Ref. 1).

12.4.4 QUALIFICATION

At CSTF, the majority of positions identified require qualification. DOE Order 426.2 provides the guidance for determining the positions requiring qualification (Ref. 10). The education, experience, qualification, and training requirements for CSTF operations, maintenance, engineering, and training personnel are specified in the TPDs. The TPDs are approved by the responsible Line Manager.

12.4.4.1 Qualification

The candidates must successfully complete training and examinations that include written examinations and performance demonstrations applicable to their position. The candidates must also meet other specified requirements (e.g., medical examination for certain positions, oral boards and simulator evaluations for certain operator and supervisory positions) to obtain qualification. The methods, criteria, the setting for the evaluation process, and the standards for evaluation are specified in Procedure Manual 4B and the applicable TPDs (Ref. 1).

Operators or managers who are required to qualify in specific areas are not to be assigned to, or assume, any duty in an area for which they are not qualified unless they are designated “unqualified trainee” and have qualified personnel supervising. Chapter 11 provides more detail regarding control of on-shift training.
12.4.4.2 Deleted

12.4.4.3 Requalification and Retraining

Operations requalification requirements for CSTF personnel are conducted in accordance with the requirements of Procedure Manual 4B (Ref. 1). Continuing Training is structured according to specific job position needs and is conducted at scheduled intervals. Periodic written examinations (and operational examinations as appropriate) are conducted throughout the training cycle in accordance with the requirements of Procedure Manual 4B and the applicable TPDs (Ref. 1).

12.4.4.4 Medical Examination Requirements

The CSTF organization determines the physical demands imposed upon certain positions by the job tasks that are required to perform both routine and emergency functions. A medical examination is given by Medical, initially, and then at specified times thereafter, to personnel assigned to these positions to verify health and physical fitness to safely perform their assigned tasks. These personnel must also be cleared by medical examination prior to returning to work following any serious illness or injury that keeps the person from performing their duties for a predetermined period.

12.4.5 TRAINING RECORDS

The qualification cards, completed job performance measures, and written/oral examinations serve as training records and are considered permanent records. Access to these records is controlled. Electronic tracking of individuals training is accomplished through the use of the Training Records and Information Network System, which is a password protected database.

Procedure Manual 4B addresses the requirements for the management of training related records generated in accordance with, or as a result of, an established training program (Ref. 1).
12.5 REFERENCES

CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 13
HUMAN FACTORS

Revision 20
August 2017
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13.0 HUMAN FACTORS

13.1 INTRODUCTION

13.1.1 OBJECTIVE

This chapter describes the influence of Human Factors on the safety analysis for the Concentration, Storage, and Transfer Facilities (CSTF).

13.1.2 SCOPE

Human actions are relied on for certain controls and operations that affect the safety of the CSTF. Human actions affecting safety are those associated with monitoring the facility parameters, responding to alarms or out-of-limit parameters, and placing the facilities in a safe condition prior to or following Natural Phenomena Hazard (NPH) events.

The CSTF have been in operations for over 40 years and, as such, not all of the controls meet the latest Human Factors standards. Based on the number of safety related controls, age of the equipment, and cost of upgrading the controls to current standards, a graded approach to Human Factors is presented in this chapter.

A graded approach to Human Factors was applied for this Documented Safety Analysis (DSA). Credited operator actions required in less than 30 minutes require a detailed Human Factors analysis. Credited actions that are required in more than 30 minutes were qualitatively assessed for Human Factors issues as part of the control selection process, and Technical Safety Requirement (TSR) development. Additionally, Human Factors were qualitatively assessed during implementation of DOE-STD-1186-2004 (Ref. 11) as discussed in the applicable portions of Section 5.5.4.2.

The unmitigated scenarios discussed in Chapter 3 also rely on operators to respond to various indications to define the scenarios. These actions have been qualitatively evaluated in this chapter.
13.2 REQUIREMENTS

The CSTF predates Department of Energy (DOE) requirements for identifying and applying Human Factors Engineering (HFE) considerations to the design and operation of DOE facilities. However, many of the current HFE criteria (human dimension considerations, environmental considerations, normal and emergency lighting, noise, etc.) were contained within other national consensus standards such as Occupational Safety and Health Administration (OSHA) and National Fire Protection Association (NFPA). These criteria were considered during the design processes at the Savannah River Site and have been validated during years of successful operation. The CSTF has been in operation for a sufficient number of years that drills, training, assessments, and other activities have identified the following:

- Optimum instrumentation
- Provisions for communications
- Operational aids
- Layout and design of instrumentation and controls
- Standardized labeling
- Improvements in work environment and other factors bearing on Human-Machine Interface (HMI)

The Standards/Requirements Identification Document (S/RID) (Ref. 1) specifies the codes, standards, and regulations governing the operational safety policies and elements of Human Factors Engineering activities (e.g., S/RID Functional Area 19). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 2). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.

All current design activities are required to follow Design Standards (Ref. 3).
13.3 HUMAN FACTORS PROCESS

13.3.1 DEVELOPMENT OF CSTF PROCESS CONTROLS

With the exception of H-Area Diversion Box (HDB) HDB-8, the 242-25H Evaporator and ARP/MCU, which were designed and constructed to DOE Order 6430.1A (Ref. 4), the majority of CSTF equipment was designed and constructed prior to the current DOE regulations and before specific emphasis on HFE was applied to facility designs. However, HFE under various titles has been included in design engineering requirements for many years and is identified in national codes and standards, including OSHA and NFPA, whenever the design includes HMI. References 5, 6, 7, 8, 9, and 10 specify requirements for the inclusion and assessment of HFE in the design, startup, and operation of CSTF Structures, Systems, and Components (SSCs). These requirements are reflected in site procedures for labeling, annunciators, communication, status boards and procedures as discussed in Chapters 11 and 12. Human Factor aspects have been verified to be in accordance with site and facility procedures through facility walkdowns and surveillances during the years of operation.

During the development of the accident scenarios, selection of the controls, and the associated backfit analysis of the safety-related controls, experienced operations and engineering personnel were consulted to determine if, based on past operating experience, the specified human action or HMI provide sufficient reliability to be considered safety related. The results are presented in Section 13.5.

Based on the operator actions and controls outlined in Chapters 3 and 4, facility staffing requirements have been developed accounting for the facility design and the event responses required by the DSA.
13.4 IDENTIFICATION OF HUMAN-MACHINE INTERFACES

Chapters 3 and 4 identify those facility SSCs that are designated as Safety Class and Safety Significant. Chapter 3 also outlines the required human actions necessary to prevent or mitigate the postulated accident scenarios.

The human actions can be categorized into the following types of actions:

- Monitoring of safety-related SSCs to ensure continued safe operations of the facilities,
- Response to alarms or out-of-limit process parameters to stop a given activity, restore a system to operations, or take some other corrective action(s), or
- Placing the facilities in a safe condition prior to or following an NPH event.

This section evaluates the HMI that must exist to complete the above type of actions.

13.4.1 MONITORING SSC PERFORMANCE

The accident analysis credits operators with ensuring certain safety functions are being completed by monitoring the system performance. This is usually done by monitoring the system parameter of interest (e.g., ventilation flow rate). In the cases where the parameter is directly monitored the operators are reading a simple gauge or digital display in the units of interest for comparison. The instrument uncertainty analysis completed for the Safety Class and Safety Significant instruments includes allowances for any reading uncertainties.

Due to the age of the facility there are some instances where there are no instruments which provide a direct indication of the safety parameter. In these cases, Chapter 5 and the TSRs account for and provide an alternate means of ensuring proper system performance. These alternate means are simple and the parameter has sufficient margin or time to respond.

Operators have been trained in the techniques of reading each of the credited instruments or indications. The procedures used to monitor the equipment incorporate the HFE principles.

13.4.2 RESPONSE TO ALARMS

Operations are credited in Chapter 3 for responding to alarms or out-of-specification readings. The alarms that are credited are labeled to reflect the condition, include visual and audible indication, and have associated Alarm Response Procedures in the Control Area where the alarm is located for directing operator responses to the alarm. In some instances alarms are ganged. When this occurs, procedures direct operators to respond as if each of the ganged instruments is in alarm condition. This approach is reinforced by operator training.

The credited responses are simple actions that the operators have been trained to complete. Examples of such actions are closing valves to isolate a siphon or transfer line, or operating a switch to de-energize a pump motor. In every instance there are multiple means of completing the given task and, as required, at least one means is credited.
13.4.3 PLACING THE FACILITY IN SAFE SHUTDOWN

Chapter 3 credits operators with placing the facility in a safe condition before or following a tornado or seismic event. The actions necessary to put the facility in this condition are discussed in Chapters 3 and 5. Abnormal Operating Procedures or Emergency Operating Procedures will direct these actions. The operators are trained and drilled on a frequent basis sufficient to provide adequate confidence that these actions will be promptly completed as required.
13.5 EVALUATION OF HUMAN-MACHINE INTERFACES

Chapters 3 and 4 identify those facility SSCs that are designated as Safety Class and Safety Significant. Chapter 3 also outlines the required human actions necessary to define the accident scenario, prevent or mitigate the postulated accident scenarios.

The human actions can be categorized into the following types of actions:

- Credited operator actions that must be performed within 30 minutes post-event,
- Credited operator actions that must be performed (not required within 30 minutes post-event),
- Operator actions accounted for in the unmitigated events for defining the scenario.

As discussed previously a graded approached was applied to Human Factors in this DSA. Each one of these categorizes are discussed below.

13.5.1 CREDITED OPERATOR ACTIONS LESS THAN 30 MINUTES

The response to loss of Pump Pit (PP)/Pump Tank ventilation while conducting a steam jetted transfer is the only operator action credited in the DSA required to be completed in less than 30 minutes.

The TSRs require the installation of a backup portable ventilation system for the non-HDB-8 Pump Tanks while receiving steam jetted transfers (except those transfers of less than 1,200 gallons and receipts from the Canyons). The TSRs require the ventilation be restored prior to becoming flammable in the Pump Tank (i.e., starting the Pump Tank Backup Ventilation System). A Human Factors Analysis will be conducted following selection and installation of the portable equipment required to complete these actions.

This action is a compensatory action required to overcome vulnerabilities in the PP/Pump Tank Ventilation Systems. This operator action is eliminated by upgrades proposed in Table 3.3-16.

Based on the TSR controls and Human Factors Analysis that will be completed as part of the portable ventilation system selection and installation, these systems have adequately accounted for HMI.

13.5.2 CREDITED OPERATOR ACTIONS 30 MINUTES OR GREATER

Operator actions which are required to prevent or mitigate accidents in greater than or equal to 30 minutes have credited SSCs to monitor and for completing the actions. The credited controls were qualitatively assessed for Human Factors issues as part of the control selection process, and TSR development.

The credited controls and operator actions are defined in the TSRs. The TSRs setpoints are consistent with the monitored indications and include uncertainty associated with the reading of the instrumentation. Operations personnel are trained and drilled on the TSR and response to the
TSR abnormal conditions. Based on the training and inclusion in the TSRs, no detailed Human Factors Analysis was completed.

13.5.3 SCENARIO DEFINING OPERATOR ACTION

Chapter 3 defines the accident scenarios as part of the scenarios. The operator actions that are used to define the scenarios and are completed in less than 4 hours with no credited controls have been evaluated. The following key operator actions were evaluated:

- Isolating transfers on detection of a spill to the environment or secondary containment,
- Isolating steam and air to tube bundle and lance on detection of an evaporator overpressurization event,
- Isolating steam jets on detection of an aerosolization event, and
- Identifying and initiating actions following a tank leak.

Section 3.4.1.5.2 defines the maximum spill during a transfer as being no greater than 15,000 gallons (see Section 3.4.1.5.2 for events that are exceptions). Operator actions to isolate the transfer are required to limit the spill inventory. Any one of the following equipment or techniques is adequate to detect a spill with sufficient time to isolate the transfer: reel tapes, steel tapes, tank level instrumentation using radar, Area Radiation Monitors, Continuous Air Monitors, dip tubes, and conductivity probes. Based on these indications operators will become knowledgeable of material leaking from the transfer route prior to spilling 3,000 gallons which leaves sufficient time to isolate the transfer. Isolation of the transfer can occur in numerous ways: breakers in adjacent motor control centers, the Distributed Control System, various panel board switches, push buttons or pistol grips in the control rooms or by isolating one of numerous steam valves for steam jetted transfers. Procedures define multiple means of stopping every transfer. The isolation of a transfer, based on the availability and accessibility of the numerous pieces of equipment which can be used to isolate the transfer, should be completed within minutes of an operator becoming knowledgeable of the leak. Therefore, there is sufficient Human Factors designed into the systems for this action. Additionally, as part of the Specific Administrative Control implementation for the Transfer Control Program (Section 5.5.4.2.21), a Human Reliability Analysis was performed for material balance discrepancy monitoring during transfers (Ref. 12). This analysis identified no unique Human Factors considerations.

Section 3.4.2.4 defines the maximum time to isolate steam to the evaporator tube bundle and lance as 1 hour and air to the tube bundle and lance as 2 hours. Operator actions to isolate steam/air are required to limit the accident duration. Any one of the following equipment or techniques is adequate to detect a break in the tube bundle or an increase in pressure with sufficient time to isolate steam/air: two independent pressure monitors, dip tubes, overhead condenser vent temperature, cell sump probe, cell sump dip tubes, increase in overheads rates, Area Radiation Monitors, and Continuous Air Monitors. Based on these indications operators will become knowledgeable of the overpressurization of the evaporator within 30 minutes which leaves sufficient time to isolate steam/air to the tube bundle and lance. Isolation of steam/air can occur utilizing the automatic lance gang valve controls from the control room or multiple manual valves in the field. The isolation of steam/air, based on the availability and accessibility of the
multiple pieces of equipment which can be used to isolate steam/air, should be completed within minutes of an operator becoming knowledgeable of the overpressurization of the evaporator. Therefore, there is sufficient Human Factors designed into the systems for this action.

Section 3.4.2.10 defines the maximum time that a steam jet or piping that is attempting to make a transfer will be aerosolizing waste as 2 hours. This is based on the procedural requirements necessary to make transfers and the Radiation Protection Program requirements for monitoring in the area where transfers occur. It is expected that operations will become knowledgeable of the aerosolization of waste within 30 minutes of the initiation. Their indications include the missing or reduced flow from the jet, the increased radiation field in the area or in the ventilation system, and increased High-Efficiency Particulate Air filter loading. As previously discussed there are numerous means of isolating a jet therefore, the isolation of steam to the locations should occur within minutes of discovery.

Section 3.4.2.12 assumes that operations personnel will become knowledgeable of a tank leak when the leaked material approximates the residual level. Since waste tanks are the primary location of liquid waste, they are monitored routinely by many different techniques including annulus conductivity probes, annulus sump liquid level instrumentation, tank level instrumentation, annulus ventilation radiation monitoring, and a TSR surveillance. These indications are common instrumentation used throughout the facilities. When a leak occurs sufficient to build up material in the annulus, it is expected that these instruments will notify operations prior to reaching the residual quantities. This is strengthened by the added surveillance.
13.6 REFERENCES

CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 14
QUALITY ASSURANCE

Revision 20
August 2017
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<tr>
<td>CQF</td>
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<td>Concentration, Storage, and Transfer Facilities</td>
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14.0 QUALITY ASSURANCE

14.1 INTRODUCTION

14.1.1 OBJECTIVE

The purpose of this chapter is to provide information on the Savannah River Site (SRS) Quality Assurance (QA) program and the QA program requirements that affect safety of the Concentration, Storage, and Transfer Facilities (CSTF).

14.1.2 SCOPE

The QA program is described in Procedure Manual 1Q (Ref. 1). This chapter describes the implementation of the QA program and interfaces between the CSTF and the site-level organizations and programs.
14.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 2) states the codes, standards, and regulations governing the QA policies and program elements (e.g., S/RID Functional Area 2). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 3). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
14.3 QUALITY ASSURANCE PROGRAM AND ORGANIZATION

The QA program is described in Procedure Manual 1Q (Ref. 1). The CSTF uses Procedure Manual 1Q to implement the QA program (Ref. 1).

Liquid Waste (LW) Quality Assurance (QA) supports CSTF as the Cognizant Quality Function (CQF). The QA Manager manages the direct support of the CQF for the CSTF and is responsible for providing independent oversight of the facility. In addition, the QA Manager is responsible for directing assessments of the adequacy of the QA program and for identifying any management problems that hinder the QA program from achieving its objectives.

The QA Manager is responsible for managing the Quality Engineering activities. The Facility Quality Engineers (FQEs) report to the QA Manager and serve as the primary QA interface with the facility and provide a focal point for QA activities in the facility. The FQEs also perform oversight of activities. Responsibilities include reviewing and approving selected operating procedures that involve quality-related activities, as well as procurement of Level 1 items and services and Level 2 purchase documents. FQEs serve as the CQF for the facility, assuring that appropriate QA program measures are established, implemented, and maintained, as well as assuring that activities affecting quality have been performed correctly and in an adequate and effective manner. FQEs serve as the QA representative to the Facility Operations Safety Committee (FOSC) as specified in Procedure Manual 1B (Ref. 4).

The Quality Assurance Inspection Manager reports to the QA Manager and is responsible for managing the independent mechanical, electrical, instrumentation, and control inspectors in the facility. The Quality Assurance Inspection Manager is also responsible for implementing and documenting, through inspection planning and procedure or work document reviews, any necessary quality inspection witness and hold points.

The Quality Department applies the QA graded approach for projects, activities and items under its control. The graded approach functionally classifies projects, activities, and items as follows:

- Safety Class: A full QA program is applied.
- Safety Significant and Production Support: The QA graded approach is used to determine the QA requirements, as well as the verification frequency and methods for a project, activity, or item when it provides a sufficient degree of quality based upon risk, safety, and reliability considerations.
- General Services: The QA controls applied to general services projects, activities, or items are minimized. Normally, the full QA program requirements are not applied. However, the Quality Assurance Procedures (QAPs) contained in Procedure Manual 1Q may be applied to the extent necessary to establish the desired level of QA, verification frequency, and methods (Ref. 1).

Procedure Manual 1Q and PROGQATP-PDES-0001-00 delineate the indoctrination, training, and On-The-Job Training requirements necessary for certification as independent inspectors within the QA Department (Ref. 1, 7).
14.4 QUALITY IMPROVEMENT

14.4.1 IMPROVEMENT PROGRAM

Quality improvement is an ongoing effort at CSTF and is implemented in accordance with the requirements of Procedure Manual 1Q (Ref. 1).

14.4.2 CORRECTIVE ACTION PROGRAM

Procedure Manuals 1Q and 22Q establish the processes to detect, prevent, and correct quality problems (Ref. 1, 12). The CSTF implement the corrective action program in accordance with the requirements of Procedure Manual 22Q, Procedure CAP-1 (Ref. 12).
14.5 DOCUMENTS AND RECORDS

The QA documents and records are generated, issued, maintained, stored and disposed in accordance with the requirements of Procedure Manual 1Q (Ref. 1).
14.6 QUALITY ASSURANCE PROGRAM PERFORMANCE

14.6.1 WORK PROCESSES

Work is performed to established technical standards and administrative controls using approved instructions, procedures, or other appropriate means. Work control programs are implemented for the management of work at the CSTF to ensure compliance with applicable engineering, health, safety, environmental, security, quality standards, and technical requirements. These programs require line organizations and personnel performing work to be responsible for the quality of their work. This is achieved by providing people with the necessary training and maintenance of their qualifications for the job for which they are responsible. This training provides necessary knowledge of requirements for the work they perform and the capabilities of the tools and processes they use.

A graded approach is used to apply QA requirements to work processes. These requirements are based on the hazard analysis and include, as appropriate, complexity, environmental and safety consequences, and programmatic effects. Use of the graded approach is by the selective application of QA Program elements, based on required administrative controls. Procedure Manual 1Q (Ref. 1), Procedure Manual 2S (Ref. 8), and Procedure Manual 1Y (Ref. 9) provide the requirements and details of the work control program.

Additionally, the following elements of work process are implemented at CSTF in accordance with Procedure Manual 1Q (Ref. 1):

- Identification and control of items
- Handling, storing, and shipping
- Calibration and maintenance of Installed Process Instrumentation (IPI)
- Control of computer software
- Instructions, procedures, and drawings

14.6.2 DESIGN

Procedure Manual 1Q provides the SRS requirements for design control (Ref. 1). In addition, Procedure Manual E7 discusses the performance and control of SRS design, including design requirements, inputs, processes, outputs, changes, records, and organizational interfaces (Ref. 10).

SRS design program includes the following topics:

- Design control
- Design change control
- Temporary modifications
- Design interfaces
- Design records
- Design verification
- Software design control

Engineering uses Procedure Manuals 1Q and E7 to implement design control (Ref. 1, 10). The Design Authority ensures that the applicable design requirements for Safety Class and Safety Significant Structures, Systems, and Components and any non-compliances are identified and justified in accordance with the requirements of Procedure Manuals 1Q and E7 (Ref. 1, 10).

14.6.3 PROCUREMENT

SRS procurement program includes the following:

- Procurement program definition (including procurement document control)
- Supplier selection and evaluation (through in-plant audits, assessments, etc.)
- Product acceptance (by verification, surveillance, audit, and inspection)

Procedure Manual 1Q delineates the SRS requirements for procurement document control, control of purchased items and services, QA surveillance, and QA external audits (Ref. 1). In addition Procedure Manuals 7B and S18 provide guidelines regarding preparation, review, and approval of procurement documents (Ref. 11, 13). The CSTF uses Procedure Manual 1Q on the above-listed procurement-related matters (Ref. 1).

The CSTF uses Procedure Manuals 7B and S18 for procurement document control, including the preparation, review, approval, and control of purchase requisitions (Ref. 11, 13). For controlling purchased items and services, the CSTF uses QAP 7-2 of Procedure Manual 1Q (Ref. 1). This procedure uses the graded approach to establish procurement levels according to the requirements of Procedure Manual E7 (Ref. 10). The procedure also discusses product acceptance, including source inspection, receipt inspection, and post-delivery testing. In addition, the procedure provides for the establishment and maintenance of a Qualified Supplier List that identifies suppliers and the commodities or services for which they are qualified.

For replacement item evaluation, commercial grade item dedication and material upgrade, the CSTF follow the requirements of Procedure Manuals 1Q and E7 (Ref. 1, 10).

14.6.4 INSPECTION AND TESTING FOR ACCEPTANCE

14.6.4.1 Inspection

Procedure Manual 1Q defines the SRS requirements for inspection, inspection status, and control of nonconforming items (Ref. 1). The CSTF follow Procedure Manual 1Q to implement all activities related to QA inspections (Ref. 1).
14.6.4.2 **Acceptance Testing**

Acceptance testing involves demonstrating that items and processes perform as intended.

Procedure Manual 1Q delineates the SRS requirements for test control, test status and control of nonconforming items (Ref. 1). Procedure Manual 22Q (Ref. 12) delineates SRS requirements for the corrective action program. The CSTF implements the requirements of Procedure Manual 1Q for acceptance testing (Ref. 1). The acceptance test program is discussed further in Chapter 10.

14.6.4.3 **Measuring and Test Equipment, Installed Process Instrumentation and Radiation Monitoring Equipment**

Procedure Manual 1Q provides the SRS requirements for control of Measuring and Test Equipment (M&TE), Radiation Monitoring Equipment (RME), and IPI (Ref. 1). The CSTF uses Procedure Manual 1Q to implement the M&TE, IPI, and RME programs (Ref. 1).

14.6.5 **ASSESSMENT**

14.6.5.1 **Management and Self-Assessment**

Procedure Manual 1Q provides the SRS requirements for assessment of management processes to identify quality improvement opportunities (Ref. 1). In addition, Procedure Manual 22Q provides guidelines for identifying management improvement opportunities (Ref. 12).

The CSTF follows the management overview program described in Procedure Manual 2S, which requires self-assessments at the facility level to ensure key attributes of conduct of operations training and maintenance are implemented (Ref. 8). In addition, the CSTF follows the self-assessment process described in Procedure Manuals 1Q, 12Q, and 22Q (Ref. 1, 6, 12).

14.6.5.2 **Independent Assessment**

Teams have been established to measure the effectiveness of the facility and related environmental, safety, health, and QA programmatic performance. This program provides facility and senior management with performance-based information and satisfies contractual obligations for company-level independent oversight. Procedure Manual 12Q defines the structure, principles, responsibilities, associated requirements, and procedures for conducting independent assessments through this program (Ref. 6). In addition, the QA Program implementation is evaluated periodically through a series of planned and scheduled internal Quality Assurance audits.
14.7 REFERENCES


5. Deleted


CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 15
EMERGENCY PREPAREDNESS PROGRAM

Revision 20
August 2017
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15.0 EMERGENCY PREPAREDNESS

15.1 INTRODUCTION

15.1.1 OBJECTIVE

This chapter provides information on the Savannah River Site (SRS) Emergency Preparedness (EP) program that implements the proper responses to emergency conditions and the program requirements that govern emergency response in the Concentration, Storage, and Transfer Facilities (CSTF).

15.1.2 SCOPE

This chapter describes the EP Program for the CSTF, and its relationship to the SRS commitment to the applicable Department of Energy (DOE) Orders and philosophy, objectives, and organization of the EP Program.

When required information is provided in another chapter of this Documented Safety Analysis, that chapter is referenced to limit repetition. In those cases where policies, programs, and practices important to safe operation are described in detail in other site documents, the salient features are summarized for inclusion in this chapter and the documents are referenced.

SCD-7, including Annex E for the CSTF, describe the SRS and business unit-level EP programs (Ref. 1). This chapter describes the interfaces between the CSTF and the site- and business unit-level organizations and programs.
15.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 2) states the codes, standards, and regulations governing the EP policies and program elements (e.g., Functional Area 5). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 3). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
15.3 SCOPE OF EMERGENCY PREPAREDNESS PROGRAM

Annex E of SCD-7 describes the program-specific implementation of the SRS Emergency Plan and is applicable for all emergencies that fall within the emergency classification system (Ref. 1, 4). The Hazard and Safety Analysis (see Chapter 3) classifies analyzed accidents into three categories. For the CSTF, no chemicals are used or stored in quantities or concentrations that will exceed the Protective Action Criteria (PAC) for emergency conditions identified in the CSTF Emergency Planning Hazards Assessment (EPHA) (Ref. 5). Response to chemical releases is performed in accordance with facility abnormal operating procedures.

15.3.1 NATURAL DISASTERS

These include tornadoes, hurricanes, and earthquakes. For more information, refer to Chapter 3 and to Annex E of SCD-7 (Ref. 1). Possible complicating factors of a severe natural emergency include, but are not limited to, disruption of power, telephone, gas, water, and steam lines. Destruction of roads, buildings, equipment, and vehicles can hamper response and recovery operations. Refer to Chapter 3 of this document, to SCD-7, and to the CSTF EPHA for more specific information regarding the complications and consequences of natural phenomena emergencies (Ref. 1, 5).

15.3.2 FIRES

Refer to Chapter 3 of this document, to SCD-7, and to the CSTF EPHA for more specific information regarding causes, complicating factors, and consequences of fires (Ref. 1, 5).

15.3.3 OPERATIONAL EMERGENCIES

Operational emergencies include operating events (e.g., process control transients or equipment failures) that result in the release of radioactive material. Accidents can result in the release of airborne activity, partial loss of ventilation, air reversals, and damage to surrounding areas. Refer to Chapter 3 of this document, to SCD-7, and to the CSTF EPHA for more specific information regarding the causes, complications, and consequences of operational emergencies (Ref. 1, 5).
15.4 EMERGENCY PREPAREDNESS PLANNING

15.4.1 EMERGENCY RESPONSE ORGANIZATION

The Emergency Response Organization (ERO) is activated for potential and actual facility or area events. The organization augmentation and offsite support applied are detailed in Annex E of SCD-7 (Ref. 1). Annex E of SCD-7 delineates the authorities and responsibilities of essential individuals and groups during emergencies and identifies the communication chain for notifying, alerting, and mobilizing the necessary personnel (Ref. 1).

15.4.1.1 Normal Organization

If an incident occurs at the CSTF, the Shift Manager (F-Area or H-Area) or Control Room Manager (F-Area or H-Area) becomes the Facility Emergency Coordinator (FEC). Annex E of SCD-7 shows the Emergency Response Facility (ERF) interfaces and lines of communication (Ref. 1).

15.4.1.2 Facility Emergency Response Organization

Personnel on shift in the incident facility comprise the initial facility ERO. In addition to the FEC, the ERO consists of the Shift Technical Engineer, Operations Support Center (OSC) Coordinator; the Radiological Control (RC) Coordinators, the Accountability Coordinator, the Rally Point Coordinator, and the Emergency Response Teams, consisting of Operations, Radiological Control Operations (RCO), and maintenance shift personnel, augmented with personnel from non-incident facilities, as required. The OSC Coordinator is the ranking maintenance supervisor on shift and the incident facility’s RC Supervisor acts as the RC Coordinator for the Command Post. Another RC Supervisor or senior inspector serves as RC Coordinator for the OSC (Ref. 1).

The site ERO staff and their responsibilities are detailed in SCD-7 (Ref. 1).

15.4.2 ASSESSMENT ACTIONS

This section identifies the emergency classification system used at SRS and relates the classification system to the emergencies arising from the accidents, natural disasters, or security incidents analyzed in Chapter 3 of this document and in the CSTF EPHA (Ref. 5). The emergency classification system is covered in SCD-7 (Ref. 1). Source terms and release rates are specific to CSTF facilities. Releases and plumes are evaluated based on estimated source terms and wind dispersions versus bounding values described in Chapter 3 of this document.

15.4.2.1 Classification System

The emergency classification system is designed to classify an emergency condition promptly into levels commonly understood by both onsite and offsite officials, using Emergency Action Level (EAL) criteria to provide for a graded response.

Emergency classification procedure, Emergency Plan Implementing Procedure (EPIP) -CST-001, provides guidance for emergency classification for CSTF (Ref. 4). The EALs, used
for determining the appropriate emergency classification, consist of the following three categories: Radioactive Release, Toxic Chemical Release, and Other. For the CSTF, no chemicals are used or stored in quantities or concentrations that will exceed PAC for the emergency condition(s). Therefore, no EALs are established for chemical releases.

15.4.2.2 Classification Responsibilities

Classification responsibilities for operational emergencies cannot be delegated. The CSTF FEC is initially responsible for classifying emergencies that occur within the CSTF as an Alert, Site Area Emergency, or General Emergency (Ref. 4). Once the Emergency Operations Center (EOC) is activated, the Emergency Director is responsible for any changes in classification of emergencies within the facility. The FEC continues to evaluate and recommend changes in classification to the Technical Support Room (TSR) Coordinator, who provides that information to the Emergency Director, as appropriate. While the EOC is operational, the Emergency Director declares all emergency classifications. The senior Law Enforcement Division Supervisor on duty is responsible for security phase declarations.

Terminating emergencies from an Alert or higher level requires approval from the Emergency Director. State and local response actions are based upon this same emergency classification system.

15.4.3 NOTIFICATION

This section provides information on the notification processes and the communication systems used if there is an emergency at SRS. The notification/communication process has been prearranged and/or standardized to reduce any confusion during an emergency. This process and the follow-up notification process, as well as the integration of public information in the emergency are specified in SCD-7 (Ref. 1).

15.4.3.1 Incident Facility

People in the CSTF are notified of emergency conditions through alarms and/or public address announcements. The Safety Alarm System (SAS) is the primary means for notifying personnel within the incident area. Additional information about the SAS is provided in Annex E of SCD-7 (Ref. 1).

The FEC is responsible for notifying emergency response personnel in the Control Room and the OSC and for notifying all non-essential personnel. These notifications are accomplished through radios, public address announcements, telephones, and personal contact.

15.4.4 EMERGENCY FACILITIES AND EQUIPMENT

15.4.4.1 Emergency Facilities

ERFs at the CSTF have been pre-designated and equipped for use in an emergency to support the activities of members of the ERO who perform specific tasks and responsibilities in these facilities. Procedure Manual 6Q8-4.2 identifies the designated Control Rooms and the OSC, in addition to the augmented staffing required by the emergency plan (Ref. 6). This document also
specifies the departments responsible for performing checks and the steps necessary to verify equipment availability and operability.

Checks of ERFs and dedicated emergency equipment are conducted periodically to ensure continued availability. Checklists specify inventory and operation checks to be performed.

Centralized emergency support facilities, such as the SRS Operations Center (SRSOC) (manned at all times) and EOC (partially staffed during an Operational Emergency and fully staffed during an emergency classification of Alert or higher) are discussed in SCD-7 (Ref. 1).

DECONTAMINATION FACILITIES

Annex E of SCD-7 contains information on the location and use of the decontamination facilities in the CSTF (Ref. 1).

MEDICAL FACILITIES

Medical Facilities are available seven days/24 hours on site.

SECURITY FACILITIES

Annex E of SCD-7 contains information on the Security Facilities (Ref. 1).

15.4.4.2 Emergency Equipment

COMMUNICATIONS EQUIPMENT

Annex E of SCD-7 contains a description of communications equipment available at CSTF for use in an emergency response (Ref. 1).

HEAVY CONSTRUCTION EQUIPMENT

Heavy construction equipment is available via the ERO organization once it is activated.

RESCUE/FIRST AID TEAM EQUIPMENT

Rescue Team

Dedicated equipment is maintained by the SRS Fire Department for use by its rescue teams. Refer to Annex E of SCD-7 and Procedure Manual 2Q for information (Ref. 1, 7).

First Aid Team

Annex E of SCD-7 lists specific information on first aid team equipment at the CSTF (Ref. 1).

SANITATION EQUIPMENT

Portable sanitation facilities are available from existing site resources. These would be requested by the FEC, as needed.
TRANSPORTATION EQUIPMENT

Transportation equipment includes vans with various passenger capacities and buses provided by existing site resources.

PERSONAL PROTECTION EQUIPMENT

Annex E of SCD-7 specifies locations of personal protection equipment (Ref. 1).

HAZARDOUS MATERIAL DETECTION AND MONITORING

Annex E of SCD-7 describes equipment and instrumentation available at the facility as part of the Radiological Protection, Industrial Hygiene, and Employee Safety programs (Ref. 1).

DAMAGE CONTAINMENT EQUIPMENT

Damage containment equipment and supplies (i.e., sandbags, booms, shielding materials) are available from existing site resources. Requests are routed through the Emergency Duty Officer (EDO) or EOC.

FIRE FIGHTING EQUIPMENT

Refer to the Procedure Manual 2Q for specific information on fire fighting equipment (Ref. 7).

EMERGENCY POWER EQUIPMENT

Specific information on available emergency power equipment is contained in Annex E of SCD-7 (Ref. 1).

LOGISTIC SUPPORT EQUIPMENT

Specific information on available logistic support equipment is contained in Annex E of SCD-7 (Ref. 1).

15.4.5 PROTECTIVE ACTIONS

This section addresses equipment, procedures, and response actions at the CSTF necessary to provide maximum protection for onsite personnel. For detailed information concerning protective actions and range of population for facility, onsite and offsite personnel, refer to SCD-7 including Annex E (Ref. 1).

For radiological emergencies, protective actions are designed to keep onsite and offsite exposures as low as possible. For the CSTF, no chemicals are used or stored in quantities or concentrations that will exceed the PAC for the emergency condition(s). Therefore, no EALs are established for chemical releases.

For emergencies based on safeguards and security events, protective actions are designed to provide maximum physical safety of onsite personnel while maintaining operational and security
integrity of site facilities. Protective actions that may be used onsite in response to an emergency include the following.

15.4.5.1 Onsite Precautionary Actions

At the discretion of the FEC or Area Emergency Coordinator (AEC), visitors are cleared from the incident facility/area following an event.

At the Alert level, except for security-related incidents when an advisory is issued for evacuation, sheltering, or remaining indoors, visitors will be assisted by their escorts in implementing appropriate actions.

15.4.5.2 Onsite Protective Actions

Facility/Area personnel are notified by the SAS and public address announcements of appropriate actions to take. Telephone contact with supervisors and/or personal contact through use of messengers are also alternatives, based on the circumstances of the event. Additional information on alarms and protective actions is provided in Annex E of SCD-7 (Ref. 1).

15.4.5.3 Radiological Exposures - Essential Workers

All essential personnel are occupational radiation workers and are provided dosimetry appropriate to their work place. In addition, all permanent personnel on site must wear a picture security badge at all times. If time allows, the FEC should base decisions about exposures on advice from senior RCO representatives in the facility. If site-level response facilities are activated and time allows, FEC should consult with the TSR Coordinator and Radiological Protection Department (RPD) Manager.

Emergency response-related activities that might involve substantial risk and/or radiation exposures shall be applicable only to volunteers. Refer to Procedure Manual 5Q for more information (Ref. 8).

CHEMICAL EXPOSURES - ESSENTIAL WORKERS

No chemical exposure guidelines have been issued by the Environmental Protection Agency equivalent to those for radiation exposure during an accident. Occupational Safety and Health Administration and National Institute of Occupational Safety and Health have established Permissible Exposure Limits, Threshold Limit Values, and Short Term Exposure Limits to determine when protective equipment should be used. SCD-7 provides details on the PAC (Ref. 1).

EMERGENCY RESPONSE FACILITY HABITABILITY

Remaining in, or evacuating an ERF, is a decision made by the Emergency Director, the AEC, or the FEC, as applicable to the situation. When the radiological exposure approaches the administrative limit in the facility or the chemical exposure exceeds PAC-1 (see Section 15.4.5.9 for a description of the PAC levels) or equivalent, the Emergency Director, AEC, or FEC
determines if the staff should remain or evacuate to an alternate ERF. Any radiation exposures above the administrative limit require approval of appropriate management (Ref. 1).

15.4.5.4 Decontamination

Area decontamination locations and medical facilities are listed in Annex E of SCD-7 (Ref. 1).

15.4.5.5 Access Control

Access control is implemented to restrict entry into potentially hazardous areas or contain a security-related event (Ref. 1).

15.4.5.6 Responsibility for Protective Actions

FACILITY

If a Protective Action Guide (PAG) (see Section 15.4.5.8 for a discussion of PAGs) is exceeded in the incident facility only, the FEC has the responsibility for determining and directing appropriate protective actions within the property protected facility fence. The FEC shall implement protective actions within the incident facility. The AEC will implement appropriate protective actions based on conditions and wind direction at other affected facilities. These actions are communicated to the SRSOC during the activity.

AREA

If a PAG is exceeded beyond the protected area fence, the AEC has the responsibility for determining and directing appropriate protective actions for the incident area. SCD-7 provides additional discussions of these actions (Ref. 1).

15.4.5.7 Protective Equipment and Supplies

Annex E of SCD-7 lists the protective equipment and supplies and their locations within CSTF (Ref. 1).

The RC Coordinator within the CSTF OSC determines required protective clothing and survey equipment for each emergency response team assignment.

15.4.5.8 Protective Action Guides

For events that cause an actual or projected radiological release, appropriate protective actions have been pre-determined based on trigger points called PAGs, also referred to as Protective Action Criteria. These are listed in SCD-7 (Ref. 1).

15.4.5.9 Chemical Protective Action Criteria

For events that cause an actual or projected chemical release, a series of guidelines for use as indicators of the need for protective actions based on chemical concentrations have been developed by three different organizations. The chemical PAC used in Emergency Planning listed in order of preference are: Acute Exposure Guideline Levels (AEGLs) promulgated by the
Environmental Protection Agency (EPA) (Ref. 11); Emergency Response Planning Guidelines (ERPGs) published by the American Industrial Hygiene Association (Ref. 12); and Temporary Emergency Exposure Limits (TEELs) developed by DOE (Ref. 13). The limits used in the CSTF EPHA are PAC-2 (irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape) and PAC-3 (life-threatening health effects or death). These guidelines have been adopted by the site and are applied in the EPHA (Ref. 5). For further discussion on the PAC, refer to SCD-7 (Ref. 1).

15.4.5.10 Records

Procedures used in ERFs establish requirements for key positions to maintain logs. These logs and other documents generated by response activities in ERFs are maintained as official records. All records are handled in accordance with site standards.

15.4.5.11 Personnel Accountability

Accountability is performed to determine the whereabouts of everyone at the incident location. The mechanisms used to perform facility accountability are listed in Annex E of SCD-7 (Ref. 1).

The FEC is responsible for ensuring that all personnel within the facility are accounted for. The FEC directs appropriate activities for locating identified missing personnel (Ref. 1).

15.4.5.12 Emergency Planning Zones

Emergency Planning Zones are areas for which planning is needed to ensure prompt and effective actions can be taken to protect offsite personnel, public health and safety, and the environment.

15.4.5.13 Shutdown of Operations

The responsibility for the safe operational shutdown of the incident facility rests with the FEC, using the applicable procedures.

Shutdown procedures are also implemented by non-incident facilities that are, or may be, affected by the incident facility (i.e., downwind locations) or to free up manpower and resources needed to help mitigate the emergency. Upon activation of the EOC, this authority shifts to the Emergency Director.

15.4.6 TRAINING AND EXERCISES

15.4.6.1 Concentration, Storage, and Transfer Facilities Specific Training

The ERO training requirements are identified in Attachments 1 and 2 of Procedure Manual 6Q8-4.2 (Ref. 6).

All permanently assigned shift personnel and personnel that serve as shift relief are required to complete the Area Emergency Operations training, which has no associated examination, prior to assignment and annually thereafter. Certain positions must also complete Area/Facility
Emergency Coordinator (AEC/FEC) training initially and annually thereafter. AEC/FEC initial training requires a minimum examination score of 80%.

The Area and Site Emergency Response team training requirements are listed in SCD-7 (Ref. 1). This includes minimum training and qualification requirements for specialists assigned to the ERO.

15.4.6.2 Drills and Exercises

Drills and exercises are conducted to develop, maintain and test response capabilities of ERO members, and validate adequacy of emergency facilities, equipment, procedures and training. Facility drills are scheduled to accommodate the different work shifts of that facility so that shift ERO-assigned personnel participate in at least one drill annually (Ref. 1).

These drills are conducted in as realistic a manner as possible, minimizing simulation. Participants use emergency equipment and follow emergency procedures, including use of designated routes, staging areas, etc., as appropriate.

EXERCISES

An exercise is a comprehensive performance test of the integrated capability of most aspects in the emergency management program. Periodically, exercises include the participation of federal, state and county emergency management agencies that represent the population groups described in SCD-7 that could be exposed to facility hazards (Ref. 1). Conduct of exercises is also specified in SCD-7 (Ref. 1).

Drill or exercise reports are processed for record storage and retained in accordance with the Procedure Manual 1Q (Ref. 9).

CORRECTIVE ACTIONS

For discrepancies noted during drills and exercises, corrective actions are established and assigned to the responsible organization. Realistic dates are established for correction and these are tracked to completion (Ref. 1).

15.4.7 RECOVERY AND REENTRY

The operating contractors and security contractor are responsible for planning and implementing recovery activities at the SRS, following termination of the emergency (Ref. 1). The Department of Energy-Savannah River (DOE-SR) is responsible for ensuring the adequacy and appropriateness of recovery operations. For the CSTF, EPIP-HLW-111, Attachment 7, “Reentry Guidelines Checklist,” and Attachment 8, “Termination/Recovery Guidelines Checklist,” are the guiding facility procedures (Ref. 10).

15.4.7.1 Reentry

Reentry may be performed during an emergency to rescue personnel, secure critical equipment, assess the accident, and perform initial mitigation.
15.4.7.2 Recovery

Recovery includes those actions necessary to restore an incident facility and surrounding environs to pre-emergency or safe condition.

RECOVERY ORGANIZATION

Upon termination of an emergency, the ERO is deactivated and a Recovery Organization is established to implement recovery plans. This is detailed in SCD-7 (Ref. 1).

RESUMPTION OF NORMAL OPERATIONS

Compliance with the CSTF Technical Safety Requirements is necessary in order to terminate recovery operations. DOE-SR approval is required before normal operations can be resumed. A final briefing of all recovery organization personnel is held to discuss resumption of normal operations and procedural requirements for final reports on recovery operations. All documentation of recovery operations is collected and processed for storage in accordance with Procedure Manual 1Q (Ref. 9).

15.4.8 EMERGENCY MANAGEMENT PROGRAM ADMINISTRATION

Development and maintenance of the EP program is performed by the Facility Emergency Preparedness Coordinator, in conjunction with management, as specified in Annex E of SCD-7 (Ref. 1). The program procedures and Annex E of SCD-7 are reviewed and updated annually (Ref. 1).
15.5 REFERENCES

CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 16

PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

Revision 20
August 2017
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16.0 PROVISIONS FOR DECONTAMINATION AND DECOMMISSIONING

16.1 INTRODUCTION

16.1.1 OBJECTIVE

This chapter provides information relating to Decontamination and Decommissioning (D&D) of Concentration, Storage, and Transfer Facilities (CSTF) Structures, Systems, and Components (SSCs). This chapter lists design features in the existing facilities that facilitate D&D and operational considerations that permit D&D processes to be completed.

16.1.2 SCOPE

This chapter describes the development, verification, and approval of the plans and processes for closure and D&D of CSTF SSCs (e.g., evaporators, pump pits [PPs], diversion boxes [DBs], transfer lines, and waste tanks), using a graded approach. It describes the conceptual D&D planning process and the waste tank closure process already in progress. This chapter also describes how D&D activities associated with major modifications in the CSTF are planned and executed.
16.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 1) states the codes, standards, and regulations governing D&D activities and program elements for the programs and procedures that implement D&D activities (e.g., S/RID Functional Areas 15 and 16). Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 2). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
16.3  DECONTAMINATION AND DECOMMISSIONING

Preliminary planning for the D&D of the CSTF is included in the process design, facility design, and operational planning. The CSTF is assumed to be one of the last Savannah River Site facilities decommissioned in the event of site shutdown, although individual storage tank/process area closures will take place as waste is removed, to the extent technically and economically feasible, and the tank or process area is retired from service. Reference 3 describes the waste tank closure efforts at the CSTF.

16.3.1  DESIGN FEATURES

Design of the CSTF incorporates the following features that will facilitate decommissioning:

- **Process Equipment** — Equipment that constitutes a risk to health and safety is enclosed in concrete structures. Process equipment that does not create a significant risk has been placed outside of the concrete structure, but is designed and contained so that effective decontamination methods can be used.

- **Ventilation** — Ventilation of operating and processing areas minimizes the contamination of surfaces by airborne contaminants because ventilation flow is from the less contaminated areas to the more-highly-contaminated areas. All contaminated exhausts are routed through sand filters and/or high efficiency particulate air filters prior to atmospheric release.

- **Flushing** — Methods are available for equipment flushing, drainage, decontamination, and removal from the facility.

- **Handling** — Decontamination cells are available in 299-H and the Defense Waste Processing Facility for equipment cleaning and dismantling. These are equipped with overhead cranes for the handling of large, heavy equipment items.

- **Remote Maintenance and Disassembly** — The capability to introduce, loosen, take apart, disconnect, locate, relocate, and remove all equipment using remote lifting and handling tools is provided in the evaporator cells, PPs, and DBs. Direct maintenance is acceptable in other specified locations, such as 299-H. Mobile cranes are used to facilitate washdown and packaging of in-tank equipment and transfer onto flatbeds or railcars for transfer to decontamination and disassembly facilities.

- **Compartmentalization of Process Functions** — As much as practicable, operating functions are divided into separate shielded compartments. PPs and evaporator cells are examples of this concept. These compartments can be isolated during decommissioning.

- **Cell and Area Liners** — The floors and walls are covered by protective coatings. In selected areas where radioactive contamination, chemical attack, or heavy equipment impact could increase personnel radiation exposure or damage the surfaces, a stainless steel liner is provided. These areas typically include evaporator cells, PPs, DBs, and the decontamination/maintenance areas located in 299-H.

- **Access to Process Equipment** — Remote access is provided to all contaminated process equipment. For example, evaporator cells, pump tank cells, and tanks include
16.3-2

removable shielded covers. Obstructions to the removal of equipment piping have been minimized.

- Provisions for Decontamination — Equipment is designed to minimize areas where contaminated materials could accumulate. Field installation of temporary containment huts and use of portable glove boxes are two other techniques used to contain contamination and facilitate disassembly or packaging.

- Openings, Wall Penetrations, and Service Piping — Wall penetrations are at relatively high elevations in the evaporator cells, PPs, and DBs. The number of penetrations has been minimized.

- Protective Coatings — Protective coatings are applied to concrete surfaces subject to chemical or radioactive spills to reduce the amount of radioactive contamination absorbed into the concrete. Where stainless steel liners are not used, a protective coating is applied that is resistant to deterioration from radiation and from process and decontamination chemicals. Nuclear Regulatory Commission Regulatory Guide 3.30 on the selection and application of protective coatings has been followed where appropriate.

In addition to the general design features described above, Reference 9 addresses the Modular Caustic Side Solvent Extraction Unit (MCU) Facility design features that will facilitate future D&D activities, since MCU will become non-operational once the Salt Waste Processing Facility (SWPF) becomes operational.

16.3.2 OPERATIONAL CONSIDERATIONS

The Radiological Protection program, described in Chapter 7, minimizes contamination of CSTF. This program ensures that radiological operations of the facilities are conducted in accordance with site and business unit policies and procedures. Control of radioactive contamination is achieved by means of Engineering and Administrative Controls, worker actions to contain contamination at the source, reducing existing areas of contamination, and promptly decontaminating areas that become contaminated.

A Technical Review of design changes, performed per Procedure Manual E7, ensures that modifications to CSTF are consistent with site and business unit D&D policies and procedures (Ref. 4). The Technical Review also ensures that modifications to CSTF have been reviewed and evaluated for waste minimization and As Low As Reasonably Achievable considerations. During operation and design modifications, these programs minimize the potential for spread of contamination that would complicate or reduce the effectiveness of future D&D or environmental restoration activities.

In addition to the general operational considerations described above, Reference 9 addresses specific MCU Facility operational features that will facilitate future D&D activities, since MCU will become non-operational once the SWPF becomes operational.

16.3.3 CONCEPTUAL DECONTAMINATION AND DECOMMISSIONING PLAN

Procedure Manual 1-01, Procedure MP 5.24 sets forth the policy for disposition of CSTF and large structures (evaporators, DBs, PPs, valve boxes) (Ref. 5). The disposition of designated
excess facilities and associated equipment will be conducted in accordance with the S/RID, applicable Department of Energy (DOE) Orders, and supplemental manuals as listed in the references. The related activities will be performed in a cost-effective manner through systematic planning, scheduling, execution, and evaluation and documentation to ensure the health and safety of the worker, the public, and the environment.

Procedure Manual 1C provides the details of the Facility Disposition Program (Ref. 6). Planning and executing the disposition of excess facilities and/or associated equipment is conducted using project management principles with a graded approach. Waste removal and closure activities for individual waste tanks are precursors to D&D of the facility (e.g., a series group of waste tanks and the associated support systems).

A D&D Partial Closure Plan for MCU is provided in Reference 9. Due to the solvent economic value, the preferred solvent removal pathway from the MCU process at the end of the operational life or performance deterioration is reuse. The combined costs of the solvent and any treatment/disposition option in consideration with the small quantity of material justify this strategy. However, this conclusion may be negated if significant modification costs are identified in the CHAP for the storage facility (Ref. 10).

16.3.4 WASTE TANK AND ANCILLARY EQUIPMENT CLOSURE

In Reference 11, DOE selected the alternative to fill the waste tanks with reducing grout to stabilize the residual material. This method was chosen as the most preferred environmental alternative and the least hazardous for closure of the waste tanks and associated equipment. The stabilized grout form will provide a chemical environment to reduce migration of contaminants into the environment, prevent inadvertent intrusion, and minimize free-standing liquids and void spaces in the waste tanks.

Performance Assessments for F-Area Tank Farm (FTF) and H-Area Tank Farm (HTF) are prepared to support closure of the tank farm underground radioactive waste tanks and ancillary equipment. The Performance Assessments provide the technical basis and results to be used in subsequent documents to demonstrate compliance with the pertinent requirements identified for operational closure of the FTF and HTF. Applicable regulations include the following:

- DOE Order 435.1 (Ref. 7)
- Title 10 Code of Federal Regulations (CFR) Part 61 (Ref. 12)
- Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005 (NDAA), Section 3116 (Ref. 13) (hereafter referred to as “NDAA Section 3116”)
- South Carolina Department of Health and Environmental Control (SCDHEC) Regulations, R.61-67 (Ref. 14)
- SCDHEC Regulations, R.61-82 (Ref. 15)

The tank farm closure process also includes operational closure of the waste tank systems under requirements from References 16 and 17.
The regulatory process to complete operational closure of the Tank Farms requires the development of multiple detailed technical documents with reviews and approvals by multiple state and federal agencies. The documents involved include a Basis for NDAA Section 3116 Determination Document for both FTF and HTF, which will be used to demonstrate compliance with the criteria set forth in Reference 13. The Basis for NDAA Section 3116 Determination Documents are to be reviewed and approved by the DOE, in consultation with the United States Nuclear Regulatory Commission.

Approval of a NDAA Section 3116 Waste Determination by the Secretary of Energy is then required to document that the residual waste can be classified as non-high level waste for purposes of on-site disposition. The Secretary of Energy determination under NDAA Section 3116 incorporates by reference 10 CFR 61, Subpart C performance objectives. Compliance with the SCDHEC regulations will be demonstrated using two primary document types. The first document type is an Industrial Wastewater General Closure Plan, which establishes the general protocols, requirements, and processes for closure of the FTF and HTF. The second document type is a tank-specific closure module that provides the SCDHEC authorization for stabilization of the residual contaminants for a specific tank, group of tanks, and/or ancillary equipment. The Industrial Wastewater General Closure Plans and tank-specific closure modules are reviewed and approved by DOE and SCDHEC.

As part of the tank farm closure process previously described, Tier 1 Closure Documentation is required to demonstrate compliance with DOE requirements, as defined in DOE Order 435.1 (Ref. 7). The primary purpose of the Tier 1 Closure Documentation is to define and bound the parameters for the tank farm closure activities, and to define the approach and plans by which closure will be accomplished. Several reference documents support the Tier 1 Closure Documentation including the National Environmental Policy Act Environmental Impact Statement, Performance Assessment, Waste Determination (and associated Basis Document), Composite Analysis, and Industrial Wastewater General Closure Plan. Upon approval of the Tier 1 Closure Documentation, an Authorization to Proceed is issued by DOE-HQ.

The Tier 2 Closure Authorization provides the system-specific information to demonstrate that the process described in the Tier 1 Closure Documentation has been implemented and the criteria required in the Tier 1 Closure Documentation have been met. The Tier 2 Closure Authorization takes into account detailed closure information from the Special Analysis, the Maximum Extent Practical Demonstration, and the State-approved system-specific Closure Module. DOE approval of the Tier 2 Closure Authorization represents DOE final authorization to proceed with permanent stabilization of the system.
16.4 REFERENCES


8. Deleted


CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 17

MANAGEMENT, ORGANIZATION, AND INSTITUTIONAL PROVISIONS

Revision 20
August 2017
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17.0 MANAGEMENT, ORGANIZATION AND INSTITUTIONAL SAFETY PROVISIONS

17.1 INTRODUCTION

17.1.1 OBJECTIVE

This chapter provides information that pertains to management, organization, and institutional safety provisions of the Concentration, Storage, and Transfer Facilities (CSTF).

17.1.2 SCOPE

This chapter contains the information on the following:

- Management
- Organizational structure
- Responsibilities
- Staffing and qualifications
- Safety reviews and performance assessments
- Configuration and document control
- Occurrence reporting and safety culture of the CSTF

This chapter also describes the interfaces between the CSTF and the site level organizations and programs.
17.2 REQUIREMENTS

The Standards/Requirements Identification Document (S/RID) (Ref. 1) states the codes, standards, and regulations governing the management, organization, and institutional safety provision policies and program elements. Programmatic compliance assessments are performed against the S/RID and documented as specified in Procedure Manual 8B (Ref. 2). The Standards Management/Compliance Section maintains records of the programmatic compliance assessments.
17.3 ORGANIZATION, FUNCTIONS, RESPONSIBILITIES, AND AUTHORITIES

The following discussion and organization descriptions found throughout this Documented Safety Analysis (DSA), are representative of the CSTF organizational structure, but may not be accurate in presenting current group and/or individual titles.

17.3.1 LIQUID WASTE CONTRACTOR

SRS management and operations are currently the responsibility of the Management and Operations (M&O) contractor and the Liquid Waste (LW) contractor. The LW organization is managed by the LW contractor President and Project Manager. The CSTF is part of the LW organization area of responsibility. The LW contractor relies on support from the M&O contractor to perform specific tasks supporting the LW mission (Ref. 22).

The organizations, that provide support to the CSTF, are listed below.

- The Savannah River National Laboratory (under the M&O contractor) develops new technologies, refines existing technologies, provides analytical and experimental safety, and environmental and production support.

- The Environmental, Safety, Health and Quality Assurance (QA) organization (under the M&O contractor) is responsible for site-wide, safety support services, and provides a point of contact between the line organizations and the Department of Energy (DOE) and regulatory agencies on safety, health, and QA issues and all site environmental matters. This organization also provides security, safeguards, emergency preparedness, fire protection services and emergency medical services to the site.

- The Infrastructure and Project Support organization (under the M&O contractor and LW contractor), as the Design Agency, designs and constructs new facilities and renovation projects. LW Engineering assigns engineers to each of the projects as the Design Authority for their respective projects in the CSTF, and approves all CSTF engineering and construction activities.

17.3.2 CONCENTRATION, STORAGE, AND TRANSFER FACILITIES ORGANIZATION, FUNCTIONS, RESPONSIBILITIES, AND AUTHORITIES

The LW organization charts identify the organizational structure and lines of communication for activities affecting quality for the CSTF. The organization charts, which are updated regularly, provide the current organization and position titles. The following paragraphs briefly describe the key positions. The organization and position titles described below are typical.

The Tank Farms Operations Director has overall responsibility for managing the safe operation and maintenance of the CSTF. The Tank Farms Operations Director and Tank Farms Facility Manager are responsible for CSTF compliance with Standards as mandated in the Safety, QA, Security, Radiological Control, Industrial Hygiene, and Procedures Manuals. The Tank Farms Facility Manager reports directly to the Tank Farms Operations Director. Operations activities at the CSTF are performed in a manner such that the safety of the public, the facility, employees,
and the environment is paramount and the consideration for maintaining production is secondary.

17.3.2.1 Concentration, Storage, and Transfer Facilities - Facility Manager

The Facility Manager is responsible for all storage, treatment, and transfer activities associated with the CSTF.

17.3.2.2 Engineering Managers

The engineering managers for LW are responsible for direct technical and engineering assistance for their respective projects and are the Design Authority for the operations, maintenance, and testing activities of the CSTF. The production and updating of the DSA, the Technical Safety Requirements (TSRs), and other safety basis documents for the CSTF are managed by Engineering. Engineering activities at the CSTF are conducted in accordance with the requirements of Procedure Manual E7 (Ref. 5) and Procedure Manual S4 (Ref. 3).

17.3.2.3 Support Managers

The Support Managers for the LW are responsible for the development and implementation of plans to ensure that the CSTF complies with DOE, Site, and oversight (Defense Nuclear Facilities Safety Board, DOE-Savannah River and Site evaluation team) programs. These managers also manage self-assessment/monitoring support activities, and preparation of responses to deficiencies identified by internal and external oversight groups, and are responsible for all aspects of the CSTF training and procedure program management.

17.3.2.4 Maintenance Managers

The Maintenance Managers for the LW are responsible for maintenance of the assigned CSTF facilities and equipment. See Chapter 10 for further discussion related to Maintenance Program organization and administration.

17.3.3 STAFFING AND QUALIFICATIONS

The staffing level and knowledge, skills, and abilities of personnel in organizations covered in this chapter contribute to the safety basis of the CSTF. This section discusses sitewide and CSTF training, qualification, fitness-for-duty requirements, and the programs and provisions for monitoring staff safety performance.

Key operations and technical related positions in the various departments of the CSTF are staffed by personnel with technical degrees and/or several years of industrial experience, primarily in the nuclear industry. The education and experience requirements for personnel involved in the operation, maintenance, training, and technical support of the CSTF are based on Procedure Manual 4B (Ref. 8) and have been established to ensure that qualified personnel are selected and assigned to positions that have a functional impact on safety and reliability.
Recruitment of new professional exempt personnel is accomplished through LW Human Resources. The staffing plan is based on the CSTF mission, specific planned activities, goals and milestones. These plans are reviewed and approved by DOE.

The shift manning requirements (beyond the minimum staffing requirements defined in this DSA and associated TSR) for normal operations of the CSTF are based upon the operational activities and support required for the Emergency Response Organization. These requirements are approved by applicable managers and are documented in Standing Orders for CSTF Operations.

The staffing levels for support personnel (e.g., radiological controls, safety) are discussed in the program-specific sections/chapters of this DSA. The minimum shift manning requirements for various conditions of CSTF operation are identified in the TSRs for the CSTF.

Training and qualification requirements for personnel involved with organizations and programs referred to in this chapter are specified in the following site documents:

- Procedure Manual 1-01 (Ref. 9)
- Procedure Manual 1B (Ref. 10)
- Program-specific manuals

Chapters 7, 11, and 12 address the training and qualification requirements for various programs.

The LW training program is established by MP 1.18, “Employee Training,” implemented through Procedure Manual 4B (Ref. 8). On-shift training is addressed in Section 11.3 of this DSA.

The CSTF Managers are trained in the ‘fitness for duty’ program, as required by Procedure Manual 4B (Ref. 8).

The Conduct of Operations program establishes high operating standards and ensures communication of those standards to operations personnel. The program also addresses accountability, utilization of resources, and general policies (Ref. 4).

Operational performance is monitored, documented, and trended for future reference and to make improvements in operational performance. Supervisors and managers spend time in the field observing operations activities. In addition, various successes and performance problems are monitored, documented, and trended on a regular basis (Ref. 4).
17.4 SAFETY MANAGEMENT POLICIES AND PROGRAMS

17.4.1 SAFETY REVIEW AND PERFORMANCE ASSESSMENT

The oversight functions in program-specific areas such as industrial safety, fire protection, and hazardous material control are described in detail in Chapters 8 and 11.

CSTF has a monitoring and assessment program to ensure that the material condition, industrial safety practices, cleanliness and housekeeping, and radiological and hazard protection practices meet management's standards. This monitoring program ensures that noteworthy practices are recognized, performance deficiencies are identified, and associated corrective actions are implemented to provide continuous improvement in facilities and operations. The comprehensive self-assessment program ensures that key attributes of Conduct of Operations, maintenance, and training are understood and are being effectively implemented in the CSTF (Ref. 4).

17.4.1.1 Consolidated Hazards Analysis Process

SCD-11 (Ref. 13) provides details of the Hazards Analysis program implementation at the CSTF including the process by which Consolidated Hazard Analyses are prepared, reviewed, approved, and issued.

17.4.1.2 Unreviewed Safety Question Reviews

Unreviewed Safety Question (USQ) reviews are used in considering whether or not a proposed activity (modification, procedure change, test, or experiment) involves a USQ as defined in Procedure Manual 11Q, Procedure 1.05 (Ref. 15).

Technical reviews verify the compatibility of a change in facility design, and ensure that the proposed change will not adversely affect facility safety, reliability, or operation (Ref. 3, 5).

Cognizant Engineers at the CSTF are qualified in the USQ process and perform USQ reviews during the Design Authority Technical Review of a proposed activity per Procedure Manual E7 (Ref. 5).

17.4.1.3 Independent Assessment

The LW contractor provides company-level independent oversight to the CSTF. Procedure Manual 12Q (Ref. 16) defines the structure, principles, responsibilities, associated requirements and procedures for conducting independent assessments.

17.4.1.4 Concentration, Storage, and Transfer Facilities Self-Assessment

The CSTF Self-Assessment Program is developed and executed based on a graded approach with depth of inquiry and frequency of review being dependent on the importance to safety (personnel, public, and environment), regulatory compliance, and operational integrity. The CSTF Self-Assessment Program includes Line Management Self-Assessment (self-verification, line management walkdowns, and formal line management self-assessments), Independent
Assessment, Management Assessment and, when applicable, Readiness Self-Assessment per Procedure Manual 12Q (Ref. 16).

17.4.1.5 Facility Operations Safety Committee

The CSTF Facility Operations Safety Committee (FOSC) reviews and advises the Facility Manager on matters that affect safe operation and associated activities of the CSTF. CSTF Management appoints the Chairman of the FOSC and approves the FOSC membership, which consists of managers or alternates from various facility organizations as core (voting members) and non-voting members.

FOSC meetings are scheduled, as needed. The FOSC members/alternates are required to complete qualification and training requirements for their assigned job position. Additionally, they are required to complete specific training identified for the FOSC membership. Procedure Manual 1B, Procedure 4.19 (Ref. 10) provides the details of function, responsibilities, membership, and qualification of members of the CSTF FOSC.

17.4.1.6 Occurrence Reporting

Procedure Manual 9B (Ref. 17) implements a system of procedures referred to as the Site Item Reportability and Issue Management (SIRIM) process.

The CSTF has a program of followup review of SIRIM events, conditions, or concerns that includes the following elements:

- Review of the final report by the responsible FOSC for emergencies and unusual occurrences
- Review of the final report by the appropriate lessons learned coordinator for identification and reporting of lessons learned

17.4.1.7 Lessons Learned Program

Procedure Manual 1B (Ref. 10), MRP 4.14 requires systematic reviews of operating experiences at SRS facilities, DOE complexes, and commercial nuclear industry facilities, to generate lessons learned that promote the safe, effective operation of SRS facilities.

17.4.2 CONFIGURATION AND DOCUMENT CONTROL

Configuration control at the CSTF is achieved through implementation of the Configuration Management (CM) program outlined in Procedures 1.05 and 1.32 of Procedure Manual E7 (Ref. 5). All activities are performed in accordance with the site QA program described in Chapter 14.

17.4.2.1 Concentration, Storage, and Transfer Facilities Configuration Management Program

The CSTF CM program is a facility lifetime program that will assure that the facility is maintained and operated within its design and safety envelopes. This program was developed in accordance with the requirements of Procedure Manual E7 (Ref. 5). The CM Implementation
Plan (Ref. 19) fulfills Procedure Manual E7 (Ref. 5) requirements by defining the following activities:

- CM integration
- Configuration definition
- CM information management
- Configuration control
- Assessments

Configuration is established by defining the physical and functional requirements, verifying the essential attributes in a field walkthrough program, and verifying critical functions. Change controls are in place to ensure proper documentation, reviews, and approvals of changes. The controls in place provide for the continual improvement of the information process. The CM Program details are summarized in Procedure Manual E7 (Ref. 5) and G-ESR-H-00127 (Ref. 19).

17.4.2.2 Quality Assurance

CM and document control activities are performed in accordance with the site QA program. The QA program is implemented at the CSTF through Procedure Manual 1Q (Ref. 7) and is described in detail in Chapter 14.

17.4.3 SAFETY CULTURE

A safety culture is a work atmosphere that promotes the interest and involvement of all personnel in their personal safety and the safety of their co-workers. The safety culture facilitates a questioning attitude toward safety-related activities and equipment and ensures that personnel understand the potential risks to the facility and workers as well as the rewards and sanctions associated with their own personal safety performance. This atmosphere is exemplified by employee participation in the site safety and health program as implemented through documents such as Procedure Manual 8Q (Ref. 20) and Procedure Manual 4Q (Ref. 21).

Management Practices, along with their implementing programs, foster a safety culture at SRS. Management Practices are specified in Procedure Manual 1-01 (Ref. 9), and are implemented through Procedure Manual 1B (Ref. 10), and program-specific site manuals.
17.5 FACILITY RECORDS

There are two major components of records management -- a document control system and a records retention system. The document control system provides a means of ensuring that documents important to the operation of SRS are controlled consistently and are available to meet prescribed requirements. Documents may be written, recorded, or photographic information describing, defining, specifying, reporting, or certifying activities, requirements, procedures, or results. Records include procedures, instructions, plant manuals, reports, drawings, standards, specifications, basic data, vendor-supplied data, and controlled correspondence.

The M&O contractor is responsible for the document control system to distribute sitewide manuals and maintains the control system for distribution of unclassified controlled documents. The Classified Document Control group maintains the control system for distribution of classified controlled correspondence that requires receipt acknowledgment by signature. The CSTF in turn is responsible for establishing and maintaining a documented administrative control system for documents generated or processed within the facilities.

The M&O contractor maintains a controlled index of controlled documents that provide sitewide instructions for performing work, the revision status, and their unique identification numbers. An index of approved procedures is maintained. Approved procedures and drawings for the CSTF are controlled and readily available.

Retention of records is based upon categories and retention periods established by the Records Schedule Matrix (RSM). The M&O contractor is responsible for the RSM. The RSM ensures that DOE retention requirements are met. The schedule identifies retention periods and disposition instructions for each category. Completed records are transmitted to the M&O contractor in accordance with RSM.

Maintenance of training records for employees is described in Chapter 12, and maintenance of Radiological Control information records (such as dosimetry records) is described in Chapter 7.
17.6 REFERENCES

6. Deleted
11. Deleted
12. Deleted
14. Deleted
17. Site Item Reportability and Issue Management (SIRIM). Procedure Manual 9B.
18. Deleted
CONCENTRATION, STORAGE, AND TRANSFER FACILITIES

DOCUMENTED SAFETY ANALYSIS

CHAPTER 18
TANK 48 ACCIDENT ANALYSIS

Revision 20
August 2017
DISCLAIMER

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<tr>
<td>GC</td>
<td>Gas Chromatograph</td>
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<tr>
<td>HEPA</td>
<td>High-Efficiency Particulate Air</td>
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<tr>
<td>HLLCP</td>
<td>High Liquid Level Conductivity Probe</td>
<td></td>
</tr>
<tr>
<td>hp</td>
<td>horsepower</td>
<td></td>
</tr>
<tr>
<td>ICRP</td>
<td>International Commission on Radiological Protection</td>
<td></td>
</tr>
<tr>
<td>IPI</td>
<td>Installed Process Instrumentation</td>
<td></td>
</tr>
<tr>
<td>ITP</td>
<td>In-Tank Precipitation</td>
<td></td>
</tr>
<tr>
<td>KTPB</td>
<td>potassium tetraphenylborate</td>
<td></td>
</tr>
<tr>
<td>LCO</td>
<td>Limiting Condition for Operation</td>
<td></td>
</tr>
<tr>
<td>LEL</td>
<td>Lower Explosive Limit</td>
<td></td>
</tr>
<tr>
<td>LFL</td>
<td>Lower Flammability Limit</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>molar</td>
<td></td>
</tr>
<tr>
<td>M&amp;TE</td>
<td>Measuring and Test Equipment</td>
<td></td>
</tr>
<tr>
<td>mg/l</td>
<td>milligram per liter</td>
<td></td>
</tr>
<tr>
<td>MOC</td>
<td>Minimum Oxygen Concentration</td>
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<tr>
<td>MSA</td>
<td>Mine Safety Appliances</td>
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<tr>
<td>NaTPB</td>
<td>sodium tetraphenylborate</td>
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ACRONYMS AND ABBREVIATIONS (continued)

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDTT</td>
<td>Nil-Ductility Transition Temperature</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>NMMP</td>
<td>Nuclear Maintenance Management Program</td>
</tr>
<tr>
<td>NPH</td>
<td>Natural Phenomena Hazard</td>
</tr>
<tr>
<td>OA</td>
<td>oxalic acid</td>
</tr>
<tr>
<td>pga</td>
<td>peak ground acceleration</td>
</tr>
<tr>
<td>ppm</td>
<td>parts per million</td>
</tr>
<tr>
<td>PVT-1</td>
<td>Process Verification Testing - Phase I</td>
</tr>
<tr>
<td>Q-time</td>
<td>quiescent time</td>
</tr>
<tr>
<td>ROCTP</td>
<td>Radioactive Operations Commissioning Test Plan</td>
</tr>
<tr>
<td>SAC</td>
<td>Specific Administrative Control</td>
</tr>
<tr>
<td>SAR</td>
<td>Safety Analysis Report</td>
</tr>
<tr>
<td>SC</td>
<td>Safety Class</td>
</tr>
<tr>
<td>SCC</td>
<td>Stress Corrosion Cracking</td>
</tr>
<tr>
<td>scfm</td>
<td>standard cubic feet per minute</td>
</tr>
<tr>
<td>SMP</td>
<td>Submersible Mixer Pump</td>
</tr>
<tr>
<td>SRR</td>
<td>Savannah River Remediation LLC</td>
</tr>
<tr>
<td>SRS</td>
<td>Savannah River Site</td>
</tr>
<tr>
<td>SS</td>
<td>Safety Significant</td>
</tr>
<tr>
<td>SSC</td>
<td>Structure, System, and Component</td>
</tr>
<tr>
<td>ST</td>
<td>sodium titanate</td>
</tr>
<tr>
<td>STPB</td>
<td>sodium tetraphenylborate</td>
</tr>
<tr>
<td>TBP</td>
<td>tributyl phosphate</td>
</tr>
<tr>
<td>TPB</td>
<td>tetraphenylborate</td>
</tr>
<tr>
<td>TSR</td>
<td>Technical Safety Requirement</td>
</tr>
<tr>
<td>USQ</td>
<td>Unreviewed Safety Question</td>
</tr>
<tr>
<td>VAC</td>
<td>Volts Alternating Current</td>
</tr>
<tr>
<td>VB</td>
<td>Valve Box</td>
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<tr>
<td>VFD</td>
<td>Variable Frequency Drive</td>
</tr>
<tr>
<td>vol. %</td>
<td>volume percent</td>
</tr>
<tr>
<td>XTPB</td>
<td>tetraphenylborate species</td>
</tr>
</tbody>
</table>
18.0 HAZARD AND ACCIDENT ANALYSIS

The scope of this chapter includes only the unique hazards and accidents associated with Tank 48. Based on Reference 1, this analysis was not redone and reflects the safety analysis previously contained in WSRC-SA-15, Rev. 12 (Ref. 2).

The subsequent sections describe the methodology used to identify the Tank 48 hazards and safety features that mitigate these hazards.

International Commission on Radiological Protection (ICRP) 30 Dose Conversion Factors (DCFs), as opposed to the most current ICRP-68/72 DCFs, are used in this chapter.

Events not covered in Section 18.3 for Tank 48 are described in Chapter 3. Events involving the Submersible Mixer Pumps (SMPs) are analyzed in Chapter 3 and are not assessed against the events described in this chapter. Therefore, SMP operation is prohibited in Tank 48.
18.1 IDENTIFICATION OF HAZARDS

This chapter contains historical information about the In-Tank Precipitation (ITP) process involving Tanks 48, 49, and 50. The ITP process was suspended in December 1997. Actions were successfully completed to reduce the quantity of tetraphenylborate (TPB) and its degradation products in Tanks 49 and 50. Tanks 49 and 50 have been returned to Tank Farm service as non-organic tanks and are no longer part of the ITP process. Tank 48 contains large quantities of cesium (Cs)/potassium tetraphenylborate (KTPB), with virtually no decomposition evident (only a small quantity of benzene produced based on years of slurry pump operation) because of chemistry controls (free hydroxide and temperature) in place. Much of the discussion below pertains to the suspended process and is retained for historical purposes only.

A series of studies have identified the hazards related to the ITP process. These studies include early Process Hazard Reviews and more recent Hazard Assessments/Analyses (Ref. 3, 4, 5, 6, 7, 8, 9). The methodology used to identify hazards included the following:

- Correlation of existing hazards to the ITP process
- Application of classical chemical hazard assessment techniques
- Analysis of hazardous material inventories

The principal hazard introduced in the Tank Farms by the ITP process comes from the chemicals used in the process. Although restrictions are imposed on facility operations, this hazard is categorized and described in Section 18.1.1 through 18.1.5 as the process was originally intended to operate.

- Section 18.1.1 Flammable Vapors
- Section 18.1.2 Combustible Liquid
- Section 18.1.3 Combustible Solids
- Section 18.1.4 Releases of (Chemical) Toxic Gases
- Section 18.1.5 Subsurface Gas Collection

Tank 49 is a supernate/salt storage tank with air-based purge ventilation. The hazards previously created by benzene and phenylborates in Tank 49 have been removed (Ref. 10). Therefore, the physical and administrative controls and compensatory measures previously required to prevent and mitigate the accidents associated with benzene and phenylborates in Tank 49 are no longer necessary. Tank 49 is the only other waste tank besides Tank 48 that is qualified and equipped to implement the requisite controls (primarily those associated with inerting), for benzene and phenylborate hazards. Therefore, Tank 49 could receive transfers from Tank 48 in the event of a Tank 48 leak in accordance with an approved Response Plan.

18.1.1 FLAMMABLE VAPORS

The precipitation and adsorption processes, by which radioactive constituents are removed from the salt supernates, produce flammable vapors, predominately benzene, not previously present in
the Tank Farm. The high vapor pressure of benzene allows evaporation at the temperatures in
the waste tanks and can result in flammable vapor concentrations. Formerly, the principal
hazardous vapor was hydrogen from the radiolysis of water in the high level wastes (Ref. 11).
The only organic vapor produced was from traces of solvents in fresh canyon wastes. The new
vapor space components in Tank 48 may consist of benzene, butanol, isopropanol, and methanol.
The benzene enters the waste tank through the use of sodium tetraphenylborate (STPB). STPB
is a precipitating agent for Cs-137 and can generate/release benzene via four mechanisms:

- An impurity (free benzene) in the supplies of STPB
- As a result of chemical/thermal degradation of STPB
- As the product of acid hydrolysis of STPB
- As the product of radiolysis of STPB

STPB is soluble in water to about 0.9 molar (M) and is a crystalline solid at room temperature.
Thermal decomposition can occur at temperatures above 60°C, but STPB is stable during
thermal cycling of the solution from ambient temperatures to 50°C. STPB solubility decreases
with increasing sodium concentration. STPB decomposes to aromatic organics (benzene,
biphenyls, and triphenyls) and salts of sodium and boron if the pH drops below seven.
Water-insoluble salts are formed in the presence of many ions, including cesium, rubidium,
potassium, silver, and ammonium. After processing, the precipitate consists principally of
KTPB, up to 99-mol. %, and the remainder cesium tetraphenylborate (CsTPB) (Ref. 12).
Changes in the slurry chemistry can increase the solubility of KTPB, releasing TPB ions to
undergo radiolytic and catalytic degradation. Under the conditions in this process, TPB also
reacts with soluble mercury salts to form insoluble diphenyl mercury. Testing has demonstrated
that catalysis with copper ions and sludge solids can significantly increase the rate of
decomposition of TPB slurries (Ref. 13). Further testing has demonstrated that the presence of
oxygen impacts the decomposition mechanism. In a low oxygen atmosphere, the reaction
(catalytically driven) initiates instantaneously with benzene as the nearly exclusive product. In
the presence of oxygen, benzene is still the predominant decomposition product, but an induction
period is observed before the decomposition begins. Large quantities of phenol and some
biphenyls are formed. Laboratory tests indicate that in the presence of air, phenol is the main
product; however, in the waste tanks, even if the tank vapor space is not inerted, the oxygen
concentration in the slurry is limited by diffusion into the liquid (Ref. 14, 15). Therefore, the
main reaction product remains benzene. Benzene poses a flammability hazard. Laboratory
studies of benzene production mechanisms and flammable retention characteristics and release
rates of the slurry are continuing.

The radiolysis of TPB species (XTPB) (1 mole) produces benzene (1.73 moles), phenol
(0.94 moles), biphenyl (0.40 moles), phenylboric acid (0.53 moles), boric acid (0.47 moles),
nitrobenzene (0.005 moles), and hydrogen (1.34 moles) (Ref. 16).

Calculated benzene generation rates in Tank 48 during one process cycle are contained in
Reference 17. These generation rates are based on the operating schedule assumed for a cycle as
given in Table 18.6-1 (Ref. 12). See Section 18.2.3.1 for a current assessment of the production
of benzene in Tank 48 while precipitate processing is suspended.
Benzene generation estimates (given in Reference 18 and based on test data in Table 18.6-2) indicate that dilution with ventilation air would produce a nonflammable benzene-air mixture in the tank exhaust, even in the extreme case where all of the benzene is assumed released in the washing step. For over two-thirds of the processing time, benzene evolution rates are low in Tank 48. However, the exhaust concentration estimates during washing in Tank 48 represented a larger fraction of the Composite Lower Flammability Limit (CLFL) than was deemed prudent for routine operation. Historically, the flammable vapor (hydrogen) in tank exhaust is kept below 10% of its Lower Flammability Limit (LFL) (4.1 vol. % in air). Note that the LFL of benzene vapors in air is 1.3 vol. % (Ref. 19, 20). An inert (nitrogen) atmosphere can be provided in Tanks 48 and 49.

Benzene will evaporate at the liquid surface and diffuse into the tank vapor space. The diffusion process is driven by thermal gradients within the tank. Benzene mixing and layering is discussed in Section 18.2.3 and in References 18, 21, and 22. When the benzene vapor mixes with air, a flammable benzene-air mixture could be formed in Tank 48 if its ventilation flow was interrupted for extended periods. Nitrogen inerting helps prevent the accumulation of a flammable vapor.

The ITP process also introduces other flammable vapors (i.e., methyl and isopropyl alcohol) that are present in the sodium titanate (ST) adsorbent, and 1-butanol, which is a decomposition product of tributyl phosphate (TBP). Compared to benzene, the alcohols are more soluble in the waste solutions and are more difficult to remove by stripping methods. Thus, alcohol vapors can contribute to the flammable vapor hazard operation. The LFLs for these vapors in air are 6% and 2% for methanol and isopropanol, respectively (Ref. 19).

Flammable vapors are a concern because they could initiate a vapor explosion/deflagration or solids fire.

18.1.2 COMBUSTIBLE LIQUID

TBP, added as a defoamer in the filtrate, can accumulate in Filtrate Hold Tanks (FHTs) and Tank 48. TBP is a combustible (flash point of 146°C) and a non-volatile (boiling point of 292°C) toxic liquid (Ref. 23). It decomposes by hydrolysis to 1-butanol, dibutyl phosphate, and monobutyl phosphate in proportions dependent upon time of exposure (Ref. 24). When exposed to radiation, it also decomposes into the same products as well as smaller hydrocarbon compounds and hydrogen (Ref. 24).

The hazards of 1-butanol are addressed in Section 18.1.1.

The solubility of TBP in salt solution and wash water is approximately 1 milligram per liter (mg/l) and 12 mg/l, respectively (Ref. 24). The TBP concentration required in the filtrate is approximately 30 mg/l and the addition rate is up to 2.5 liter per hour (Ref. 25). Therefore, insoluble TBP will collect on the surface of contents of FHTs and ITP tanks posing a potential combustibility concern. The combustion tests on pure TBP showed that a floating layer of TBP on salt solution at 70°C could not be ignited by a butane flame. The TBP layer containing flammables (>0.5 vol. %) could be ignited by a butane flame only if the vapor phase concentration of the flammables exceeded the CLFL (Ref. 26).
18.1.3 COMBUSTIBLE SOLIDS

In Tank 48, deposits of solids containing TPB may form on waste tank walls, cooling coils, and other installed equipment from evaporated films or foams that develop during stirring of the slurry. Dried samples of these solids have been ignited with a continuous flame/spark source in test conditions, and the solids burn with a yellow flame and produced sooty smoke. A discrete electrical spark will not ignite the dried solids. The Minimum Oxygen Concentration (MOC) for combustion of dry KTPB solids is about 12%. The solids exhibit no explosive properties (Ref. 27).

Testing has shown that undried solids will not burn (Ref. 28). The moisture content of these solids is very sensitive to the amount of soluble salts in the deposit; high-salt solids retain more water than low-salt solids. The high-salt solids are usually too wet to burn, but high-salt solids could become combustible as they dry out on tank surfaces above the water line if there were long periods of extremely low humidity in the vapor space (Ref. 27). As the integrated radiation dose is increased, the slurry becomes less viscous and forms thinner deposits.

Another solid compound that could form is a mixture of KTPB and sodium nitrate (Ref. 27). Solids containing KTPB and sodium nitrate do not have explosive properties (Ref. 27). A weight ratio of KTPB to sodium nitrate of 1:6 gives a maximum energy release of 1.2 kcal per gram of mixture (Ref. 29).

Sixty-seven kilograms of solids were analyzed for this reaction based on a 10-cm-wide-by-1-cm-thick layer of solids (based on experimental observation [Ref. 27]) deposited as a ring around the outside circumference of the tank, the inside column, and on each of the cooling coils. One mole of solid KTPB would produce 34 moles of gas when reacted with 24 moles of sodium nitrate. The pressure increase from this solids fire would be 6% of the pressure produced by benzene deflagration.

The frequency of the vapor phase deflagration in the tank combined with solids fire, as discussed in Section 18.3.2, is not credible; therefore, the frequency of the combustion of KTPB and sodium nitrate is not credible.

18.1.4 RELEASES OF (CHEMICAL) TOXIC GASES

Airborne benzene releases represent a toxic gas hazard. Abnormal benzene releases are discussed in Section 18.2.4.1. The incremental cancer risks of benzene exposures during full ITP operations were reported in Appendix E of Reference 2; however, due to the suspension of the ITP process, benzene exposures will be insignificant.

18.1.5 SUBSURFACE GAS COLLECTION

In 1990 a potential safety hazard was identified at the Hanford, Washington nuclear facility. A high-level waste tank containing high concentrations of salt and organic matter (ethylene diamine tetraacetic acid) had developed a thick crust that was floating or bridged. The principal concern was that radiogenic or chemical reaction gases might accumulate under the crust and
then explode. Hanford waste produces both combustible (H₂) and oxidant (N₂O) gases. Although there are obvious similarities (e.g., high-level waste, solids, organics, and combustible gases), qualitative and semi-quantitative analyses indicate that a crust/gas-bubble explosion hazard cannot occur in the ITP system. The basic differences between ITP tanks and Hanford's "double shell slurry" tanks that lead to this conclusion are as follows:

- Nature of the solid
- Nature of the gases
- System dynamics (hydraulics)

18.1.5.1 Solids

Freshly made precipitate has been likened to shaving cream in consistency. The density is close to that of the waste slurry, so it can float. These organic solids do not form a rigid mass similar to the hard crust believed to be the bulk of the Hanford crusts. The relatively small quantity of ST adsorbent is heavier and tends to sink, but it can be held up by precipitate and is easily suspended by the pump agitation. The XTPB precipitate slurry thins dramatically by self-irradiation. Slurry rheology changes from non-Newtonian, with an apparent viscosity of about 50 cp, to almost water-like in a matter of weeks (Ref. 30). In 1983, a batch of radioactive XTPB precipitate and ST adsorbent was made from real waste in a full-scale in-tank demonstration using temporary auxiliary equipment. The filtered and washed slurry, as observed after 1.5 years of relatively stagnant storage in the tank, did not crust over. Solids had sunk to the bottom and were covered by liquid. Currently, there are no significant floating or bridged solids in the tank.

18.1.5.2 Gases

ITP slurries produce benzene, hydrogen, and nitrous oxide by radiolysis. Benzene and hydrogen are fuels; nitrous oxide is an oxidant. In washed slurry the relative molar production is H₂>C₆H₆>N₂O. In unwashed slurry the relative molar production is C₆H₆>H₂>>N₂O. No O₂ or NOₓ is observed (Ref. 31).

When the ventilation system is running in Tank 48, the N₂O concentration will be less than 200 parts per million (ppm) (by volume). The contribution of N₂O to the total oxidant concentration is negligible.

Benzene radiolysis has been studied extensively (Ref. 16). In fresh, unwashed precipitate the "G" value is high (approximately 7 molecules/100 electron volt [eV]), and about 90% of this benzene is trapped in the crystal lattice. No "slurry growth" (a phenomenon observed at Hanford) has been observed due to this trapped benzene. In trapped form, benzene is not a flammable gas hazard because it is not a continuous phase but is dispersed in solids. Some of the trapped benzene is released relatively rapidly when the slurry is washed in Tank 48 due to the dissolution of excess (solid) STPB. Although washing operations in Tank 48 are prohibited at this time, the waste in the tank would be continuously and vigorously agitated during washing, and the inert gas purge system is designed for this release of benzene. The "G" value for free benzene is about 0.3 molecules/100 eV in washed precipitate. Benzene is formed in the aqueous
phase, where it is slightly soluble, and is released continuously by diffusion from the surface of the liquid phase only to the tank vapor space.

18.1.5.3 Hydraulics

Although processing in Tank 48 is prohibited, periodic slurry pump operations will provide vigorous agitation. For this hydraulic reason, the formation of gas pocket buildup under a stable crust is judged to be infeasible in Tank 48.

For the reasons given and because a subsurface ignition source is highly improbable, no subsurface or under-crust gas explosion scenario has been added to the Tank 48 accident analysis.
18.2 PREVENTION/MITIGATION OF HAZARDS

This section provides an overview of the methods to prevent or mitigate hazards in Tank 48. Specific measures for preventing or mitigating potentially hazardous events are discussed in each accident analysis section.

The location of the H-Area Tank Farm is a mitigating feature for offsite consequences. The distance (at least 7 miles) between H Area and the site boundary provides substantial dilution of any airborne releases before they reach the site boundary.

18.2.1 METHODS OF PREVENTION/MITIGATION

The risks from flammable materials can be mitigated by controlling fuel, oxygen, and sources of ignition.

The traditional method at the Savannah River Site (SRS) has been to dilute the fuel to safe concentrations either in the liquid phase or in the vapor phase. For example, the hydrogen that slowly evolves from radiolysis in a waste tank is diluted/purged with ventilation air to concentrations below the LFL. This method was shown to be effective for benzene vapors despite the slow diffusion (mixing) of benzene in air (Ref. 22). The accumulation of combustible solids on tank interior surfaces is not subject to operational control.

Sources of ignition can be eliminated from the equipment by design and administrative controls. These precautions, coupled with well-defined recovery options are sufficient to significantly lower the probability of a deflagration (Ref. 32).

Tank 48 utilizes two safety strategies for preventing the accumulation (or mitigating the consequences) of flammable mixtures. The first strategy involves nitrogen purging of the tank vapor space and the preservation of an inert tank atmosphere. The second strategy involves control of the fuel composition of the vapor and liquid phases in Tank 48, including purge ventilation of the tank. Both strategies are discussed in detail in Section 18.3.1.

In addition to the strategies identified above, Administrative Controls are in place to control benzene levels in the tank waste and vapor space. These Administrative Controls include the control of Tank 48 waste temperature and the free hydroxide concentration in the Tank 48 waste. These Administrative Controls also require the Tank 48 slurry pumps to be operated periodically to deplete trapped/retained flammable vapor inventory. The strategy employed to define the desired level of flammable vapor inventory depletion and supplemental controls in place to further ensure flammable vapor releases to the tank vapor space are within acceptable limits are described in Section 18.3.1.

In addition, an Administrative Control program has been established for Tank 48 that requires the time to increase the flammable vapor concentration in the vapor space, assuming a starting point of 37% to 100% CLFL is 9 days (applies during non-inerted operation only) or longer following a loss of ventilation.
The CLFL and MOCs for various vapor mixtures have been determined by empirical correlation to experimental data. The CLFL correlation employed is described in Reference 33. The approach employed is to use LeChatelier's rule with the LFL values published by the Bureau of Mines corrected for temperature effects. Benzene (C₆H₆) and hydrogen (H₂) are the only combustible gases explicitly accounted for. Other combustible vapors are also generated, but these would have very small concentrations relative to H₂ and C₆H₆ and are implicitly accounted for by the use of conservative H₂ and C₆H₆ production rates (Ref. 34).

The LFL values given in the Bureau of Mines flammability data compilation for C₆H₆-air and H₂-air mixtures, as documented in Reference 33, are 1.3% at 100°C and 4.0% at 25°C, respectively. These may be corrected for temperature effects using the Burgess-Wheeler law (Ref. 35, 36). This approach gives a 25°C LFL value of 1.37% for C₆H₆-air mixtures. The 25°C C₆H₆-air LFL is consistent with experimental data given in other Bureau of Mines reports (Ref. 37). The 25°C CLFL correlation for C₆H₆-H₂-air mixtures is therefore:

\[
CLFL(C₆H₆ - H₂ - air, 25°C) = \frac{1}{\frac{f_{BZ}}{1.37} + \frac{f_{H₂}}{4.0}}
\]

Where \( f_{BZ} \) and \( f_{H₂} \) are the fractions of benzene and hydrogen, respectively, in the combustible gas.

The values calculated with this expression are conservative with respect to the available experimental data for C₆H₆-H₂-air mixtures at ambient temperature.

The MOC for pure benzene is 11 vol. % (Ref. 38). The MOC for pure methanol is 10 vol. % (Ref. 38). There are no MOCs for isopropanol or n-butanol in the literature. The MOC for ethanol is 12.3 vol. %. Higher homologs of alcohols (e.g., isopropanol or n-butanol) are expected to have an MOC that is similar to or higher than the MOC for ethanol. The MOCs for mixtures of hydrogen, benzene, and alcohols are as follows (Ref. 20):

<table>
<thead>
<tr>
<th>H₂ concentration</th>
<th>MOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>vol. % of total combustibles</td>
<td>vol. %</td>
</tr>
<tr>
<td>0 &lt; H₂ &lt; 10</td>
<td>9.0</td>
</tr>
<tr>
<td>10 ≤ H₂ &lt; 60</td>
<td>8.0</td>
</tr>
<tr>
<td>H₂ ≥ 60</td>
<td>5.0</td>
</tr>
</tbody>
</table>

These MOCs were experimentally determined using various mixtures of hydrogen, benzene, alcohols, and toluene. The MOCs for mixtures containing 3% and 93% alcohol were 8.9 and 9.0 vol. %, respectively. This indicates that alcohols have no significant affect on the MOC.
18.2.2 WASTE TANK VENTILATION

Under normal operating conditions, Tank 48 is ventilated to maintain a slightly sub-atmospheric pressure in its vapor space. The intent is to dilute/purge flammable vapor concentrations below the CLFL and to prevent unfiltered releases of tank vapors that could carry airborne activity from the tank. When conducting inerted operations, the nitrogen purge rate and the exhaust rate must be balanced to produce this condition and to avoid pressurizing a tank. At the same time, the purge rate must provide adequate vapor dilution and must be adequate to maintain the inert atmosphere (i.e., an oxygen concentration below the MOC for combustion of flammable gases). A similar ventilation configuration could be maintained on Tank 49 following a transfer of Tank 48 waste material to Tank 49, following a Tank 48 leak.

The MOC limit is designed to protect the tanks from solids fires and, in conjunction with the dilution of flammable vapors provided by the ventilation flow, from vapor deflagrations. The MOC for the precipitated solids was determined to be greater than or equal to 12 vol. % oxygen (Ref. 27). Although the MOC for pure benzene is 11 vol. %, the MOCs for mixtures of hydrogen, benzene, and alcohols are as given in Section 18.2.1.

The MOC for hydrogen is about 5 vol. % oxygen. If the vapors were predominantly hydrogen, an MOC limit based on the 12 vol. % (Ref. 27) for precipitated solids would be inadequate. However, when hydrogen is the predominant component of the flammable vapors with tank ventilation operational, the concentration of the flammable vapors is so small that it is already below the CLFL.

The CLFL analyzer is designed to monitor the tank flammable vapor concentration. The sample is taken via a line that extends into the vapor space. This provides a representative sample of the tank vapor composition since the nitrogen purge ventilation system provides sufficient forced convective mixing to ensure a homogeneous vapor mixture. Since the tank composition is well mixed, a sample taken will be representative of the tank vapor composition.

A hardwired interlock exists between the nitrogen supply flow switches and the exhaust fans. On loss of nitrogen flow during ventilation in Mode B, the operating exhaust fan automatically shuts down. Slight pressurization of the tank and an airborne activity release could occur. Restarting of the ventilation when nitrogen becomes available would restore the sub-atmospheric pressure and the purge at the same time.

If the exhaust fan were allowed to run with no nitrogen purge, air would be rapidly drawn into the tank. The concentration of flammables in the vapor space would remain below the CLFL. Controls for the protection against a solids fire are discussed in Section 18.3.2. The Emergency Purge Ventilation Equipment (EPVE) with power supplies was previously designated as Safety Class (SC). However, with the change in deflagration protection requirements, the EPVE now serves a Safety Significant (SS) function only for Tank 48. Two EPVE engine/blower assemblies are stored in 241-242H, which is a seismic and high wind qualified structure. The structure meets 2 over 1 seismic criteria (Ref. 39). These EPVE engine/blower assemblies (capacity of about 500 standard cubic feet per minute [scfm]) (Ref. 39) would draw ambient air through the tank to maintain the average vapor composition below the CLFL.
Actions are taken to reduce the probability of an ignition source during a loss of nitrogen ventilation to Tank 48 while in inerted operation. Immediately above the liquid in the tank there may be a layer of vapors that has a high benzene concentration. The thickness of this layer is a function of the benzene generation rate and the rate of ventilation with ambient air. This has been shown to be acceptable (Ref. 21, 22). For a deflagration to occur an ignition source would also have to be present within the tank and the vapor space must exceed the CLFL.

18.2.3 TIME TO COMPOSITE LOWER FLAMMABILITY LIMIT

Flammable vapors, such as hydrogen and benzene, are formed during the ITP process. The critical parameters, including their variability, which contribute to the generation/release rate of flammable vapors and the process controls that are used to limit vapor generation were assessed (Ref. 17, 34, 40). Benzene contribution in Tank 49 would be considered only after a transfer of Tank 48 waste material into Tank 49, following a Tank 48 leak. Benzene is not considered a contributor to the CLFL in Tank 49 during normal operation since it contains supernate/salt waste material that contains trace quantities of phenylborates (Ref. 10).

Formulae for calculating the hydrogen generation rate are discussed in Section 3.4.1.1.2.

The key parameters that influence the time to CLFL are discussed in the following subsections.

18.2.3.1 Production of Benzene

Benzene is produced from the radiolytic and thermal/chemical breakdown of a TPB compound and associated degradation. Experimental results have determined that catalytic degradation of TPB compounds can be a major contributor to the production of benzene. Tests have shown that the catalytically active species of most concern in the ITP process are copper and palladium. In waste simulant experiments, palladium is a more effective catalyst for the decomposition of TPB and triphenylboron (3PB) while copper is more effective in the decomposition of diphenylboronic acid (2PB) and phenylboronic acid (1PB) (Ref. 18).

The relative stability of TPB compounds in simulated waste is as follows:

\[
\text{Rate}_{\text{NaTPB}} > \text{Rate}_{\text{KTPB}} > \text{Rate}_{\text{CsTPB}}
\]

This order of reactivity is consistent with conditions that led to the relatively rapid chemical decomposition in Tank 48 at the end of Batch 1 precipitation when a significant quantity of sodium tetraphenylborate (NaTPB) was present (Ref. 18). Tests to measure the relative stability of CsTPB/KTPB in the absence of excess NaTPB show that KTPB and CsTPB are also more stable in a real waste environment.

Results from solids decomposition tests using simulants indicate a minimum hydroxide concentration of 0.6 M (pH = 13.8) will control the decomposition of TPB and 3PB and the resulting benzene production at 40°C. Best chemistry knowledge indicates that free hydroxide concentration does not control the rate of decomposition for 1PB and 2PB and the rate of decomposition is not appreciably different under air or nitrogen environments (Ref. 41).
Tank 48 currently has K/CsTPB solids with no excess NaTPB (excess NaTPB from Batch 1 and Process Verification Testing – Phase I [PVT-1] has decomposed). Periodic samples taken during and after PVT-1 have shown that the rate of increase of K+ is consistent with radiolytic decomposition of KTPB solids only. A flammable vapor inventory control program has been established to control the buildup of flammable inventory in the waste. In order to minimize the benzene production rate, the following storage conditions are applicable to Tank 48 (Ref. 18):

- Free hydroxide concentration shall be \( \geq 1.0 \) M
- Waste temperature shall not exceed 35°C
- Addition of fresh NaTPB is prohibited

Since Tank 49 is the designated receipt tank for Tank 48 in the event of a primary tank leak, the following Technical Safety Requirement (TSR) Administrative Control has been implemented:

- Sludge slurry transfers into Tank 49 are prohibited

This control is necessary to preclude the production of benzene as a result of the catalytic decomposition of the Tank 48 XTPB waste material in the presence of a sludge slurry mixture.

Benzene is also produced via radiolysis in TPB solutions (Ref. 34). The radiolytic production of benzene is described by G-values, which are defined as the yield of benzene per unit of absorbed radiolytic decay energy (molecules per 100 eV). Thus, the rate of benzene generation (molecules per unit time) can be calculated from the G-value and the dose rate (eV per unit time). Two radiolytic production mechanisms for benzene are included in the analysis: free benzene and trapped benzene. Free benzene is formed from radiolysis reactions involving dissolved TPB ions or the surface of TPB crystals. The benzene is formed in solution or at the interface between the solids and solution. Mass transfer of benzene from the interface or solution into the tank vapor space is treated as a rapid process in the time to CLFL analysis. Trapped benzene is formed by damage caused from radiation passing through the TPB crystals. The trapped benzene is released when the crystals dissolve, such as occurs with the excess NaTPB during the washing portion of an ITP cycle. An average G-value for free benzene is 0.0071 molecules/eV and the average G-value for trapped benzene is 0.034 molecules/eV. The range sampled includes the experimental uncertainty for these values (Ref. 34). Note also, that the maximum radiolytic benzene production rates are much lower than those discussed above for thermal/chemical TPB degradation.

18.2.3.2 Production of Hydrogen

The irradiation of water forms free radicals that can combine into such species as H₂ and H₂O₂. The production of hydrogen from the recombination of the noted free radicals is negatively influenced by the presence of nitrates (NO₂⁻) and nitrites (NO₃⁻). The G-value for hydrogen in TPB solutions and slurries is reported to be (Ref. 42):

\[
G_{H_2} = 0.4597 - 0.3803 ([NO_3^{-}] + 0.5[NO_2^{-}])^{1/3}
\]

for: \( 0 \leq ([NO_3^{-}] + 0.5[NO_2^{-}])^{1/3} \leq 1 \)
and

\[ GH2 = 0.1199 - 0.0504 \left( [\text{NO}_3^-] + 0.5[\text{NO}_2^-] \right)^{1/3} \]

when: \( 1 \leq \left( [\text{NO}_3^-] + 0.5[\text{NO}_2^-] \right)^{1/3} \leq 2 \)

18.2.3.3 Ventilation Exhaust Flow Rate

The ventilation exhaust flow rate determines the flammable vapor concentration prior to accident initiation. A minimum flow of 300 scfm was used in the analysis for Tank 48 (Ref. 34).

18.2.3.4 Waste Volume

The waste volume together with the Curie (Ci) content determines the radiation dose that will generate benzene and hydrogen. It is assumed that none of the radiation emitted within the waste escapes the waste volume. The waste volume also determines the vapor volume. A larger waste volume will lead to a smaller vapor space and a reduction in the time to reach the CLFL. The uncertainty in the reel tape measurements is used to adjust the measured waste level used in calculating time to CLFL (Ref. 34).

The Tank 48 liquid level shall be controlled to ensure that the tank liquid level does not reach the point (252 inches from the tank bottom) where entrainment through a riser becomes a deflagration release mechanism.

18.2.3.5 Excess STPB

The excess sodium tetraphenylborate (STPB) is the amount of solid STPB present in the predominantly KTPB slurry. The amount of undissolved STPB affects the amount of trapped benzene that could be released and how fast benzene is released during solids dissolution (Ref. 18).

Regulating the flow of STPB into the tank can minimize the excess STPB concentration by allowing sufficient time for STPB to react, forming the less soluble species (CsTPB, KTPB, etc.). However, fresh STPB additions are prohibited due to the suspension of precipitate process activities.

18.2.3.6 Tank Waste Temperature

The waste temperature affects the solubility of STPB, its dissolution rate during the washing phase, and the rate of the chemical breakdown of TPB compounds. As the temperature increases, the rate of benzene production increases. The waste temperature is a significant contributor to the benzene generation rate. Analysis has shown that maintaining the waste temperature at or below 35°C is a key control to minimizing the chemical production rate of benzene (Ref. 18).

18.2.3.7 Curie Content

The analysis considered the uncertainty in laboratory analysis instrumentation and procedures and the uncertainty in the tank sampling for Ci content (Ref. 34). The Tank 48 Cs-137 loading is
established at a maximum of 3.94E+05 Ci with a 25% uncertainty applied in a conservative manner to account for sampling and analysis inaccuracies (Ref. 43).

18.2.3.8 Initial Sodium Concentration

The sodium ion concentration directly affects the solubility of STPB. An increase in the soluble benzene concentration can result in an increase in the benzene release rate, particularly during slurry pump operations. Therefore, the sodium concentration is particularly important when fresh STPB is to be added to the waste tank (Ref. 18). However, fresh STPB additions are prohibited due to the suspension of precipitate process activities.

18.2.3.9 Free Hydroxide Concentration

Analysis has shown that a free hydroxide concentration greater than or equal to 1 M is a key control to minimizing the decomposition of NaTPB and 3PB and thus, the chemical production rate of benzene (Ref. 18).

18.2.3.10 Tank 48 Quiescent Time

Quiescent time (Q-time) relates to the maximum allowed interval between required pump runs. The allowable time between pump runs is adjusted to ensure that the time to CLFL is preserved. During non-inerted operation in Tank 48, a minimum time to CLFL of 9 days is required. The Q-time between pump runs is established based on the accumulated inventory of flammable vapors that may be retained in the waste.

The time to CLFL depends on the rate that hydrogen and benzene are produced/released. Operation of the Tank 48 slurry pumps liberates benzene and hydrogen retained/trapped within the waste, which results in elevated flammable vapor concentrations in the vapor space. Similar to operation of the slurry pumps, a seismic event could liberate retained/trapped flammable gases.

FLAMMABLE VAPOR INVENTORY CONTROL

In order to safely manage the inventory of flammable vapors that are retained within the waste, during non-inerted operation, a slurry pump run program has been implemented to liberate retained flammable vapors before they accumulate in sufficient quantity to challenge the 9 days to CLFL requirement for Tank 48. As described in Section 18.3.6 for Tank 48, MOC control is adequate to prevent a deflagration in these tanks if an earthquake evolves quantities sufficient to support a deflagration while in inerted operation. Although the consequences are well below the Evaluation Guidelines (EGs) for an Anticipated Event and a deflagration is prevented, additional fuel control inventory requirements are imposed to preclude the unabated buildup of flammable vapors during long periods of inerted operation. Slurry pumps are periodically operated in accordance with a Q-time that ensures that the retained flammable vapor inventory is less than the equivalent quantity that, if instantaneously released, could raise the vapor space concentration from 37% of the CLFL to 100% of the CLFL in the bulk vapor space in less than 9 days.
An additional consideration in the determination of Q-time is the hydrogen contribution and its effect on the Composite MOC. For additional information, refer to Section 18.3.1.1, “Basis for Crediting Inerting”.

Slurry pumps are run periodically to ensure that:

- Bulk vapor space deflagration is prevented during non-inerted operation. This assumes the instantaneous release of accumulated benzene since the last depletion run so that a minimum of 9 days to CLFL is protected following a loss of ventilation event,
- The potential is minimized for a solid surface layer to form that could inhibit or otherwise prevent the release of flammable vapors, and
- Significant quantities of flammable vapors do not accumulate in the waste during extended periods of inerted operation.

For slurry pump operations involving Tank 48, flammable vapor depletion is achieved provided that a minimum number of four pumps are operated simultaneously for a minimum of 24 hours.

If the required number of pumps is not used, programmatic controls are established to adjust the Q-time.

Past operation has shown that 24 hours of slurry pump operation is sufficient to deplete the flammable vapors from the waste (Ref. 90). It is recognized that following a depletion run that meets the criteria above, residual amounts of hydrogen or benzene can remain in solution. The residual concentration remaining in the waste is only a fraction of the solubility limit and is compensated for in the conservative Q-time program. The conservatisms in the program include assuming an initial condition of 37% of the CLFL, 100% retention, and instantaneous 100% release. During non-inerted operation, an additional conservatism includes 9 days of free release of flammable vapors at the assumed generation rate. Furthermore, the residual flammable vapors are unlikely to be evolved by an earthquake if simultaneous operation of slurry pumps could not evolve them during 24 hours of pump operation. Based on the above conservatisms, and the acceptance criteria established, the relatively small residual amount of flammable vapor remaining in solution following a depletion run need not be considered in the determination of time to CLFL.

OPERATIONAL CONTROLS FOR FLAMMABLE VAPOR CONTROL

Operational controls that implement the Q-time program include:

- Slurry pump operation shall be immediately terminated if the indicated CLFL reaches the prescribed TSR CLFL limit.
- The number of pumps operated, pump speed, and hold times shall be controlled to minimize the possibility of a rapid release of retained benzene during pump startup or a change in pump speed. The amount of Q-time that has elapsed shall be considered in developing and applying this pump control.
TIME TO CLFL DETERMINATION

The time to CLFL is determined by calculating the minimum amount of time to increase the flammable vapor concentration to 100% of the CLFL using a determined or measured generation rate and an initial condition of 37% of the CLFL. Retention is assumed to be 100% during the Q-time and 100% of the retained flammable vapor is assumed to be released instantaneously into the vapor space concurrently with a loss of ventilation event. Once released, the vapor space must be capable of accommodating an additional 9 days of free release (i.e., release rate equals generation rate) into the bulk vapor space. It is assumed that all benzene/hydrogen release during this subsequent 9-day period is retained in the tank vapor space. A minimum of 9 days to CLFL in the bulk vapor space must be satisfied prior to entry into non-inverted operation. Other requirements to permit slurry pump operations on Tank 48 are specified in Section 18.3.1.

BENZENE GENERATION RATE DETERMINATION

For Tank 48, due to the temperature and hydroxide controls established, there is virtually no decomposition of phenylborates (source of benzene), and little or no benzene is generated as evidenced by the results of several years of slurry pump operation.

18.2.4 PROCESS ACCIDENTS

18.2.4.1 Abnormal Benzene Release from a Waste Tank

The accidents analyzed are abnormal benzene releases from Tank 48 during planned water additions, inadvertent water additions, or inadvertent oxalic acid (OA) additions. In addition, this section addresses benzene releases during Tank 48 slurry pump operations.

BACKGROUND

Benzene vapors are released in the exhaust from Tank 48 during every phase of processing. The maximum benzene release rate is limited by the Occupational Safety and Health Act benzene limits. The atmospheric benzene concentrations from routine emissions from Tank 48 at breathing level will vary from 0 to 0.49 ppm, depending on the location in the facility.

Analyses indicate that the benzene release rate in any process step is enhanced by agitation and by the stirring effect of additions of water or acid. Agitation/stirring can increase the mass transfer of benzene in the slurry to the vapor space.

Previously, water additions at high addition rates (1,000 gallons per minute) were a concern because it was believed that trapped benzene would be released as a result of dissolution of solid STPB. This effect would be minimized under current operations since minimal soluble STPB solids are available in Tank 48 and further STPB use is prohibited. In addition, analysis (Ref. 44) shows that the potential for producing trapped benzene is significantly lower than previously assumed. Therefore, even if STPB solids were present, trapped benzene would not contribute substantially to benzene releases following water additions.
Nevertheless, during previous Tank 48 operations, increased benzene releases to the vapor space have been observed following liquid additions to the tank. This occurred when there was a large amount of benzene in the tank liquid available to be released. Analyst judgment is that the addition of water changed the mass transfer capabilities of the liquid, leading to a more rapid release rate into the tank vapor space. These same conditions will not exist because controls are in place (i.e., periodic operation of slurry pumps and prohibition on waste transfers to Tank 48, addition of OA to Tank 48, and use of STPB) to assure that a limited amount of benzene is available to be released.

Water additions of any amount are permitted in Tank 48 as long as the nitrogen purge ventilation system is operating in Mode B and the tank is inerted. Additional precautionary controls are in place for Mode C and non-inerted operation. Liquid additions must be demonstrated to be acceptable in Mode B (inerted operation) prior to making additions in these modes.

Additional controls also exist for water additions when no ventilation is running. For this case, liquid additions must first be shown to be acceptable in Mode B and will be limited to those required to perform the following: filling of seal legs in the purge condensers, condenser/demister flushing, or flushing the reheater. Any other liquid additions into Tank 48 will be allowed only after the satisfactory completion of an Unreviewed Safety Question (USQ) review.

Similar to planned water additions, inadvertent water additions will not significantly increase the release of benzene.

Inadvertent addition of OA into Tank 48 is not likely. In order for OA to be added from the OA dumpster, an administratively controlled OA dumpster spool piece must be physically connected so that the chemical can be added. Additionally, multiple valve misalignments would be required and the OA transfer pumps started to complete the addition. These valve positions and pump status are displayed on the Distributed Control System in the control room. Inadvertent OA addition could occur by direct addition of chemicals to Tank 48; however, there are Administrative Controls that require independent verification of chemicals when unloaded. This ensures that OA is not added into another chemical storage tank or added directly to Tank 48.

Operation of the slurry pumps in Tank 48 has been shown to elevate benzene release rates causing an increase in the vapor space benzene concentration. During slurry pump runs to deplete the tank liquid contents of flammable vapors, benzene concentrations as high as 2,000 ppm in Tank 48 have been observed. Several months of intermittent slurry pump operation successfully de-inventoried the flammable vapor concentration in the tank liquid to the point where, during PVT-1 operations, benzene concentrations in the vapor space rarely exceeded 20 ppm during full speed operations of all four slurry pumps (Ref. 45).

While operating Tank 48 under the requirements/restrictions of this Documented Safety Analysis (DSA), benzene generation and release rates are expected to remain at minimal levels based upon analysis of the benzene release rate and concentration data obtained during and since
PVT-1 operations (Ref. 45). A return to non-inerted operation requires that the time to CLFL be greater than or equal to 18 days at the liquid-vapor interface and that the time to CLFL, using derived or measured benzene generation rates, is a minimum of 9 days to CLFL in the bulk vapor space. Tank 48 benzene production has been controlled by maintaining required free hydroxide concentrations and temperature. Release quantities are controlled via periodic slurry pump operations.

The key assumptions include the following:

- OA additions to Tank 48 are prohibited.
- Use of the CFA to Tank 48 chemical addition line is prohibited.
- Delivery, storage, or further use of STPB at the Concentration, Storage, and Transfer Facilities (CSTF) is prohibited (excluding incidental samples; however, these samples shall not be disposed of in CSTF waste tanks).
- Transfers of radioactive waste into or out of Tank 48 are prohibited.
- Administrative Controls require periodic slurry pump operation to control the retained flammable vapor inventory in Tank 48.
- Administrative Controls require independent verification of chemicals prior to unloading to Tank 48.
- Liquid additions to Tank 48 must meet the requirements as specified in Tables 18.6-7, 18.6-8, and 18.6-9 when ventilation is in Mode C, non-inerted operation, or no ventilation.
- The Tank 48 waste temperature shall be maintained ≤ 35°C and the free hydroxide concentration in the Tank 48 waste shall be ≥ 1.0 M to minimize the non-radiolytic production of benzene.

INITIATORS

No credible initiators have been identified, only normal operational releases are possible.

FREQUENCY

Since OA additions to Tank 48, use of the CFA to Tank 48 chemical addition line, use of STPB, and transfers of radioactive waste into or out of Tank 48 are prohibited, the frequency of this accident is considered not credible. In addition, administrative controls require periodic slurry pump operations, maintaining a minimum of 9 days to CLFL in the bulk vapor space during non-inerted operation, and maintaining minimum free hydroxide concentration requirements and temperature controls to minimize the generation and buildup of retained flammable vapors in Tank 48.
CONSEQUENCES

There are no increased radiological consequences for this event because no additional radioactive material is released through the waste tank High-Efficiency Particulate Air (HEPA) filter. The benzene concentrations in the facility will be less than 0.5 ppm during normal water additions to Tank 48.

MITIGATION

Mitigation measures for this accident include the following:

- OA additions to Tank 48 are prohibited.
- Use of the CFA to Tank 48 chemical addition line is prohibited.
- Delivery, storage, or further use of STPB at CSTF is prohibited (excluding incidental samples; however, these samples shall not be disposed of in CSTF waste tanks).
- Transfers of radioactive waste into or out of Tank 48 are prohibited.
- Administrative Controls require periodic slurry pump operation to control the retained flammable vapor inventory in Tank 48.
- Administrative Controls require independent verification of chemicals prior to unloading to Tank 48.
- The Tank 48 waste temperature shall be maintained \( \leq 35^\circ\text{C} \) and the free hydroxide concentration in the Tank 48 waste shall be \( \geq 1.0 \text{ M} \) to minimize the non-radiolytic production of benzene.
- Liquid additions to Tank 48 must meet the following conditions when ventilation is in Mode C, non-inerted operation, or no ventilation (see Tables 18.6-7, 18.6-8, and 18.6-9 for more details):
  - Liquid additions must be demonstrated to be acceptable in Mode B prior to making additions in these modes.
  - Liquid additions made without ventilation will be limited to those required to perform the following: filling of the seal leg in the purge condenser, condenser/demister flushing, or flushing of the reheater. Any other liquid additions will be allowed only after the satisfactory completion of a USQ review.
18.3 MAJOR ACCIDENTS

The following sections provide in-depth analyses of the major accidents related to Tank 48 that are unique within CSTF, due to hazards associated with benzene. As discussed in Section 18.0, unique hazards related to this tank are predominantly related to the introduction of organics into the waste streams.

The introduction of organics into the ITP process (the addition of STPB and to a much lesser extent the addition of ST and TBP) were necessary to provide the waste pre-treatment needed for successful Defense Waste Processing Facility (DWPF) operations. However, these organics increase the amount of flammable vapor generated and add to the combustibility of the waste stream.

Sections 18.3.1, 18.3.2, and 18.3.3 describe ITP accidents in which the radioactive release can only be initiated by a deflagration.

In addition to the flammable vapor hazards, waste streams that are heavy in organics may be combustible if allowed to dry out. Unlike flammable vapors (which a single spark may ignite), even the driest solids tested require a significant energy source (sustained spark or open flame) to ignite. If the solids water content is greater than 27% (Ref. 46, 47), the flame will not propagate. Solids burning are of concern because it provides a mechanism for airborne radioactive releases. Evaporative losses from an exposed waste stream are very limited. However, burning solids can release as much as 9% (Ref. 27, 48) of the Cs-137 present. The cesium release is dependent on the organic to inorganic ratio of the waste stream. Washed precipitate, which contains a limited amount of inorganic salts, burns cleaner, and the cesium release from the burn is an order of magnitude less than that for unwashed precipitate. In addition, qualitative experimental work has shown that only the surface of the dried waste will burn leaving a large percentage of unburned material (much like a charred piece of firewood).

Tank 48 waste could leak into the tank annulus and eventually dry. The annulus contains leak detection capability supplemented by periodic visual inspections. Open flames and high voltages (>480VAC) are not present in the annulus. While these measures assure that significant amounts of waste will not accumulate and go undetected, the accident is analyzed in a conservative manner assuming that waste does indeed accumulate, dry, and then ignite. Once ignited, the waste is assumed to burn completely, providing a maximum dose consequence analysis.

The annulus deflagration and fire scenario and related consequences are discussed in Section 18.3.3.

Section 18.3.6 provides the seismic event analysis for Tank 48. A brief assessment of postulated beyond Evaluation Basis Earthquake (EBE) events is also included for completeness.

Risk is a term used to express the safety of a facility for a given incident. Risk is generally defined as the product of the frequency and consequence of the incident. In most cases, both frequency and consequence are random variables. However, for clarity of presentation it is
usually the case to provide point value estimates of the frequency, consequences, and risk associated with an incident.

This chapter used limiting industry data or site-specific data (when available) to compile point estimate frequencies. Limiting source terms were developed and applied for each accident.

The consequence calculations were performed in accordance with Reference 49, and Procedure Manual 11Q (Ref. 50) using the MACCS computer code. The 1987-1991 meteorological database and the ICRP-30 DCFs were used as input parameters. The consequences determined in the accidents described below were based on the current composition of radionuclides in Tank 48 (since waste transfers into and out of Tank 48 are prohibited).

Table 18.6-3 lists the major accidents along with a summary of the frequencies. Risks are summarized in Section 18.4.

18.3.1 TANK 48 VAPOR EXPLOSION

This accident addresses the accumulation of flammable gases in the tank vapor space with sufficient oxygen present to lead to a deflagration due to the presence of an ignition source.

18.3.1.1 Background

Tank 48 receives salt supernates (from other waste tanks) as feeds to the process. Tank 48 is the precipitation and precipitate washing tank. Hydrogen generation in this tank begins when the first supernate enters the tank. Benzene generation in this tank begins with the addition of the STPB precipitant. Hydrogen and benzene are present thereafter.

During the precipitate washing step, benzene liberation is increased by wash water addition and agitation because the benzene trapped during the precipitation step is released.

TBP, a defoaming agent used in benzene stripping, could enter this tank during operation. TBP has been included in the time to CLFL calculations. Analysis of TBP in salt solutions indicates that, in the absence of a deflagration, it cannot be easily ignited (Ref. 26).

The key assumptions are discussed in Tables 18.6-4 through 18.6-9.

Tank 48 typically maintains a large margin to CLFL conditions by limiting the flammable vapor concentration in the tank vapor space to 37% or less of the CLFL. However, the accumulation of flammable gases, principally benzene and hydrogen, during loss of ventilation conditions can be postulated to lead to the formation of a localized combustible mixture in Tank 48. Radioactive Operations Commissioning Test Plan (ROCTP) test results, along with observations during facility operations, showed that slurry pump operation increased the benzene release rate. However, observation of slurry pump operation over several years shows very low benzene release and overall contribution to Tank 48 CLFL.

The safety posture for Tank 48 operation was developed based on maintaining an inerted vapor space at all times except during non-inerted operation.
This safety strategy has two elements. The principal one is the preservation of an inert tank atmosphere for the full spectrum of internally initiated accidents and all externally initiated events, excluding seismic. The basis for accepting the seismic risk is described in Section 18.3.6.

The second element, as Defense-in-Depth (DID), is control of the fuel composition of the vapor and liquid phases in Tank 48. This strategy entails the following:

- Implementation of Administrative Controls that require periodic running of the slurry pumps to preclude the accumulation of benzene and hydrogen in the liquid waste
- Discontinued operation (pumps and chemical/water additions) if the bulk vapor space exceeds 37% of the CLFL
- Prohibit further STPB addition to Tank 48
- Maintain waste temperature $\leq 35^\circ C$ and free hydroxide concentration $\geq 1.0$ M to minimize the non-radiolytic production of benzene (Ref. 18)
- Prohibit waste transfers into Tank 48

Extended non-inerted operation will result in elevated oxygen concentrations in the Tank 48 vapor space. Although the presence of oxygen is not expected to challenge the safety measures in place for fuel control (Ref. 14), it is recognized that the role of oxygen in the formation of benzene is still under study. The facility monitoring requirements on benzene concentration and the benzene release rate prior to entry into non-inerted operation serve as the primary control for the preservation of tank safety.

The radiolytic hydrogen production rate for Tank 48 will be unaffected by non-inerted operation since hydrogen production is attributed to radiolytic degradation of waste. Minimization of the inventory of hydrogen and benzene in the waste will be accomplished by periodic agitation. If the benzene release rate or benzene vapor concentration is verified to result in a time to CLFL of less than 18 days at the liquid/vapor interface, entry into non-inerted operation is not permitted.

The strategy applied to maintain tank inerting and control the fuel composition of Tank 48 is described below. Inerted operation applies to Tank 49 only following the transfer of Tank 48 material into Tank 49 per an approved Response Plan due to a Tank 48 leak. Non-credited mitigative controls include performance of periodic maintenance activities to verify the functionality of the oxygen analyzers and the nitrogen inerting system (including the low nitrogen flow interlock) associated with Tank 49 to ensure that it can be activated, if needed, to inert the waste tank vapor space.

BASIS FOR CREDITING INERTING

Taking credit for nitrogen inerting is based on an analysis of the tank vapor space under a spectrum of atmospheric and operational conditions. The two principal concerns are as follows:

1) Maintaining an inert atmosphere when the nitrogen supply is interrupted during inerted operations
2) Restoration of the nitrogen supply before inerting is lost during inerted operations

In order to credit inerting as one of two safety strategies for Tank 48, the MOC required to support a deflagration in the tank was determined. The MOC value is based on the composition of flammable materials in the vapor space. For Tank 48, the major flammable materials of concern are hydrogen and benzene. Other materials are present, but their contribution to the flammable composition is negligible (Ref. 20). In Tank 48, the composition of flammable gases at the liquid-vapor interface is dominated by benzene, especially if molecular diffusion is the only transport mechanism credited (Ref. 51, 52). Past operating experience, which includes the ROCTP test data and routine vapor space monitoring up to the present date, were analyzed to determine the maximum hydrogen concentrations and the concentrations relative to a total flammable gas concentration. This data shows that the contribution of hydrogen and other flammables is less than 8% of the total required to reach a flammable gas composition (Ref. 53), and it is much less for the rates of benzene release that have been observed during Tank 48 slurry pump operations. For mixtures in which benzene makes up more than 50% of the total flammable gas composition (Ref. 54), the MOC required to support combustion is greater than 9 vol. % oxygen. The MOC approaches 11 vol. % as the flammable vapor composition approaches pure benzene, and approaches 5 vol. % as the composition approaches pure hydrogen (Ref. 54). The hydrogen fraction is equivalent to a total vapor volume concentration of 1.25 vol. % when the total mixture is just at the CLFL value. Therefore, as long as the hydrogen vapor volume concentration stays below 1.25%, the MOC of 9 vol. % is valid. Following a loss of ventilation, and assuming no actions are taken and hydrogen that was previously retained is instantaneously released, radiolysis of the slurry would yield a vapor volume concentration of 1.25% at the end of the allowed quiescent time (Ref. 43). A nitrogen purge rate of 5 scfm is sufficient to maintain the hydrogen concentration below this value (Ref. 53). Required actions to establish a purge of at least 5 scfm within 8 hours following a loss of ventilation are sufficient to protect the MOC value of 9 vol. %.

An inherent assumption in protection of the MOC value of 9 vol. % is that the hydrogen is retained in the liquid up to the point of a loss of ventilation event, at which time it is instantaneously released into the tank vapor space. Plant data suggests that a hydrogen retention phenomenon applies to Tank 48, possibly up to 100%. As a measure of conservatism, the program to deplete benzene from the liquid will be used to assure the hydrogen concentration in the liquid will not impact the assumption in the calculation. The time between pump runs will be determined based on the more conservative of the two constituents (benzene or hydrogen). This will be controlled as part of the TSR Administrative Controls for flammable vapor depletion.

The oxygen concentration in Tank 48 shall be maintained at less than 8 vol. % oxygen during inerted operations. To support combustion of a benzene rich layer, the oxygen concentration must increase by at least 1% to reach the 9 vol. % oxygen concentration required to support combustion.

To ensure safe tank operation during inerted operations, a margin to MOC is required that is adequate for recovery from loss of nitrogen flow events. Modeling of the vapor exchanges between the tank and the atmosphere has demonstrated that, upon loss of the nitrogen purge and termination of exhaust fan flow, the tank vapor space stays below the MOC for several days under nominal conditions and for at least 24 hours under worst case conditions (Ref. 52). Since the facility is required to maintain the oxygen concentration at or below 8 vol. %, the analysis
can be extrapolated to show that the tank would remain below the 9 vol. % oxygen concentration necessary to support combustion for 12 hours. Although this analysis applies specifically to Tank 48, the results can be qualitatively applied to Tank 49 as well, should the need to inert Tank 49 ever arise (i.e., a Tank 48 leak develops). Hydraulic resistance data (Ref. 55), operating experience, and design attributes (less penetrations) provide assurance that Tank 48 results sufficiently bound Tank 49 hydraulic resistance data. Remaining below the 9 vol. % oxygen concentration for 12 hours is a conservative conclusion since the bounding analysis used conservative conditions (tank liquid levels, temperatures, atmospheric pressure variations, natural convection, wind effects, diffusion, and doubling the air inleakage rate to account for potential riser seal degradation and/or vibration during seismic conditions).

Therefore, time is available following the loss of ventilation to either restore normal ventilation or, if that is not possible, to begin nitrogen flow into the tank in sufficient quantities to maintain inerting for a period long enough to develop and implement longer term corrective measures. Calculations have established that 30-scfm nitrogen is sufficient to maintain an inert atmosphere (Ref. 52).

The results from this bounding analysis were used to determine how long the tank would stay under the MOC assuming the tank started at 8 vol. %. Applying a starting point of 8 vol. %, it is concluded that the tank would remain below the 9 vol. % oxygen concentration necessary to support combustion for 12 hours. This is a conservative conclusion because operation at bounding conditions (e.g., high liquid level) is controlled.

NOTE: Section 2.7.2 of the National Fire Protection Association (NFPA) 69 requires that a safety margin be maintained between the operating oxygen concentration and the MOC. This margin is to compensate for oxygen fluctuations, sensitivity and reliability of the monitoring and control equipment, and the probability and consequences of an explosion. The MOC for the most restrictive accident scenario, where the benzene concentration is 43% of the flammable vapors present and hydrogen is 57% of the flammable vapors present, is an MOC of 9 vol. %. The analysis already assigns a 1 vol. % margin associated with the protection of MOC. The balance of the NFPA 69 margin will be reflected in the facility TSRs, depending on the uncertainty analysis associated with the oxygen analyzers. The TSR LCO limit is 6.9 vol. %.

The oxygen fluctuations, to the extent they occur, take place over long periods of time even when inerting equipment is taken off-line. Redundant diverse supplies of nitrogen ensure a high reliability of the nitrogen inerting equipment. System operation and testing has demonstrated its capability to reliably control oxygen concentrations.

Finally, the probability and consequences of a deflagration event have been subject to a detailed analysis that is described within this document. The analysis shows that both the probability and consequences of a deflagration event are low. Based on these considerations, it is judged that the 2.1% margin (use of 6.9 vol. % versus 9 vol. % MOC) provided for Tank 48 (and Tank 49 when used for receipt of Tank 48 waste following a Tank 48 leak) meet the requirements of NFPA 69.

The discussion above shows that, during tank inerted operations, time is available following loss of ventilation to either restore normal ventilation or, if that is not possible, to begin nitrogen flow
to the tank in sufficient quantity to maintain inerting for a period long enough to develop and implement longer term corrective measures. A conservative value of 8 hours is credited to restore normal nitrogen purge ventilation flow (versus the 12 hours available as discussed above). Prior to the end of the eight-hour period, if restoration is unsuccessful, a flow of nitrogen (5 scfm minimum) will be supplied to the affected tank. At the end of the eight-hour period (following loss of ventilation), if oxygen monitoring is unavailable, a flow of at least 30 scfm will be initiated into the tank vapor space with the purge exhaust dampers closed and the conservation vent bypass valve open.

Finally, in order to take credit for inerting, a reliable source of nitrogen must be available for extended periods to allow time for recovery actions to be developed and implemented. A nitrogen supply, sufficient to provide nine days of inerting for Tank 48, is judged to be sufficient for this purpose. Reference 52 determined that 30 scfm is sufficient to maintain an inert atmosphere in Tank 48 following a loss of ventilation. The normal nitrogen system inventory reserve (i.e., TSR inventory limit) is sufficient to supply Tank 48 with 30 scfm for greater than 9 days (Ref. 56). Tables 18.6-4 through 18.6-9 describe the equipment and controls needed to provide this capability.

**MONITORING AND NITROGEN INERTING/VENTILATION EQUIPMENT**

The monitored parameters for Tank 48 include CLFL concentration, oxygen concentration, normal nitrogen flow, purge exhaust flow, normal nitrogen storage tank inventory, and high liquid level. The alarms include high CLFL concentration, high oxygen concentration, and high liquid level. A hardwired interlock includes shutting off the purge exhaust fan on low nitrogen flow. Local indications include CLFL concentration, oxygen concentration, purge exhaust flow, normal nitrogen storage tank level, and normal nitrogen supply flow indicators. Benzene concentration can also be monitored with a GC.

The H-Area Tank Farm Control Room Consolidation Project relocated alarms into the 241-2H Control Room. This project utilized previously installed fiber optic cable or installed new fiber optic cable through cable routing and support systems which do not meet some of the SC/SS requirements. The fiber optic cable design and multiplexing the alarm signals has a negligible impact on the overall failure probability and is considered compliant with the SC/SS requirements if the following requirements are met (Ref. 91, 92, 93, 94, 95):

- Alarm signals using optical fibers are not credited to perform safety functions during or after Natural Phenomena Hazard (NPH) events, fire or explosion events (SC only), or internal hazard events (SC only)
- Signals from redundant SC trains shall not be transmitted over the same optical fiber
- Non-SC signals shall not be transmitted over the same optical fiber as SC signals
- Non-SS signals shall not be transmitted over the same optical fiber as SS signals
- Transmitted alarm signals must be of a fail-safe design (i.e., alarm occurs on circuit interruption)
- Alarm instrument loops using fiber optic transmission are periodically tested (within the loop failure probability analysis)
A nitrogen supply sufficient to provide 9 days of inerting (during inerted operations) is judged to be sufficient to develop and implement longer-term corrective actions. A description of the equipment available to support this requirement is described below.

**Normal Nitrogen Supply System and Nitrogen Purge Ventilation System**

The Normal Nitrogen Supply System includes one 28,000-gallon horizontal and four 13,000-gallon vertical, insulated, double shell tanks. In addition, two sets of five ambient air vaporizers are fed liquid nitrogen from the storage tanks in two piping trains that may be isolated individually for maintenance or repair without rendering the nitrogen system out of service. Either set of five vaporizers can be operated independently of the other, or all ten units can be operated simultaneously. The nitrogen flows from the vaporizers to a manifold that feeds two supply lines.

The SS function of the Normal Nitrogen Supply System is to provide a sufficient inventory and flow of nitrogen to the Tank 48 nitrogen purge ventilation system to maintain the oxygen concentration below the MOC required to support a deflagration in the tank. This credited safety function is required during normal operations only (not during or after NPH events), except during non-inerted operation.

The Normal Nitrogen Supply System has demonstrated a high degree of reliability to perform its credited function; however, the system was not procured and installed as SS. Based on the assessment in Reference 96 (including implementation of SS requirements for system maintenance/modification and implementation of the Structural Integrity Program), the Normal Nitrogen Supply System is deemed acceptable to meet its SS requirements.

The SS function of the Normal Nitrogen Storage Tank local indications is to alert the operators before the normal nitrogen inventory reaches the minimum needed to support inerting operations for Tank 48. No alarms are credited. Operators are required to periodically verify the total usable nitrogen inventory using the local indications. This credited safety function is required during normal operations only (not during or after NPH events), except during non-inerted operation.

The nitrogen purge piping at Tank 48 has two parallel purge supply lines. Each of these lines contains flow control valves and monitoring instrumentation. Two bypass lines are installed around these purge supply lines to manually regulate nitrogen flow into the tank should the normal flow control paths become inoperable.

The SS function of the Nitrogen Flow local indication is to indicate a loss of normal nitrogen flow to allow for operator response. This indication capability will warn of a potential increase in oxygen concentration in the tank vapor space. No alarms are credited. Operators are required to periodically verify proper nitrogen flow into Tank 48 using local indication. This credited safety function is required during normal operations only (not during or after NPH events), except during non-inerted operation.

The purge exhaust fans are provided with a hardwired Nitrogen Low Flow Interlock and backup software interlock (non-credited) to trip the fans upon the loss of nitrogen flow into the tank. Flow switches generate the hardwired interlock, while the computer generates the software
interlock (non-credited), based on input from flow transmitters. The SS function of the Nitrogen Low Flow Interlock is to terminate exhaust fan operation (to support the ability to maintain an inerted vapor space) when the normal nitrogen flow drops below the minimum flowrate (during Mode B operation). This credited safety function is required during normal operations only (not during or after NPH events), except during non-inerted operation.

The nitrogen flow control valves are provided with a hardwired interlock (non-credited) to trip the nitrogen supply on high tank pressure. These valves are also provided with a software interlock (non-credited) to trip the nitrogen flow should the purge exhaust fans trip for any reason. The primary purpose of these interlocks is to prevent an over-pressure condition in the tank.

The nitrogen storage and distribution system is designed so that a single point failure in the piping will not result in a loss of nitrogen supply. With the possible exception of power, there is no single active failure that can prevent the system from performing its safety function. A loss of power, however, will cause the flow control valves to fail in the closed position. If this occurs, the low nitrogen flow-fan interlock will stop the exhaust fan operation so that an inert atmosphere is maintained. If the power loss includes the interlock, the fail-safe design of the interlock will still cause the exhaust fans to trip. Also, available, but not credited, is a backup diesel generator.

The passive and fail safe design of the Normal Nitrogen Supply System, combined with a significant amount of installed redundancy, results in a very reliable nitrogen supply system.

**Composite Flammable Vapor Monitoring**

The SS function of the CLFL Monitoring System for Tank 48 is to monitor the composite flammability of benzene and hydrogen detected in the tank vapor volume. This monitoring capability will warn control room operators of a potential increase of flammable vapors in the tank vapor space.

The CLFL analyzer must be capable of detecting benzene and hydrogen gas in units of percent CLFL within a range of 0 to 100%. Additionally, the CLFL Monitoring System shall be capable of alarming in the associated control room upon detecting a high CLFL. The control room alarm must provide both audible and visual indications of the alarm condition. These credited safety functions are required during normal operations only (not during or after NPH events).

Instrument air from the plant instrument air header is supplied to the CLFL analyzer for the eductor motive force and sample gas dilution. The exhaust from the Tank 48 CLFL analyzer is directed to the purge exhaust system, and from there it is discharged to the atmosphere.

**Benzene Concentration Monitoring**

The function of the Tank 48 GC is to measure the benzene concentration in the tank vapor space and can be used to verify benzene release rate. Hydrogen concentration can also be measured by the GC. The GC is calibrated using known calibration gases and an analysis is performed on a vapor sample pulled from the tank interior via a multi-port sample pole. The ports on the sample pole are at different levels allowing the sample to be withdrawn at different elevations within the tank.
tank interior. The sample is analyzed in the GC columns by using a Wheatstone bridge circuit that compares a known carrier gas flow to a combination of the carrier gas and sample flow. After the analysis is completed and a computerized output of gas concentration, retention time, and a chromatogram is received, the sample is routed back to the tank interior. The GC is not required to be functionally classified as SS or SC equipment.

Oxygen Concentration Monitoring

The SS function of the Oxygen Monitoring System for Tank 48 is to alert the operators before the tank oxygen concentration reaches the minimum needed to support a deflagration.

Tank 48 is equipped with two primary tank vapor space Oxygen Monitoring Systems that continuously sample the tank vapor space. Each system shall be capable of providing local indication of the current oxygen level. Additionally, each Oxygen Monitoring System shall be capable of alarming in the associated control room upon detecting a high oxygen concentration. The control room alarm must provide both audible and visual indications of the alarm condition. These credited safety functions are required during normal operations only (not during or after NPH events), except during non-inerted operation.

Tank vapor sample gas is drawn from the tank vapor space through a manual valve, filter, and sample line solenoid-operated valves before entering the analyzer chamber. From the oxygen analyzer, the sample is drawn into a nitrogen driven eductor and exhausted to the purge exhaust system, and from there it is discharged to the atmosphere.

Bottled nitrogen and span calibration gases are admitted to the monitor through regulators and used for zero reference and span calibrations. Normal plant nitrogen is used as the motive force in the eductor.

Purge Exhaust Flow Monitoring

The SS function of the Purge Exhaust Flow Monitor for Tank 48 is to indicate a loss of purge exhaust ventilation flow to allow for operator response. This credited indication capability will warn of a condition that may result in a potential increase of flammable vapors in the tank vapor space. No alarms are credited. Operators are required to periodically verify proper exhaust flow using local indication.

The Tank 48 Purge Ventilation System shall be maintained at least as a Level 4 duct class (per Reference 97) for normal permissible leakage rates. Per Reference 98, the bounding in-leakage rate associated with Level 4 duct class for all waste tank types is 1 scfm. This potential in-leakage rate is extremely small and the minimum ventilation flow rate requirements for Tank 48 were derived assuming normal ITP processing operations (e.g., STPB additions with elevated benzene production). Additionally, the nominal flow rate from the ventilation system typically exceeds minimum ventilation flow rate requirements by a significant amount. Therefore, no adjustment is necessary to flow rate requirements (determined/provided in the DSA/TSR) to account for the Level 4 duct class permissible leakage rates.

The purge exhaust flow is monitored by a flow element that produces a differential pressure in proportion to the flow rate. The purge exhaust flow indicator includes the flow-sensing element,
the local indicating gage, and the tubing and valves, which provide the flow signal to the indicating gage. By periodically monitoring this indication, the operators can determine if the ventilation system is sweeping the tank vapor space, thereby maintaining the bulk flammable gas concentration below the CLFL.

The Purge Exhaust Flow Monitor for Tank 48 must be capable of indicating flow during normal operations only (not during or after NPH events). Purge exhaust flow monitoring during inerted operation is for DID purposes only.

Emergency Purge Ventilation Equipment

The SS function of the EPVE is to provide DID backup ventilation capability in the event of a loss of ventilation. This credited safety function provides DID during non-inerted operation and after NPH events (not during NPH events).

The EPVE (consisting of two engine/blower assemblies with support equipment) is staged in a seismic and high-wind qualified structure. If available and needed, the EPVE could also be used for purging the tank annuli of Tank 48.

High Liquid Level Conductivity Probe

The SC function of the Tank 48 High Liquid Level Conductivity Probe (HLLCP) and Alarms is to continuously monitor the tank fill limit and alert operators when the tank liquid level has reached the fill limit. The tank HLLCP is at a fixed level and is the credited means to ensure that the liquid level in a tank does not exceed the maximum fill limit. The HLLCP shall be capable of alarming in the associated control room. Time delay relays (less than or equal to 60 seconds) are permitted on the alarm actuation circuits. The control room alarm must provide both audible and visual indications of the alarm condition. This credited safety function is required during normal operations only (not during or after NPH events). See Chapter 4 for additional information regarding HLLCP safety functions.

REQUIREMENTS ASSOCIATED WITH VENTILATION OPERATION

Tables 18.6-4 through 18.6-9 list the compensatory measures implemented to preserve tank inerting and/or fuel control for various operational modes or in response to a loss of inerting. Measures that are applicable to all modes of operation are listed in Table 18.6-4. These measures are designed to preserve tank inerting and control the accumulation of benzene in the tank.

Results from the chemistry program clearly show the effect of temperature and hydroxide concentration on the degradation of TPB. Results from solids decomposition tests using simulants indicate a minimum hydroxide concentration of 0.6 M (pH = 13.8) will control the STPB and 3PB decomposition and the resulting benzene production at 40°C (Ref. 18).
As compared to benzene release rates with agitation, the release behavior from the slurry in Tank 48 is different for the quiescent state. In the quiescent state the following occurs:

- Releases are dominated by the controlling liquid phase boundary layer that is depleted of benzene.
- Releases increase with increasing temperature due to increasing benzene vapor pressure, generation rate, and convective mixing in the liquid phase.
- At a constant benzene generation rate, benzene accumulates until the release rate equals the generation rate.
- Quiescent release rates (Evolution rates)
  - Are initially lower than the generation rate resulting in accumulation of benzene
  - Increase as the benzene accumulates in solution
  - Can exceed the actual generation rate (at that time) but only after the generation rate declines significantly
  - Never exceed the initial (peak) benzene generation rate

The very low release rate from stagnant slurry, or slurry that is being agitated, enables non-inerted operation if the conditions that minimize TPB decomposition are maintained. The performance of slurry pump depletes the flammable vapor inventory in the slurry.

18.3.1.2 Initiators

A deflagration in Tank 48 requires the combination of fuel, oxygen, and a spark source. In order to produce a flammable mixture, inerting must be interrupted or the facility must be in non-inerted operation coupled with a failure to manage fuel concentration in the tank.

The ignition source is assumed to be a spark.

Fuel originates from the waste within the tank. If the ventilation flow in the tank stops, the flammable vapor concentrations in the vapor space are no longer controlled by dilution below the CLFL. Fuel concentration can reach the CLFL if the following occurs:

- Operators fail to stop slurry pumps due to the flammable vapor concentration reading (instrument or operator errors) or loss of ventilation.
- Instruments are mis-calibrated.
- High flammable vapor concentration is not detected either due to instrument failure or operator error.

A detailed model of these initiators leading to a deflagration is described in Reference 57.
Oxygen can be provided to the tank vapor space in three ways. All three can be initiated by failure of the nitrogen system that maintains the oxygen concentration (in the tank vapor space and tank ventilation exhaust) below the MOC for combustion of the solids. The ways to exceed the MOC are as follows:

- Air inlet (via inleakage due to low nitrogen flow or via a return to air-based ventilation) into the tank vapor space with the exhaust fan running
- Air inleakage into the tank vapor space with the exhaust fan off (note that the exhaust fan and the nitrogen flow are interlocked so that failure of one shuts down the other while operating in Mode B)
- Flow failure (either the exhaust fan or the nitrogen flow) for more than the allowable time (When ventilation flow is restored, the flammable vapor concentration in the tank exhaust could be so high that the vapors cannot be diluted with air without passing through the envelope of flammable fuel-oxygen mixtures. In this case, the conditions for fire occur in or above the tank exhaust stack.)

During inerted operations, the oxygen concentration may reach the MOC if instrument and/or mechanical failures, coupled with operator errors, lead to:

1. Nitrogen purge not restored following loss of normal purge
2. Exhaust fan continues to run without nitrogen purge
3. Ventilation restored without nitrogen purge flow
4. Failure to monitor oxygen concentration and/or nitrogen flow

A seismic event may, independently of the internal events described above, lead to the release of a portion of the benzene and hydrogen inventory resident in the liquid slurry. Seismic events are addressed in Section 18.3.6.

18.3.1.3 Frequency

The frequency of the Tank 48 deflagration event has been categorized as “Anticipated.”

18.3.1.4 Consequences

Based on allowed operations, an estimate of the consequences for this accident has been calculated (Ref. 58). This calculation analyzed the consequences for three cases. Case 1 is a deflagration of a stoichiometric benzene-hydrogen-air mixture. Case 2 is a deflagration of a benzene-hydrogen-air mixture at CLFL. Case 3 is a deflagration of a 1-meter thick benzene-air mixture at the LFL. Case 1 and 2 assume the worst case volume of flammable vapor in deriving the energy from a deflagration (uses entire tank volume).

The maximum offsite and onsite doses are less than 100 mrem for all cases (Ref. 58). Since the consequences do not account for entrainment of waste, the facility is required to ensure the waste tank level does not exceed 252 inches. Additionally, the reported consequences are based on the
radiolytic concentrations adjusted for uncertainties in Reference 58. These consequences are well within the EGs for “Anticipated” accidents.

18.3.1.5 Risk

The risks for this accident are summarized in Section 18.4.

18.3.1.6 Mitigation

Consequences for a deflagration in Tank 48 are well below EGs for an “Anticipated” event. Therefore, no mitigation is required other than those required to protect assumptions in the consequence calculations (e.g., source term control, liquid level control, and prohibition on transfers into Tank 48). However, the facility has elected to implement a mitigation strategy to conservatively prevent a deflagration in Tank 48.

Mitigation measures for this accident during all operational modes of Tank 48 (exclusions for non-inerted operation are noted) are as follows:

- **Prohibited Operations:** Waste transfers into or out of Tank 48, OA and STPB additions to Tank 48, and processing operations (concentration/washing) in Tank 48 are prohibited.
- **Slurry Pump Operation:** Slurry pumps shall be operated periodically to deplete the benzene and hydrogen inventories.
- **Vapor Composition:** Bulk flammable vapor concentration shall be maintained equal to or less than 37% of the CLFL.
- **Instrument Air:** Instrument air supplied to the CLFL monitor shall not be exhausted to the tank vapor space (excluding non-inerted operation).
- **Conservation Vent Bypass Valve:** The conservation vent bypass valve shall remain closed during inerted operation except as noted in Table 18.6-5.
- **Portable Oxygen Monitor:** One portable oxygen monitor shall be stored in 241-242H. This instrument shall be surveyed once a week to ensure operability (excluding non-inerted operation).
- **Tank Oxygen Analyzers:** A loop check of the installed Tank 48 oxygen analyzers shall be performed every 24 hours (excluding non-inerted operation).
- **Nitrogen Supply Flow:** The nitrogen supply flow shall be at least 50 scfm to Tank 48 through the normal or bypass feed line (excluding non-inerted operation).
- **Nitrogen Capacity:** The normal nitrogen system shall maintain sufficient inventory to provide a flow of 30 scfm to Tank 48 for 9 days (excluding non-inerted operation).
- **Waste Tank Level:** Tank 48 liquid level shall not exceed 252 inches.
- **Waste Chemistry:** The waste temperature shall be maintained ≤ 35°C, and the free hydroxide concentration shall be ≥ 1.0 M to minimize the non-radiolytic production of benzene (Ref. 18).
Mitigation measures for this accident following a loss of nitrogen while in Mode B include the following:

- **Termination of Normal Exhaust Fan Operation:** The hardwired nitrogen flow-exhaust interlock shall trip the exhaust fan. The operator shall immediately ensure that the exhaust fans are shutdown and verify the shutdown locally (i.e., on the tank top).

- **Closure of Purge Exhaust Dampers:** The operator shall immediately close the manual purge exhaust dampers.

- **Termination of Pump Operation:** The operator shall immediately shutdown all slurry pumps and verify that the pumps have stopped.

- **Termination of Liquid Additions:** The operator shall immediately terminate all liquid additions into Tank 48.

- **Maintain Nitrogen Inerting:** Nitrogen inerting of Tank 48 shall be maintained by establishing a nitrogen flow to the tank within 8 hours. In order of preference, nitrogen inerting shall be maintained by: (1) re-establishing nitrogen purge ventilation, or (2) establishing supplementary nitrogen flow. The supplementary nitrogen flow requirements are governed by the following conditions:
  - If nitrogen purge ventilation cannot be restored, a supplementary nitrogen flow (5 scfm minimum indicated) shall be established into Tank 48. This action shall be completed within 8 hours of loss of nitrogen purge ventilation.

If the oxygen concentration is 8 vol. % or higher, supplementary nitrogen flow shall be supplied at a rate sufficient to attempt to restore and maintain oxygen concentration to less than 8 vol. %. If no indication of the oxygen concentration is available within the 8-hour limit described above, a minimum nitrogen flow of 30 scfm (indicated) shall be continuously supplied to the tank until oxygen monitoring is re-established. If the oxygen analyzers are unavailable, a GC or portable instrument (e.g., MSA) may be used for this purpose.

- **Control of Conservation Vent Bypass Valve:** The conservation vent bypass valve shall remain closed until a nitrogen supply source is available (i.e., the conservation vent bypass valve is opened only immediately prior to establishing supplementary nitrogen flow and during non-inerted operation). Opening of the conservation vent bypass valve just prior to establishing supplementary nitrogen flow protects against the possibility of tank over-pressurization. If supplemental nitrogen flow cannot be re-established, the conservation vent bypass valve will be closed immediately, but not to exceed 20 minutes from the time when the valve was opened. Twenty minutes is based on engineering judgment and is consistent with the results of oxygen ingress calculations.
Mitigation measures for this accident while in Mode C, non-inerted operation, or no ventilation operations include the following:

- Benzene Composition of Bulk Vapor Space: Within 12 hours of entry into Mode C ventilation operations and within 12 hours prior to entry into non-inerted operation, the benzene concentration shall be verified to be \( \leq 50 \) ppm and the release rate shall be verified to be \( \leq 2.3 \) grams per minute (g/min).

- Pump Operation: Slurry (no ventilation operations only), filter feed, and transfer pump operation is not permitted.

- Tank Additions, Benzene Impact: Liquid additions shall be demonstrated to be acceptable in Mode B prior to making these additions in these modes. A liquid addition of equal or greater volume and rate in a similar manner as that proposed in an alternate mode will be made in Mode B. The resulting benzene release from the Mode B addition will be analyzed to determine whether this release complies with the 18 day to CLFL requirement at the liquid/vapor interface assuming no ventilation. This analysis will use the actual benzene concentration resulting from the Mode B liquid addition as a starting point. If the analysis shows it would take longer than 18 days to reach this condition assuming molecular diffusion only, the addition will be allowed in ventilation configurations other than Mode B.

Mitigation measures for this accident specific to operation without ventilation include the following (these measures are in addition to those stated above for no ventilation operations):

- Time Limit: Operations in this configuration (with no ventilation and no nitrogen flow) shall be limited to 8 hours (excluding non-inerted operation).

- Liquid Additions: Liquid additions shall be limited to those required to perform the following:
  - Filling the seal leg in the purge condenser
  - Condenser/Demister flushing
  - Flushing of the reheater

  Any other liquid additions shall be allowed only after the satisfactory completion of a USQ review.

Mitigation measures for this accident specific to non-inerted operation include the following:

- Purge Exhaust Flow: Purge exhaust flow shall be \( \geq 300 \) scfm with operable instrumentation to monitor the flow. Loss of ventilation events shall require re-establishing exhaust flow within 7 days.

- CLFL Analyzer Operability: The CLFL analyzer shall be operable. An Instrument Loop Check shall be performed on the CLFL analyzer every seven days.

- EPVE Operability: Two dedicated EPVE engine/blower assemblies and a portable Lower Explosive Limit (LEL) monitor shall be operable.
• Pre-Entry Conditions for Non-Inerted Operation: Within 12 hours prior to entry into non-inerted operation in Tank 48, the following controls ensure that at least 18 days to CLFL is maintained at the liquid/vapor interface following a loss of ventilation event:
  - Transfer, and filter feed pump operation, is not permitted
  - The benzene release rate shall be verified to be \( \leq 2.3 \text{ g/min} \)
  - The benzene vapor concentration shall be verified to be \( \leq 50 \text{ ppm} \)

• GC Operability: A GC with multi-position sample capability shall be operable prior to entry into non-inerted operation for the purpose of performing the benzene concentration and release rate verification.

• Liquid Addition Restrictions: Liquid additions shall be demonstrated to be acceptable under inerted operations (Mode B) prior to making these additions while conducting non-inerted operation.

• Actions in Response to a Loss of Ventilation During Non-Inerted Operation: Upon a loss of ventilation (purge exhaust flow < 300 scfm or inoperable purge exhaust flow indication) to Tank 48 during non-inerted operation, the following actions shall be taken to control the flammable vapor concentration in the tank vapor space:
  - Slurry pump operation shall be immediately terminated
  - Liquid additions into the tank shall be immediately terminated
  - Tank flammable vapor concentration monitoring shall be performed at an increased frequency (every 12 hours)

• Actions in Response to Exceeding 37% of the CLFL During Non-Inerted Operation:
  - Slurry pump operation shall be immediately terminated
  - Liquid additions into the tank shall be immediately terminated
  - The flammable vapor concentration shall be restored to within limits in 12 hours or nitrogen flow must be established within 24 hours and an oxygen concentration of less than or equal to 6.9 vol. % (indicated) must be attained within 36 hours.

18.3.2 TANK 48 SOLIDS FIRE

This section describes the sequence of events that lead to a solids fire. When this tank is maintained in an inert atmosphere, as described in Section 18.3.1, a deflagration is mitigated/prevented, and consequently, so is a solids fire.

During non-inerted operation, sufficient oxygen may be present to support combustion of dried solids. As described below, these solids are not easily ignited. A sustained flame or deflagration, as opposed to a spark, would be required to ignite them and then only if the solids water content is less than 27%. Reference 46 evaluated the potential for a solids fire during an ITP waste tank deflagration and concluded that it would result in charring of any dry solids but would not result in a fire. Additionally, Reference 59 concluded that the consequences from the
charring of solids would contribute less than 2% to the deflagration source term. A deflagration in Tank 48 is mitigated/prevented by controls.

18.3.2.1 Background

Tank 48 receives salt supernates (from other waste tanks) as feeds to the ITP process. Tank 48 is the precipitation and precipitate washing tank for the ITP. During this process, the precipitate is expected to accumulate on tank surfaces (i.e., walls and cooling coils). As the liquid level in the tank rises, more surface area is exposed for possible accumulation of solids. As the liquid level falls, older solids are re-exposed and covered with more solids. These partly dried precipitates are potentially combustible; however, not easily. This conclusion is based on a series of slurry studies (Ref. 26, 27, 28, 47) that show that slurries are difficult to ignite and burn. A sustained flame is required to ignite the slurry. A deflagration is a possible ignition source for a solids fire, but only if the solid's water content is less than 27% (Ref. 46).

The key assumptions are discussed in Section 18.3.1.

The initiators, frequency, consequences, risk, and mitigation are as described in Section 18.3.1.

18.3.3 TANK 48 ANNULUS DEFLAGRATION/FIRE

This section analyzes two bounding event sequences: a leak of liquid with the annulus ventilation system failed, (which permits accumulation of benzene and/or hydrogen vapors in the annulus accompanied by deflagration of the vapors), or a leak into the annulus that dries out accompanied by burning the organic solids that are formed.

18.3.3.1 Background

The annulus between the primary and secondary containment walls of a Type IIIA waste tank is ventilated with air. Should a leak occur in the primary tank wall in Tank 48, liquid wastes containing hydrogen, benzene, and combustible solids (also capable of generating more of these flammable gases) could accumulate in the annulus creating the possibility of a deflagration and fire hazard.

The leak rate is dependent on both the size and location of the leak site. Other factors, such as ventilation rate, waste rheology, temperature, salt concentrations, and weight percent of solids in the spilled solution, influence the leak rate and the time required to form dry, flammable solids. All of these factors make defining a "slow" leak rate and predicting the length of time required to accumulate a flammable vapor and/or flammable solids in one of these waste tanks difficult (Ref. 60). Possible ignition sources in the annulus space include the conductivity probes and thermocouples that are located in the inner and outer annulus and the occasional introduction of remote inspection equipment (Ref. 60).

The safety strategy adopted to address a deflagration in the tank annulus is based on 1) the structural design of the primary tank, 2) maintaining waste tank chemistry to control corrosion, and 3) annual inspection of the annulus space to detect any degradation or leakage. This safety
strategy is considered acceptable given that the onsite and offsite consequences, for a Tank 48 annulus deflagration/fire, are well below EGs for an “Anticipated” event.

The key assumptions in the analysis include the following:

- Waste transfers into Tank 48 are prohibited.
- Tank 48 waste tank level does not exceed 252 inches.
- Tank 48 has a SC primary waste tank that is seismically qualified. Additionally, Tank 48 is one of fourteen Type IIIA waste tanks, which have had global stress relieving of the primary steel tank to eliminate residual stresses in the steel and lessen the impacts of externally applied stresses (such as loads, temperatures) (Ref. 61, 62). Also, the low Nil-Ductility Transition Temperature (NDTT) of the steel comprising the inner tank wall coupled with the application of a 33°C uncertainty ensures protection against brittle fractures (Ref. 61).
- Inspections will be performed annually for the outer wall of the primary tank. The annual inspection is required to ensure that a crack has not occurred. If a crack is discovered by the inspection, the USQ process is initiated (Ref. 50). If these inspections indicate a potential tank wall crack, then ultrasonic testing for cracks, wall thinning, etc. may be conducted. Additionally, this inspection is required to confirm that a tank leak has not occurred, thus preventing a buildup of waste material that could lead to a deflagration or fire.
- A program is in place for corrosion control chemistry (temperature, pH, OH-, NO2-, NO3-, SO4-2, and Cl-) to ensure protection of the primary tank wall from corrosion.

18.3.3.2 Initiators

A major, catastrophic failure of the primary tank wall could lead to a large spill of waste from the primary tank into the annulus space. The release of flammables (benzene and/or hydrogen) from Tank 48 could form a flammable vapor space, depending on the condition of the waste prior to the tank breach.

Based on the results of primary tank wall inspections, there has been no indication to date of leaks, cracks or wall thinning in Type IIIA tanks (Ref. 61). A major tank wall failure is not considered likely. Operating experience has shown that there have been no failures in Type III tanks in 381 tank years of operation (Ref. 61, 63, 64). The initiators for a major primary tank failure are driven by excessive, externally applied stresses on the primary tank wall. In order to prevent such stress, the design of these tanks addressed those failure modes that could make them susceptible to failure. These factors, which include, general corrosion, Stress Corrosion Cracking (SCC), pitting, and brittle failure, were analyzed and steps taken to alleviate them (including global stress relieving of the primary steel liner, chemistry control, and tank wall temperature control). Each of these is discussed below.

GENERAL CORROSION

General corrosion attacks the surface of the metal uniformly and results in a gradual thinning of the structure, weakening the primary tank wall integrity which leads to susceptibility to brittle
fractures, SCC, or external stresses induced by a seismic event. Steel thickness measurements were made of all waste tanks using ultrasonic techniques. In the Type IIIA tanks, the wall thickness was measured from the annulus. No thinning of the primary walls was detected in 24,000 measurements made over a period of 14 years, 1972 through 1985 (Ref. 64).

STRESS CORROSION CRACKING

Under the influence of an imposed stress and a slightly corrosive environment, such as nitrates, the metal cracks at an imposed load much lower than its normal tensile strength. Cracks are usually observed perpendicular to weld seams in heat-affected zones that have high residual stresses. Temperature is also a factor in SCC. Nitrate induced SCC was determined to be responsible for a number of failures observed in non-stress relieved Type I and II SRS waste tanks (Ref. 61). Extensive laboratory studies and large-scale experimental studies were completed (Ref. 65, 66, 67, 68) identifying that the SCC was nitrate-induced and the key causal factors were residual stress, nitrate presence, and temperature. As a result of these studies, 1) global stress relieving of the primary steel liner of the Type IIIA waste tanks was conducted during construction (Ref. 62) to relieve residual stresses in the tank liner; and 2) programmatic controls were imposed on temperature and on the primary waste tank chemistry using caustic and nitrite, as corrosion inhibitors. The primary waste tank composition and temperature controls, along with stress relief, have successfully prevented any failure including SCC failures in the Type IIIA tanks (Ref. 61).

PITTING

Carbon steel can be attacked at very localized sites while a protective oxide film remains intact over the remainder of the steel’s surface. Pitting may cause very rapid, localized penetrations of the structure. Carbon steel is vulnerable to this in dilute nitrate solutions at or above the waterline (and infrequently below the waterline). Pitting can be induced by the dilution of the waste in the Tank 48. Other mechanisms identified for these phenomena were the rapid absorption of CO₂ from the atmosphere (Ref. 69, 70, 71), radiolysis of caustics and organics (Ref. 16, 72), and chemical reactions that reduce the pH in the aqueous film to a steady-state value (Ref. 71). These mechanisms eventually make the steel subject to pitting (Ref. 71). The waste tank compositional controls (i.e., preventative caustic and nitrite inhibitor concentrations) have successfully prevented pitting related failures in the Type IIIA tanks (Ref. 61 for data up to 1994, and Reference 64 and 73 for more recent inspection results).

BRITTLE FAILURE

Brittle failures can occur in mild steel as a function of flaw size, NDTT, and stress in relation to the yield stress. For a given flaw size and stress, brittle failure is possible if the temperature is sufficiently below the NDTT. For Type IIIA waste tanks, a catastrophic brittle fast fracture failure is not credible because of the low NDTT (-45°C) for the A537 class I (mill normalized) steel used in these tanks (Ref. 61). Additionally, procedural controls are in place to respond to low temperatures. The steel plates for these tanks were cooled to -23°C and subjected to a weight drop test. Though the specific material used in the fabrication of these waste tanks was
not tested below -23°C, the tests did demonstrate that the material’s NDTT is very low. In order to enhance that safety posture and ensure no brittle fractures, it is industry practice to add a conservative safety margin (33°C) to the specific NDTT. Consistent with the cited values and the results of the testing of the steel plates, the CSTF opted to define the NDTT as the cited code value (-45°C) plus a 33°C uncertainty, or a value of +10°F. Based on an evaluation of 34 years of meteorological data for the local area, the 99th percentile minimum daily temperature is only 18°F, and a minimum daily temperature of 10°F corresponds to approximately the 99.9th percentile (Ref. 74). Furthermore, the underground steel waste tanks have a significant amount of thermal inertia and will not respond rapidly to changes in the exterior environmental temperature. The average daily temperature is therefore a much more relevant parameter with respect to the tank wall temperature. The lowest average daily temperature in the meteorological database was 13°F. In addition, since the tanks contain radioactive waste, it is expected that the tank wall temperature would be greater than the exterior environmental temperature. Hence, a 10°F NDTT is judged to provide a large degree of margin with respect to potential tank wall temperatures.

18.3.3.3 Frequency

Based on the structural design of the primary tank wall and the programs designed to prevent leakage of materials into the annulus, combined with annual inspections to detect leakage if it were to occur, it is judged that a leak leading to a deflagration is not likely. However, for the purposes of assessing consequences and determining the need for safety controls, these design and programmatic features are ignored and a through wall tank leak that potentially could lead to a deflagration or fire is considered an “Anticipated” event.

18.3.3.4 Consequences

The source term for a Tank 48 annulus deflagration was calculated (Ref. 75). This calculation indicated that the source term for this accident is well below the maximum source term value for the primary tank deflagration. Additionally, the resulting dose from a solids fire would also be similar to, but less than, that for a primary tank deflagration (Ref. 75). Therefore, the consequences of this accident are bounded by the consequence results of a Tank 48 primary tank deflagration (see Section 18.3.1). These consequences are well below the onsite and offsite EGs for “Anticipated” accidents.

18.3.3.5 Risk

The risks for this accident are summarized in Section 18.4.

18.3.3.6 Mitigation

Consequences for a Tank 48 annulus deflagration/fire are well below EGs for an “Anticipated” event. Therefore, no mitigation is required other than those required to protect assumptions in the source term calculation used for consequence analysis (e.g., liquid level control and prohibition on transfers into Tank 48). However, the facility has elected to implement a mitigation strategy to conservatively prevent a Tank 48 annulus deflagration/fire.
Mitigation measures for this accident include the following:

- Waste transfers into Tank 48 are prohibited.
- Tank 48 liquid level shall not exceed 252 inches.
- Tank 48 shall have a SC primary waste tank that is seismically qualified.
- Administrative Controls shall be implemented to perform an annual inspection for the outer wall of the primary tank on Tank 48. The annual inspection is required to ensure that a crack has not occurred. If a crack is discovered by the inspection, the USQ process is initiated (Ref. 50). If these inspections indicate a potential tank wall crack, then ultrasonic testing for cracks, wall thinning, etc. may be conducted. Additionally, this inspection is required to confirm that a tank leak has not occurred, thus preventing a buildup of waste material that could lead to a deflagration or fire.
- Administrative Controls shall be implemented to ensure that the internal tank chemistry in Tank 48 is controlled to prevent corrosion of the tank wall. This program shall limit temperature, pH, OH-, NO2-, NO3-, SO4-2, and Cl- as necessary to ensure the tank contents do not become corrosive. Verification of tank chemistry shall be performed by periodically sampling the tank contents.

Mitigation measures that are not credited for this accident include the following:

- The Tank 48 annulus Continuous Air Monitor (CAM) can detect small volumes of leaked material long before the CLFL in the annulus is a concern (Ref. 76). The CAM provides an alarm to the Control Room upon detection of an elevated radiation reading, which immediately alerts operators of a potential tank leak. Additionally, the filter paper for the annulus CAM is periodically collected and monitored.
- The annulus for Tank 48 is provided with an annulus ventilation system. The exhaust fan flow, nominally about 500 to 1,000 scfm, is sufficient to prevent any leak from elevating the concentrations of flammables in the annulus vapor space to the CLFL.
- The annulus for Tank 48 is equipped with several conductivity probes and a bubbler. Each annulus conductivity probe provides an alarm to the Control Room upon detection of liquid in the annulus space, which immediately alerts operators of a potential tank leak. The annulus bubbler provides a method for determining the amount of material contained in the annulus.
- Response procedures are established to address removal of waste material from the annulus (for a waste tank leak event), thus preventing accumulation of waste material in sufficient quantities that could lead to a deflagration or waste material fire hazard. Upon detection of material in the annulus, a visual inspection is performed to determine if tank leakage occurred and the extent of leakage. If material is present in the annulus, the material is assessed to determine if it is radioactive waste. If the material is radioactive waste, waste removal will be initiated. Additionally, the annulus ventilation system will be operated periodically to purge the annulus vapor space as necessary to maintain flammable vapor concentration below the CLFL.
- Operational procedures are established to protect the tank walls from excessively low temperatures. If the tank wall temperature falls below a predetermined limit,
corrective actions are taken to minimize tank wall stress and increase tank wall
temperature. These actions may include stopping pump operation, isolation of the
tank vapor space (which elevates the tank wall temperature due to decay heat), and
operation of the annulus steam heaters in concert with the annulus ventilation system.

- Operational procedures are established to monitor waste tank and annulus level. If
  the waste tank level decreases beyond a predetermined limit or if radioactive waste is
detected in the annulus, response procedures are entered to mitigate the waste tank
  leak event.
- The Tank 48 reel tape provides indication of tank liquid level. The reel tape provides
  an alarm to the Control Room upon detection of waste tank level below the low-level
  limit, which immediately alerts operators of a potential tank leak.

18.3.4 TANK 48 LARGE LIQUID WASTE RELEASE AND FIRE

This section considers the surface spill of precipitate solution with no operator response before
the spill dries out, accompanied by burning of the dried organic salts that accumulate.

18.3.4.1 Background

The key assumptions in this analysis include the following:

- Transfers of radioactive waste to/from Tank 48 are prohibited.

18.3.4.2 Initiators

The initiators for this accident are not analyzed since waste transfers into and out of Tank 48 are
prohibited.

18.3.4.3 Frequency

Since the facility is prohibited from transferring waste into or out of Tank 48, the large release of
precipitate accompanied by a fire is not credible.

18.3.4.4 Consequences

The radiological consequences of this accident are not analyzed because the accident is not
credible.

18.3.4.5 Risk

The risks of this accident are not analyzed because the accident is not credible.

18.3.4.6 Mitigation

Mitigation measures that prevent this accident include the following:

- Transfers of waste into or out of Tank 48 are prohibited.
18.3.5 TANK 48 VAPOR EXPLOSION AND SOLIDS FIRE

See the discussion of vapor explosion and solids fire in Tank 48, Sections 18.3.1 and 18.3.2, respectively.

Section 18.3.1 describes the initiators, frequency, consequences, risk, and mitigation.

18.3.6 EARTHQUAKE

The seismic analysis for the previous Tank Farm Safety Analysis Report (SAR) (Ref. 63) was based on a ground motion that is characterized by the Blume enveloping spectrum (Ref. 77); however, based on the application of local and distant controlling earthquakes, more representative ground motions (state-of-the-art models) were utilized for the seismic event evaluation basis for the Tank 48. The controlling earthquakes used to predict ground motions for Tank 48 and the resulting EBE are discussed in detail in Reference 78. The return frequency for a 0.2g earthquake is 2E-04/yr (Ref. 63).

18.3.6.1 Evaluation Basis Earthquake

For seismic events up to the EBE, no failure of the steel tanks, concrete vaults, or the berm is expected. In addition, analysis has shown that no damage will occur to the transfer lines between Tanks 48 and 49 since differential settlement is well below even the most conservative threshold for piping damage. Therefore, no surface release from the analyzed above ground transfer line piping is expected for the EBE. Furthermore, transfers of waste into or out of Tank 48 are prohibited.

The normal nitrogen inerting system and ventilation exhaust/annulus exhaust for Tank 48 (and Tank 49 following a transfer from Tank 48, in response to a Tank 48 leak) are not seismically qualified. A seismic event may lead to the release of a portion of the benzene and hydrogen inventories resident in the liquid slurry. This could result in the buildup of a flammable gas mixture either at the liquid-vapor interface or in the bulk vapor space, and result in a deflagration if the oxygen composition reaches the MOC. The frequency and consequences of a deflagration in Tank 48 due to a seismic event are the same as those presented in Section 18.3.1 for the non-seismic case.

As discussed in Section 18.3.1, measures have been taken to mitigate the release of benzene and hydrogen from Tank 48 during a seismic event. Tank 48 is periodically agitated to control the inventory of benzene and/or hydrogen (as applicable) to levels that are not sufficient to elevate the flammable vapor concentration of the bulk vapor space to the CLFL. The agitation induced by a seismic event will enhance mass transfer of the flammable vapors from the liquid to the vapor phase; however, during such agitation, mass transport is not restricted to simple molecular diffusion alone (i.e., some mixing of the bulk vapor space is expected, such that stratification of the flammable vapors would not occur). Calculations have been performed that show that energy input into Type IIIA liquid waste tanks due to seismic events varies greatly based on the height of the tank liquid contents (Ref. 79). For a full tank, the energy input is significant (approximately 139 horsepower [hp] max.) during the first 20 seconds of the seismic event and results in a maximum sloshing height of approximately 25.6 inches. For a tank with a liquid
level of only 60 inches, the energy input is small (approximately 3.7 hp max.) and results in only
about a 6-inch maximum sloshing height. Thus, high tank fill levels will result in greater
releases of flammable vapors to the vapor space than those with lower tank levels, but the
resulting greater sloshing of the liquid surface will provide better mixing of the bulk vapor space.
In addition, consideration of the release of flammable vapor during slurry pump operation, over a
few minutes, easily bounds the release of flammable vapors anticipated during a few seconds of
seismic induced turbulence. As described in Section 18.3.1, Tank 48 (when in inerted operation)
is capable of maintaining an inert atmosphere for at least 12 hours following a seismic event.
Inerting (during inerted operation) and minimization of the flammable vapor inventory, limited
flammable vapor release during a seismic event, and enhanced vapor mixing due to sloshing of
the tank liquid contents during non-inerted operation serve to prevent or at least reduce the
possibility of producing a deflagrable mixture in the bulk vapor space in Tank 48 following a
seismic event.

The primary tank for Tank 48 is a SC structure and, as such, will not fail during a seismic event.
Therefore, a seismic event will not result in the leakage of waste into the tank annulus.

The Tank 48 purge/ventilation system is not seismically qualified and could fail. Failure of the
tank purge/ventilation systems could result in buildup of a flammable gas mixture in the vapor
space in Tank 48 (minimum time to CLFL is 9 days for Tank 48 during non-inerted operation)
and lead to a deflagration if ventilation is not restored. The following section discusses
mitigation of the loss of tank purge/ventilation on Tank 48 following an EBE.

A seismic event has the potential to cause the sudden release of trapped flammable gases in the
waste stored in Tank 48. Administrative Controls are in place to deplete the retained flammable
gases in order to maintain the 9 days to CLFL in the bulk vapor space thereby making a seismic
induced bulk vapor space deflagration event not credible [See Sections 18.2.3.10 and 18.3.1
(Tank 48 during non-inerted operation)]

It should be recognized for Tank 48 that these controls do not prevent the potential buildup of a
flammable vapor layer at the liquid/vapor interface when non-inerted due to benzene gas being
heavier than air and the risk of a deflagration exists at this location. The source term from a
deflagration event at the liquid/vapor interface is even lower than the bulk vapor space
deflagration that is well below EGs for an Anticipated event. To reduce the risk, as discussed in
Section 18.2.1, sources of ignition are minimized by design and/or administrative control and
minimizes the probability of a deflagration event. The effects of residual concentrations of
flammable vapor remaining in solution following slurry pump operation are insignificant and are
discussed further in Section 18.2.3.10.

18.3.6.2 Emergency Ventilation

An unmitigated ventilation system failure for Tank 48 can result in a deflagration, which has the
potential for creating an airborne release. This accident was the subject of detailed, best-
estimate analyses. As a result of this analysis, the waste level in Tank 48 is required to be
maintained ≤ 252 inches. In the event of a prolonged ventilation outage, a design for the EPVE
was developed. The EPVE includes two portable, self-powered ventilation units designed to
provide air-based ventilation that is adequate to control the accumulation of flammable vapors.
Once operational, these units ensure that adequate ventilation is provided to limit flammable
vapor buildup until normal purge/ventilation is restored and thus prevent a deflagration. Tank 48 is equipped with a backup exhaust fan unlike other waste tanks that have only one installed exhaust fan.

In the event of tank exhaust fan failure, EPVE will be available for Tank 48. Each of the EPVE engine/blower assemblies has a minimum capacity of 500 scfm (Ref. 39). The EPVE is designed so that it can be "hand-carried" and installed on top of the tank in a short period of time to provide ventilation in the event that the normal exhaust fans fail and cannot be restored. Only one EPVE engine/blower assembly is required to maintain the flammable vapor concentrations well below the flammable range. Risers on Tank 48 are available for the EPVE connection. One of these risers on the tank will be accessible following a 0.2g seismic event (Ref. 80). A qualitative comparison was made of the proximate equipment and structures to records of similar configuration subjected to loadings representative of a 0.25g peak ground acceleration (pga) seismic event or tornado with a wind speed of 185 mph. The potential collapse and resulting interactions that could affect access were included in the comparison (Ref. 80). It is concluded that a 0.25g pga seismic event would not produce any significant interactions that would preclude access to the tank top risers. Two EPVE engine/blower assemblies (and related support equipment) will be stored in a seismic and high wind qualified location near Tank 48. The EPVE engine/blower assemblies will be functionally tested periodically, and equipment necessary to install and run the units (including portable LEL analyzer) will be stored with them. Operations and maintenance personnel will be trained on the installation and operation of this equipment.

The consequence evaluation (Ref. 58) for Tank 48 shows that the maximum offsite and onsite doses are less than 100 mrem. However, since a deflagration event is unacceptable, the installation of EPVEs to sweep the vapor space of flammable vapors following a loss of ventilation event provides an additional level of defense. The EPVE require minimal time and effort to install.

18.3.6.3 EPVE Installation

Loss of the Tank 48 normal ventilation system would be expected following an EBE, and installation and operation of the EPVE described earlier would be required to prevent buildup of a flammable gas mixture leading to deflagration. The EPVE may be installed following loss of ventilation when flammable vapor concentrations could potentially approach the CLFL. Therefore, it is necessary to ensure that operators will have access to the tank top to install the EPVE following an EBE.

The effect of H Area spills on Tank 48 tank top access for EPVE installation was evaluated. It was determined that the Tank 48 tank top is not subject to direct radiation from the other tanks in
H-Area, except for the Tank 21-24 group. The Tank 21-24 group has no above ground transfer lines; therefore, leaks from these tanks would be subsurface. All above ground waste transfer lines, valve boxes (VBs), and drain VBs were seismically analyzed (Ref. 81). This analysis identified modifications necessary to seismically qualify certain transfer lines. These modifications will be completed prior to use of the transfer line for a waste transfer. Additionally, spills inside the evaporator are contained. Therefore, other H-Area spills would not preclude tank top access for Tank 48 to install the EPVE (Ref. 82, 83).

The potential for releases due to EBE-induced concurrent ventilation system failures at other tanks in the H-Tank Farm will not likely affect installation of the EPVE on Tank 48; the time to CLFL for other tanks is a minimum of 7 days (see Section 3.4.2.18). The minimum of 7 days to CLFL for other tanks is maintained through procedural and administrative controls. In addition, the EPVE required for backup ventilation for Tank 48 is dedicated equipment.

A seismic event could also result in damage at adjacent facilities in H Area (i.e., H-Canyon, Replacement Tritium Facility, Tritium, and Receiving Basin for Offsite Fuels). However, the effects of releases due to seismic damage to adjacent facilities on Tank 48 would be limited. The limited effects are due to the releases being airborne and thus quickly dissipated, and the large distance (greater than 100 meters) from Tank 48 to adjacent facilities.

18.3.6.4 Assessment of Effects of Beyond Evaluation Basis Earthquake Events

While the previous sub-sections of Section 18.3 have discussed Design/Evaluation basis events, the following discussion addresses the capability of Tank 48 to resist the effects of beyond-EBE events. The purpose of this analysis was to show the safety margins that exist for such events, or, where little to no margin could be demonstrated, to identify areas for improvement.

Best-estimate analyses indicate that the steel tanks and concrete vaults are resistant to the effects of a beyond-EBE event. Nevertheless, high magnitude earthquakes can cause damage to both concrete vaults and the steel tanks and increase settlements of the surrounding soil. This event would result in a release of waste from the tank into the annulus and/or through the vault and into the surrounding soil (subsurface release) (Ref. 83). With the berm intact, liquid from a subsurface release will not seep out of the berm (Ref. 83). The subsurface liquid release from the failed tank will eventually be transported to the underlying groundwater. The environmental cleanup would be difficult; however, the relatively long groundwater transport times allow interdiction opportunities to minimize the impact on the public (Ref. 83).

From a public health and safety perspective, an above ground transfer line break that results in a surface release was analyzed to have significant consequences. A beyond EBE seismic event could cause above ground transfer system failures. Transfer system failures can result in above ground liquid pathway releases and also affect EPVE installation on Tank 48. However, a Spill Contingency Plan (Ref. 84) is in place to mitigate the consequences of liquid pathway releases. Additionally, controls assuring a minimum of 9 days to CLFL (during non-inerted operation) for Tank 48 allow sufficient response time to install EPVE and mitigate the buildup of flammable vapors in Tank 48.

Loss of the normal ventilation systems for the tank and annulus would also be expected, and installation and operation of the EPVE described earlier would be required for Tank 48.
addition, the annulus of Tank 48 (if waste leaks into the annulus) may also need ventilation to prevent buildup of a flammable gas mixture leading to deflagration. The EPVE is staged in a seismically qualified (to the more conservative 0.2g pga Blume spectrum earthquake) building near Tank 48 to facilitate timely installation.

18.3.6.5 Conclusion

Results from the original best estimate analyses for the consequences from the EBE event yielded results that were considered acceptable from an onsite, offsite, and environmental consequences perspective. However, potential facility/operational enhancements were identified and implemented that improve the margin of safety for beyond the EBE events by significantly reducing the consequences from a beyond-the EBE. These enhancements included the following:

- Seismic analysis of all above ground waste transfer lines, VBs, and drain VBs
- Qualification of the berm surrounding Tank 48
- Qualification of Tank 48 and associated cooling coils
- Design and procurement of the EPVE
- Procedural enhancements including the development of post-seismic event response procedures and emergency planning

In summary, while many different magnitude beyond-EBE events can be postulated that could have both significant environmental and safety impacts, Tank 48 does not add to the earthquake-related risk already analyzed elsewhere in this DSA (Section 3.4.2.18).

18.3.7 FIRE IN TANK 48 VENTILATION SYSTEM

The accident scenario discussed in this section is a fire in the Tank 48 ventilation system due to the hazards associated with benzene and combustible solids.

18.3.7.1 Background

There was one HEPA fire in the history of the Tank Farms. That incident was caused by the addition of a volatile and flammable corrosion inhibitor to Tank 6F in 1965. The corrosion inhibitor (di-isopropyl ammonium nitrite or dicyclo hexyl ammonium nitrite) that caused the 1965 HEPA filter fire is prohibited in all tanks. The statement of the buildup of XTPB on the filters (discussed below) is an expression of the amount that must be deposited in a small area to support combustion of the XTPB. If the solids were dispersed over a larger area, they would not support combustion. The material deposited on the filters in the 1965 incident was different from the XTPB. The accident was re-evaluated because of the presence of organics in Tank 48. This re-evaluation considers the following fire hazards in the ventilation system of this waste tank (Ref. 85):

- Combustible solids on a HEPA filter
- Benzene condensation in a HEPA filter
• Benzene accumulation in a ventilation condenser

COMBUSTIBLE SOLIDS ON A HIGH-EFFICIENCY PARTICULATE AIR FILTER

Although most of the solids are removed from the ventilation stream by the demister, some solids may collect on the HEPA filters on Tank 48. These Tank 48 solids are flammable; however, prolonged exposure to flame is required to ignite them (Ref. 47). Precautions are taken during filter changeout to avoid ignition.

It is highly unlikely that sufficient amounts of KTPB solids can accumulate on the filters to propagate a fire if an ignition source is present. HEPA filters are normally changed before the accumulated activity reaches 3 Ci. This corresponds to about 30 grams of the XTPB solids from the ITP process. The 30 grams have to collect on 1.3% or less of the filter surface to be thick enough to propagate a fire. It is not credible that the combustible solids are confined to such a small portion of the filter. Therefore, a fire cannot propagate even if an ignition source is present (Ref. 85).

BENZENE CONDENSATION IN A HIGH-EFFICIENCY PARTICULATE AIR FILTER

Benzene does not condense in the tank ventilation HEPA filters based on the vapor pressure of benzene and the expected benzene vapor concentrations in the ITP process (Ref. 85). The maximum expected benzene vapor concentration under planned operations occurs in Tank 48 during the washing cycle. A conservatively high estimate for normal operations is 4,000-ppm (by volume) benzene and occurs only a few days a year. Condensed benzene as a separate phase requires cooling the airstream to -23°C at 4,000 ppm.

A temperature of -23°C has never been observed in the recorded history of SRS or National Weather Service. The lowest temperature observed at SRS is -20°C, which occurred in 1985 and lasted 2-3 hours (Ref. 86). The anticipated frequency of these temperatures (-23°C) occurring at SRS is low very based on the observed data. Under normal operations, the reheater upstream of the HEPA filter keeps the ventilation stream temperature between 50°C and 70°C. Thus, the following conditions are required to occur simultaneously for benzene to collect in the HEPA filter:

• Operation at the maximum allowable benzene concentration
• Failure of the reheater
• Ambient temperature below -23°C

The benzene vapor concentration required to condense liquid benzene in the HEPA filter (under normal operations with the condenser at 10°C) is 60,000 ppm (6 vol. % benzene).

Thus, benzene will not condense in the tank ventilation HEPA filter under expected process conditions (Ref. 85) and will not be present to support combustion within the HEPA filter.
BENZENE ACCUMULATION IN A VENTILATION CONDENSER

A likely location for benzene to collect is in the condenser upstream of the HEPA filter. The condenser normally operates in the temperature range between 10°C and 38°C. As discussed above, this is not cold enough to collect benzene as a separate phase; however, the water that is collected contains dissolved benzene. The benzene concentration in the water is dependent on the benzene concentration in the gas and on the condenser temperature. Assuming the highest expected benzene concentrations and a condenser temperature of 10°C, the benzene in the condensate could be as high as 115 ppm for Tank 48, with the benzene concentration in the vapor space at 4,000 ppm (Ref. 85).

If the ventilation stops and the condensate is allowed to warm while confined within the condenser, some of the dissolved benzene will evaporate. The final benzene concentration in the airspace depends on the volume ratio of air to condensate. Based on the design of the bottom bonnet of the condenser and the drain piping, the ratio of vapor volume to liquid volume is greater than 50. If this ratio is assumed to be 50:1 and the maximum temperature reached is 38°C, the resulting benzene concentration in the air would be 4,500 ppm (Ref. 85).

The final benzene concentration reached in the vapor is far below the CLFL for Tank 48.

This evaluation assumes that the condensed water is free of dissolved salts. The amount of soluble salts that can pass through the tank demister is assumed to be small (< 0.01 M) and does not significantly affect the evaluation.

Since the CLFL cannot be reached, the vapor in the condenser can neither burn nor deflagrate.

18.3.8 WASTE TANK OVERPRESSURIZATION

The accident scenario discussed in this section is overpressurization of Tank 48 due to excessive nitrogen purge and other causes.

18.3.8.1 Background

During normal waste tank operations, the pressure in the tank vapor space is maintained below atmospheric by a purge exhaust fan for contamination and flammable vapor control. The negative pressure in the waste tank assures air leakage is into the tank. The tank ventilation system could be overcome by High Heat Waste boiling or excess steam injection due to a steam jet malfunction. If the tank becomes overpressurized, airborne activity may be released as an aerosol or mist. However, neither of these initiators is credible for Tank 48, given the current waste characteristics, the prohibition on transfers into Tank 48, and the lack of a primary transfer jet in Tank 48.

For a tank with a nitrogen purge capability (Tank 48), tank overpressurization can also be caused by excessive nitrogen flow into the tank. In Tank 48, the negative tank pressure is maintained by controlling the exhaust rate. Excessive nitrogen flow alone can pressurize the tank. The nitrogen supply rate is controlled by maintaining a set oxygen concentration. High tank pressure
automatically shuts down the tank ventilation system by closing the nitrogen supply valves and shutting down the exhaust fans.

Overpressurization of Tank 48 is not expected to be more frequent with nitrogen purge than in the air-purged tanks due to design features of the ventilation system. The first feature is an installed spare exhaust fan. The effect of this feature is to reduce the duration of exhaust fan outages. The second feature is an interlock that shuts off nitrogen flow on a loss of both purge exhaust fans. The effect of this feature is to minimize the opportunity for overpressurization due to nitrogen purge. This interlock only functions during ventilation Mode B operations.

The consequences of a tank overpressurization are sufficiently small (estimated at 0.5 Ci released for the Tank 12 incident in 1956) that a sophisticated frequency determination is not justified.

18.3.9 ACCIDENT SUMMARY

This section summarizes the results of the major accidents analyzed in Section 18.3. The consequences reported in this chapter are based on the ICRP-30 DCF for effective dose equivalent.

The onsite doses to a worker at 100 meters (0.06 miles), contained in Reference 58, were used to evaluate the safety of the facility. Onsite accident risk evaluation and acceptance systems generally used realistic modeling and data in the areas of demography, meteorology, and personal actions including use of protective gear or evacuation. For example, DOE Draft Notice 5480.PP (Ref. 87), in regard to occupational risk goals for accidents, states "Risk assessments employed in estimating how facilities or particular safety issues or accident sequences compare with these quantitative goals may employ full realistic models and data."

The consequences of a deflagration event are well below the onsite and offsite EGs, and clearly bound the consequences for all other Tank 48 unique accidents presented in this chapter.

Based on this analysis, Tank 48 can be maintained without undue risk to the health and safety of the facility worker, the public, or the environment.
18.4 ADMINISTRATIVE CONTROLS

This section describes Administrative Controls required for Tank 48 accident analyses outlined in Sections 18.2 and 18.3. These Administrative Controls may be Programmatic Controls or Specific Administrative Controls (SACs) as described in Section 5.3. Each Administrative Control is listed by TSR reference number below.

18.4.1 SPECIFIC ADMINISTRATIVE CONTROL 5.8.2.48.A

18.4.1.1 Safety Function

The safety function of this SAC is to protect bounding initial conditions in the accident analyses regarding time to CLFL in Tank 48. This SAC is credited SS in the following Tank 48 accidents:

- Tank 48 Vapor Explosion (Section 18.3.1)
- Tank 48 Solids Fire (Section 18.3.2)
- Tank 48 Vapor Explosion and Solids Fire (Section 18.3.5)
- Earthquake (Section 18.3.6)

18.4.1.2 SAC Description

When the ventilation system is in non-inerted operation, the minimum amount of time to increase to 100% of the CLFL, assuming the loss of the ventilation system and assuming a starting point of 37% CLFL, must be 9 days or longer.

Due to the nature of this program (i.e., determining and tracking time to CLFL), this function cannot be performed by a Structure, System, and Component (SSC) and is therefore designated as a SAC. Equipment relied upon to implement this SAC includes the GC and ventilation purge exhaust flow indication (Section 18.3.1.1).

Adequate conservatism exists for this SAC due to basing the time to CLFL calculation on an assumed starting point of 37% CLFL (versus actual CLFL) and that limited operations, which would cause benzene release, are permitted in non-inerted operation.

18.4.1.3 Functional Requirements

Functionality of the Tank 48 GC is assured by facility calibration procedures and calibration requirements of LCO 3.2.10. The purge exhaust flow indication is maintained functional in accordance with LCO 3.2.10. The determination of time to CLFL is a routine task and is governed by existing procedures.
18.4.1.4 SAC Evaluation

This SAC is required to ensure that Tank 48 time to CLFL is verified prior to entering non-inerted operation to ensure that adequate time exists to respond following loss of primary ventilation. Monitoring of Tank 48 CLFL, as required by LCO 3.2.10, ensures that this SAC is performing the intended safety function.

18.4.2 SPECIFIC ADMINISTRATIVE CONTROL 5.8.2.48.B

18.4.2.1 Safety Function

The safety function of this SAC is to prevent excessive benzene releases due to liquid additions and protect the time to CLFL in Tank 48 during non-inerted operation. This SAC protects bounding initial conditions in the accident analyses and is credited as a SS preventer in the following Tank 48 accidents:

- Abnormal Benzene Release from a Waste Tank (Section 18.2.4.1)
- Tank 48 Vapor Explosion (Section 18.3.1)
- Tank 48 Solids Fire (Section 18.3.2)
- Tank 48 Vapor Explosion and Solids Fire (Section 18.3.5)

18.4.2.2 SAC Description

Liquid additions must be demonstrated to be acceptable in ventilation Mode B prior to making these additions in non-inerted or ventilation Mode C operations. This means that planned water additions for these modes will be done twice. Prior to adding water in non-inerted operations or adding water in ventilation Mode C, a water addition of equal or greater volume and rate and in a similar manner as that proposed in non-inerted or ventilation Mode C operations will be made in ventilation Mode B. The resulting benzene release from the ventilation Mode B addition will be analyzed by Engineering to determine whether, without ventilation, this release complies with the 18 day-to-CLFL requirement at the liquid/vapor interface using the actual starting point concentration. If the analysis shows it would take longer than 18 days to reach this condition, the addition will be allowed during non-inerted or ventilation Mode C operations.

Due to the nature of this program (i.e., performing planned addition and calculating time to CLFL), this function cannot be performed by an SSC and is therefore designated as a SAC. Equipment relied upon to implement this SAC includes the GC (Section 18.3.1.1) and the liquid source addition tank/tanker volume indication (e.g., Inhibited/Flush Water, chemical addition tanker).

Adequate conservatism exists for this SAC due to making the first liquid addition while the tank is inerted with nitrogen, and determining the actual resulting benzene release.
18.4.2.3  Functional Requirements

Functionality of the Tank 48 GC is assured by facility calibration procedures and calibration requirements of LCO 3.2.10. Since this SAC involves making two liquid additions from the same source and in a similar manner, instrument error involved with the liquid source volume indication would be approximately the same for both liquid additions. Therefore, the liquid source addition tank volume indications are not required to be covered by the Installed Process Instrumentation (IPI) and Measuring and Test Equipment (M&TE) Program or Nuclear Maintenance Management Program (NMMP). The calculation of time to CLFL is a routine task and is governed by existing procedures.

18.4.2.4  SAC Evaluation

Independent verification is required for the following: addition amount (for both the test addition and the actual addition in non-inerted or ventilation Mode C operation), addition rate (for the test addition), compliance with the 18 day-to-CLFL requirement, and actual starting point benzene concentration. Monitoring of Tank 48 CLFL, as required by LCO 3.2.10, ensures that this SAC is performing the intended safety function.

18.4.3  SPECIFIC ADMINISTRATIVE CONTROL 5.8.2.48.C

18.4.3.1  Safety Function

The safety function of this SAC is to prevent excessive benzene releases due to liquid additions and protect the time to CLFL in Tank 48. This SAC protects bounding initial conditions in the accident analyses and is credited as a SS preventer in the following Tank 48 accidents:

- Abnormal Benzene Release from a Waste Tank (Section 18.2.4.1)
- Tank 48 Vapor Explosion (Section 18.3.1)
- Tank 48 Solids Fire (Section 18.3.2)
- Tank 48 Vapor Explosion and Solids Fire (Section 18.3.5)

18.4.3.2  SAC Description

When no ventilation exists, and an LCO Required Action applies that requires liquid transfers be terminated, and the LCO does not explicitly permit liquid additions in accordance with this administrative control, liquid additions are not permitted (e.g., % CLFL is greater than LCO requirement, inoperable HLLCP). When no ventilation exists, liquid additions will be limited to those required to perform the following: filling of the seal leg in the purge condenser, condenser/demister flushing, and flushing of the reheater. Any other water additions will be allowed only after the satisfactory completion of a USQ determination.

Due to the nature of this program (i.e., permitted liquid additions are based upon individual LCOs), this function cannot be performed by an SSC and is therefore designated as a SAC.
18.4.3.3 Functional Requirements

This SAC works in conjunction with Tank 48 LCOs and does not require any equipment.

18.4.3.4 SAC Evaluation

This SAC works in conjunction with Tank 48 LCOs and describes permitted liquid additions under certain LCO Conditions.

18.4.4 SPECIFIC ADMINISTRATIVE CONTROL 5.8.2.48.D

18.4.4.1 Safety Function

The safety function of this SAC is to liberate benzene and hydrogen that is retained/trapped in the waste to preserve time to CLFL assumptions in Tank 48. This SAC protects bounding initial conditions in the accident analyses and is credited as a SS preventer in the following Tank 48 accidents:

- Abnormal Benzene Release from a Waste Tank (Section 18.2.4.1)
- Tank 48 Vapor Explosion (Section 18.3.1)
- Tank 48 Solids Fire (Section 18.3.2)
- Tank 48 Vapor Explosion and Solids Fire (Section 18.3.5)
- Earthquake (Section 18.3.6)

18.4.4.2 SAC Description

Slurry pumps shall be periodically operated to control the flammable vapor inventory in Tank 48, such that the waste tank bulk vapor space does not become flammable in less than 9 days following a seismic event. This program shall determine the quiescent period and address the requirements for declaring flammable vapor depletion success for a given tank quadrant (e.g., slurry pump run times and speeds, number of pumps required to perform the safety function). The methodology for these requirements is discussed in Section 18.2.3.10.

Due to the nature of this program (i.e., calculating and tracking Q-time), this function cannot be performed by an SSC and is therefore designated as a SAC. Equipment relied upon to implement this SAC includes the slurry pumps and Variable Frequency Drives (VFDs), and waste tank level measurement devices. This equipment is described in more detail in Sections 2.4.1.3 and 2.4.4.5.

Adequate conservatism exists for this SAC due to assumptions made when calculating the Q-time (e.g., assumed 37% CLFL initial point, 100% retention capabilities, 100% instantaneous release).
18.4.4.3 **Functional Requirements**

The functionality of the waste tank reel tape and radar is assured by the NMMP as described in Section 5.5.4.2.9. Laboratory QA practices and sample analysis protocols, as described in Section 5.5.4.2.7, ensure the validity of associated sample results.

Tank parameters, such as tank level, benzene/hydrogen retention/release, and benzene/hydrogen generation rate, are used to calculate the allowed Q-time between pump runs. Slurry pump operation, sampling/analysis, determination of tank level, and calculation of Q-time are routine tasks and are governed by existing procedures.

18.4.4.4 **SAC Evaluation**

Calculations require independent verification and are performed in accordance with established procedures. Various methods, as described in Section 18.2.3.10, ensure adequate mixing of the tank. Monitoring of Tank 48 CLFL, as required by LCO 3.2.10, and historical Q-time pump run data ensures that this SAC is performing the intended safety function. Q-times can be adjusted should a slurry pump become non-functional (see Section 18.2.3.10).

18.4.5 **SPECIFIC ADMINISTRATIVE CONTROL 5.8.2.48.E**

18.4.5.1 **Safety Function**

The safety function of this SAC is to protect benzene release rate values used within the accident analyses. This SAC supports an SS preventer in the following Tank 48 accidents:

- Tank 48 Vapor Explosion (Section 18.3.1)
- Tank 48 Solids Fire (Section 18.3.2)
- Tank 48 Vapor Explosion and Solids Fire (Section 18.3.5)

18.4.5.2 **SAC Description**

The determination of benzene release rates, required by controls within the TSR, shall address instrumentation uncertainty of the parameters used as input to the calculations.

Due to the nature of this program (i.e., input of uncertainties when calculating benzene release rates), this function cannot be performed by an SSC and is therefore designated as a SAC. Equipment relied upon to implement this SAC includes the GC (Section 18.3.1.1). Adequate conservatism exists for this SAC due to the methodology used in establishing the GC uncertainty (e.g., worst case parameters assumed).

18.4.5.3 **Functional Requirements**

Functionality of the Tank 48 GC is assured by facility calibration procedures and calibration requirements of LCO 3.2.10.
18.4.5.4 SAC Evaluation

Calculations require independent verification and are performed in accordance with established procedures. Calibration of the GC ensures that this SAC is performing the intended safety function (verifies parameters within the uncertainty calculation).

18.4.6 SPECIFIC ADMINISTRATIVE CONTROL 5.8.2.48.F

18.4.6.1 Safety Function

The safety function of this SAC is to minimize benzene production in Tank 48 by maintaining assumed waste characteristics. This SAC protects bounding initial conditions in the accident analyses and is credited as SS in the following Tank 48 accidents:

- Abnormal Benzene Release from a Waste Tank (Section 18.2.4.1)
- Tank 48 Vapor Explosion (Section 18.3.1)
- Tank 48 Solids Fire (Section 18.3.2)
- Tank 48 Vapor Explosion and Solids Fire (Section 18.3.5)
- Earthquake (Section 18.3.6)

18.4.6.2 SAC Description

Controls shall be implemented to ensure that: (i) the waste temperature is monitored and maintained less than or equal to 35°C, and (ii) the free hydroxide concentration of the waste is monitored and maintained greater than or equal to 1.0 molar. If waste temperature is greater than 35°C, then maximum cooling with all available cooling coils shall be initiated immediately and the temperature restored to limits within 48 hours. If free hydroxide concentration of the waste is less than 1.0 molar, then free hydroxide concentration shall be restored to limits within 14 days. The 14-day completion time shall start after the facility has reviewed and accepted the laboratory sample results.

Due to the nature of this program (i.e., maintaining waste characteristics), this function cannot be performed by an SSC and is therefore designated as a SAC. Equipment relied upon to implement this SAC includes waste tank thermocouples, laboratory/sampling equipment, and the Chromate Cooling Water System. This equipment is described in more detail in Sections 2.4.1 and 2.8.2.5.

Adequate conservatism exists for this SAC due to margin between the analyzed values (40°C, 0.6 molar) and the SAC values for temperature and free hydroxide (Section 18.2.3, Ref. 18). Additionally, allowing temperature or free hydroxide to be out of limits within the permitted restoration completion times, would not cause a significant benzene release rate from the waste (Ref. 88, 89).
18.4.6.3 Functional Requirements

Laboratory QA practices and sample analysis protocols, as described in Section 5.5.4.2.7, ensure the validity of associated sample results. Functionality of the Chromate Cooling Water System coils is assured through the implementation of the Structural Integrity Program and associated testing/inspection. Although the waste tank thermocouples are not covered by the IPI and M&TE Program or NMMP, multiple thermocouples are available for use. Additionally, the thermocouples have high reliability and failure of a thermocouple is readily detectable. Waste tank temperature/chemistry monitoring and maintenance is a routine task and is governed by existing procedures.

18.4.6.4 SAC Evaluation

Sample results are independently reviewed. Monitoring of Tank 48 CLFL, as required by LCO 3.2.10, ensures that this SAC is performing the intended safety function. Periodic sampling of waste tanks (as part of the Corrosion Control Program as described in Section 5.5.4.2.13) gives additional assurance that the safety function of this SAC is met.

18.4.7 DELETED

18.4.8 ADMINISTRATIVE CONTROL 5.8.2.48.I

Programmatic controls shall be implemented to ensure that the conservation vent and vacuum breaker is periodically inspected. This inspection shall ensure that blockage in the relief line is not present and that the conservation vent and vacuum breaker operate as designed.

This program is designated as a Programmatic Controls Administrative Control. This program aids in ensuring the functionality of the conservation vent and vacuum breaker; however, the program is not part of a level of control or bounding condition in the Tank 48 accident analyses. Therefore, this program does not warrant identification as a SAC.

18.4.9 ADMINISTRATIVE CONTROL 5.8.2.48.J

Programmatic controls shall be implemented to ensure that sources of ignition are minimized for Tank 48.

This program is designated as a Programmatic Controls Administrative Control. This program is used to reduce the probability of a deflagration; however, the program is not part of a level of control or bounding condition in the Tank 48 accident analyses. Therefore, this program does not warrant identification as a SAC.
18.4.10 SPECIFIC ADMINISTRATIVE CONTROL 5.8.2.48.K

18.4.10.1 Safety Function

The safety function of this SAC is to prevent inadvertent addition of OA or other chemicals which could cause an abnormal benzene release within Tank 48. This SAC is credited as a SS preventer in the following Tank 48 accidents:

- Abnormal Benzene Release from a Waste Tank (Section 18.2.4.1)
- Tank 48 Vapor Explosion (Section 18.3.1)
- Tank 48 Solids Fire (Section 18.3.2)
- Tank 48 Vapor Explosion and Solids Fire (Section 18.3.5)

18.4.10.2 SAC Description

Controls shall be implemented for independent verification of chemicals prior to unloading to Tank 48.

Due to the nature of this program (i.e., independent verification), this function cannot be performed by an SSC and is therefore designated as a SAC.

18.4.10.3 Functional Requirements

This SAC requires independent verification of chemicals and no equipment is necessary for performance. Unloading chemicals to waste tanks is a routine task and is governed by existing procedures.

18.4.10.4 SAC Evaluation

Monitoring of Tank 48 CLFL, as required by LCO 3.2.10, provides assurance that the safety function of this SAC was met. Sampling of the waste tank, which is typically done after chemical additions, also provides assurance that the safety function of this SAC was met.

18.4.11 ADMINISTRATIVE CONTROL 5.8.2.48.L

Programmatic controls shall be implemented to ensure the outer primary tank wall for Tank 48 is inspected annually. The annual inspection is required to ensure that a crack has not occurred. If a crack is discovered by the inspection, the USQ process is initiated (Ref. 50). If these inspections indicate a potential tank wall crack, then ultrasonic testing for cracks, wall thinning, etc. may be conducted. Additionally, this inspection is required to confirm that a tank leak has not occurred, thus preventing a buildup of waste material that could lead to a deflagration or fire in the annulus.

This program is designated as a Programmatic Controls Administrative Control. Although this program is part of a level of control in the Tank 48 accident analyses, the program provides a support function to aid in verifying and maintaining safety SSC integrity. This program provides
a broad safety management function which is contained in organizational procedures and does not involve time critical operator actions. Therefore, this program does not warrant identification as a SAC.

18.4.12 TANK 48 UNAUTHORIZED OPERATIONS - SPECIFIC ADMINISTRATIVE CONTROL 5.8.2.49

18.4.12.1 Safety Function

The safety function of this SAC is to protect bounding initial conditions in the accident analyses. This SAC is credited SC/SS in the following Tank 48 accidents:

- Abnormal Benzene Release from a Waste Tank (Section 18.2.4.1)
- Tank 48 Vapor Explosion (Section 18.3.1)
- Tank 48 Solids Fire (Section 18.3.2)
- Tank 48 Annulus Deflagration/Fire (Section 18.3.3)
- Tank 48 Large Liquid Release and Fire (Section 18.3.4)
- Tank 48 Vapor Explosion and Solids Fire (Section 18.3.5)
- Earthquake (Section 18.3.6)
- Waste Tank Overpressurization (Section 18.3.8)

18.4.12.2 SAC Description

The following operations are not permitted:

- Chemical cleaning, including oxalic acid additions to Tank 48.
- Deliveries, storage, or further use of STPB in the CSTF (excluding incidental samples: however, these samples shall not be disposed of in waste tanks).
- Processing operations (concentration / washing) in Tank 48.
- Waste additions/transfers to or from Tank 48.
- Use of the Cold Feeds Area to Tank 48 Chemical Addition line.
- SMP operation in Tank 48.

This program was designated a SAC because there are a variety of different controls performing safety functions that cannot be accomplished with SSCs.

Equipment relied upon to implement this SAC includes transfer lines, blanks, jumpers/connectors, valves, and electrical breakers/disconnects. This equipment is described in more detail in Sections 4.3.1, 2.4.2, 4.3.2, 4.3.3, and 4.4.1, respectively.
18.4.12.3  Functional Requirements

This SAC relies on the Transfer Control Program (Section 5.5.4.2.21) and the USQ process to implement controls and prohibitions detailed above. Operations such as valve/breaker manipulations and control of the transfer path are considered to be routine tasks and are governed by existing procedures and training.

18.4.12.4  SAC Evaluation

The Transfer Control Program (Section 5.5.4.2.21) including independent verification of the transfer path, independent verification of chemicals (Section 18.4.10), and the USQ process ensure that the safety function of this SAC is met. Electrical or mechanical isolation and independent verification is required to prevent transfers out of Tank 48.
18.5 REFERENCES


78. In Tank Precipitation (ITP) and H-Tank Farm (HTF) Geotechnical Report. WSRC-TR-95-0057, Rev. 0, September 1995.


86. Hunter, C.H.  *A Climatological Description of the Savannah River Site.*

87. DOE Nuclear Safety Goals.  DOE Draft Notice 5480.PP, U.S. Department of Energy,

88. Lambert, D.P., et al.  *Copper Hydrolysis and Peroxide Oxidation Testing for the*
    *Decomposition of Tetraphenylborate in Tank 48H.*  WSRC-TR-2004-00306, Rev. 0,
    November 2004.


    X-CLC-H-00781, Rev. 1, August 2009.

91. HLW (Tank Farm) Backfit Assessment Package Fiber Optic Alarm Cable.

92. Suttinger, L.T.  *Assessment of Safety Class Alarm Loops for the H-Tank Farm Control*

93. Campbell, T.C.  *Assessment of Safety Significant Alarm Loops for the H-Tank Farm*

94. Barnes, W.M. to Lex, T.J.  *Engineering Position: Guidance in Application of IEEE 384 to*
    *the H-Tank Farm Control Room Consolidation Project Safety Class Design.*
    CBU-HDP-2004-00345, Westinghouse Savannah River Company, Aiken, SC,
    January 11, 2005.

95. Single Failure Analysis of Safety Class Alarm Design H-Tank Farm Control Room


97. DOE Handbook - Nuclear Air Cleaning Handbook.  DOE-HDBK-1169-2003,

98. Mobley, L.L.  *Permissible Leak Rate for Level 4 Waste Purge Ventilation Systems.*
    M-CLC-G-00460, Rev. 0, May 2017.
## Table 18.6-1 Planned Cycle Times for In-Tank Precipitation

<table>
<thead>
<tr>
<th>Batch No.</th>
<th>Operation</th>
<th>Duration</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Days</td>
<td>Days</td>
</tr>
<tr>
<td>1</td>
<td>Transfer waste in</td>
<td>4.9</td>
<td>4.9</td>
</tr>
<tr>
<td></td>
<td>Add water, TPB, &amp; ST</td>
<td>2.4</td>
<td>7.3</td>
</tr>
<tr>
<td></td>
<td>Agitate slurry</td>
<td>3.0</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>Settle</td>
<td>9.4</td>
<td>19.7</td>
</tr>
<tr>
<td></td>
<td>Filter</td>
<td>4.7</td>
<td>24.4</td>
</tr>
<tr>
<td></td>
<td>Clean filter</td>
<td>2.0</td>
<td>26.4</td>
</tr>
<tr>
<td>2</td>
<td>Transfer waste in</td>
<td>4.9</td>
<td>31.3</td>
</tr>
<tr>
<td></td>
<td>Add water &amp; TPB</td>
<td>2.2</td>
<td>33.5</td>
</tr>
<tr>
<td></td>
<td>Agitate slurry</td>
<td>3.0</td>
<td>36.5</td>
</tr>
<tr>
<td></td>
<td>Settle</td>
<td>9.4</td>
<td>45.9</td>
</tr>
<tr>
<td></td>
<td>Filter</td>
<td>4.7</td>
<td>50.6</td>
</tr>
<tr>
<td></td>
<td>Clean filter</td>
<td>2.0</td>
<td>52.6</td>
</tr>
<tr>
<td>3</td>
<td>Transfer waste in</td>
<td>4.9</td>
<td>57.5</td>
</tr>
<tr>
<td></td>
<td>Add water &amp; TPB</td>
<td>2.2</td>
<td>59.7</td>
</tr>
<tr>
<td></td>
<td>Agitate slurry</td>
<td>3.0</td>
<td>62.7</td>
</tr>
<tr>
<td></td>
<td>Settle</td>
<td>9.4</td>
<td>72.1</td>
</tr>
<tr>
<td></td>
<td>Filter</td>
<td>4.8</td>
<td>76.9</td>
</tr>
<tr>
<td></td>
<td>Clean filter</td>
<td>2.0</td>
<td>78.9</td>
</tr>
<tr>
<td></td>
<td>Wash precipitate</td>
<td>37.5</td>
<td>116.4</td>
</tr>
<tr>
<td></td>
<td>Move precipitate to Tank 49</td>
<td>3.1</td>
<td>119.5</td>
</tr>
<tr>
<td></td>
<td>Clean filter</td>
<td>2.0</td>
<td>121.5</td>
</tr>
</tbody>
</table>

(This Table reflects the original flowsheet for ITP process)
Table 18.6-2  Benzene and Hydrogen Generation Rates

<table>
<thead>
<tr>
<th>Tank/Step</th>
<th>Hydrogen</th>
<th>Free Benzene$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>48/Precipitation</td>
<td>0.08</td>
<td>0.7</td>
</tr>
<tr>
<td>48/Washing</td>
<td>0.3</td>
<td>0.7$^b$</td>
</tr>
</tbody>
</table>

$^a$ Reference 16

$^b$ Dominated by the release of trapped benzene, which accumulated during the precipitation step, with a G value of 3.4.

$^c$ G = Molecules/100evf. Tank 49 is a supernate/salt storage tank. The Tank 48/Precipitation G values would be applicable to Tank 49 only after a transfer of Tank 48 waste material to Tank 49 due to a Tank 48 leak.
<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Frequency (per year)</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tank 48 Vapor Explosion</td>
<td>&gt; 1E-2 *</td>
<td>18.3.1</td>
</tr>
<tr>
<td>2</td>
<td>Tank 48 Solids Fire</td>
<td>&gt; 1E-2 *</td>
<td>18.3.2</td>
</tr>
<tr>
<td>3</td>
<td>Tank 48 Annulus Deflagration/Fire</td>
<td>&gt; 1E-2 *</td>
<td>18.3.3</td>
</tr>
<tr>
<td>4</td>
<td>Tank 48 Large Liquid Release and Fire</td>
<td>NC</td>
<td>18.3.4</td>
</tr>
<tr>
<td>5</td>
<td>Tank 48 Vapor Explosion and Solids Fire</td>
<td>&gt; 1E-2 *</td>
<td>18.3.5</td>
</tr>
<tr>
<td>6</td>
<td>Earthquake</td>
<td>2E-4</td>
<td>18.3.6</td>
</tr>
</tbody>
</table>

* The frequency of these accidents is assumed to be > 1E-2 (i.e., Anticipated); however, the accident is prevented by the controls specified in the applicable Accident Analysis Section indicated above.

NC = Not Credible
Table 18.6-4   Tank 48 Requirements For All Operational Modes

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prohibited Operations</td>
<td>Waste transfers into or out of Tank 48, OA or STPB additions to Tank 48, Submersible Mixer Pump operation, and processing operations (concentration/washing) in Tank 48 are prohibited.</td>
</tr>
<tr>
<td>Slurry Pump Operation</td>
<td>Slurry pumps shall be operated periodically to deplete the benzene and hydrogen inventories.</td>
</tr>
<tr>
<td>Vapor Composition</td>
<td>Bulk flammable vapor concentration shall be maintained equal to or less than 37% of the CLFL.</td>
</tr>
<tr>
<td>Instrument Air</td>
<td>Instrument air supplied to the CLFL monitor shall not be exhausted to the tank vapor space (excluding non-inerted operation).</td>
</tr>
<tr>
<td>Conservation Vent Bypass Valve</td>
<td>The conservation vent bypass valve shall remain closed during inerted operation except as noted in Table 18.6-5.</td>
</tr>
<tr>
<td>Portable Oxygen Monitor</td>
<td>One portable oxygen monitor shall be stored in 241-242H. This instrument shall be surveyed once a week to ensure operability (excluding non-inerted operation).</td>
</tr>
<tr>
<td>Tank Oxygen Analyzers</td>
<td>A loop check of the installed Tank 48 oxygen analyzers shall be performed every 24 hours (excluding non-inerted operation).</td>
</tr>
<tr>
<td>Nitrogen Supply Flow</td>
<td>The nitrogen supply flow shall be at least 50 scfm to Tank 48 through the normal or bypass feed line (excluding non-inerted operation).</td>
</tr>
<tr>
<td>Nitrogen Capacity</td>
<td>The normal nitrogen system shall maintain sufficient inventory to provide a flow of 30 scfm to Tank 48 for 9 days (excluding non-inerted operation).</td>
</tr>
<tr>
<td>Waste Tank Level</td>
<td>The Tank 48 liquid level shall not exceed 252 inches.</td>
</tr>
<tr>
<td>Waste Chemistry</td>
<td>The waste temperature shall be maintained at or less than or equal to 35°C and free hydroxide concentration shall be equal to or greater than 1.0 M to minimize the non-radiolytic production of benzene (Ref. 18).</td>
</tr>
</tbody>
</table>
Table 18.6-5  Tank 48 Requirements For Loss of Nitrogen While In Mode B

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Termination of Normal Exhaust Fan Operation</td>
<td>The hardwired low nitrogen flow-exhaust fan interlock shall trip the exhaust fan on low nitrogen flow. The operator shall immediately ensure that the exhaust fans are shutdown and verify locally (i.e., on the tank top).</td>
</tr>
<tr>
<td>Closure of Purge Exhaust Dampers</td>
<td>The operator shall immediately close the manual purge exhaust dampers.</td>
</tr>
<tr>
<td>Termination of Pump Operation</td>
<td>The operator shall immediately shutdown all slurry pumps and verify that the pumps have stopped.</td>
</tr>
<tr>
<td>Termination of Liquid Additions</td>
<td>The operator shall immediately terminate all liquid additions into the affected tank.</td>
</tr>
<tr>
<td>Maintain Nitrogen Inerting</td>
<td>Nitrogen inerting of Tank 48 shall be maintained by establishing a nitrogen flow to the tank within 8 hours. In order of preference, nitrogen inerting shall be maintained by: (1) re-establishing nitrogen purge ventilation, or (2) establishing supplementary nitrogen flow. The supplementary nitrogen flow requirements are governed by the following conditions:</td>
</tr>
<tr>
<td></td>
<td>• If nitrogen purge ventilation cannot be restored, a supplementary nitrogen flow (5 scfm minimum indicated) shall be established into the tank. This action shall be completed within 8 hours of loss of nitrogen purge ventilation.</td>
</tr>
<tr>
<td></td>
<td>• If the oxygen concentration is 8 vol. % or higher, supplementary nitrogen flow shall be supplied at a rate sufficient to attempt to restore and maintain oxygen concentration to less than 8 vol. %.</td>
</tr>
<tr>
<td></td>
<td>• If no indication of the oxygen concentration is available within the 8 hour limit described above, at least 30 scfm (indicated) nitrogen flow shall be continuously supplied to the tank until oxygen monitoring is re-established. If the oxygen analyzers are unavailable, a GC or portable instrument (e.g., MSA) may be used for this purpose.</td>
</tr>
<tr>
<td>Control of Conservation Vent Bypass Valve</td>
<td>The conservation vent bypass valve shall remain closed until a nitrogen supply source is available (i.e., the conservation vent bypass valve is opened only immediately prior to establishing supplementary nitrogen flow and during non-inerted operation). Opening of the conservation vent bypass valve just prior to establishing supplementary nitrogen flow protects against the possibility of tank over-pressurization. If supplemental nitrogen flow cannot be established, the conservation vent bypass valve will be closed immediately, but not to exceed 20 minutes from the time when the valve was opened. Twenty minutes is based on engineering judgment and is consistent with the results of oxygen ingress calculations.</td>
</tr>
</tbody>
</table>
Table 18.6-6 Deleted
Table 18.6-7  Tank 48 Requirements While in Mode C, Non-Inerted Operation, or No Ventilation Operations

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene Composition of Bulk Vapor Space</td>
<td>Within 12 hours of entry into Mode C ventilation operations and within 12 hours prior to entry into non-inerted operation, the benzene concentration shall be verified to be $\leq 50$ ppm and the release rate shall be verified to be $\leq 2.3$ g/min.</td>
</tr>
<tr>
<td>Pump Operation</td>
<td>Slurry (no ventilation operations only), filter feed, and transfer pump operation is not permitted.</td>
</tr>
<tr>
<td>Tank Additions, Benzene Impact</td>
<td>Liquid additions shall be demonstrated to be acceptable in Mode B prior to making these additions in these modes. A liquid addition of equal or greater volume and rate in a similar manner as that proposed in an alternate mode will be made in Mode B. The resulting benzene release from the Mode B addition will be analyzed to determine whether, without ventilation, this release complies with the 18-day to CLFL requirement at the liquid/vapor interface assuming no ventilation. This analysis will use the actual benzene concentration resulting from the Mode B liquid addition as a starting point. If the analysis shows it would take longer than 18 days to reach this condition assuming molecular diffusion only, the addition will be allowed in ventilation configurations other than Mode B.</td>
</tr>
</tbody>
</table>
Table 18.6-8  Tank 48 Requirements Specific to Operation Without Ventilation

<table>
<thead>
<tr>
<th>Action</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time Limit</td>
<td>Operations in this configuration (with no ventilation and no nitrogen flow) shall be limited to 8 hours (excluding non-inerted operation).</td>
</tr>
<tr>
<td>Liquid Additions</td>
<td>Liquid additions shall be limited to those required to perform the following:</td>
</tr>
<tr>
<td></td>
<td>- Filling the seal leg in the purge condenser,</td>
</tr>
<tr>
<td></td>
<td>- Condenser/Demister flushing, and</td>
</tr>
<tr>
<td></td>
<td>- Flushing of the reheater.</td>
</tr>
<tr>
<td></td>
<td>Any other liquid additions shall be allowed only after the satisfactory completion of an USQ review.</td>
</tr>
</tbody>
</table>
### Table 18.6-9  
**Tank 48 Requirements Specific to Non-Inerted Operation**

<table>
<thead>
<tr>
<th><strong>Action</strong></th>
<th><strong>Description</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Purge Exhaust Flow</td>
<td>Purge exhaust flow shall be $\geq 300$ scfm with operable instrumentation to monitor the flow. Loss of ventilation events shall require re-establishing exhaust flow within 7 days.</td>
</tr>
<tr>
<td>CLFL Analyzer Operability</td>
<td>The CLFL analyzer shall be operable. An Instrument Loop Check shall be performed on the CLFL analyzer every 7 days.</td>
</tr>
<tr>
<td>EPVE Operability</td>
<td>Two dedicated EPVE engine/blower assemblies and a portable LEL monitor shall be operable.</td>
</tr>
</tbody>
</table>
| Pre-Entry Conditions for Non-Inerted Operation | Within 12 hours prior to entry into non-inerted operation, the following controls ensure that at least 18 days to CLFL at the liquid/vapor interface is maintained in the tank following a loss of ventilation event:  
  - Transfer and filter feed pump operation is not permitted. 
  - The benzene release rate shall be verified to be $\leq 2.3$ g/min. 
  - The benzene vapor concentration shall be verified to be $\leq 50$ ppm. |
| GC Operability                    | A GC with multi-position sample capability shall be operable prior to entry into non-inerted operation and shall be used to perform the benzene concentration and release rate verification. |
| Liquid Addition Restrictions      | Liquid additions shall be demonstrated to be acceptable under inerted operations (Mode B) prior to making these additions while conducting non-inerted operation.                                      |
| Actions in Response to a Loss of Ventilation During Non-Inerted Operation | Upon a loss of ventilation (purge exhaust flow $< 300$ scfm or inoperable purge exhaust flow indication) during non-inerted operation, the following actions shall be taken to control the flammable vapor concentration in the tank vapor space:  
  - Slurry pump operation shall be immediately terminated.  
  - Liquid additions into the tank shall be immediately terminated.  
  - Tank flammable vapor concentration monitoring shall be performed at an increased frequency (every 12 hours). |
| Actions in Response to Exceeding 37% of the CLFL During Non-Inerted Operation | Should the Tank 48 flammable vapor concentration exceed 37% of the CLFL, slurry pump operation shall be immediately terminated, liquid additions into the tank shall be immediately terminated, and the flammable vapor concentration must be restored to within limits within 12 hours or nitrogen flow must be established within 24 hours and an oxygen concentration of less than or equal to 6.9 vol. % (indicated) must be attained within 36 hours. |