



ENGINEERING STANDARD

RADIOLOGICAL DESIGN REQUIREMENTS

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ESB TECH COMMITTEE: RADIOLOGICAL TECHNICAL
COMMITTEE

Approved by:

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REVISION HISTORY

REV	DATE	DESCRIPTION OF REVISION
0	1/8/02	Initial Issue
1	8/6/02	Revised Sections 1.4, 5.1, 5.3, 5.4.1.1, and 5.16.3. Changed Reference 6.2. Deleted Reference 6.15. Made minor editorial changes.
2	1/25/05	Periodic review. Added Section 1.5. Revised Sections 1.3, 2.1, 2.3, 3.2, 4.1.1, 4.1.2, 4.1.5, 4.1.7, 5.1, 5.3, 5.4.3.1, 5.5, 5.6.1.2, 5.6.2, 5.9, 5.13, 6.5, and 6.6. Deleted References 2.4, 2.6, and 6.17.
3	10/5/05	Added section 5.4.2.1.1 and Ref. 6.22 for Recycled Lead
4	11/27/07	Periodic review. Revised Sections 1.1, 1.2, 1.3, 2.1, 3.2, 4.1.2, 4.1.3, 4.1.6, 4.1.7, 5.1, 5.4.1.1, 5.4.1.4, 5.4.2.1, 5.4.2.4, 5.5, 5.6, 5.6.2, 5.8, 5.9, 5.10, 5.12, 5.13, 5.15, 5.16.3, 6.5, 6.14, 6.16, 6.19, 6.23, and 6.24.
5	6/22/09	Revised Sections 1.3, 1.5, 2.3, 4.1.1, 4.1.2, 4.1.5, 5.1, 5.4.3.1, 6.1, 6.7, 6.8, 6.12, 6.13, and 6.16.

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1.0 PURPOSE AND SCOPE

- 1.1 This standard provides the minimum radiological design requirements for all new SRS facilities and modifications to facilities that will contain radiological material or radiation generating devices.
- 1.2 Deleted.
- 1.3 This standard specifically excludes radiological design requirements relative to radiological effluent sampling and monitoring, nuclear incident monitoring, and environmental protection program elements, as these requirements are covered in SRS Manual 3Q [6.8], WSRC-IM-91-69 [6.9], WSRC-SCD-3 [6.14], and DOE Order 450.1A [2.3].
- 1.4 Deviation requests to the requirements of this standard shall be in accordance with WSRC-TM-95-1 [6.2] and require coordination with the Engineering Standards Board (ESB) Radiological Technical Committee.
- 1.5 Compliance with the applicable design requirements of this standard will be documented in a Radiological Design Summary Report (RDSR). The contents of the RDSR will present the technical basis for how the design addresses the applicable requirements. All radiological design documentation shall include the approval of the Radiological Technical Agency of the company responsible for the operation of the impacted facilities to ensure compliance with SRS Manual 1-01 MP4.4 [6.1].

2.0 DOE ORDERS AND STANDARDS APPLICABILITY

- 2.1 DOE Order 420.1B, *Facility Safety*.
- 2.2 DOE Order 435.1, *Radioactive Waste Management*.
- 2.3 DOE Order 450.1A *Environmental Protection Program*.
- 2.4 Deleted.
- 2.5 DOE-STD-1128-98, *Guide of Good Practices for Occupational Radiological Protection in Plutonium Facilities*.
- 2.6 Deleted.

3.0 NATIONAL CODES AND STANDARDS APPLICABILITY

- 3.1 National Codes and Standards incorporated by reference in this document shall be the revision number and date at the time this document is invoked, or as otherwise noted.
- 3.2 Deleted.

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4.0 DEFINITIONS

4.1 Definitions

- 4.1.1 Contamination Area (CA) - An area with removable surface contamination levels exceeding those in WSRC Manual 5Q Table 2-2 but not exceeding 100 times those values [6.12].
- 4.1.2 Derived Air Concentration (DAC) - A DAC is the airborne radionuclide concentration that would result in a committed effective dose of 5 rem or committed equivalent dose of 50 rem (whichever is more limiting) if inhaled by a worker for 2000 hours in a year (i.e., continuous occupancy). The individual radionuclide DAC values are contained in Chapter 4, Appendix 4B of SRS Manual 5Q [6.12].
- 4.1.3 Derived air concentration hour (DAC-hr) is the product of the concentration of radioactive material in air (expressed as a fraction or multiple of the DAC for each radionuclide) and the time of exposure to the radionuclide, in hours.
- 4.1.4 Extremities - The hands and arms below the elbow or the feet and legs below the knee.
- 4.1.5 Radiological Buffer Area (RBA) - Areas posted to minimize the spread of contamination and limit doses. An RBA boundary limits doses to general employees outside the posted area to less than 100 mrem/year. The upper limits within the RBA are 5 mrem/hr external dose rate at 30 cm and the removable surface contamination limits of SRS Manual 5Q Table 2-2 [6.12].
- 4.1.6 Shall consider/shall evaluate - Indicates that the designer must examine the requirement for their particular design and either incorporate or provide a technical justification in the documentation required by Section 1.5 as to why the requirement is not incorporated or applicable.
- 4.1.7 Total Effective Dose (TED) - TED is the sum of the effective dose (for external exposures) and the committed effective dose (for internal exposures).
- 4.1.8 Whole Body Dose Rate - Dose rate at a distance of 30 cm from a radiation source or from any surface that the radiation penetrates.

5.0 DESIGN REQUIREMENTS

5.1 Radiation Exposure Limits

During the design of new facilities or modification of existing facilities, the design objective for controlling personnel exposure from external sources of radiation in areas of continuous occupancy (2000 hours per year) shall be to maintain exposure levels below an average of 0.5 mrem per hour and as far below this average as is reasonably achievable. The design

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objectives for external dose rates for potential exposure to a radiological worker where occupancy differs from the above shall be As Low As Reasonably Achievable (ALARA) and shall not exceed the limits in Table 5-1. Regarding the control of airborne radioactive material, the design objective shall be, under normal conditions, to avoid releases to the workplace atmosphere and in any situation, to control the inhalation of such material by workers to levels that are ALARA; confinement and ventilation shall normally be used. [6.3, 6.12]. Table 5-1 summarizes the design basis external radiation exposure limits.

Table 5-1 - Design Basis Annual Occupational Radiation Exposure Limits

Type of Exposure	Limit (rem)
TED	1.0
Lens of Eye	3
Extremity	10
Any Organ (other than eye) or Tissue	10

To meet the Site's no deliberate intake policy, engineered controls will be evaluated and implemented to ensure that, under normal operating conditions, no worker will receive a deliberate intake of radionuclides.

The dose to any member of the public or a minor exposed to radiation at a DOE facility shall not exceed 0.1 rem total effective dose in a year.

5.2 Facility and Equipment Layout

5.2.1 Facility layout shall be based on segregation of facility functional areas. The first level of segregation should be separation of the process areas from the non-process areas. Within the process areas, rooms that have no significant sources of radiation, such as control rooms and Radiological Control Operations (RCO) rooms, should be separated from rooms that contain significant sources of radiation. Additional layout considerations include:

- Segregation of facility functional areas based on accessibility, shielding, and contamination control requirements.
- Grouping of rooms that are functionally and operationally alike. For example, grouping the rooms that require substantial shielding of the radioactive material and a minimum of manned access. Grouping the various rooms in one specific area of the facility will result in a more cost-effective shielding configuration.
- Grouping rooms with similar radiation/contamination potential. This will help in contamination control, access control, and Heating, Ventilation and Air Conditioning (HVAC) design. For example, parallel glovebox lines could share a common maintenance area or similar operations rooms could share a common airlock versus two small airlocks.
- Separation of components or areas potentially containing radioactive materials from clean components or areas.

5.2.2 The facility layout shall provide for segregation of administrative and other support personnel from operations and process activities.

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5.3 Access Control

Minimizing the number of entry points into a Radiological Buffer Area (RBA) shall be considered such that appropriate qualifications can be checked and access controlled. Within the RBA, appropriate entry control features shall be established for each radiological area per Reference 6.3. The degree of control shall be commensurate with existing and potential radiological hazards within the area. Controls in a High or Very High Radiation Area shall not prevent rapid evacuation of personnel. All radiological access control features shall be consistent with the site radiological access control program.

5.4 External Radiation Exposure

5.4.1 Area Radiation Levels

- 5.4.1.1 Compliance with the ALARA process and the regulatory dose limits is accomplished in part by designing radiological portions of the facility to meet predetermined maximum area radiation dose rate levels. The radiation zoning criteria for the facility is given in Table 5-2.

Table 5-2 Radiation Zoning Criteria

Radiation Zone	Design Basis Maximum Area Radiation Dose Rate (mrem/hr)	Description
1	$D \leq 0.05$ (@30cm)	Non-Rad Continuous Occupancy
2	$D > 0.05$ and $D \leq 0.5$ (@30cm)	Rad-Worker Continuous Occupancy
3	$D > 0.5$ and $D \leq 5$ (@30cm)	Intermittent Occupancy RBA
4	$D > 5$ and $D \leq 100$ (@30cm)	Radiation Area
5	$D > 100$ @30cm and $D \leq 500,000$ mrad/hr @100cm	High Radiation Area
6	$D > 500,000$ mrad/hr @100cm	Very High Radiation Area

- 5.4.1.2 The assignment of the design basis maximum radiation dose rate criteria for each area or room in the facility shall consider the occupancy times required by personnel, design basis limits on annual dose, and dose rates required for the operation of radiation sensitive equipment. These design basis maximum area radiation dose rates shall be used to determine the shielding thickness requirements for the facility. These shield thickness values, required to meet the maximum area radiation dose rates, will then be optimized to meet the ALARA principle.
- 5.4.1.3 The facility shall have design radiation dose rate information (e.g. drawings, tables, etc.) documenting the maximum area radiation dose rates in each room or area from all radiation sources during normal operation modes, shutdown, standby, and maintenance conditions. The radiation zoning criteria in Table 5-2 shall be used.

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5.4.1.4 Dose rates to personnel will be computed based on the International Commission on Radiological Protection (ICRP) Publication No. 74 fluence-to-dose conversion factors [6.24] or the ANSI/ANS-6.1.1-1977 flux-to-dose-rate conversion factors [6.23], modified as needed for consistency with 10 CFR 835 neutron radiation weighting factors (June 8, 2007 version or later).

5.4.2 Radiation Shielding

5.4.2.1 Radiation shielding may be designed using any applicable method. The selection of material properties of all shielding materials, as used in the analysis, shall be made such that the calculation results are conservative.

5.4.2.1.1 Selection of shield materials shall also consider minimization of hazardous materials (e.g. lead) and/or the encasing of such materials to preclude the generation of a mixed waste.

5.4.2.1.2 SRS recycled Lead that has no traceable material certificate will be considered 85% pure for density calculation purposes based upon information and recommendations contained in Reference 6.22.

5.4.2.2 The data necessary to develop the design basis radioactive source neutron and photon emission rates, required to perform shielding calculations, shall be provided in applicable design input documents (e.g. Plant Modification Traveler, Task Requirements and Criteria, Facility Design Description). This includes data such as isotopic distributions, masses, etc. as appropriate.

5.4.2.3 For glovebox designs, shielding for radiation sources inside the glovebox shall be considered in addition to glovebox structural shielding.

5.4.2.4 For glovebox designs, shield covers or plugs shall be supplied for each gloveport with shielding equivalent to the materials surrounding the port if the potential exists that material in the glovebox will cause dose to personnel through unused ports.

5.4.3 Penetrations

5.4.3.1 Straight-line penetrations of shield walls shall be avoided to the extent necessary to prevent radiation streaming. All penetration configurations in radiation shield walls shall be evaluated to ensure compliance with the radiation zone criteria. Higher, localized dose rates will require a case-by-case approval by the Radiological Technical Agency of the company responsible for the operation of the impacted facilities.

5.4.3.2 The design shall consider guidance from Reference 6.4 Part II Section 1.4.3 on radiation shielding penetration seals and shall incorporate requirements from Reference 6.18.

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5.4.4 Extremity And Eye Protection

Specialized tools and remote handling equipment, such as remote manipulators, shall be considered where it is anticipated that exposures to extremities and eyes would otherwise approach the dose limits in Section 5.1 or where contaminated puncture wounds could occur.

5.5 Internal Radiation Exposure

The design objective shall be, under normal and postulated operational upset conditions, to avoid releases to the workplace atmosphere. Engineered controls and features (i.e. confinement and ventilation) shall be provided to eliminate the need for respiratory protection under normal operating conditions and to minimize potential inhalation of radioactive and other hazardous material under all conditions to ALARA levels.

5.6 Radiological Monitoring Systems

Radiological monitoring equipment models specified in the SRS Radiation Monitoring Equipment (RME) Technical Basis Manual [6.5] shall be used unless otherwise approved by the Site RME Technical Authority.

All monitoring equipment shall provide means for calibration of the instruments to appropriate standards. All radiological monitoring alarm and warning systems that are required to function during a loss of power shall be provided with an uninterruptible power supply (UPS) unless it has been demonstrated that the system can tolerate a temporary loss of power without losing required data, and they are provided with standby power. Additional information on the power supply type and quality is contained in Reference 6.4 Part I Section 1.3.3.

Radiological warning and alarm systems shall be designed, installed, and tested to ensure that they can be heard in the ambient condition of the area they are intended to cover. All radiological alarm systems required for personnel protection shall annunciate inside and outside the affected area to identify hazardous condition to anyone inside or outside in the vicinity of the affected area. All radiological alarms shall be provided with both audible and visual signaling systems. The audible alarm shall have the capability to be acknowledged while the visual alarm remains. Alarm sound level guidance is contained in Reference 6.21.

In addition to a local station alarm, radiological monitoring system signals in new facilities shall have central (e.g. control room or radiation monitoring office) read-out and alarm panels that are accessible after anticipated events to evaluate internal conditions. For modified facilities, the use of central read-out and alarm panels shall be considered. For glovebox design, the use of an audible and visual alarm that can be manually activated (e.g. foot pedal, within glovebox trouble button, etc.) to signal radiological problems without removing one's arms from the glovebox shall be evaluated. The alarm shall occur in continuously occupied areas, identify the room of concern, and be uniquely identifiable versus other alarm signals.

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5.6.1 Airborne Sampling and Monitoring

- 5.6.1.1 Air sampling shall be performed in occupied areas where an individual is likely to be exposed to 40 DAC-hrs over a one year period of airborne radioactive material. Guidance on placement of samplers, in order to comply with the SRS program, is given in Reference 6.6. The design shall also evaluate particulate line loss as necessary between the sampling location and sample collection media.
- 5.6.1.2 Continuous air monitoring equipment shall be installed in occupied areas as necessary to detect and warn personnel of airborne radioactive material concentrations which could result in exceeding 40 DAC-hours in one week prior to detection by sampling. Guidance on placement of monitors, in order to comply with the SRS program, is given in Reference 6.6. The design shall also evaluate particulate line loss as necessary between the monitoring location and sample collection media.

5.6.2 Personnel Contamination Monitoring

The design shall provide for the monitoring of occupational workers in areas where radioactive materials (other than tritium only) are stored and handled. Personnel contamination monitoring equipment (with appropriate detection capability) shall be provided at the exit from all Contamination, High Contamination, and Airborne Radioactivity Areas (as defined by Reference 6.12) and Radiological Buffer Areas containing these areas to prevent the spread of contamination. Whole body personnel contamination monitoring equipment is not required at the exits from a High Contamination or Airborne Radioactivity Area if that area is contained within an appropriately monitored Contamination Area. The background radiation dose rate for personnel contamination monitors must be designed to meet the specifications of the unit (typically <0.02 mrem/hr for automated systems) and not subject to fluctuations.

5.6.3 Area Radiation Monitoring

Area radiation monitors shall be installed in occupied locations with the potential for an unexpected increase in dose rates and in locations where there is a need for local indication of dose rate prior to personnel entering remote locations.

5.7 Personnel Decontamination

The facility shall provide for a personnel decontamination facility close to the area that represents the source of potential contamination. The use of nearby, existing decontamination resources shall be considered.

5.8 Facility Operations, Maintenance, Decontamination, and Decommissioning

The design or modification of a facility and the selection of materials shall include features that facilitate operations, maintenance, decontamination, and decommissioning. For ease of operations and maintenance the design shall consider the following:

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- locating process and radiological monitoring readouts and equipment outside of radiological areas
- life expectancy and reliability of equipment to be maintained in radiological areas
- quick connect fittings or quick opening fasteners versus bolted or welded connections
- components containing radiological material or fluids must be easily drained, flushed, and/or cleaned by chemical or mechanical means
- remote or extended handle valve operators versus manual valve operators

The facility design shall incorporate measures to simplify decontamination of areas that may become contaminated with radioactive or hazardous materials. Items such as service piping, conduits, and ductwork shall be kept to a minimum in potentially contaminated areas, use of pipe/service chases shall be considered, and equipment shall be arranged to facilitate decontamination. Walls, ceilings, and floors in areas vulnerable to contamination shall be finished with washable or strippable coverings (for concrete and masonry see Reference 6.20). Liners shall be used in areas that have the potential to become highly contaminated. Cracks, crevices, and joints shall be filled and finished smooth to prevent accumulation of contaminated material. The facility design shall incorporate features that will facilitate decontamination to achieve facility decommissioning, to increase the potential for other uses, or both.

Reference 6.4 Part I Section 2.12 contains additional guidance that shall be considered.

5.9 Change Rooms / Areas

Men's and women's change rooms shall be provided for changing into and out of modesty clothing if areas within the facility will require work in protective clothing on a routine basis. The use of nearby, existing change rooms shall be considered. Change areas for the removal of protective clothing shall be provided at the exit of areas that have the potential to become contaminated. These areas shall provide space for protective clothing removal and personnel monitoring. These areas shall ensure that storage of contaminated clothing will control contamination so that it does not spread beyond the storage container.

5.10 Breathing Air Systems

Operations and maintenance of special facilities may lead to situations (e.g., accidents, special maintenance, and spill recovery) where air-supplied respiratory protection is required. For modifications, the use of existing breathing air manifolds shall be considered. Breathing air shall meet the requirements of SRS Engineering Standard 11595 [6.11].

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5.11 Contamination Control

5.11.1 Confinement

The facility shall be provided with a confinement system to prevent the migration of radioactive materials from confinement enclosures, containment vessels, process equipment, and their associated ventilation systems to occupied and unoccupied work areas. Design of confinement systems shall ensure compliance with both the internal and external radiation exposure criteria contained in Section 5.1. The design of confinement systems is an iterative process that must consider the quantity, physical form, and chemical form of the material; the efficiency of the confinement system; conditions for dispersing materials; and the type and severity of potential accidents. Hazard evaluations, risk assessments, and experience should be used to develop a practical design that will achieve the confinement system objectives.

5.11.2 Ventilation

Confinement ventilation design requirements are located in SRS Engineering Standard 15889 [6.10].

5.11.3 Access Ways

Special features (e.g. air locks, enclosed vestibules) shall be provided for access through confinement barriers to minimize the impact of facility access requirements on the ventilation system and to prevent the release of radioactive airborne materials. Guidance on the design of personnel airlocks is provided in SRS Engineering Standard 15889 [6.10].

5.11.4 Transfer Pipes And Encasements

- 5.11.4.1 When a pipe is used as the primary confinement barrier for materials (excluding ventilation systems), and the pipe exits the facility, a secondary confinement shall be provided by a double-walled pipe or other encasement/spill control. In areas within the facility, the use of double-walled pipe shall be considered.
- 5.11.4.2 Where double-walled piping or encasements are employed, leak detection shall be provided for the primary pipe, which may include liquid detection, airborne contamination monitoring, or other means, in areas affecting personnel protection or the environment.
- 5.11.4.3 There shall be no interconnection among storm water systems, the sanitary waste systems, and the radioactive or other hazardous material handling systems or areas.
- 5.11.4.4 Chilled water systems shall be designed to minimize the volume of water that can be contaminated. One technique is to use secondary water-to-water heat exchangers or double walled, gas-flushed water-to-gas heat exchangers to isolate the high volume central cooling system from possible contamination.

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5.11.4.5 The Design Agency shall consider the general guidance provided in Reference 6.4 Part II Section 1.3.8.

5.12 Material Radiation Tolerance and Compatibility

Materials inside radiation areas shall be capable of withstanding the total absorbed dose over the lifetime of the system, structure, or component or if not possible shall be easily replaceable. The use of Teflon or organic materials in radiological areas should be avoided. Reference 6.4 Part II Section 5.4 contains additional guidance related to material tolerance that shall be considered.

Facilities that handle tritium have special material radiation tolerance and compatibility considerations. The design shall consider the special tritium considerations in Section 5.1 of Reference 6.16.

5.13 Radioactive Waste

The facility design shall meet the general and facility specific waste requirements of DOE Order 420.1B Chapter I Section 3b(6) [2.1].

5.13.1 Waste Management

5.13.1.1 The design requirements for storage, transfer, monitoring, surveillance, and leak detection of high-level and low-level radioactive wastes are stated in DOE Order 435.1 [2.2].

5.13.1.2 The design shall provide for decontamination and decommissioning, and waste disposal of radioactive material. The design shall limit dispersion of radioactive materials and simplify decontamination and decommissioning.

5.13.2 Mixed Waste Requirements

Radioactive mixed wastes shall be avoided where practicable. Mixed waste that cannot be avoided shall be identified and considered in the design at the earliest possible time. Mixed waste shall be segregated and handled separately from the other types of wastes.

5.13.3 Waste Segregation

The facility design shall provide for the segregation of waste into compatible groups for storage and disposal.

5.14 Spill Prevention And Control

Spill prevention and control shall be considered in the design stage of the facility to minimize the possibility of accidentally releasing radioactive material to the environment.

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5.15 Radiological Control Space Requirements

The facility shall contain designated areas for radiological support functions. Specifically, space is required for a RCO Office, instrument storage and decontamination areas, RCO supervisor's office, desk space for RCO inspectors, counting equipment, ventilated hood as necessary for RCO operations support and records storage. The design shall evaluate the power supply and environmental needs of the counting equipment required to operate during routine and non-routine conditions.

Space for radiation monitoring equipment shall be available in shipping and receiving areas for surveying the contamination level on the surface of shipping containers and other radioactive material received from or to be shipped off-site and on-site.

5.16 ALARA

- 5.16.1 Radiation exposure of the work force and public shall be controlled such that radiation exposures are well below regulatory limits and that there are no radiation exposures without commensurate benefit.
- 5.16.2 Measures shall be taken to maintain radiation exposure ALARA through facility and equipment design and administrative control. The primary methods used shall be physical design features (e.g. confinement, ventilation, remote handling, and radiation shielding). Administrative control and procedural requirement shall be employed only as supplemental methods to control radiation exposure.
- 5.16.3 Optimization principles shall be utilized in developing and justifying facility shield design as early as possible in the design effort. A value of \$6,600/person-rem shall be used in the optimization analysis when the design limit TED of 1000 mrem is used [6.19]. If a TED limit less than that required in Section 5.1 is used, then the cost per person-rem can be taken from Table 5.3.2.1 of Reference 6.19. The design objective for personnel exposure from all sources of radiation is to reduce doses to ALARA and not exceed the Table 5-1 design basis dose limits.

6.0 References

- 6.1 SRS Manual 1-01, *Management Policies*, MP4.4 *Radiological Protection*.
- 6.2 WSRC-TM-95-1, *SRS Engineering Standards Manual, Responsibilities and Requirements*
- 6.3 Title 10 Code of Federal Regulations, Part 835, *Occupational Radiation Protection*.
- 6.4 DOE-HDBK-1132-99, *Design Considerations*, April 1999.
- 6.5 WSRC-IM-2006-00003, *Radiation Monitoring Equipment Technical Basis Manual*.
- 6.6 WSRC-IM-2001-00025, *The Savannah River Site Workplace Air Monitoring Technical Basis Manual (U)*.

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- 6.7 Deleted
 - 6.8 SRS Manual 3Q, *Environmental Compliance Manual*.
 - 6.9 WSRC-IM-91-69, *SRS Environmental Permitting "HOW" Manual*.
 - 6.10 WSRC-TM-95-1, *SRS Engineering Standards Manual*, Standard 15889, *Confinement Ventilation Systems Design Criteria*.
 - 6.11 WSRC-TM-95-1, *SRS Engineering Standards Manual*, Standard 11595, *Breathing Air Distribution Systems*.
 - 6.12 SRS Manual 5Q, *Radiological Control*.
 - 6.13 Deleted
 - 6.14 WSRC-SCD-3, *Washington Savannah River Company Nuclear Criticality Safety Manual*.
 - 6.15 Deleted
 - 6.16 DOE-HDBK-1129-2008, *Tritium Handling and Safe Storage*.
 - 6.17 Deleted
 - 6.18 WSRC-TM-95-1, *SRS Engineering Standards Manual*, Standard 07270, *Installation and Inspection of Penetration Seals (U)*.
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