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FINAL SAFETY ANALYSIS REPORT

SAVANNAH RIVER SITE

DEFENSE WASTE PROCESSING FACILITY

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SAVANNAH RIVER SITE
DEFENSE WASTE PROCESSING FACILITY

CHAPTER 12

QUALITY ASSURANCE

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12.0 QUALITY ASSURANCE (QA)

12.1 INTRODUCTION

This chapter describes the essential features of the SRS QA Program and the QA requirements that affect safety of the Defense Waste Processing Facility (DWPF). The SRS QA program is described in the Quality Assurance Manual 1Q (Ref. 11). The QA program (prior to SRS QA program) that was in place during the design and construction of DWPF is summarized in WSRC-RP-90-00593, Quality Programs Overview and History (Ref. 7).

12.2 QA CRITERIA

SRR Standards/Requirements Identification Documents (S/RIDs), SRR-RP-2009-00558-000 (Ref. 30), state the codes, standards, and regulations governing the Quality Assurance policies and program elements of the Savannah River Site (SRS). The SRS QA program is described in the Quality Assurance Manual 1Q (Ref. 1). Programmatic assessments have been performed against the S/RIDs and documented as specified in Manual 8B, Compliance Assurance Manual (Ref. 10).

12.3 QA PROGRAM MANAGEMENT

12.3.1 QA PROGRAM AND ORGANIZATION

The QA Program includes policies, plans, manuals, and implementing procedures. The QA Program employs a graded approach that applies to all items and activities of the DWPF. The extent of application is proportional to the magnitude and consequences of any hazards involved; the effect the item or activity has on safety; environmental protection; the site mission; the loss impact on the mission; and the quality of the canistered waste form. Fundamental to the graded approach is the SRS functional classification process that is used to evaluate various Structures, Systems or Components (SSCs). The requirements, methodology, and criteria for functional classifications are stated in Manual E7 (Ref. 15). The established functional classification for a SSC serves as the driver for the level and rigor of analysis, amount of technical reviews and verification actions, the level of administrative controls and documentation requirements to be applied, and specific types of actions to be taken. Chapters 4 and 9 of the FSAR provide the functional classification of safety related SSCs.

The QA requirements of DOE/RW-0333P are applied to the DWPF High Level Waste Form Production Activities as identified in the Standards/Requirements Identification Documents (S/RIDs), SRR-RP-2009-00558-000 (Ref. 30).

The QA Program at DWPF meets the requirements of 10 CFR 830.120 (Ref. 1) and DOE/RW-0333P (Ref. 2) as stipulated in S/RIDs (Ref. 30) and the Quality Assurance Manual 1Q (Ref. 11).

The DWPF organization is shown in the current organizations charts and is briefly described in Chapter 10.0 of the FSAR. The DWPF senior manager and his staff are responsible for operation, maintenance, and technical support of the DWPF and for the quality of the work by implementation of the DWPF QA Program through the line organization. Quality is an individual and line organization responsibility. Individuals self-check their activities to ensure quality. Each department manager has the overall responsibility for the quality of the activities managed.

The Quality Assurance Manual 1Q (Ref. 11) provide the details of the organization and responsibilities related to Quality Assurance. The QA personnel assigned to DWPF provide the Cognizant Quality Function (CQF) for DWPF.

The CQF provides independent oversight for DWPF activities and to verify that the SRS QA Program and DWPF specific QA requirements (DOE/RW-0333P) are effectively implemented at DWPF. The CQF responsibilities include verification of adequate QA Program implementation through audit, surveillance, inspection and assessment; and review of purchase requisitions, design documents and procedures for adequate specification of witness and hold points.

DWPF personnel provide QA representatives the opportunity to perform quality verification tasks. QA representatives have access to facilities, records, and management pertinent to their activity.

12.3.2 PERSONNEL TRAINING AND QUALIFICATIONS

A sufficient number of QA personnel are assigned to DWPF to support quality related activities at DWPF. These personnel are qualified and trained according to the scope, complexity, and nature of the activity being supported. The Quality Assurance Manual 1Q (Ref. 11) provides the details of the qualification and training requirements. Chapter 10 of the FSAR describes the training program and training requirements for operations, engineering, and maintenance personnel.

12.3.3 QUALITY IMPROVEMENT

The Quality improvement is an ongoing effort at DWPF and is implemented in accordance with the requirements of the Quality Assurance Manual 1Q (Ref. 11). DWPF implements the corrective action program in accordance with the requirements of Manual 1-01 (Ref. 13). Processes to detect and prevent quality problems have been established and implemented at DWPF. The items, activities including services, and processes that do not meet established requirements are identified, controlled, and corrected according to the importance of the problem and the work affected. Correction includes identifying the causes of problems and working to prevent recurrence. The extent of cause analysis for nonconformances is commensurate with the importance or significance of the problem.

The Quality Assurance Manual 1Q (Ref. 11) prescribes the method for identifying and resolving nonconforming items to prevent their inadvertent use or installation. Problems such as deficiencies/deficient conditions, procedure noncompliance, radiological deficiencies, adverse trends, or recurring errors which lead to programmatic conditions and activities that do not meet established requirements, or management expectations are identified and resolved in accordance with Manual 1B (Ref. 12).

12.3.4 DOCUMENTS AND RECORDS

The QA documents and records are generated, issued, maintained, stored and disposed in accordance with the requirements of the Quality Assurance Manual 1Q (Ref. 11).

12.4 QA PROGRAM PERFORMANCE

12.4.1 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 management of work at DWPF 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 capability 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. The Quality Assurance Manual 1Q (Ref. 11); Manual 2S, Conduct of Operations (Ref. 16); Manual 1B, Management Requirements and Procedures; and Manual 1Y, Conduct of Maintenance (Ref. 17) provide the requirements and details of work control programs.

Additionally, the following elements of work process are implemented at DWPF in accordance with the Quality Assurance Manual 1Q (Ref. 11):

- 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

12.4.2 DESIGN

Items and processes are designed using sound engineering/scientific principles, and appropriate standards. Engineering practices and procedures have been established and implemented in Manual E7 (Ref. 15) to perform and control design, including design requirements, inputs, processes, outputs, changes, records, and organizational interfaces. Design control measures correctly translate appropriate codes, standards and quality

requirements to ensure a safe, reliable and environmentally sound structure, system, or component. DWPF Engineering Department is the design authority for design activities at DWPF and is responsible to ensure that the requirements for design control are met. Manual E7, Conduct of Engineering (Ref. 15) and Quality Assurance Manual 1Q (Ref. 11) provide the requirements and direction needed to implement design control, which includes the following elements:

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

12.4.3 PROCUREMENT

The SRS procurement program includes the following:

- Procurement Process
- Procurement Document Control
- Supplier Selection and Evaluation
- Oversight of Subcontractor and Supplies
- Product Acceptance

The SRS procurement process incorporates a graded approach for controlling procurement actions commensurate with the functional, quality, and technical requirements associated with the intended use or application of the procured item or service. The Quality Assurance Manual 1Q (Ref. 11) outlines specific sitewide responsibilities for the procurement of items and services using a graded approach, including bid package preparation, bid evaluation, supplier evaluation, verification of supplier/subcontractor activities, control of nonconformances, and acceptance of items and services. Procurement documents include the technical, design, fabrication, construction, maintenance, inspection, testing, quality assurance, handling, acceptance criteria, and records requirements. Procurement documents are generated in accordance with requirements of the Quality Assurance Manual 1Q (Ref. 11). The CQF performs independent reviews of DWPF procurement packages that are important to safety and product quality.

Suppliers are evaluated, selected, and overseen on the basis of specified criteria, using a graded approach in accordance with requirements of the Quality Assurance Manual 1Q (Ref. 11).

The acceptance methods and required documentation for acceptance of purchased items and services is specified in the procurement documents in accordance with requirements of the Quality Assurance Manual 1Q (Ref. 11). Procured items are put into service only when the acceptance requirements of the procurement documents have been satisfied. Post-maintenance, functional, or pre-operational testing is performed after installation of procured items when specified. These tests verify actual performance of the item against established criteria for the item and the system.

12.4.4 INSPECTION AND ACCEPTANCE TESTING

12.4.4.1 Inspection

Quality Assurance Manual 1Q (Ref. 11) defines the SRS requirements for inspection, inspection status, and control of nonconforming items. DWPF follows the Quality Assurance Manual 1Q (Ref. 11) to implement activities related to inspections.

12.4.4.2 Acceptance Testing

Acceptance testing involves demonstrating that items and processes perform as intended. Quality Assurance Manual 1Q (Ref. 11) delineates the SRS requirements for test control, test status and control of nonconforming items. DWPF implements the requirements of the Manual 1Q for acceptance testing.

12.4.4.3 Measuring and Test Equipment

The requirements, defined in the Quality Assurance Manual 1Q (Ref. 11) are implemented to ensure that Measuring and Test Equipment (M&TE) used by DWPF is controlled and properly calibrated at specific intervals to maintain accuracy within necessary limits.

12.5 QA PROGRAM ASSESSMENT

12.5.1 MANAGEMENT ASSESSMENT

The Quality Assurance Manual 1Q provides the SRS requirements for assessment of management processes to identify quality improvement opportunities (Ref. 11). DWPF also follows the management overview program described in Conduct of Operations Manual 2S (Ref. 16), which requires self-assessments at the facility level to ensure key attributes of conduct of operations, training, and maintenance are implemented (Ref. 13). Procedure Manual 12Q (Ref. 31) establishes the management assessment program and defines the scope, planning requirements, management responsibilities and participation, assessment frequency, and the reportability requirements for results.

12.5.2 AUDITS AND SURVEILLANCES

Audits (internal and external) are performed to verify the compliance to, and the effectiveness of, the SRS Quality Assurance Program. Surveillance is the process of monitoring or observing work In progress, generally of a short duration, to verify whether an item or activity of a predetermined scope conforms to specified requirements, and/or to identify any process improvements. Audits and surveillances are scheduled, conducted, documented, and responded in accordance with the requirements of the Quality Assurance Manual (Ref. 11).

12.5.3 SELF ASSESSMENTS AND MANAGEMENT EVALUATIONS

Self-assessments are conducted to (1) foster continuous improvement in the performance of SRS activities and development of SRS products and services, and (2) demonstrate ongoing compliance to company requirements and commitments. Management Evaluations are conducted to determine the effect of performance of various assessments on achievement of objectives or mission. Assessment Manual 12Q (Ref. 31) provides requirements for planning, conducting, and documenting self-assessments and management evaluations.

12.6 REFERENCES

1. 10 CFR Part 830, Subpart A, 830.120, Quality Assurance Requirements.

2. Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program. Department of Energy (DOE) OCRWM Specification DOE/RW-0333P.

3. Deleted.

4. Deleted.

5. Deleted.

6. Deleted.

7. Quality Programs Overview and History (U). WSRC-RP-90-00593, July 1990.

8. Deleted.

9. Deleted.

10. Compliance Assurance Manual 8B.

11. Quality Assurance Manual 1Q.

12. Deleted.

13. Management Requirements and Procedures Manual 1B.

14. Deleted.

15. Conduct of Engineering and Technical Support Procedure Manual E7.

16. Conduct Of Operations Manual 2S.

17. Conduct of Maintenance Manual 1Y.

18. Deleted.

19. Deleted.

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28. Deleted.

29. Deleted.

30. Standards/Requirements Identification Documents (S/RID). SRR-RP-2009-00558-000.

31. Procedure Manual 12Q, Assessment Manual.

32. Deleted.

33. Deleted.

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12.7 FIGURES

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CHAPTER 13

EMERGENCY PREPAREDNESS

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13.0 EMERGENCY PREPAREDNESS

13.0.1 INTRODUCTION

This chapter provides an overview of the Emergency Preparedness (EP) program established for the Defense Waste Processing Facility (DWPF). In addition, the chapter also describes the philosophy, objectives and organization of the EP program for a wide spectrum of emergencies, ranging from local area emergencies to those that could affect the general public.

The scope of this chapter includes the following:

- Identification, Classification and Notification of Postulated Accidents
- Emergency Response Measures
- Maintenance of Emergency Preparedness
- Emergency Planning Zone Considerations

13.0.2 REQUIREMENTS

DWPF is required to comply with the DOE Orders, codes, standards, and regulations that contain the basic requirements for emergency preparedness and stated in the SRR Standards/Requirements Identification Documents (S/RIDs) (Ref. 5).

13.1 DWPF FACILITY DESCRIPTION

13.1.1 DESCRIPTION OF DWPF ACTIVITIES

The Defense Waste Processing Facility (DWPF) immobilizes radioactive sludge presently stored in the F-Area and H-Area waste tank farms. The DWPF is designed to convert high level radioactive sludge into a durable borosilicate glass waste form for eventual disposal in a geological repository. The glass is encapsulated in stainless steel canisters within the DWPF Vitrification Building, and the canisters are stored in the Glass Waste Storage Buildings until they can be transferred to a federal repository for final disposal. A plan view of the DWPF, showing the relative location of major buildings is shown in Chapter 1, Figure 1.2-1. Chapters 5 and 6 of the FSAR provide description of major facilities/buildings with respect to design, activities and process.

Various chemicals including nitric acid, formic acid, sodium hydroxide, potassium hydroxide, nitrogen, etc., are stored in DWPF for use in the vitrification process. The types of radioactive and chemical materials normally present in the DWPF are given in Chapter 6, which describes the physical, chemical and radiological characteristics of materials that are received, processed, and produced in the DWPF. Chapter 8 describes the hazards to health and safety as well as the programs that are designed to help protect personnel and the environment from the chemical and radiological hazards of these materials.

13.1.2 DESCRIPTION OF AREA NEAR THE SITE

A drawing illustrating the location of DWPF with respect to the site is shown in the SCD-7, SRS Emergency Plan (Ref. 1). A description of the geographic, topographic, demographic, meteorologic, hydrologic, seismic and geologic characteristics of the site is also provided in the SCD-7. Additionally, the following are described in SCD-7:

- Population Centers and Facilities that would require special consideration for evacuation or other protective measures, such as communities, industries, schools, and health-care facilities
- Routes (roads, highways, and railroads on or near the SRS) for Emergency Access or Relocation/Evacuation
- Roles and responsibilities of offsite support organizations
- Sites (at or near SRS) of potential emergency significance that could affect the DWPF

13.1.3 DESCRIPTION OF FACILITY AND SITE

The SCD-7, SRS Emergency Plan (Ref. 1) provides the overview of various facilities at SRS. Annex B of the SCD-7 provides the description of the facility, DWPF emergency response facilities, communications, and shelter and evacuation rally points.

13.2 DESCRIPTION OF ACCIDENTS

Since the DWPF is a first-of-a-kind facility with limited operational experience, the accidents are based on either postulated events (and the theoretical results of these events) or on Building 221-F, 221-H and tritium facilities experience when comparable or appropriate. Natural phenomena, offsite events, and site-wide and area-wide emergencies that could affect 200-F and H Areas are considered for their potential to affect the DWPF.

13.2.1 DESCRIPTION OF POSTULATED ACCIDENTS

The facility Emergency Planning Hazards Assessment (EPHA) for DWPF is documented in S-EHA-S-00001 (Ref. 6). The EPHA was written in accordance with SRS Emergency Management Program Procedures (EMPP) Manual 6Q, Volume II (Ref. 7). The EPHA provides the technical basis for facility emergency planning efforts by identifying and analyzing those hazards that are significant enough to warrant consideration in the DWPF operational emergency management program.

The consequence thresholds used in the accident analysis section of the EPHA are the same as those used for classification of operational emergencies (Ref. 7). The Protective Action Criteria (PAC) include a radiological and nonradiological threshold.

For the materials present within DWPF that required a full consequence assessment in the EPHA, accident scenarios were identified that may exceed the defined PAC at the downwind receptor points of interest. For each scenario identified, a consequence assessment and corresponding Emergency Action Level (EAL) determination was made. The results show the potential for Site Area Emergency (SAE) conditions, and Alert conditions. For these different emergency conditions, DWPF facility personnel can accurately classify events and recommend protective actions through the use of the Emergency Plan Implementing Procedures (EPIPs), which are included in Manual 6Q4-1.1 (Ref. 2).

13.2.2 EMERGENCY PLANNING ZONE (EPZ) CONSIDERATIONS

The facility Emergency Planning Zone (EPZ) is defined as the area within which special planning and preparedness efforts are warranted as a means of apportioning preparedness resources. The EPZ for the facility was based on objective analyses of the hazards associated with that facility and not on arbitrary factors such as historical precedent or distance to the site boundary. The methodology used in determining the EPZ is outlined in EMPPs Manual 6Q (Ref. 7). The SCD-7, SRS Emergency Plan (Ref. 1) provides detailed information related to EPZs and appropriate response measures for the management of emergencies within the site boundary.

13.2.3 DETECTION OF EMERGENCY CONDITIONS

The EPHA for DWPF (Ref. 6) and Chapter 9 of the DWPF FSAR have identified both radiological and non-radiological hazardous material accident scenarios. The EPHA (Ref. 6) also documents the hazardous material detection instrumentation available to assist the

operators in the determination of event classification. The equipment specific to the hazards identified in the EPHA are controlled and maintained in accordance with the requirements of QA, Radiological Control, or Industrial Hygiene programs.

Operator and manager knowledge of the systems and processes, along with procedures, are used to determine the consequences of the incident/event. Emergency Operating Procedures (EOPs), Abnormal Operating Procedures (AOPs) and the Emergency Classification EPIP are used to evaluate the potential hazard to determine if an emergency condition exists.

13.3 CLASSIFICATION AND NOTIFICATION OF ACCIDENTS

13.3.1 CLASSIFICATION SYSTEM

Emergencies are classified at the DWPF according to the level of severity. The classification levels used for the DWPF are Alert and Site Area Emergency (SAE). The classification level would depend on the form, quantity, and location of hazardous material released. Various accident types have been identified for possible emergency initiators at the DWPF.

Plausible accident scenarios have been postulated for all accident types. The specific accident scenarios for each type, the means of detection, and the severity of each are fully developed in Chapter 9.

Emergency classes and EALs are included in the DWPF EPHA document (Ref. 6). Based on the information in the EPHA, Emergency Plan Implementing Procedures (EPIPs) have been developed to allow DWPF personnel to accurately classify events and recommend protective actions in the event of an emergency at DWPF. These EPIPs are contained in manual 6Q4-1.1 (Ref. 2). Specific criteria are provided in the Emergency Plan Implementing Procedures (EPIPs) for the recognition, characterization, and declaration of each of the emergency classes.

The DWPF Area Emergency Coordinator (AEC) for the S-area has the responsibility for classifying emergencies at DWPF until the EOC is activated. Once the EOC is activated, the Emergency Director has that responsibility. The AEC continues to evaluate and recommend changes in classification to the Technical Support Coordinator, as appropriate. For more details concerning classification, refer to SCD-7, SRS Emergency Plan (which includes the DWPF Annex).

13.3.2 NOTIFICATION AND COORDINATION

The decision to make notification is based on the emergency classifications and action level scheme. The AEC is responsible for ensuring appropriate notifications are initiated when an emergency is classified. DWPF Emergency Response Organization (ERO) and non-ERO personnel are notified via the Safety Alarm System, if necessary, and the Public Address (PA) system announcements. The Annex B of the SCD-7, SRS Emergency Plan (Ref. 1) provides the details of the notifications and equipment used for the notifications/communications. The AEC is responsible for timely notification of the emergency classification to the Emergency Duty Officer (EDO).

SRS Emergency Plan, SCD-7, (Ref. 1) provides the details of the responsibilities and authority of the EDO. It also identifies the positions providing assistance to EDO.

The EDO is relieved by the Emergency Director (after the activation of the EOC) of the responsibility for overseeing emergency response actions for all other areas of the site outside the incident area and for offsite interactions. SRS Emergency Plan, SCD-7, (Ref. 1) provides the details of the responsibilities and authority of the Emergency Director.

13.3.3 INFORMATION TO BE COMMUNICATED

The AEC is responsible for collecting vital information regarding emergency conditions and for relaying this information to the EDO/Technical Support Room. Information gathered at the scene, and at various locations in the path of the release, is communicated to the EDO/Technical Support Room to guide decisions regarding the need for additional protective measures.

13.4 RESPONSIBILITIES

13.4.1 NORMAL PLANT ORGANIZATION

The DWPF senior management is responsible for the management and operation of the DWPF and has overall responsibility for Operations and Radiological Control at DWPF. The DWPF Operations Manager has responsibility for the day-to-day operations of DWPF.

The DWPF Shift Manager reports to the Operations Manager and has overall control of all shift operations in DWPF. The Shift Manager also assumes management responsibility when the senior management is not in the area. The Vitrification Control Room Manager is in charge of the vitrification process and related functions during normal operations. Operations, Maintenance, E&I, RCO, Work Control, Laboratory and Engineering personnel are assigned or available to each shift to support process operations.

The onshift staff for DWPF provides the DWPF Emergency Response Organization (ERO). The DWPF Shift Manager or the Vitrification Control Room Manager assumes the duties of AEC. Designated onshift staff positions assume the various positions in the ERO. If the normally designated person is unable to assume or continue to fulfill the emergency position, then another trained member of the Emergency Response Organization (ERO) can be designated by the AEC to fill the position. SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex) describes the details of the DWPF Organization, Emergency Response Organization, positions, and responsibilities. The DWPF ERO is augmented by support personnel from other areas as needed.

13.4.2 ONSITE EMERGENCY RESPONSE

The positions that make up the DWPF Emergency Response Organization, are described in SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex), and 6Q4-1.1, DWPF Emergency Plan Implementing Procedures (Ref. 2). The AEC has overall responsibility for any emergency that occurs in the DWPF during all modes of operations. The AEC interfaces with the EDO / Technical Support Coordinator for all aspects of a declared emergency. For additional information on the SRS and DWPF Emergency Response Organizations, refer to SCD-7, SRS Emergency Plan as well as the DWPF Annex in SCD-7.

13.4.2.1 Direction and Coordination

The AEC has the overall responsibility for the actions taken during a declared emergency for the incident area (DWPF). The responsibility for the safe operational shutdown of DWPF rests with the AEC, who uses applicable procedures including Emergency Operating Procedures (EOPs). The AEC reports information and actions taken to the EDO during the initial stages of the declared emergency.

Upon activation of the EOC, the Emergency Director is responsible for command and control of emergency response actions. The Emergency Director is responsible for downgrading or termination of a declared emergency.

In summary, as emergency response facilities are activated, the responsibility for certain functions and decisions shifts upward to higher positions of authority in higher tiered emergency response facilities. For a detailed description of the SRS and DWPF ERO command and control functions, refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex).

13.4.2.2 DWPF Staff Emergency Assignments

The onshift staff for DWPF provides the DWPF Emergency Response Organization (ERO). The DWPF ERO provides resources and materials as requested/needed for the assessment, mitigation, and recovery from a declared emergency. For duties and responsibilities of the DWPF ERO, refer to Annex B of SCD-7, SRS Emergency Plan (Ref. 1).

13.4.3 LOCAL OFFSITE ASSISTANCE TO FACILITY

DWPF does not interface directly with offsite authorities. This function is performed by the SRS ERO. For additional information, refer to SCD-7, SRS Emergency Plan (Ref. 1).

13.4.4 COORDINATION WITH PARTICIPATING GOVERNMENT AGENCIES

DWPF does not interface directly with other participating government agencies. Assistance to DWPF from offsite organizations is coordinated exclusively through the SRS ERO. For additional information, refer to SCD-7, SRS Emergency Plan (Ref. 1).

13.5 EMERGENCY RESPONSE MEASURES

Emergency response measures for each emergency class are established in SCD-7, SRS Emergency Plan. This manual specifies the actions necessary to prevent or minimize injuries and property damage during declared emergencies that are the result of operational accidents, forces of nature, or deliberate damage. Manual SCD-7, SRS Emergency Plan (Ref. 1) also provides the framework on which the DWPF Area Emergency Plan is based.

13.5.1 ACTIVATION OF THE EMERGENCY RESPONSE ORGANIZATION

Activation of the DWPF ERO is the responsibility of the AEC. ERO activation is accomplished by activating the DWPF Emergency Response Facilities at different emergency classification levels. For detailed information, refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes DWPF annex), and 6Q4-1.1, DWPF Emergency Plan Implementing Procedures (Ref. 2).

13.5.2 ASSESSMENT ACTIONS

Through classroom training, on-the-job training, simulator training, proficiency drills and other ERO training requirements in addition to experience gained with day-to-day operations, operators and managers are qualified to assess actual or potential emergency conditions. Installed instrumentation and controls in DWPF are used by the operators and managers to assess any incident that could create a potential hazard for the facility. Operator and manager knowledge of the systems and processes, along with procedures, are used to determine what the consequences of any incident/event would be. Emergency Operating Procedures (EOPs), Abnormal Operating Procedures (AOPs) and the Emergency Classification EPIP are used to evaluate the potential hazard to determine if an emergency condition exists.

Weather information is available through the EDO. The EDO/Technical Support Room is relayed vital information regarding emergency conditions at DWPF from the AEC including the material released, the quantity released, the events that triggered the release, the mitigating actions taken. Upon activation, the SRS ERO is staffed to provide rapid assessment of release consequences, current and forecast meteorological information, monitoring team coordination and results, source term development, interpretations of technical information, and recommendations for appropriate protective response to radiological and toxic chemical releases. For additional details refer to SCD-7, SRS Emergency Plan (which includes the DWPF Annex).

13.5.3 CORRECTIVE ACTIONS

DWPF System Operating Manual (SOM), Standard Operating Procedures (SOPs), Alarm Response Procedures (ARPs), Abnormal Operating Procedures (AOPs) and Emergency Operating Procedures (EOPs) provide directions and actions required for shutdown of systems/processes for any reason, including emergencies. The senior management/Shift Manager would decide what systems/processes to shutdown based on the type of emergency and/or system/process affected.

13.5.4 ONSITE PROTECTIVE ACTIONS

EPIPs describe the required actions to be taken to protect personnel within the DWPF in the event of an Alert or higher emergency classification. The following protective actions will be considered depending on the severity of the emergency:

- Remain Indoors
- Shelter
- Evacuation
- Relocation

The AEC has the following responsibilities:

- Determining protective actions for DWPF.
- Ensuring the protective action instructions are made and implemented in a timely manner.
- Transmitting protective action instructions to DWPF personnel.
- Notification to the EDO.

The EDO has the responsibility for protective action decisions for onsite personnel outside of DWPF during the initial stages of an emergency. Upon activation of the Emergency Operations Center, the EDO is relieved by the Emergency Director. The Emergency Director has the responsibility for overseeing emergency response actions for all other areas of the site outside the incident area.

13.5.4.1 Personnel Evacuation/Relocation and Accountability

Personnel in DWPF shall be accounted for during an emergency requiring the protective action of sheltering or evacuation by using an accountability system. For additional details on personnel accountability at DWPF in the event of a declared emergency, refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex), and 6Q4-1.1, DWPF Emergency Plan Implementing Procedures (Ref. 2).

The Safety Alarm System is used to alert personnel in the affected area to take protective actions. The Public Address System provides a means of area communications. If relocation for an incident area is required, the Emergency Duty Officer (EDO) or the Emergency Operations Center (EOC) staff determines the appropriate onsite host location (referred to as a reception center) as well as relocation routes to be followed. If a radiological or toxic material release occurs, all potentially contaminated people are monitored at the rally point, the alternate rally point, the assembly area or the remote rally point by radiological control personnel. RCO will determine the appropriate decontamination measures.

For additional details refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex), and 6Q4-1.1, DWPF Emergency Plan Implementing Procedures (Ref. 2).

13.5.4.2 Use of Protective Equipment and Supplies

Protective clothing, supplies, and equipment are available for assigned essential workers and are stored in or near each emergency facility. For additional details refer to SCD-7, SRS Emergency Plan (which includes the DWPF Annex).

13.5.4.3 Contamination Control Measures

Exposure to, and the spread of a hazardous material, is minimized by isolating the incident area and preventing access through the use of ropes and/or access control personnel. Protective actions are issued for non-essential personnel to ensure that their exposure to the hazardous material is minimized or prevented. SRS Emergency Support personnel (for example, Fire Department Hazardous Material Team) assisted by the DWPF Emergency Response personnel attempt to contain and control the introduction and spread of the hazardous material.

For additional information on radiological exposure and contamination, refer to Manual 5Q, Radiological Control (Ref. 4), and SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex).

13.5.5 EXPOSURE CONTROL IN EMERGENCIES

Exposure control is provided to non-essential workers through sheltering or relocation to another area onsite and restricting access to the affected area.

13.5.5.1 Radiological Exposures - Essential Workers

Special equipment and strict exposure controls are provided for workers who are pre-designated as essential personnel and must remain in the area. Emergency response actions at SRS are conducted in accordance with DOE emergency dose guidelines. The Emergency Director has the ultimate responsibility for approving radiological over-exposures received during emergency response-related activities. The Emergency Director delegates this responsibility to the Area Emergency Coordinator (AEC) who shall advise the Emergency Director whenever this delegated authority is implemented. Emergency response-related activities that might involve substantial risk and/or radiation exposures shall be applicable only to volunteers.

The AEC determines the required protective clothing and equipment for each protective action. The AEC confers with the SRS ERO when the EOC is activated, on actions involving exposures, concentrations and contamination levels. Exposure guidelines and limits are established in Manual 5Q, Radiological Control (Ref. 4).

13.5.5.2 Chemical Exposures - Essential Workers

No guidelines have been issued by EPA that are equivalent to those for radiation exposures during an accident. OSHA and NIOSH have established Permissible Exposure Limits (PELs), Threshold Limit Values (TLVs), and Short Term Exposure Limits (STELs) to determine

when protective equipment should be used. The AEC will consider the use of applicable protective clothing and respiratory protection, in consultation with RCO and/or IH, for continuing emergency response activities.

13.5.5.3 Decontamination of Personnel

If a release of radioactive material occurs, the potentially contaminated people are monitored by RCO personnel. RCO staff determines appropriate decontamination measures. For toxic chemical situations, exposed people requiring decontamination or exhibiting exposure symptoms are transported to a medical facility immediately. Essential workers are monitored on an ongoing basis and decontaminated as warranted by circumstances.

For additional details refer to SCD-7, SRS Emergency Plan (Ref. 1) and Manual 5Q, Radiological Control (Ref. 4).

13.5.6 MEDICAL TRANSPORTATION

SRS maintains ambulances with the required equipment for advanced life support. Additional ambulance service is provided by Aiken County Emergency Medical Services. If necessary, other vehicles (cars, trucks, buses) could be used to transport patients. In addition, a DOE helicopter operated by the security contractor may be used for patient transport to medical facilities.

For additional details refer to SCD-7, SRS Emergency Plan (Ref. 1).

13.5.7 MEDICAL TREATMENT

An area medical facility is maintained, which provides treatment and/or offsite referral for SRS personnel injured. Temporary Area Medical Facilities can be established as needed. First Aid teams consisting of on-shift personnel are available at DWPF to assist Medical personnel. Medical staff assesses patient condition, provide necessary emergency care and determine appropriate supplemental treatment, such as transport to offsite medical facilities. Radiological Control Operations (RCO) personnel survey patients and provide decontamination advice. For life threatening situations, medical attention takes precedence over radiation and contamination concerns.

RC personnel needed to perform bioassay analysis are activated as needed. The bioassay group also performs fecal analysis and in-vivo counting (whole-body or chest) for the confirmed assimilations of radioactive materials.

For detailed information, refer to SCD-7, SRS Emergency Plan (which includes the DWPF Annex).

13.6 EMERGENCY RESPONSE EQUIPMENT AND FACILITIES

13.6.1 CONTROL POINT

At DWPF the Central Control Room (CCR) in 210-S has the necessary instrumentation and controls to operate, monitor, and assess process problems during normal operation and emergencies. In case the CCR is damaged or has to be evacuated, the Field Operating Station #1 (FOS1) in 221-S is the alternate control room. The Control Room and FOS1 have the necessary normal and emergency communications equipment to communicate with the EOC.

The Operations Support Center (OSC), located in Building 210-S, also serves as an assembly point for DWPF emergency response personnel from DWPF. Various equipment and supplies that would be needed by the Emergency Response Teams are stocked near the OSC. Radios and the normal SRS telephone system are available for Emergency Response Teams to communicate with each other and the Control Room and the OSC. The hallway area near and around FOS1 serves as the alternate OSC.

For additional information refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex).

13.6.2 EMERGENCY RESPONSE FACILITIES

Savannah River Site maintains emergency response facilities. The Emergency Operations Center (EOC) provides space for the three "Command Centers"- the Command Room, the Logistic Support Room, and the Technical Support Room. The DWPF emergency response facilities consist of the DWPF Control Room and the DWPF OSC.

For additional details refer to SCD-7, SRS Emergency Plan (which includes the DWPF Annex).

13.6.3 COMMUNICATIONS EQUIPMENT

13.6.3.1 Onsite Communications

DWPF uses a Safety Alarm System (SAS) consisting of protective action signals (voice and tone) that are broadcasted over the DWPF Public Address (PA) system, telephones, portable communication equipments, and fax machines to communicate within/around DWPF and to communicate with SRS EOC.

13.6.3.2 Offsite Communications

As stated in Subsections 13.4.3 and 13.4.4, DWPF does not interface directly with offsite authorities. The off site notification/communication is provide by SRS EOC. For additional details on offsite communications, refer to SCD-7, SRS Emergency Plan (Ref. 1).

13.6.4 ONSITE MEDICAL FACILITIES

Facilities and medical supplies at SRS designated for emergency first-aid treatment and decontamination of onsite individuals is discussed in Section 13.5.7. For additional information refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex).

13.6.5 EMERGENCY MONITORING EQUIPMENT

See Subsection 13.2.3, Detection of Emergency Conditions, for emergency monitoring equipment that would be used for personnel and area monitoring as well as equipment for assessing release of radioactive and/or other hazardous materials to the environment.

13.7 MAINTENANCE AND EMERGENCY PREPAREDNESS CAPABILITY

13.7.1 WRITTEN EMERGENCY PLAN IMPLEMENTING PROCEDURES

Emergency Plan Implementing Procedures (EPIPs) for DWPF are developed, reviewed, and approved per existing administrative procedures to ensure they meet necessary aspects of emergency preparedness requirements at SRS. For additional details see SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex), 6Q4-1.1, DWPF Emergency Plan Implementing Procedures (Ref. 2), and 6Q4-1.2, DWPF Emergency Plan Administrative Procedures (Ref. 3).

13.7.2 TRAINING

The goal of the training program is to provide a systematic, structured plan for the initial and requalification training for DWPF ERO personnel. The training program consists of classroom instruction, procedure and facility walkthroughs, and drill participation. ERO members are provided initial emergency preparedness training and retraining to ensure proper response to emergencies.

For additional details refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex).

13.7.3 DRILLS AND EXERCISES

Emergency drills (involving Emergency Action Levels) are conducted in DWPF. These drills may involve any incident that would meet or exceed an Emergency Action Level. Other drills of a non-emergency type are conducted periodically that may include fires, small leaks or spills, injuries, or failed equipment.

The site exercises are conducted among the various facilities at SRS on a rotating basis. All personnel (essential, non-essential, SRS ERO, security contractor, visitors, etc.,) identified by the management in the selected area are required to participate in the exercise. DOE and other departmental observers are notified in advance of each drill.

For additional details see SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex).

13.7.4 EXERCISE CRITIQUES

A formal critique is conducted for key participants, controllers and evaluators following each drill or exercise. Participants are encouraged to identify areas where improvements are required. Controllers and evaluators discuss identified deficiencies and recommendation for improvement. For additional details refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex).

13.7.5 REVIEW AND UPDATING OF THE PLAN AND PROCEDURES

The DWPF Annex in SCD-7 and its implementing and administrative procedures are reviewed and updated periodically. The updates also incorporate required changes to correct deficiencies identified in emergencies, training, drills and/or exercises.

For additional details refer to SCD-7, SRS Emergency Plan (Ref. 1, which includes the DWPF Annex), and 6Q4-1.2, DWPF Emergency Plan Administrative Procedures (Ref. 3).

13.7.6 MAINTENANCE AND INVENTORY OF EMERGENCY EQUIPMENT, INSTRUMENTATION, AND SUPPLIES

Refer to Section 13.6 for information on maintenance and inventory of emergency equipment, instrumentation, and supplies.

13.7.7 VERIFICATION OF EMERGENCY TELEPHONE NUMBERS

Since DWPF ERO personnel are on shift 24-hours a day, a list of emergency telephone numbers is not required. Site ERO is notified of an emergency by a pager system.

13.8 RECORDS AND REPORTS

The Shift Manager is required to maintain an official log of shift operations including any incidents/emergencies that may occur in the DWPF. The conditions and indications leading up to an emergency, the emergency itself, and post emergency actions and follow up will be recorded in this official log. This log is used to reconstruct the emergency if needed. This log is maintained as a DWPF official record, and it is retained in accordance with the Retention Schedule Matrix (RSM).

All other documents/records generated during an emergency are collected and maintained in accordance with the requirements of the SRS Emergency Plan, SCD-7, (Ref. 1).

13.9 RECOVERY AND REENTRY

Recovery includes those actions necessary to restore an incident site and surrounding environs to pre-emergency or safe conditions. The operating contractor and security contractor are responsible for planning and implementing recovery activities. Upon termination of an emergency, the Emergency Response Organization is deactivated and a Recovery Organization is established to implement recovery operations. Special procedures and training will be developed as needed to meet the requirements of recovery operations. If the emergency involves a release of hazardous materials to site buildings or the environment, appropriate monitoring is conducted to characterize the levels and extent of contamination. Disposal of radioactive/contaminated waste generated by response recovery activities will be handled in accordance with normal site policies and procedures. Information on hazardous material release rates, quantities and composition as well as meteorological and other data will be periodically provided to the states of South Carolina and Georgia per SRS Emergency Plan, SCD-7 (Ref. 1).

The SRS Emergency Plan, SCD-7, identifies requirements for reentry, downgrading/ termination of an emergency, recovery planning and actions, and resumption of normal operations. More specifically, the DWPF Annex of SCD-7 addresses reentry into the affected area of DWPF as well as restoration of the area after an emergency.

Refer to EPIP in manual 6Q4-1.1 (Ref. 2) for initiation, implementation, and support of recovery operations within the DWPF Area.

13.10 REFERENCES

1. SRS Emergency Plan. SCD-7.

2. DWPF Emergency Plan Implementing Procedures. Procedure Manual 6Q4-1.1.

3. DWPF Emergency Plan Administrative Procedures. Procedure Manual 6Q4-1.2.

4. Radiological Control Manual. Manual 5Q.

5. Standards/Requirements Identification Document (S/RID). SRR-RP-2009-00558-000.

6. Emergency Planning Hazards Assessment for the Defense Waste Processing Facility (U). S-EHA-S-00001.

7. SRS Emergency Plan - Emergency Management Program Procedures (EMPPs) Manual. Manual 6Q, Volume II.

13.11 FIGURES

Figure 13.11-1 Deleted

FINAL SAFETY ANALYSIS REPORT
SAVANNAH RIVER SITE
DEFENSE WASTE PROCESSING FACILITY

CHAPTER 14

GLOSSARY OF TERMS

November 2018

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14.0 GLOSSARY OF TERMS

14.1 DEFINITIONS

absorbed dose	The amount of energy absorbed per unit mass of irradiated material.
actinides	The radioactive elements with atomic numbers of 89 and above. The name is taken from actinium, the first member of the series.
activity	See "radioactivity."
agitator	A mechanical device (motor-driven paddle) used for stirring the contents of a tank.
airborne activity	Radioactive materials that are present in air.
alpha (alpha radiation, alpha particle)	A helium nucleus, consisting of two protons and two neutrons, with a double positive charge. The alpha particles will not penetrate a sheet of paper.
anion	A negatively charged ion such as OH^- in an aqueous solution.
aqueous	Water-based phase or solids derived therefrom. Usually predominantly liquid (solution and/or slurry), but may refer to dry or nearly dry salt cake or sludge solids derived from water solution or slurry. Contrasts with "organic" (usually also liquid) and "solid" (fuels, targets, structural or decontamination materials, etc.).
aquifer	A water-bearing layer of permeable rock or soil.
attenuation	The reduction of radiation quantity upon passage of radiation through matter resulting from all types of interaction with that matter.
Authorization Basis (AB)	Those aspects of the facility design basis and operational requirements relied upon by DOE to authorize operation.
background, background radiation	The radiation of the normal general environment around a given location. May refer strictly to the natural environment as affected by cosmic rays and the naturally occurring radioactive elements of the earth, including those within man's body.
beta (beta radiation, beta particle)	Charged particle emitted from the nucleus of an atom and having a mass and charge equal in magnitude to those of the electron.
body burden	The total quantity of radionuclides present in the body.
bone seeker	Any substance that migrates, in vivo, preferentially into the bone.

boundary conditions	Conditions that define the limits for which a system is to be analyzed.
cation	A positively charged ion such as Na^+ in an aqueous solution.
concentrate	In this report, aqueous waste that has had some of its water content removed by evaporation. May denote liquid, solid salts, or a slurry of both.
concentrate, supernate	The decantable liquid phase in or from a concentrate receiving tank. Usually saturated with dissolved salts but free of suspended solid phase.
condensate	The product of condensation with specific regard to waste evaporation; condensate is the vapor from the boiling waste after it is condensed in a water-cooled condenser.
consequence	The result or effect (especially projected doses or dose rates) of a release of radioactive or hazardous materials to the environment.
contamination	Radioactive material located where it is undesirable (outside its normal location).
Controlled Area (CA)	A specified area in which exposure of personnel to radiation or radioactive material is controlled and which is under the supervision of a person who has knowledge of the appropriate radiation protection practices. These practices include pertinent regulations, and who has responsibility for applying them.
credible event	An event with a frequency greater than 1E-06 per year.
critical organ	That organ (or tissue) in which the dose equivalent would be most significant due to a combination of the organic radiosensitivity and a particular dose pattern through the body.
criticality incident	The release of energy as a result of accidentally producing a self sustaining or divergent nuclear chain reaction.
Curie (Ci)	Unit used in measuring radioactivity; the quantity of any radioactive atom of a specific nuclear constitution in which the number of disintegrations per second is 3.7E+10.
decay	The spontaneous radioactive transformation of one nuclide into a different nuclide or into a different energy state of the same nuclide.
decommissioning	The measures taken at the end of a facility's operating lifetime.

decontaminate, decontamination	The process of removing unwanted radioactivity (a) from equipment or environment not of themselves radioactive, frequently a matter of cleaning surfaces; or (b) from materials in process, in which the undesirable activity is intimately intermixed.
Decontamination Factor (DF)	A measure of the degree to which the concentration of radioactivity is reduced by evaporation, ion exchange, filtration, etc. DF = the concentration of radioactivity in the feed divided by the concentration of radioactivity in the effluent.
defense in depth	The process of selecting structures, systems, components, and administrative controls to provide several layers of protection with successive barriers to prevent the release of hazardous material to the environment or to mitigate the consequences of the release.
Design Basis Earthquake (DBE)	An earthquake producing ground accelerations at the site of 20% of the acceleration of gravity (0.2g) at zero period.
disposal	The planned release of radioactive waste in a controlled manner that precludes recovery, or its placement in a manner and location that are considered permanent.
dose commitment	The total radiation dose equivalent from a release of radioactive material to the environment that will be absorbed by the total population assuming each individual lives 50 years after the release.
dose conversion factor	A factor for each radionuclide released for each dose vector in terms of integral lifetime dose (50 years) per annual average air or water concentration (rem-m^3/Ci-yr.) and areal deposition (rem-m^2/Ci-yr.).
dose equivalent	The absorbed dose multiplied by the quality factor, which accounts for the biological effects observed with a given absorbed dose.
DWPF	The DWPF consists of: 1 Vitrification Building (221-S) 2 Sand Filter (294-S) 3 Glass Waste Storage Buildings (250-S and 251-S) 4 Fan House (292-S) 5 Low Point Pump Pit (511-S) 6 Exhaust Stack (291-S) 7 Cold Chemical Storage / Bulk Frit Storage Building (422-S) 8 Failed Equipment Storage Vault (260-S)

9 Water & Chemical Waste Treatment, Neutralized Fire Water Storage Tank, and Domestic Water Storage Tank (980-S)

10 Service Building (210-S)

11 Operations Building (704-S)

12 Cooling Tower (981-S)

13 Deleted

14 512-S Complex

15 Computer Facility / Simulator (706-S)

16 Effluent Retention Tank

17 Primary Substation (951-S)

18 Interarea Transfer Lines

and other support buildings and structures.

Effective Dose Equivalent (EDE)	The summation of the products of the dose equivalent received by specified tissue of the body and the appropriate weighting factors. It includes the dose from radiation sources internal and/or external to the body.
Emergency Action Level (EAL)	Specific, predetermined, and observable criteria used to detect, recognize, and determine the emergency class of operational emergencies.
emergency preparedness	The training of personnel, acquisition and maintenance of resources, and exercising of the plans, procedures, personnel and resources essential for emergency response.
Emergency Response Planning Guidelines (ERPGs)	Estimates of concentration ranges (dosage) for specific chemicals which acute (<1 hour) exposure would be expected to lead to adverse health effects of increasing severity for ERPG-1, ERPG-2, and ERPG-3.
emissions	Releases of radioactive, hazardous, or mixed materials into the environment - either gaseous or aqueous pathways.
enriched uranium	Uranium containing greater than 0.711% of the uranium isotope ^{235}U.

failure	The condition of a component, equipment, or system whereby a particular performance characteristic has moved outside the assessed specification range in such a way that the component, equipment, or system can no longer perform adequately in the desired manner.
fault	In geology, a break in rock strata or veins that causes a section to become dislocated along the line of fracture.
fault tree analysis	A formalized deductive process for identifying the possible modes of occurrence of a specified undesired event in a given system.
Four Mile Creek	An onsite river tributary. Four Mile Creek receives effluents from F and H areas.
functional classification	A graded classification system used to determine minimum requirements for SSCs (e.g., design, operation, procurement, and maintenance requirements). The four functional classifications in order of precedence are Safety Class, Safety Significant, Production Support, and General Services.
"G" Value	The radiolytic generation rate is governed by the "G" value, which provides the number of molecules of hydrogen that are produced per 100 ev of radiolytic energy absorbed by the solution.
gamma (gamma radiation, gamma ray)	High energy, short-wave-length electromagnetic radiation emitted by a nucleus. Gamma radiation usually accompanies alpha and beta emissions and always accompanies fission.
General Services (GS)	The functional classification assigned to all SSCs not required to provide a Safety Class, Safety Significant or Production Support function.
groundwater	Water in the zone of saturation (i.e., filling all voids between soil particles) beneath the land surface.
groundwater pathway	The path taken by subsurface release of activity followed by migration through the soil before release to surface streams that transport the radionuclides to man.
half-life, biological	The time required for the amount of particular substance in a biological system to be reduced to one-half of its original value by biological processes when the rate of removal is approximately exponential.
half-life, radioactive	The time required for a radioactive substance to lose 50% of its activity by decay. Each radionuclide has a unique half-life.
hazard	A process, condition or asset which has the potential to adversely impact the health and safety of personnel, the public, the environment or national security.

hazardous materials	Any solid, liquid, or gaseous material that is toxic, flammable, radioactive, corrosive, chemically reactive or unstable upon prolonged storage, in quantities that could pose a threat to life, property or the environment.
Hazards Assessment Document (HAD)	A document, typically prepared early in the project life cycle, that assesses the unmitigated hazards of a facility based on conservative accident scenarios and the calculated effects of the radionuclide and chemical inventories.
High Efficiency Particulate Air (HEPA)	A type of filter designed to remove from the flowing stream 99.97% of all suspended particles 0.3 micron (10^{-6} meter) and greater in diameter.
homogeneous	The same in structure, quality, etc. Composed of similar or identical elements or parts; uniform.
Independent Verification (IV)	A formal method of checking, by a separate qualified person (separated by time and space), that a given operation or component's position conforms to established criteria.
ion exchange	A reversible chemical reaction between a solid (usually) and a fluid mixture or solution, by means of which two or more components may be interchanged between the two phases. Ion exchange may be used either to concentrate a given element (ion) for recovery or to remove unwanted ions from a process stream, or both.
isotope	One of two or more atomic forms of an element that differ in atomic weight. In general, all isotopes of a given element behave the same chemically but differ slightly in physical behavior and may differ tremendously in radioactive behavior, if any.
jumper	A piece of pipe used to connect two other pipes so as to provide a continuous conduit, as in a diversion box. SRS jumpers for transfer of radioactive fluids usually are fitted at each end with remotely operable gasketed connectors.
lightning arrester	A device to protect electrical lines and equipment from damage due to lightning.
maximum individual dose	The maximum probable dose commitment that is received by a single individual in a 50-year lifetime as a result of a given release of radioactive materials to the environment.
maximum inventory	For a process, the maximum quantity of a hazardous material that a process is expected to produce during the process cycle. For storage tanks, the maximum inventory equivalent to the physical capacity of the tank.

mitigate	To lessen the severity of consequences of an event that has happened.
natural uranium	Uranium as found in nature. Contains 99.3% of the fertile uranium isotope ^{238}U and 0.7% of the fissionable uranium isotope ^{235}U.
neutron	An uncharged elementary particle of matter with a mass nearly equal to that of a proton. The fission chain reaction in a nuclear reactor is sustained by absorption of energized neutrons by atomic nuclei, with resultant fission and the release of more energized neutrons (as well as fission products).
nuclear criticality safety	The prevention or termination of inadvertent nuclear criticality and protection against injury or damage due to accidental nuclear criticality.
nuclide	Any atomic nucleus specified by its atomic weight, atomic number, and energy state. A radionuclide is a radioactive nuclide.
offsite	Beyond the boundary line marking the limits of the site property.
onsite	Within the boundary line marking the limits of the site property.
pan	The steel secondary tank or liner under and around (the lower portion of) a free-standing primary tank for waste storage, especially in the Type I and II tanks, in which the steel secondary liner wall is five feet high.
partition factor	A factor that indicates what fraction of a radionuclide in fresh liquid waste is associated with the insoluble fraction (sludge) of the waste.
plant stream	Any natural stream on the SRS site.
prevent	To keep an event from happening.
Production Support (PS)	The functional classification that applies to those SSCs necessary to support continued operation of a Nuclear Production Facility and to selected environmental monitoring and Emergency Plan communication devices.
Pu, plutonium	A man-made radioactive element with atomic number 94. Its most important isotopes are fissionable plutonium-239, produced by neutron irradiation of uranium-238, and plutonium-238, produced by neutron irradiation of uranium-236 and of the resultant neptunium-237, and used as an energy source for instrumentation in space and other remote locations.
public	Everyone outside the SRS boundary at the time of the event.
pump pit	Concrete cells that serve as secondary containment for pump tanks.

pump tanks	Tanks containing two transfer devices per tank (pump and/or eductor). These tanks are used to transfer liquid waste to storage tanks at significant distances and/or higher elevations than the feed tanks.
Quality Assurance (QA)	All those planned and systematic actions necessary to provide adequate confidence that a structure, system or component will perform satisfactorily in service
quality factor	A factor by which the absorbed dose is multiplied to obtain dose equivalent; used in radiation protection to take into account the fact that equal absorbed doses of radiation of different qualities have, in general, different biological effects.
rad	The unit of absorbed dose, which is 100 ergs/gram in any medium.
radioactivity	The spontaneous decay or disintegration of unstable atomic nuclei, accompanied by the emission of radiation.
Radiological Buffer Area (RBA)	An area where in which access is controlled due to the presence or potential for the presence of radioactive materials or elevated radiation levels.
radiolytic decomposition (radiolysis)	The action of ionizing radiation on solutions, e.g., the decomposition of nitrates to form oxygen and nitrite.
radionuclide, radioisotope	See "nuclide."
reactor	A device within which reaction can be initiated, maintained, and controlled.
release guides	Limits imposed on the total quantities of radionuclides that might be released to the environment. These guides are carefully reviewed annually.
release height	The height above ground that a release of radioactive or hazardous material is assumed to enter the atmosphere.
rem	The unit of dose equivalent. The “rem” unit is used to express human biological doses as a result of exposure to one of many types of ionizing radiation.
risk	The product of the probability and consequence of an event.
risk analysis	The process by which the risk of a system is determined. There are two principal methods of analysis - inductive and deductive.

roentgen	A unit of exposure to ionizing radiation. It is that amount of gamma-rays or x-rays required to produce ions carrying one electrostatic unit of electrical charge in one cubic centimeter of dry air under standard conditions.
Safety Analysis	A documented process to systematically identify the hazards of a DOE operation; to describe and analyze the adequacy of measures taken to eliminate, control or mitigate identified hazards, and to analyze and evaluate potential accidents and their associated risks.
Safety Analysis Report (SAR)	The principal documentation of the evaluation of a process facility or process, made to determine that the facility or process can be operated without undue risk to personnel onsite or offsite.
Safety Class (SC)	The functional and safety classification that applies to those structures, systems, or components or Administrative Controls whose preventative or mitigative function is necessary to keep hazardous material exposure to the public below the Offsite Evaluation Guidelines.
Safety Significant (SS)	The functional and safety classification that applies to those structures, systems, or components or Administrative Controls not designated as safety class SSCs but whose preventative or mitigative function is a major contributor to defense in depth (i.e., prevention of uncontrolled material releases) and/or worker safety as determined from hazard analysis.
safety Structures, Systems, and Components (SSCs)	The set of Safety Class structures, systems, and components, and Safety Significant structures, systems, and components for a given facility.
sand filter	A particulate filter composed of several layers of graded sand, designed for the removal from air or water of residual trace quantities of suspended inert or radioactive materials.
Savannah River Laboratory (SRL)	See “Savannah River National Laboratory.”
Savannah River Plant (SRP)	See “Savannah River Site.”
Savannah River Site (SRS)	A major government-owned plant for the production of nuclear energy materials for military and peacetime purposes.

Savannah River National Laboratory (SRNL)	The chief research and development organization within the Savannah River Site.
scenario	An outline indicating the action of a chain of events in order of its development.
Second Person Verification (SPV)	A formal method of checking an operation, an act of positioning, or a calculation, in which the verifier observes before, during and/or after an action and confirms the operation or calculation.
segregated water	Cooling water that is not recirculated. This water is used in process vessels and systems judged to have the highest potential for becoming accidentally contaminated.
seismicity	The tendency for the occurrence of earthquakes.
separations process	Chemical processes used to separate nuclear products from byproducts and from each other.
site boundary	In general, the perimeter of the DOE-owned and controlled land at SRS.
source term	The amount of material available for release.
specific gravity	The ratio of the density of a body to that of water at a specified temperature.
specific heat	The ratio of the thermal capacity of a substance to that of water at $15^{o}C$.
storm water	See “surface water.”
sump	A low-lying vessel or space to receive and contain liquid drainage.
supernate	A contraction of "supernatant liquid,” i.e., the liquid phase currently or formerly above and/or intermingled with a solid phase such as sludge or salt cake.
surface water	Rainwater or other water standing on or running along the surface of the ground (including paved areas). Includes permanent and temporary surface streams. Also called “storm water.”
surface water pathway	The path taken by the ground surface release of liquids to surface streams that transport the radionuclides to man.
System Design Description (SDD)	The facility system technical document that defines the functional, physical, testing, interface, operating, and maintenance requirements for a system and the associated components.

Tank Farm	An installation of interconnected underground tanks at SRS for the storage and processing of radioactive high level liquid waste.
Tank Farm Evaporator	At SRS, a waste evaporator located in a tank farm and used to concentrate aqueous waste supernate into salt cake and/or concentrate supernate. Distinguished from other waste evaporators located in the main separations building (canyons) and used to produce a concentrate designed to remain fluid and unsaturated until processed further.
Technical Safety Requirements (TSRs)	Those requirements that define the conditions, safe boundaries, and the management or administrative controls necessary to ensure the safe operation of a nuclear facility and to reduce the potential risk to the public and facility workers from uncontrolled releases of radioactive materials or from radiation exposures due to inadvertent criticality.
Test Authorization (TA)	A document authorizing temporary departures from Technical Standards or Mechanical Standards or for authorizing operation with potential risks sufficiently large as to warrant higher levels of authorization.
tritium	A radioactive isotope of hydrogen of atomic mass 3, with two neutrons and one proton in the nucleus. It is produced primarily by neutron irradiation of lithium-6, and is used in thickness and vacuum gages, as a label in tracer experiments, in controlled nuclear fusion experiments, and for many other industrial uses, as well as in thermonuclear weapons.
Upper Three Runs Creek	The only plant surface stream with head water arising outside the SRS site that has never received heated discharges of cooling water from the production reactors.
U, uranium	The heaviest naturally occurring element, of atomic number 92, all isotopes of which are radioactive. The two principal naturally occurring isotopes are fissionable uranium-235 (0.7% of natural uranium) and fertile uranium-238 (99.3% of natural uranium).
viscosity	A property of all fluids to resist a change of form (a sort of internal resistance).
volume reduction factor	The ratio of volumes of a unit quantity of waste before and after concentration in an evaporator. Synonymous with the term "boildown."
waste management	The planning, execution, and surveillance of essential operations related to radioactive wastes, including treatment, solidification, packaging, and disposal.

waste, radioactive	Equipment and materials (from nuclear operations) that are radioactive or have radioactive contamination and for which there are not recognized uses or for which recovery is impracticable.
water table	The upper surface of the groundwater.
worker	Population within the site boundary.

14.2 UNITS, ABBREVIATIONS

α	alpha
β	beta
cfm	cubic feet per minute
cfs	cubic feet per second
Ci	curie
Ci/m^2	curie per square meter
^oC	degrees Celsius
^oF	degrees Fahrenheit
dis	disintegrations
ev	electron volt
fpm	feet per minute
ft	feet
ft^3	cubic feet
g	gram
g/L	grams per liter
gal	gallon
γ	gamma
gph	gallons per hour
gpm	gallons per minute
gpm/ft^2	gallons per minute per square foot
hr	hour
in. wc.	inches of water column
k	kilo
kJ	kiloJoules
kw	kilowatt
lb	pound
L (or 1)	liter
m	meter; as prefix, milli
M	molar
mCi	millicurie
mg	milligram
mg/l	milligrams per liter

megaton	one million tons (normally refers to TNT explosive mass equivalent)
μ	micron, prefix, one millionth of a unit (10^{-6})
μg	microgram
μg/L	micrograms per liter
mi	mile
mi^2	square mile
min	minute
ml	milliliter
mm	millimeter
mph	miles per hour
mrem	millirem
nano	prefix, one thousandth of a micro unit (10^{-9})
nCi	nanocurie (10^{-9} Ci)
nCi/g	nanocuries per gram
pico	prefix, one millionth of a micro unit (10^{-12})
pCi	picocurie (10^{-12} Ci)
pH	measure of the hydrogen ion concentration in aqueous solutions
ppb	parts per billion
ppm	parts per million
psig	pounds per square inch (gage)
psi	pounds per square inch
Ref	reference
rem	roentgen equivalent man
RTD	Resistance Temperature Detector
scf	standard cubic feet
scfm	standard cubic feet per minute
sec	second
sol	solvent
VAC	Volts Alternate Current
VDC	Volts Direct Current
vol%	volume percent
WC	water column
WG	water gage
wt. %	weight percent

14.3 COMMON ACRONYMS

AC	Alternating Current
ADP	Antifoam Degradation Product
AEC	Area Emergency Coordinator
AHJ	Authority Having Jurisdiction
AI	Analog Input
ALARA	As Low As Reasonably Achievable
ALOHA	Areal Locations of Hazardous Atmospheres
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOP	Abnormal Operating Procedure
APP	Auxiliary Pump Pit
ARF	Airborne Release Fraction
ARM	Area Radiation Monitor
ARP	Actinide Removal Process
ARR	Airborne Release Rate
ASME	American Society of Mechanical Engineers
ASPS	Area Support Project Services
ASPS QA	Area Support Project Services Quality Assurance
ASRT	Actinide Solids Receipt Tank (formerly PRBT & renamed SEFT)
ASTM	American Society for Testing and Materials
BDBA	Beyond Design Basis Accident
BDR	Basic Data Report
BSRI	Bechtel Savannah River Company Incorporated
BUOG	Backup Off-gas
BUOGC	Backup Off-gas Condenser
BUOGCT	Backup Off-gas Condensate Tank
BUOGFC	Backup Off-gas Film Cooler
CAM	Continuous Air Monitor
CBU	Closure Business Unit
CCR	Central Control Room
CCTV	Closed Circuit Television
CDC	Canister Decontamination Cell
CDCSTS	CDC Smear Test Station

CDMC	Contact Decontamination Maintenance Cell
CFR	Code of Federal Regulations
CGA	Compressed Gas Association
CHA	Consolidated Hazards Analysis
CHAP	Consolidated Hazards Analysis Process
CLFL	Composite Lower Flammability Limit
CMA	Crane Maintenance Area
CMM	Canister Manipulation Mechanism
CMSD	Crane Maintenance Shield Door
CNSI	Chem Nuclear Systems, Inc.
CPC	Chemical Process Cell
CPT	Cone Penetration Testing
CQF	Cognizant Quality Function
CRAC	Control Room Action Committee
CRDR	Control Room Design Review
CRO	Control Room Operator
CRM	Control Room Manager
CSEP	Control Room Expert Panel
CSSX	Caustic Side Solvent eXtraction
CST	Concentration, Storage, and Transfer
CSTF	Concentration, Storage, and Transfer Facility
CW	Collocated Worker
CWNT	Caustic Waste Neutralization Tank
DA	Design Area
DAC	Derived Air Concentration
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DBT	Design Basis Tornado
DC	Direct Current
DCE	D'Appolonia Consulting Engineers, Inc.
DCF	Dose Conversion Factor
DCS	Distributed Control System
DDEAMC	Dwight David Eisenhower Army Medical Center

DEWS	Decontaminated Equipment and Waste Staging
DF	Decontamination Factor
DFSFT	Decontamination Frit Slurry Feed Tank
DG	Diesel Generator
DID	Defense in Depth
DIDE	Defense in Depth Evaluation
DOE	Department of Energy
DOE-SR	Department of Energy, Savannah River
DOE-STD	DOE Standard
DPHR	Design Process Hazards Review
DSA	Documented Safety Analysis
DSS	Decontaminated Salt Solution
DSST	Decontaminated Salt Solution Tank
DWPF	Defense Waste Processing Facility
DWTT	Decontamination Waste Treatment Tank
E&I	Electrical and Instrument
EDE	Effective Dose Equivalent
EDO	Emergency Duty Officer
EER	Electrical Equipment Room
EG	Evaluation Guideline
EIS	Environmental Impact Statement
EMM	Electromechanical Manipulator
ENN	Emergency Notification Network
EOC	Emergency Operations Center
EOP	Emergency Operating Procedure
EPA	Environmental Protection Agency
EPHA	Emergency Planning Hazards Assessment
EPIP	Emergency Plan Implementing Procedure
EPZ	Emergency Planning Zone
ERAP	Emergency Readiness Assurance Plan
ERD	Equipment Requirement Drawing
ERF	Emergency Response Facility
ERO	Emergency Response Organization
ERPG	Emergency Response Planning Guideline

ES&H	Environment, Safety, and Health
FAVC	Formic Acid Vent Condenser
FAWH	Formic Acid Waste Header
FC	Functional Classification
FEC	Facility Emergency Coordinator
FESV	Failed Equipment Storage Vault
FGE	Fissile Gram Equivalent
FHA	Fire Hazards Analysis
FI	Flow Indicator
FIT	Flow Indicator Transmitter
FOS	Field Operating Station
FSAR	Final Safety Analysis Report
FSO	Facility Support Operation
FW	Facility Worker
GC	Gas Chromatograph
GCO	Generator Certification Official
GET	General Employee Training
GS	General Services
GSAR	Generic Safety Analysis Report
GWSB	Glass Waste Storage Building
HA	Hazards Analysis
HAZOP	Hazard and Operability
HDB	H-Area Diversion Box
HDB-8	H Area Diversion Box # 8
HDWH	Hot Decontamination Waste Header
HEME	High Efficiency Mist Eliminator
HEPA	High Efficiency Particulate Air
HF	Human Factors
HFE	Human Factors Engineering
HLW	High Level Waste
HLWM	High level Waste Management
HMDSO	hexamethyldisiloxane
HP	Health Physics
HVAC	Heating, Ventilation, and Air Conditioning

IC	Initial Condition
ICC	Inner Canister Closure
ICR	Incremental Cancer Risk
ICRP	International Commission on Radiological Protection
IDP	Inhalation Dose Potential
IGEG	Interim Guidance Evaluation Guidelines
IH	Industrial Hygiene
IPC	Immediate Procedure Change
IPE	Investment Protection Earthquake
ISC	Incident Scene Coordinator
ITP	In-Tank Precipitation
KE	Kinetic Energy
LAN	Local Area Network
LCO	Limiting Condition for Operation
LCS	Local Control Station
LDB	Leak Detection Box
LEL	Lower Explosive Limit
LFL	Lower Flammability Limit
LIMS	Laboratory Information Management System
LOC	Level Of Control
LPF	Leak Path Factor
LPPP	Low Point Pump Pit
LPPP-PPT	Low Point Pump Pit Precipitate Pump Tank
LPPP-SPT	Low Point Pump Pit Sludge Pump Tank
LPPP-RPT	Low Point Pump Pit Recycle Pump Tank
LRWHF	Liquid Radioactive Waste Handling Facility
LWF	Late Wash Facility
LWHT	Late Wash Hold Tank
LW	Liquid Waste
LWO	Liquid Waste Operations
LWPT	Late Wash Precipitate Tank
M&TE	Measuring and Test Equipment
MACCS	Melcor Accident Consequence Code Systems
M & O	Management and Operations

MAR	Material at Risk
MAWT	Mercury Acid Wash Tank
MC	Melt Cell
MCC	Motor Control Center
MCU	Modular (Caustic Side Solvent eXtraction) Unit
MFT	Melter Feed Tank
MOU	Memorandum of Understanding
MPC	Main Process Cell
MRJD	Mueser, Rutledge, Johnson, and DeSimone Consulting Engineers
MRS	Manipulator Repair Shop
MSDS	Material Safety Data Sheet
MSF	Mercury Storage Facility
MST	Monosodium Titanate
MWWT	Mercury Water Wash Tank
NA	Not Applicable
NCSA	Nuclear Criticality Safety Assessment
NCSASR	Nuclear Criticality Safety Analysis Summary Report
NCSE	Nuclear Criticality Safety Evaluation
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NGS	Next Generation Solvent
NIOSH	National Institute for Occupational Safety and Health
NOx	Nitrogen Oxides
NPH	Natural Phenomena Hazard
NRC	Nuclear Regulatory Commission
NWTF	New Waste Transfer Facility
OGCT	Off-gas Condensate Tank
OGFC	Off-gas Film Cooler
OSC	Operations Support Center
OSHA	Occupational Safety and Health Administrative
OSHT	Occupational Safety and Health Technology
P&ID	Piping and Instrument Diagram
PBA	Phenylboric Acid
PCR	Procedure Change Request

PCV	Pressure Control Valve
PCW	Process Cooling Water
PEL	Permissible Exposure Limit
PFSFT	Process Frit Slurry Feed Tank
PGA	Peak Ground Acceleration
PHA	Preliminary Hazards Analysis, Precipitate Hydrolysis Aqueous
PHR	Process Hazards Review
PIMS	Process Information Management System
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PNL	Pacific Northwest Laboratory
PPE	Personal Protective Equipment
PPT	Precipitate Pump Tank
PPV	Pump Pit Ventilation (LPPP), 512-S Process Vessel Ventilation
PRBT	Precipitate Reactor Bottoms Tank (Renamed ASRT and then SEFT)
PRFT	Precipitate Reactor Feed Tank
PS	Production Support
PSA	Probabilistic Safety Analysis
PSAR	Preliminary Safety Analysis Report
PSM	Process Safety Management
PTT	Pour Turntable
PVV	Process Vessel Ventilation System (Vitrification Building)
PVVF	Process Vessel Vent Filter
PVVH	Process Vessel Vent Header
QA	Quality Assurance
QAAP	QA Action Plan
QAPR	Quality Assessment Planning Report
RA	Radiation Area
RBA	Radiological Buffer Area
RC	Radiological Control
RCO	Radiological Control Operations
RCT	Recycle Collection Tank
RDCT	Regulated Drain Collection Tank
REDC	Remote Equipment Decontamination Cell

RF	Respirable Fraction
RPC	Remote Process Cell
RPD	Radiological Protection Department
RPT	Recycle Pump Tank (also called Recycle Waste Pump Tank)
RQ	Reportable Quantity
RR	Required Reading
RRW	Railroad Well
RS	Regulated Shop
RSM	Retention Schedule Matrix
RWP	Radiation Work Permit
SAC	Specific Administrative Control
SAE	Site Area Emergency
SAIC	Science Applications International Corporation
SAR	Safety Analysis Report
SAS	Steam Atomized Scrubber
SBS	Safety Basis Strategy
SC	Safety Class
SCDHEC	South Carolina Department of Health and Environmental Control
SCE&G	South Carolina Electric and Gas
SCI	Safety Class Item
SCT	Shielded Canister Transporter
SDD	System Design Description
SE	Strip Effluent
SEFT	Strip Effluent Feed Tank
SEHT	Strip Effluent Hold Tank
SIH	Standard Industrial Hazard
SIRIM	Site Item Reportability and Issue Management
SL	Safety Limit
SME	Slurry Mix Evaporator
SMECT	Slurry Mix Evaporator Condensate Tank
SMSA	Standard Metropolitan Statistical Area
SOM	System Operating Manual
SPC	Salt Process Cell
SPF	Standard Project Flood

SPT	Sludge Pump Tank
SR	Surveillance Requirement
SRAT	Sludge Receipt and Adjustment Tank
SREL	Savannah River Ecology Laboratory
SRFS	Savannah River Forestry Service
S/RID	Standards and Requirements Identification Document
SRNS	Savannah River Nuclear Solutions
SRR	Savannah River Remediation (formerly WSRC)
SRS	Savannah River Site
SRSOC	Savannah River Site Operations Center
SS	Safety Significant
SSC	Structures, Systems and Components
SS&ESD	Safeguards, Security and Emergency Services Division
SSRT	Salt Solution Receipt Tank
SST	Selective Signal Terminal
ST	Source Term
STD	Standard
STEL	Short Term Exposure Limit
SWPF	Salt Waste Processing Facility
TDS	Total Dissolved Solids
TEDE	Total Effective Dose Equivalent
TL	Transfer Line
TLD	Thermoluminescent Dosimeter
TLV	Threshold Limit Value
TMS	trimethylsilanol
TPB	Tetraphenyl Borate
TQ	Threshold Quantity
TSD	Technical Services Division
TSR	Technical Safety Requirement
TTR	Technical Task Request
TWA	Time-Weighted Average
UBC	Uniform Building Code
UFL	Upper Flammability Limit
UPS	Uninterruptible Power Supply

USCS	Unified Soil Classification System
USFS	US Forestry Service
USQ	Unreviewed Safety Question
USQE	Unreviewed Safety Question Evaluation
UTRC	Upper Three Runs Creek
VEGP	Vogtle Electric Generating Plant
WAC	Waste Acceptance Criteria
WAPS	Waste Acceptance Product Specifications
WD	Waste Disposition
WDWH	Warm Decontamination Waste Header
WSRC	Washington (formerly Westinghouse) Savannah River Company
WTC	Weld Test Cell

14.4 RADIOISOTOPES

Radioisotope		Half-life
^{3}H	tritium	12.3 years
^{129}I	iodine-129	1.7E+07 years
^{60}Co	cobalt-60	5.27 years
^{90}Sr	strontium-90	28.6 years
^{106}Ru	ruthenium-106	368.2 days
^{106}Rh	rhodium-106	29.8 seconds
^{125}Sb	antimony-125	2.76 years
^{125m}Te	tellurium-125m	58 days
^{134}Cs	cesium-134	2.07 years
^{137}Cs	cesium-137	30.17 years
^{137m}Ba	barium-137m	2.55 minutes
^{144}Ce	cerium-144	285 days
^{144}Pr	praseodymium-144	17.28 minutes
^{144}Pm	promethium-147	2.62 years
^{235}U	uranium-235	7.1E+08 years
^{238}U	uranium-238	4.5E+09 years
^{238}Pu	plutonium-238	87.8 years
^{239}Pu	plutonium-239	2.4E+04 years
^{240}Pu	plutonium-240	6.6E+03 years
^{241}Pu	plutonium-241	14.35 years
^{241}Am	americium-241	432 years
^{244}Cm	curium-244	163 days