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**TECHNICAL STANDARD: MANAGEMENT OF RADIOACTIVE
WASTE AT THE SRS STORAGE/DISPOSAL FACILITIES,
643-7G, 643-29G, 709-2G, JUNE 1990**

by

Cook, J. R.

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

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JUNE 1990

TECHNICAL STANDARD

MANAGEMENT OF RADIOACTIVE WASTE
AT THE SRS STORAGE/DISPOSAL FACILITIES
643-7G, 643-29G, 709-2G

JUNE 1990

James R. Cook

Interim Waste Technology Section
Savannah River Laboratory

JUNE 1990

TECHNICAL STANDARD: MANAGEMENT OF RADIOACTIVE
WASTE AT THE SRS STORAGE/DISPOSAL FACILITIES
643-7G, 643-29G, and 709-2G

A.1 APPLICABILITY

This Standard applies to the storage or disposal of Low-Level Radioactive Waste and Transuranic Waste at the Savannah River Site (SRS) Radioactive Waste Storage/Disposal Facility 643-7G, and to the storage of Mixed Waste at facilities 643-29G and 709-2G. This Standard applies strictly to current operations. There is no intent, stated or implied, to enforce the provisions of this Standard upon past actions or practices.

A.2 COMPLIANCE WITH DEPARTMENT OF ENERGY ORDER 5820.2A

The Department of Energy (DOE) Order 5820.2A, "Radioactive Waste Management", issued September 26, 1988 recognizes in Item 10 (Implementation Procedures and Requirements) that strict compliance with the Order cannot be accomplished immediately, but that an implementation plan will be prepared by SRS that describes schedules, costs, and quality assurance activities for meeting the requirements of the new DOE Order. As implementation schedules are met, this Standard will be modified as required to comply with the Order. The Implementation Plan and Schedule of Compliance was approved by DOE in April 1989, and was updated in the Savannah River Waste Management Operations Program Plan for FY 1990 in December 1989.

A.3 DEFINITIONS

CLEAN WASTE Waste from areas of potential radionuclide contamination which has no detectable radionuclide contamination. The waste must be verified as clean waste at the Landfill Monitoring Facility prior to disposal in a sanitary landfill. The Landfill Monitoring Facility cannot detect low levels of tritium or alpha radiation, so waste suspected of contamination with these materials cannot be verified as clean waste.

DISPOSAL Emplacement of waste with no intent of retrieval. Deliberate action is required to regain access to the waste.

DISPOSAL FACILITY The land, structures, and equipment used for disposal of waste.

ENGINEERED LOW-LEVEL TRENCH (ELLT) A disposal facility that is a large earthen pit designed for placement of boxes and other waste containers. It has sloping sides, a crusher run base underlain by a geotextile membrane a berm to protect against surface water run on, a floor sloped to a sump, and a vehicle ramp.

FREE LIQUIDS Liquids which readily separate from the solid portion of a waste under ambient temperature and pressure.

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A.3 DEFINITIONS (CONTINUED)

GREATER CONFINEMENT DISPOSAL (GCD) A disposal facility that provides greater stability of the waste and better intruder protection than shallow land burial. An example of GCD disposal is waste disposal in a concrete borehole or trench, into which grout is poured to stabilize the waste forms before closure.

HAZARDOUS WASTES Those wastes that are designated hazardous by EPA regulations (40 CFR 261) and South Carolina Hazardous Waste Management Regulations.

HIGH-LEVEL WASTE The highly radioactive waste material that results from reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid that contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

INTERMEDIATE-LEVEL WASTE A term specific to the Savannah River Site for the higher activity fraction of low-level waste which contains beta-gamma emitters that produce a dose rate equal to or greater than 300 mR/hr (or 300 mrad/hr or 300 mrem/hr) at 3 inches from an unshielded container.

LOW-LEVEL WASTE Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel or byproduct material as defined by DOE Order 5820.2A. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic radionuclides is less than 100 nCi/g. ~~4-100 nCi/g. (or 100 nCi/g.)~~

MIXED WASTE Waste containing both radioactive and hazardous components as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act, respectively.

NEAR SURFACE DISPOSAL Disposal in the upper 30 meters of the earth's surface (e. g., shallow land burial).

PYROPHORIC MATERIAL A material which under normal conditions can cause fires through friction, retained heat from manufacturing or processing, or which can be ignited readily, and when ignited, burns so vigorously and persistently as to create a serious transportation, handling, or disposal hazard.

RADIOACTIVE WASTE Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act of 1954, as amended, and of negligible economic value considering costs of recovery.

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A.3 DEFINITIONS (CONTINUED)

STORAGE Retrievable retention of waste pending recycle, treatment, or disposal.

STORAGE FACILITY Land area, structures, and equipment used for the storage of waste.

TRANSURANIC (TRU) RADIONUCLIDE Any radionuclide having an atomic number greater than 92.

TRANSURANIC WASTE Without regard to source or form, waste that is contaminated with alpha-emitting transuranic radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g at the time of assay. The Manager of the Savannah River Operations can determine that other alpha-contaminated wastes, peculiar to a specific site, must be managed as transuranic waste.

WASTE ISOLATION PILOT PLANT (WIPP) A geologic repository near Carlsbad, New Mexico, constructed to accept TRU waste from DOE storage and/or generating sites to demonstrate TRU waste disposal.

B. OBJECTIVE

The objective for prescribing the requirements in this Standard is to provide for storage and disposal of radioactive waste at SRS in a manner that will ensure the safety and health of employees and of the public, and that will protect the environment.

Technical Standards are defined by Procedure Manual 1B, "Management Requirements and Procedures", in Section 4.04, "Nuclear Facility Safety", as limits for important technical variables such as time, temperature, and flow in a process or operation. These limits are specified for reasons of safety, quality, and/or limitations of known technology. As stated in the Manual, all Technical Standards must be within the limits of the Operational Safety Requirements (OSR).

The Technical Standards and Operational Safety Requirements are the formal instruments for setting boundaries for administrative control of all processes. Operating procedures specify the operating limits, which must be within the limits of the Technical Standards with sufficient margin to ensure that normal fluctuations in the operation will not result in operation outside the Standards.

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TECHNICAL STANDARD

C. REQUIREMENTS

1. GENERAL REQUIREMENTS

- WAST AQ1.1
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- a. All low-level solid radioactive waste, TRU waste, and mixed waste originating at SRS shall be stored or disposed at the SRS storage/disposal facilities: 643-7G, 643-29G, and 709-2G.
 - b. Only radioactive or suspect radioactive waste not practical to designate as clean waste shall be shipped to SRS storage/disposal facilities 643-7G, 643-29G, and 709-2G. (An exception is classified waste described in Section C.3.g.)
 - c. Mixed waste, hazardous waste, and/or clean waste will not be disposed of in 643-7G.
 - d. Permanent records and maps documenting waste inventories and disposal locations shall be maintained by the designated custodian of the facility. Records shall be maintained to allow for retrieval of stored waste.
 - e. The following minimum requirements for waste storage or disposal must be met:
 - (1) The outer container of waste shall not be a cardboard or fiberboard box.
 - (2) Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water.
 - (3) Waste must not contain, or be capable of generating, quantities of toxic gases, vapors, or fumes (excluding tritium) harmful to persons transporting, handling, or disposing the waste.
 - ~~(4) Waste in gaseous form must be initially packaged at or below ambient pressure. Pressurized containers such as aerosol cans shall be permanently vented.~~
 - (5) Waste for disposal must not be pyrophoric. Pyrophoric materials contained in waste shall be treated, prepared, and packaged to be nonflammable by the waste generator.
 - (6) Pyrophoric waste for storage must meet minimum packaging requirements per the Mixed Waste Storage Building and TRU Pad RCRA Part B Permit Applications to prevent uncontrolled reactions.

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TECHNICAL STANDARD

C. REQUIREMENTS (CONTINUED)

1. GENERAL REQUIREMENTS (CONTINUED)

- (7) No material shall be accepted for storage unless all waste is packaged and external surfaces are free of transferable contamination (less than 500 dpm/0.1 square meters alpha and less than 10,000 dpm/ 0.1 square meter beta-gamma.
- f. Waste shall be characterized with sufficient accuracy to permit segregation, storage or disposal, and inventory control.

2. STORAGE OF WASTE

- a. Low-Level Liquid Waste shall be stored in the 643-7G solvent storage tanks S23-S30. The volume in each tank shall be limited to 24,253 gallons. Liquid waste must be within the following limits:

<u>Parameter</u>	<u>Limit</u>
pH	>4
Alpha activity	<5 x 10 ⁴ d/m/ml
Beta-gamma activity	<2 x 10 ⁷ d/m/ml
²³⁵ U	<16 d/m/ml
Tritium activity	<0.050 uCi/ml (overall tank concentration)

- b. Low-Level Solid Waste may be stored on a temporary basis within 643-7G for up to six months while a suitable disposal facility (such as an Engineered Low-Level Trench) is being constructed.

c. Mixed Waste

(1) ~~Mixed waste shall be stored (disposal is not~~
 allowed) on a concrete pad or in a building which must be permitted by the South Carolina Department of Health and Environmental Control (SCDHEC). Interim storage (90 days plus any extensions approved by the state of South Carolina) in unpermitted staging areas is allowed.

- (2) Waste shall be packaged, handled, and monitored in a manner consistent with SCDHEC hazardous waste regulations.

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TECHNICAL STANDARD

C. REQUIREMENTS (CONTINUED)

2. STORAGE OF WASTE (CONTINUED)

d. Transuranic (TRU) Waste

- (1) TRU waste shall be stored on concrete pads which are sloped with drainage to a sump. It shall be protected from contact with water-saturated soil in containers that can be retrieved intact and free of contamination for at least 20 years from the time of storage.
- (2) WIPP certified transuranic waste shall be segregated, clearly identified, and shall be stored in a manner unlikely to alter its certification status.
- (3) Drums containing TRU waste contaminated with more than 0.5 curies of transuranic isotopes shall be stored in concrete containers.
- (4) The heat load and nuclear safety limits that apply to the storage of TRU waste are given in Requirement 6.
- (5) Drums containing TRU waste must be vented to control the buildup of flammable gases to less than the corresponding material's lower flammability limit. Other containers (boxes, casks, etc.) must be evaluated, based on waste content, to determine venting requirements.
- (6) A Contingency Plan which describes emergency response procedures in the event of an emergency at the TRU Pads will be available at Wackenhut, Fire Protection, Medical, the Emergency Operating Center and the Spill Response Team.

- e. Reusable Contaminated Equipment may be stored in containers until returned to service. The containers must not permit release of contaminants to the environment.

~~Liquid waste, or waste containing free liquid, must either~~
be packaged with sufficient inert absorbent material to absorb three times the volume of the liquid present, or be stored in a facility which is constructed with dikes and a sump with sufficient capacity to contain 10% of the volume of the containers stored in the facility, or the volume of the largest single container stored in the facility, whichever is larger. Wastes stored in the solvent tanks are exempt from this requirement.

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TECHNICAL STANDARD

C. REQUIREMENTS (CONTINUED)

3. DISPOSAL OF WASTE

a. Low-Level Waste

- (1) Low-level waste shall be placed in containers such as metal or concrete boxes or drums and disposed in an Engineered Low-Level Trench, Greater Confinement Disposal, or earthen trenches. This should be the standard practice, except for C.3.a.(2) below.
- (2) Non-containerizable low-level waste, such as building debris, soil, equipment, or other bulky material that will not fit into standard containers, shall be disposed directly in an Engineered Low-Level Trench, Greater Confinement Disposal, or earthen trenches.

b. TRU Waste and Low-Level Alpha-Emitting Waste

Canyon equipment and other bulky waste that may be contaminated with greater than 100 nanocuries/gram alpha, and also contaminated with gamma emitters to a level which does not permit direct assessment of the TRU nuclide content, shall be excluded from packaging and storage requirements of Section C.2.d. These wastes shall be disposed either in earthen trenches protected from contact with water-saturated soil, or in a Greater Confinement Disposal Facility.

- c. Low-level waste originating at other DOE or Department of Defense sites may be disposed at SRS. These wastes must meet all of the requirements for SRS generated waste.
- d. Liquid waste, or waste containing free liquids, must be converted into a form that contains as little freestanding and noncorrosive liquid as is reasonably achievable, but, in no case, shall the liquid exceed 1% of the volume of the waste when the waste is in a disposal container, or 0.5% of the volume of the waste processed to a stable form. Waste placed in direct contact with sufficient absorbant to absorb three times the volume of liquid present meets the intent of this requirement.
- e. At least ten feet of undisturbed soil shall exist between disposed waste and the water table.
- f. Waste disposed in below-grade trenches using shallow land burial techniques shall be covered by at least four feet of soil.
- g. Classified waste may be disposed of in 643-7G for purposes of maintaining national security. This waste may be either clean waste or radioactive waste.

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TECHNICAL STANDARD

C. REQUIREMENTS (CONTINUED)

4. CURIE DISPOSAL LIMITS

The limits on the quantity of beta-gamma radioactivity emplaced each year at 643-7G are the following:

<u>RADIONUCLIDE</u>	<u>ANNUAL DISPOSAL LIMIT (Ci)</u>
(a) ^{137}Cs	50
(b) ^{90}Sr	50
(c) ^{60}Co	60,000
(d) ^3H	100,000
(e) Fission Products with half-lives greater than 1 year	7,500
(f) Activation Products with half-lives greater than 1 year	40,000

Note 1: The limits for Cs-137, Sr-90, and Co-60 as single isotopes are intended for separated material such as sources. Additional quantities of these isotopes are included in the limits for Fission Products (Cs-137 and Sr-90) and Activation Products (Co-60).

5. STORAGE/DISPOSAL FACILITY SURVEILLANCE

A comprehensive surveillance program shall be provided to monitor potential migration of radionuclides and chemicals from the storage and disposal locations.

This surveillance program shall include, but not be limited to, a groundwater well monitoring system and Health Protection Department survey of area radiation rates, radionuclide uptake by biota, and transferable contamination on personnel and equipment.

RCRA-type groundwater wells on the perimeter of the disposal facility will be sampled and the samples analyzed on a quarterly basis.

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TECHNICAL STANDARD

C. REQUIREMENTS (CONTINUED)

6. HEAT LOAD, NUCLEAR SAFETY, AND COMBUSTIBLE GAS LIMITS

The heat load and nuclear safety limits must conform with those stated in the Operational Safety Requirements (OSR).

a. The heat load requirements for storage of TRU waste are:

- (1) When anion resin in the nitrate form is present, heat load is limited to 2.0 Btu/hr (e.g., 1.1 grams of Pu-238) per 55-gallon drum, and 118 Btu/hr (e.g., 62 grams of Pu-238) per concrete culvert (Ref. 5).
- (2) The heat load limit in the absence of nitrate is 59.8 Btu/hr (e.g., 31 grams of Pu-238) per 55-gallon drum and 215 Btu/hr (e.g., 113 grams of Pu-238) per culvert (Ref. 5).

Maximum Isotopic Loadings for Individual Drums

Numbers in parentheses apply if nitrate based ion exchange resin is present. Underlined numbers indicate cases where heat loading criteria are more limiting than criticality considerations.

Isotope	Heat Load Limit grams/55-gal drum	Heat Load Limit grams/culvert
U-235	2.4×10^8 (8.0x10 ⁶)	8.6×10^8 (4.4x10 ⁸)
Np-237	3.4×10^5 (2.4x10 ⁴)	2.5×10^6 (2.4x10 ⁶)
Pu-238	<u>31</u> (<u>1.1</u>)	<u>113</u> (<u>62</u>)
Pu-239	9200 (310)	3.3×10^4 (1.8x10 ⁴)
Pu-240	<u>2490</u> (<u>83</u>)	8900 (4900)
Pu-241	175 (<u>5.8</u>)	632 (350)
Pu-242	1.6×10^5 (5900)	5.7×10^5 (3.1x10 ⁵)

b. Nuclear Criticality Safety requirements are:

- (1) Nuclear criticality safety controls will be implemented by documenting that all containers are handled and stored such that the neutron multiplication factor (k-effective) will not exceed 0.95 (Ref. 8). The k-effective will be calculated for existing and proposed arrays of containment vessels, and procedural controls will be instituted or changed as necessary to ensure that this safety factor is maintained. Separate calculations of k-effective will not be required where the following restrictions upon fissile material are adhered to:

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TECHNICAL STANDARD

C. REQUIREMENTS (CONTINUED)

6. HEAT LOAD, NUCLEAR SAFETY, AND COMBUSTIBLE GAS LIMITS
(CONTINUED)

b. Nuclear Criticality Requirements (Continued)

(2) For a single isotope present (Ref. 15):

Isotope	Limit, grams per package Column 1	Culvert limit, grams Column 2
U-235	320	208
Np-237	5000	3250
Pu-238	*	*
Pu-239	195	130
Pu-240	*	3250
Pu-241	100 ⁺	32
Pu-242	5000	3250

Notes:

- * Heat loading criteria are more restrictive.
- + Heat loading criterion may be more restrictive.

The packages referred to in Column 1 may be 55 gallon drums, polyethylene boxes, special steel boxes, or SRL casks. Only three of these packages with quantities of radionuclides not exceeding those shown in Column 1 may be stored in a single concrete culvert. The remaining packages must contain no more than the limits shown in Column 2.

- (3) When multiple isotopes are present, the nuclear safety limits are calculated by determining the fraction of nuclear safety limit for each isotope (grams present/nuclear safety limit in grams), and then adding the fractions together. The sum of fractions must be less than 1.0 (Ref. 5).
- (4) An infinite planar array of 55-gallon drums one layer high may contain up to 195 grams of Pu-239, or its equivalent, in each drum (Ref. 15).
- (5) For drums containing more than 1 gram but less than 500 grams of enriched uranium for disposal, no more than 500 grams can be placed within a 10 foot by 10 foot square, and for drums containing greater than 100 grams, there must be 3 lateral feet distance from another drum of enriched uranium (Ref. 8, p.4-77).

TECHNICAL STANDARD

C. REQUIREMENTS (CONTINUED)

6. HEAT LOAD, NUCLEAR SAFETY, AND COMBUSTIBLE GAS LIMITS
(CONTINUED)

b. Nuclear Criticality Requirements (Continued)

(6) An infinite planar array of 55-gallon drums stacked two high may contain up to 208 grams of U-235 in each drum (Ref. 14).

(7) An infinite planar array of B-25 boxes stacked four high may contain up to 150 grams of U-235 in each box (Ref. 13).

c. Combustible gas concentrations are limited to the lower flammability limit for each respective gas that may be present. The lower flammability limit for hydrogen (of primary importance) is 4 mole-percent.

All waste materials that generate combustible gases must be vented or limited in curie content to maintain gas concentrations below the lower flammability limit.

D. BASES FOR THE STANDARDS

The general bases for the revised Technical Standard are 35 years of operating experience (Ref. 1,2,3 and 8), the policies and criteria established by the Department of Energy (Ref.4), the policies and practices of the Savannah River Site (Ref. 5), the recommendations of the radiation standards-setting organizations to keep exposures to the public as low as reasonably achievable (ALARA) (Ref. 6), and the criteria established for disposal of TRU waste at the Waste Isolation Pilot Plant (Ref. 7).

1. BASES FOR THE GENERAL REQUIREMENTS

Requirement 1.a

For reasons of control and economy, solid radioactive waste should be stored or disposed in centralized locations.

Requirement 1.b

Generators should not send, nor should the radioactive and mixed waste management facility accept, clean waste for storage or disposal. In past practices, large volumes of waste containing no measurable activity have been disposed because of its point of origin. Segregation of clean waste from radioactive waste and disposal of clean waste in the sanitary landfill should become standard practice whenever practical.

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TECHNICAL STANDARD

D. BASES FOR THE STANDARDS (CONTINUED)

1. BASES FOR THE GENERAL REQUIREMENTS (CONTINUED)

Requirement 1.c

Facility 643-7G is not designed, nor permitted, as a mixed or hazardous waste disposal facility. The limited disposal volume remaining in 643-7G should be reserved for actual radioactive waste.

Requirement 1.d

Permanent records of waste inventory (isotopic, curie content, and volume) are required for many purposes: closure actions, modeling, surveillance, and other environmental considerations. Maps showing disposal and storage locations are required for modeling, future closure actions, and waste retrieval.

Requirement 1.e

The general bases for the minimum requirements for waste are improved waste containerization, avoidance of groundwater contamination by liquid wastes, and protection of employees and the public from results of explosive decomposition and fire.

Requirements 1.e.(1) through (5) are necessary to comply with DOE Order 5820.2A (Ref. 4). Requirement 1.e.(6) is required by 40 CFR 264 (Ref. 9). Requirement 1.e.(7) states the limits in Procedure Manual 5Q (Ref. 19) for contact handled waste.

Requirement 1.f

Waste must be characterized as accurately as possible to ensure that limits are maintained on nuclear criticality safety, heat load, and radiolytic gas generation. Inventory control of radionuclides is required to maintain operation within the boundaries established in the Safety Analysis (Ref. 8) and the Operational Safety Requirements (Ref. 5). Volume information is required to determine facility lifetime and construction schedules.

2. BASES FOR REQUIREMENTS FOR STORAGE OF WASTE

The basis for the requirements for storage of waste is that the waste must be stored in a retrievable manner that results in zero release of chemicals and radioactivity during the temporary storage period. It is intended that all of the stored waste will be removed before the facility is closed.

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TECHNICAL STANDARD

D. BASES (CONTINUED)

2. BASES FOR THE REQUIREMENTS FOR STORAGE OF WASTE (CONTINUED)

Requirement 2a

The operating volume limit and limits on waste parameters are used in the bases for the Safety Analysis Report (Ref. 8).

Requirement 2b

Short-term temporary storage of waste routinely placed in trench disposal is needed to maintain operational continuity if construction activities within 643-7G are delayed by weather or other events beyond the control of Waste Management.

Requirement 2c

The hazardous fraction of mixed waste is regulated by the South Carolina Department of Health and Environmental Control. Requirements 2.c.(1) and (2) state that packaging, handling, storage and monitoring will comply with applicable SCDHEC regulations.

Requirement 2d

Requirements 2.d.(1) and (3) are necessary for consistency with the assumptions and bases of the Safety Analysis Report (Ref. 8). Requirements 2.d.(2) and (5) provide compliance with DOE Order 5820.2A (Ref. 4). The heat loading and nuclear safety limits are those in the SAR and OSR documents (Refs. 5 & 8).

Requirement 2e

From time to time equipment used in radioactive service is replaced before its useful service life has been reached. Since the possibility exists that at some time in the future the equipment could be placed into service again, a location which has access control and radiological monitoring is needed. The ground surface of 643-7G provides such a location.

Requirement 2f

The requirement for three times the volume of liquid is an assumption used in the Safety Analysis Report (Ref. 8) for tritiated oil. The requirement for diked containment storage capacity is that of SCDHEC and is included in the Part B Application for mixed waste storage at SRS.

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TECHNICAL STANDARD

D. BASES (CONTINUED)

3. BASES FOR REQUIREMENTS FOR DISPOSAL OF WASTE

Requirement 3.a

Containerization of low-level waste in metal, wood, and concrete containers is standard practice at commercial facilities.

Intermediate-level waste, in general, has a greater radionuclide content than lower activity, low-level waste, and therefore requires greater protection for operations personnel during transportation, handling, and disposal operations. GCD, by its basic engineering design, should be the first choice for disposal, rather than trenches. GCD will provide a water-free solid monolithic disposal structure.

Disposal of bulky, non-containerized waste in earthen trenches provides a convenient and economical method of disposal for these items. This practice is considered in the bases for the SAR (Ref 8.).

Requirement 3.b

The large-scale nature of the chemical and reactor processes at the Savannah River Site occasionally produces large pieces of equipment that are demonstrably highly contaminated with beta-gamma emitting radionuclides and may contain high levels of alpha activity. The gamma intensity is such that measurement of the alpha activity is not possible. Operator exposure may exceed established guidelines if further decontamination of the equipment is attempted.

To meet the requirement that this equipment be protected from contact with water-saturated soil, the earthen trench in which it is to be placed shall be backfilled with approximately six feet of water-permeable material before placing the equipment in it. Experience at the waste disposal facility has shown that an earthen trench in wet weather may act as a collection sump because of the increased permeability of the backfilled soil, which is not packed as densely as the soil of the trench walls. Partially backfilling the trench prior to waste emplacement will isolate the waste from the possible water-saturated soil in the bottom four or five feet of the trench.

Alternatively, the large bulky highly contaminated equipment may be disposed of in the GCD boreholes or trenches in 643-7G. Disposal in the GCD facilities will minimize release of radioactivity to the soil or groundwater.

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D. BASES (CONTINUED)

3. BASES FOR REQUIREMENTS FOR DISPOSAL OF WASTE (CONTINUED)

Requirement 3.c

Waste from other DOE and DOD sites does not differ in any significant way from waste generated at SRS. The potential environmental effects from disposal of offsite waste at SRS have been evaluated (Ref. 12). As long as this waste meets all the requirements for disposal at SRS it can safely be disposed here.

Requirement 3.d

Absorption of liquids minimizes potential of spills during the transport, handling, and emplacement of the waste, and may slow the migration of radionuclides to the environment. The degree of liquid absorption required is that specified in DOE Order 5820.2A (Ref. 4).

Requirement 3.e

Ten feet between the bottom of the waste and the water table provides a buffer for seasonal variation in the water table. This distance is one of the bases for the SAR (Ref. 8).

Requirement 3.f

Waste is to be covered with at least four feet of soil to prevent the transport of waste materials by wind or severe storms, and to prevent fires. A depth of four feet is also required to prevent root penetration to the waste by the shallow-rooted vegetation allowed as a ground cover in the disposal facility, and to minimize personnel dose rates.

Requirement 3.g

DOE-SR security may require that certain materials that cannot be destroyed or shredded be disposed of in an irretrievable manner.

4. BASES FOR CURIE DISPOSAL LIMITS

The basis for the curie emplacement limits is that the number of curies of certain radionuclides allowed in the disposal facility should not be greater than the inventory value that is used in the Safety Analysis for the storage/disposal facility (Ref. 8). Thus, the number of curies that can be added each year should be less than or equal to the number that decay each year, thereby maintaining the present inventory level (decayed) at a relatively constant value. This constant value is the decayed inventory of radionuclides that existed at the end of calendar year 1986 when the Safety Analysis (Ref. 8) was performed.

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D. BASES (CONTINUED)

4. BASES FOR CURIE DISPOSAL LIMITS (CONTINUED)

The disposal limits are given below in rounded figures. If N_0 is the decayed inventory value, then the annual limit is $((0.693/\text{half-life}) * N_0)$.

CURIE DISPOSAL LIMITS

Radionuclide	Assumed Inventory (1986)* Rounded (curies)	Half-life, years	Annual Limit, curies/year
Cs-137	2,000	30.2	50
Sr-90	2,000	28.9	50
Co-60	410,000	5.26	60,000
H-3	2,000,000	12.33	100,000
Fission Products	20,000	Note 1	7,500 (Note 3)
Activation Prod.	350,000	Note 2	40,000 (Note 3)

* Radionuclide data is based on the COBRA burial records decayed through December 31, 1986.

Note 1: Only fission products (FP) with half-lives greater than one year are considered. These are: Sr-90, Ru-106, Cs-134, Cs-137, and Pm-147. The fraction of isotopes assumed to be present is that of high-heat waste (Reference 13); these are 0.015, 0.051, 0.018, 0.017, and 0.034, respectively. When the sum of these fractions is normalized to 1 and the decay factors applied, the total curies decaying each year is approximately 7,500.

Note 2: Only activation products (AP) with half-lives greater than one year are considered. These are Co-60 and Ni-63. The fractions of these isotopes assumed to be present are 0.62 and 0.095, respectively (Reference 12). When the sum of these fractions is normalized to 1, and the decay factors applied, the total curies decaying each year is approximately 40,000.

Note 3: Individual curie limits for fission products and activation products have been established. This activity was formerly included in the designations for other radionuclides with half-lives less than or greater than 10 years.

TECHNICAL STANDARD

D. BASES (CONTINUED)

4. BASES FOR CURIE DISPOSAL LIMITS (CONTINUED)

The table below compares the new limits with the limits in the 1975 Technical Standard, and compares the limits with the radioactivity that has been added for the years 1985 - 1987.

Radio-nuclide	New Limit	Old Limit	Curies Added*		
			1985	1986	1987
Cs-137	50	500	5.5	1.5	7.5
Sr-90	50	500	6.4	1.4	0.2
Co-60	60,000	300,000	2,700	7	35,900
H-3	100,000	400,000	44,200	14,000	47,000
FP	7,500	NA	1,680	1,790	1,550
AP	40,000	NA	5,300	5,560	9,650
Half-life > 10y	-	1,000	-	-	7.5
Half-life < 10y	-	500,000	-	-	2,550

* Values based on those reported in the COBRA database.

No annual limits are placed on TRU waste since most of this waste is stored retrievably and because of the inability to quantify TRU isotope concentrations for high gamma waste.

5. BASES FOR THE SURVEILLANCE PROGRAM

The surveillance program is required to provide a database of radiological information from which the performance of the disposal facilities can be measured.

6. BASES FOR THE HEAT LOAD, NUCLEAR SAFETY, AND COMBUSTIBLE GAS LIMITS

Requirement 6a

The heat load limits are set to avoid temperatures in excess of 190°F (the decomposition temperature of ion exchange resins in the NO₃ form) when anion resin is present in a concrete culvert, and to avoid temperatures in excess of 265°F (the melting point of high-density polyethylene) at the drum liners. Heat load limits are prescribed in the Operational Safety Requirements (OSR) (Ref. 5), which define the envelope of authorized operation of nonreactor nuclear facilities.

Requirement 6b

The nuclear criticality safety limits are set to eliminate the possibility of a nuclear excursion even if containment were breached and flooded, and the optimum moderation and fissile material configuration were obtained.

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TECHNICAL STANDARD

D. BASES (CONTINUED)

6. BASES FOR THE HEAT LOAD, NUCLEAR SAFETY, AND COMBUSTIBLE GAS LIMITS (CONTINUED)

Heat load and nuclear safety limits are prescribed in the Operational Safety Requirements (OSR) (Ref. 5), which define the envelope of authorized operation of nonreactor nuclear facilities. Other references provide the basis for nuclear criticality safety limits for B-25 boxes (Ref. 14), for drums containing Naval Fuels waste (Ref. 15), for various nuclides in concrete culverts (Ref. 16), and for storing drums of TRU waste in a planar array (Ref. 17).

Requirement 6c

Combustible gas concentrations are maintained below their flammability limit in order to prevent spontaneous combustion or explosion. Combustible gases are generated mainly from radiolytic decomposition of waste materials. The production rate of combustible gases is directly related to the curie content and amount of venting in a container.

E. RISKS

1. STORAGE OF WASTE

The policy of the Savannah River Site is that storage of TRU and other waste is only a temporary measure. The TRU waste will be retrieved, processed to meet the WIPP Waste Acceptance Criteria (Ref. 7), and transported to a repository (WIPP). TRU waste that is not practical to certify would only be disposed at SRS or another facility upon approval by DOE Headquarters (DP-12 and EH-1). Mixed low-level waste will be stored until it can be incinerated, or disposed of in the proposed Hazardous Waste/Mixed Waste Disposal Facility.

The risk of storage of TRU waste has been analyzed extensively (Ref. 8). Consequences and frequencies of occurrence have been combined for natural phenomena (high winds, earthquakes, meteorite hits), for external events (airplane, helicopter, and vehicle crashes), and for process incidents (criticality, fire, drum rupture, and solvent spills, leaks, and fires). Some events have extremely small risks because the frequencies are so low -- the estimated frequency for a meteorite hit on a TRU waste pad is $2E-10$ /year, and for an airplane crash, $6E-8$ /year. Other events, such as a fire in a drum or culvert, are estimated to have larger frequencies.

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TECHNICAL STANDARD

E. RISKS

1. STORAGE OF WASTE (CONTINUED)

In order of decreasing risk to the offsite population, the events of most significance are: fire in a culvert (frequency of occurrence $8.1\text{E-}04/\text{year}$), fire or explosion on a TRU pad (frequency of occurrence $2.1\text{E-}02/\text{year}$), and drum rupture (frequency of occurrence $2.1\text{E-}02/\text{year}$). The risks are calculated to be: 2.4, 0.19, and 0.19 person-rem/year to the offsite population, respectively. The total risk from identified pathways is 2.8 person-rem/year.

For the maximally exposed individual the events of most significance are the same, i.e., fire in a culvert, fire or explosion on a TRU pad, and drum rupture. The risks are calculated to be $5.4\text{E-}04$, $4.3\text{E-}05$, and $4.3\text{E-}05$ rem/year, respectively. The total risk to the maximally exposed individual from the identified pathways is $6.4\text{E-}04$ rem/year.

The above analyses do not take account of mitigation of radionuclide migration and remedial action by operating personnel. If these were to occur, the calculated risks would be even lower.

Other safety-related items which tend to reduce the risk of radioactive waste storage in 643-7G are:

- o The TRU waste containers are designed to be retrievable after 20 years, and to remain intact without release of contaminants during the storage period. Drum integrity has been monitored periodically since the storage operation was begun.
- o Drums containing greater than 0.5 curies of TRU waste are also placed inside of heavy concrete culverts for additional protection.
- o The TRU waste storage pads are concrete, and sloped to provide drainage to a contained sump. Liquid in the sump is analyzed for contaminants before release.
- o For mixed waste dikes and drainage to sumps provide secondary containment for spills and run-on or blowing rain water. Analysis of collected liquids, surveillance of the integrity of waste containers, and characterization and segregation of incompatible waste reduce environmental risk associated with storage of mixed waste.

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TECHNICAL STANDARD

E. RISKS (CONTINUED)

2. DISPOSAL OF WASTE

As a consequence of applying a limit on the number of curies of the different isotopes that can be added each year, the decayed inventory of radionuclides will stay relatively constant at the 1986 values used in the Safety Analysis (Ref. 8). The quantities of long-lived fission products and induced radionuclides that will survive after 100 years of surveillance and control of the disposal facility are not large -- less than 1000 curies each for Cs-137 and Sr-90, less than 10 curies of Co-60, and less than 10,000 curies of tritium.

The environmental effects and risk to man of waste disposal in the facility have been evaluated in an extensive study of the future effects of radionuclides and non-radioactive wastes (lead, mercury, cadmium) (Ref. 11). The risks have been evaluated for three cases:

1. No action
2. Closure of the site, leaving the waste.
3. Waste removal and closure.

The calculated risks are dominated by the effects of tritium, Np-237, Sr-90, and lead. All cases result in health effects of less than $3E-6$ /year for 100 years after 1986, and less than $2E-6$ /year for 1000 years after 1986.

3. HEAT LOAD, NUCLEAR SAFETY, AND COMBUSTIBLE GAS GENERATION LIMITS

The risks associated with adhering to these limits are errors made in estimating the quantity of heat-producing fissile material or combustible gas-generating material that is placed in a container.

The heat load limits are set to avoid reaching the ignition point of paper (450°F) and the melting temperature of polyethylene drum liners (256° to 275°F). The consequence of exceeding the heat load limits would be the fire in a culvert or drum as described above.

The nuclear safety limits are based on a maximum k_{eff} of 0.95. In addition, an extensive fault tree analysis has shown that the frequency of attaining criticality in the storage/disposal operation is less than once per million years (Ref. 8). Inherent risks are those resulting from errors in calibration of the assay equipment used to measure the level of radionuclides in the waste. These risks are reduced by incorporating errors associated with assay equipment into operating procedures.

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TECHNICAL STANDARD

E. RISKS (CONTINUED)

3. HEAT LOAD, NUCLEAR SAFETY, AND COMBUSTIBLE GAS GENERATION
LIMITS (CONTINUED)

The consequence of exceeding the combustible gas generation limits would be internal rupture of a drum. The risks due to this occurring are given above in E.1.

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TECHNICAL STANDARD

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