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Revision 0

Building 773-A, Lab F003 Glovebox Project

Radiological Design Summary Report

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LIST OF ACRONYMS

Acronym / Abbreviation	Definition
ALARA	As Low As Reasonably Achievable
CAM	Continuous Air Monitor
CEDE	Committed Effective Dose Equivalent
CFR	Code of Federal Regulations
DAC	Derived Air Concentration
DOE	Department of Energy
HDBK	Handbook
HEPA	High-Efficiency Particulate Air
HPT	Health Physics Technology
PCM	Personnel Contamination Monitor
RadCon	Radiological Control
RBA	Radiological Buffer Area
SRS	Savannah River Site
SRTC	Savannah River Technology Center
TEDE	Total Effective Dose Equivalent
WSRC	Westinghouse Savannah River Company

1.0 INTRODUCTION

Manual WSRC-TM-95-1, Engineering Standard Number 01064, presents the radiological design criteria and requirements, which must be satisfied for all SRS facility designs. The radiological design criteria and requirements specified in the standard are based on 10 CFR 835, DOE Order 420.1, the WSRC Manual 5Q, other applicable standards, and various DOE guides and handbooks, see the References for applicable documents.

This report contains top-level requirements for the various areas of radiological protection for workers. For the purposes of demonstrating compliance with these requirements, per Engineering Standard 01064, *shall consider / shall evaluate* indicates that the designer must examine the requirement for the design and either incorporate or provide a technical justification as to why the requirement is not incorporated.

This report is to perform a radiological design review for the SRTC lab F003 glovebox upgrades of inlet ventilation, additional mechanical and electrical services, new glovebox instrumentation and alarms. This report demonstrates that the SRTC lab F003 and the gloveboxes 12, 13, and 14 meet the radiological design requirements of Engineering Standard 01064, "Radiological Design Requirements".

1.1 Project Description

It is proposed that three inactive gloveboxes previously used for analytical processes that supported the Californium Separations and Source Fabrication Process be modified to support Savannah River Technology Center (SRTC) Neptunium/Plutonium Mission work.

Within SRTC lab F003 there are currently six gloveboxes, connected to a fume hood through interlocks. These gloveboxes are identified with nameplates individually as EP 7225, EP 7224, EP721-3, EP 7222, EP 7223, and EP 7226. The first three gloveboxes, EP 7225, EP 7224, EP721-3 are from here on referred to as gloveboxes 12, 13, and 14, respectively. The last three (EP 7222, EP 7223, and EP 7226) will be detached from the first three, left in place, and not addressed further within this design change.

The following components are addressed:

- Task 1 Install inlet HEPA Filter housings
- Task 2 General Decommissioning and Removal (D&R)
- Task 3 D&R rabbit system in glovebox (GB) 14
- Task 4 Install 4 x 4 HEPA filter bank
- Task 5 Install gas tube service panel in GB 14
- Task 6 Install power service panel in GB 14
- Task 7 Install thermocouple panel in GB 14
- Task 8 Cap unused services
- Task 9 Stud welding for instrument panel attachment
- Task 10 Install glovebox 12 services
- Task 11 Install glovebox 13 services
- Task 12 Install glovebox 14 spare penetration
- Task 13 D&R glovebox 12 vacuum system

Task 14 Perform rate of rise leak test on the glovebox system

1.2 Facility Description

The existing gloveboxes have not been used for some time and this design change is required to ensure the reactivation of the SRTC Lab F003, limited to only the three gloveboxes 12, 13, and 14, including modifications to meet the new mission, come up to the current SRS radiological design requirements.

1.3 Facility Conditions

1.3.1 Normal Operations

The laboratory gloveboxes in F003 are located in an existing radiological facility. Normal operations will involve the transfer of materials associated with the Neptunium (Np) mission into and through the gloveboxes for experimental purposes. The gloveboxes will be set up in a fashion such that one will be used for separation columns where approximately 5 to 10 gram samples will be placed on ion exchange columns in an attempt to separate the Np from impurities. The Np material will be removed and placed into another glovebox where it will be precipitated at a slightly elevated temperature. The third box will be used as a place where the material may be calcined into an oxide form. The first two steps have been performed in the current location of C-159/163.

It is expected that no more than 100 g of ^{237}Np will be available at one time consisting of 50 grams in solution and 50 grams in powder form, per the accident analysis, Reference 9. The typical operation will be with approximately 5 grams of material. Material controls are in place to maintain the amount of fissile material to less than 400 grams (Reference 13) in F003. The lab is considered a Mass Control Zone, Actinide Technology Section Area VII, which has an actinide mass limit of 400 grams and strict accountability requirements per the procedure.

1.3.2 Shutdown Operations

During shutdown operations activity within the gloveboxes will cease. If necessary material will be removed from the gloveboxes for safe keeping. Minor decontamination may take place at this time.

1.3.3 Maintenance Operations

Maintenance activities will be performed using approved procedures/work packages in accordance with WSRC Manual 1Y, "Conduct of Maintenance." As necessary these procedures/work packages will identify associated precautions and applicable maintenance history information.

1.3.4 Transient Operations

There are no transient operations associated with the Neptunium removal process. The radiological status of 773-A during transient operations has not changed as a result of this glovebox modification.

1.3.5 Postulated Events and Accident Conditions

Postulated events and accident conditions have been evaluated in "SRTC F003 Lab Glovebox Upgrade Accident Analysis; Inputs and Assumptions", Reference 9.

2.0 DESIGN REQUIREMENTS

This section presents the technical basis for how the design ensures compliance with applicable requirements for each facility condition, including normal, shutdown, maintenance, transient, and postulated events and accidents.

2.1 Radiation Exposure Limits

Per SRS Engineering Standard 01064:

Per WSRC Manual 5Q, Articles 113 and 128, an individual worker's total effective dose equivalent shall be ALARA and shall be less than 1000 mrem per year. The remaining SRS radiation exposure design limits shall be ALARA and shall not exceed 20 percent of the regulatory limits. A total of 2000 hours shall be used as worker stay times for areas of continuous occupancy. Table 2-1 summarizes the design basis radiation exposure limits.

Table 2-1. Design Basis Annual Occupational Radiation Exposure Limits

Type of Exposure	Limit (rem)
Whole Body TEDE (internal + external)	1.0
Internal CEDE	0.1
Lens of Eye	3
Extremity	10
Any Organ (other than eye) or Tissue	10

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 equivalent in a year.

2.2 Facility and Equipment Layout

Per SRS Engineering Standard 01064:

Facility layout shall be based on segregation of facility functional areas.

The laboratory gloveboxes in F003 are located in an existing radiological facility. Glovebox modification activities have not affected existing layout.

2.3 Access Control

Per SRS Engineering Standard 01064:

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 10 CFR 835. The degree of control shall be commensurate with existing and potential radiological hazards within the area. No control(s) shall be established in a high or very high radiation area that would prevent rapid evacuation of personnel. All radiological access control features shall be consistent with the site radiological access control program.

The existing layout, with the included design changes, meets the need of the new mission with the three gloveboxes. Currently there are no radiation sources above background radiation in the F003 lab. This analysis only addresses up to 100 grams of Np that is being handled in the three

gloveboxes. The addition of other radioactive materials in the room for other processes is outside of the scope of this analysis. If work is conducted at the work bench or at the hoods in the room such that a radioactive source is behind the worker RCO should evaluate the need for multiple TLD's .

The ability to change the placement of the existing gloveboxes is not practical, therefore, the existing layout is analyzed for keeping dose ALARA. The separation of the column separation step from the precipitation step and the calcination step provides distance between these source terms. This is advantageous because of the L shape of the gloveboxes. The work being performed in F003 has been done in C-159/163 for over six months and the worker who does most of the work in the glovebox has only received a whole body TEDE of 111 mrem for the first six months. The extremity dose to this worker was 142 mrem to the left hand and 157 mrem to the right hand for the six month period. Therefore, controls that have been in place have kept the dose low and the workers in the lab have apparently tried to minimize their dose and properly implemented the SRTC Procedure 2.28 "ALARA Implementation Procedure". Continuation of these practices will help maintain doses ALARA.

The laboratory gloveboxes in F003 are located in an existing radiological facility with proper access controls currently in place. Glovebox modification activities have not affected existing layout.

2.4 External Radiation Exposure

This section deals with external radiation exposures and addresses whether engineered design features are required to limit worker exposures to ALARA below the Table 2-1 external exposure limits. Individuals working in SRTC are covered with division level procedures in Manuals L1 and L7.7. The facility has established good radiological practices within the procedures in these manuals as shown by Manual L1, Procedure 2.32, section on responsibilities which states each SRTC radiological worker is responsible for:

- Maintaining personal radiation exposure ALARA
- Properly donning the prescribed protective clothing and dosimetry in accordance with applicable Radiation Work Permits (RWP) while working in an area operated under radiological controls or with radioactive materials
- Observing and complying with radiological postings, labels and tags throughout SRTC facilities
- Following the requirements of this procedure and the WSRC 5Q, Radiological Control Manual, and the applicable RWPs
- Monitoring for radioactive contamination according to the requirements in this procedure, WSRC 5Q, and the posted instructions in each laboratory module or process area
- Notifying management immediately of conditions or situations where a loss of radiological control has occurred or is likely to occur
- Contacting supervision if the glovebox differential pressure is not within proper operating range

The design basis whole body TEDE (internal and external) to an individual worker shall be ALARA and shall be less than 1000 mrem/year per WSRC Manual 5Q Articles 113 and 128. Measures are taken to maintain radiation exposure in controlled areas ALARA through physical design features and administrative control. The primary methods used shall be physical design features (e.g., confinement, ventilation, remote handling, and shielding). Administrative controls shall be employed only as supplemental methods to control radiation exposure.

2.4.1 Area Radiation Levels

Per SRS Engineering Standard 01064:

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 2-2.

Table 2-2 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	$0.05 < D \leq 0.5$ (@30cm)	Rad-Worker Continuous Occupancy
3	$0.5 < D \leq 5$ (@30cm)	Intermittent Occupancy RBA
4	$5 < D \leq 100$ (@30cm)	Radiation Area
5	$100 < D$ @30cm and $D \leq 500,000$ mrad/hr @100cm	High Radiation Area
6	$D > 500,000$ mrad/hr (@100cm)	Very High Radiation Area

Current radiological surveys indicate no radiation levels above background within the F003 lab. Glovebox modification activities do not change radiation zones for the room. Previous radiation surveys of the C-159/163 lab show radiation levels in the room to be less than 5 mrem per hour which is expected to remain the same in F003. RCO procedures (Reference 6, Chapter 2, Section 224) require routine surveys and the facility RCO group has set a minimum survey frequency of daily surveys of the following areas within F003:

- Gloves
- Radiation dose rates throughout the room
- Step off pad
- Hood lips (first 6" inside of the hood)
- Any counter area

2.4.2 Radiation Shielding

Per SRS Engineering Standard 01064:

Radiation shielding may be designed using any applicable method... 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.

For glovebox designs, shielding for radiation sources inside the glovebox shall be considered in addition to glovebox structural shielding. In addition, shield covers or plugs shall be supplied for each gloveport with shielding equivalent to the glovebox if the potential exists that material in the glovebox will cause dose to personnel other than those directly handling the sources during processing operations.

For glovebox designs, shielding for radiation sources inside the glovebox shall be considered in addition to glovebox structural shielding. Consideration shall be given to shielding radiation sources inside the glovebox as the source term is developed and expanded to meet the current needs. Current work activities in C-159/163 have produced radiation whole body exposures and extremity exposures to the maximally exposed individual for the first six months of 2003 far below (< 20%) the administrative limits of Table 1-1. Projected work for F003 is similar to the activities previously done in C-159/163 so additional shielding is not warranted at this time.

The gloveboxes in F003 contains 3/8" borosilicate glass viewing windows and 1/4" front stainless steel. The gloveboxes used in C-159/163 contained 3/8-inch acrylic viewing windows and 1/8" stainless steel fronts. Dose histories for workers using the existing gloveboxes in C-159/163 did not challenge the dose limit of Table 1-1. The additional shielding of the borosilicate glass and stainless steel will ensure that glovebox activities similar to those used previously will be less than those encountered using the old gloveboxes.

2.4.3 Penetrations

Per SRS Engineering Standard 01064:

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 Technology Group of HPT.

The design shall consider guidance from HDBK-1132-99 Part II Section 1.4.3 on radiation shielding penetration seals and shall incorporate requirements from Engineering Standard 07270, Installation and Inspection of Penetration Seals

Normal penetrations such as bag-in, bag-out, and glove ports exist in the glovebox structure to allow for routine operations. Stainless steel covers exist for transfer ports on the gloveboxes. Shield covers or plugs shall be supplied for each gloveport with shielding equivalent to the glovebox, as necessary.

2.4.4 Extremity And Eye Protection

Per SRS Engineering Standard 01064:

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 Table 2-1 or where contaminated puncture wounds could occur.

The laboratory gloveboxes in F003 are located in an existing radiological facility. Extremity exposures to the worker who performed the most work on this process in C-159/163 were 142 mrem to the left hand and 157 mrem to the right hand for the first six months of 2003. The work in the new gloveboxes in F003 will be similar to that in the C-159/163 gloveboxes. Extremity exposures are comparable to the prior operation.

2.5 Internal Radiation Exposure

Per SRS Engineering Standard 01064:

The design shall ensure that respiratory personnel protective equipment is not required to meet the dose limits for operations including normal, shutdown, maintenance, transient, and postulated events and accidents. Engineered controls and features shall be provided to minimize potential inhalation of radioactive and other hazardous material under all operating conditions.

The HVAC system upgrades for the gloveboxes to make them conform to the Hood and Glovebox Guide provide improvement in airborne contamination control. The glovebox has a minimum air flow of 35 cfm and the room has at least 10 air changes per hour. To look at the possible internal exposure results from a spill the following calculations were done to show the resultant dose meets the necessary design criteria.

A scenario was chosen where a 100 gram sample vial breaks and is spilled in the glovebox, breaking the glove while being resuspended in the glovebox (25 ft³) and becoming available to the worker giving:

$$C_a = \frac{S_g}{V_g} * ARF * RF = \frac{7.05 E + 04 \mu Ci}{7.1E + 05 cc} * 3.9E - 07 = 3.9E - 08 \mu Ci cc^{-1}$$

Where:

- C_a = airborne concentration in the glovebox
- S_g = the source activity in the glovebox (100 g x 705 $\mu Ci/g$ (specific activity of Np-237)),
- V_g = the volume of the glovebox, 25 ft³, (7.1E+05 cc)
- RF = Respirable Fraction, Reference 7, equation 4.1
- ARF = the Airborne Release Fraction, from Reference 7, equation 4.1, page 4.6, given below

$$ARF * RF = A * \rho * g * h = 2E - 11 * 2 * 980 * 10 = 3.9E - 07$$

Where:

- A = empirical correlation factor of 2E-11 cm³ per g-cm² sec⁻²
- ρ = specimen density, 2 g cm⁻³
- g = gravitational acceleration, 980 cm sec⁻²
- h = fall height, 0.1 m, 10 cm

The glovebox has a ventilation of $35 \text{ ft}^3 \text{ min}^{-1}$ and a volume of 25 ft^3 , which gives 1.4 air changes per minute. If there is one minute before the individual removes their hand from the glove the dilution concentration in the glovebox, C_g , is:

$$C_g = C_a e^{-It} = 3.9E-08 \mu\text{Ci cc}^{-1} * e^{-1.4*1} = 9.6E-09 \mu\text{Ci cc}^{-1}$$

Where I is the air changes per minute and t is the time. A breach in a glove occurs and the individual draws their hand out which draws a cylinder ($r=3''$, $h=18''$, $V_c = 8341 \text{ cc}$) of air out to the workers breathing zone, BZ, ($BZ = 2 \text{ foot cube}$, 8 ft^3 or $V_{BZ} 2.3 \text{ E}+05 \text{ cc}$) giving a breathing zone concentration, C_{BZ} , of:

$$C_{BZ} = \frac{C_g * V_c}{V_{BZ}} = \frac{9.6E-09 \mu\text{Ci cc}^{-1} * 8341 \text{ cc}}{2.3E+05 \text{ cc}} = 3.5E-10 \mu\text{Ci cc}^{-1}$$

If the worker breathes this air and it is, very conservatively, assumed this air concentration is throughout the room, then we can use the room exhaust dilution (10 air changes per hour = 0.17 per minute). The Derived Air Concentration for Class W Np-237 $2 \text{ E}-12 \mu\text{Ci cc}^{-1} \text{ hr}^{-1}$ per 2.5 mrem. If it takes an exit time of 0.5 minute her dose would be:

$$CEDE = \frac{3.5E-10 \mu\text{Ci cc}^{-1} * 2.5 \text{ mrem}}{2E-12 \mu\text{Ci cc}^{-1} \text{ hr}^{-1} * 10 \text{ hr}^{-1}} * (1 - e^{-0.17*0.5}) = 3.6 \text{ mrem}$$

This is below the Table 1-1 design limit of 100 mrem CEDE.

An additional scenario of dropping 20 grams of material that is in a glass vial in a plastic bag onto the floor and the bag and vial rupture is considered. The individual is immediately enveloped in the source and takes 30 seconds to leave the room. A drop height of 1 meter will be used.

$$ARF * RF = A * \rho * g * h = 2E-11 * 2 * 980 * 100 = 3.9E-06$$

Where:

A	=	empirical correlation factor of $2E-11 \text{ cm}^3 \text{ per cm}^2 \text{ sec}^{-1}$
ρ	=	specimen density, 2 g cc^{-1}
g	=	gravitational acceleration, 980 cm sec^{-2}
h	=	fall height, 1.0 m, 100 cm

Source term (S_g) = MAR x DR x ARF x RF

Where:

MAR	=	Material at risk = 20 grams of Np-237, $14.1E+03 \mu\text{Ci}$
DR	=	Damage ratio = 0.5 only 50% of the material is available from breach of both the vial and plastic bag
ARF*RF	=	Airborne Release Fraction = $3.9E-06$, from above

$$S_g = 14.1 \text{ E}+03 \text{ } \mu\text{Ci} \times 0.5 \times 3.9\text{E}-06 = 0.03 \text{ } \mu\text{Ci}$$

Using reference woman as the worker 160 cm tall who is enveloped in a hemisphere with 160 cm radius = $(4/3 \pi r^3)/2 = 1.72\text{E}+07\text{cc}/2 = 8.58\text{E}+06 \text{ cc}$

$$C_a = \frac{S_g}{V_g} = \frac{0.03 \text{ } \mu\text{Ci}}{8.58\text{E} + 06 \text{ cc}} = 3.2\text{E} - 09 \text{ } \mu\text{Ci cc}^{-1}$$

Her breathing rate is 9100 L per 8 hr shift, which is 0.316 L sec^{-1} . For 10 seconds the volume of air breathed, V_a , is:

$$V_a = 10 \text{ sec} * 0.316 \text{ L sec}^{-1} * 1000 \text{ cc L}^{-1} = 3.16\text{E}+03 \text{ cc}$$

If she is exposed to this activity for 10 seconds on her way out she will get an uptake of:

$$U_{w1} = \int_0^t C_a * V_a * e^{-It} dt = C_a V_a * \int_0^t e^{-It} dt = \frac{C_a V_a}{I} (1 - e^{-It})$$

Where:

U_{w1} is the worker uptake,

I is the air changes per minute (0.17) and

t is the exposure time, 10/60 minute.

Which becomes:

$$U_{w1} = \frac{3.2\text{E} - 09 \text{ } \mu\text{Ci cc}^{-1} * 3.16\text{E} + 03\text{cc}}{0.17} (1 - e^{-0.17*0.167}) = 1.7\text{E} - 06 \text{ } \mu\text{Ci}$$

The activity to which the worker was exposed is then dispersed into an half right circular cylinder along the pathway she walks for 20 seconds to get out of the room. The RCC is 160 cm x 305 cm (10^3) = $2.46\text{E}+07/2 = 1.23\text{E}+07 \text{ cc}$

The activity in this air volume is:

$$(0.03 \text{ } \mu\text{Ci} - 1.7\text{E}-06 \text{ } \mu\text{Ci})/1.23\text{E}+07 \text{ cc} = 2.4\text{E}-09 \text{ } \mu\text{Ci cc}^{-1}$$

This activity is diluted with room ventilation and her uptake for the 20 seconds to get to the door is:

$$U_{w2} = \frac{C_a V_a}{I} (1 - e^{-It}) = \frac{2.4\text{E} - 09 \text{ } \mu\text{Ci cc}^{-1} * 6.32\text{E} + 03\text{cc}}{0.17} (1 - e^{-0.17*0.33}) = 4.9\text{E} - 06 \text{ } \mu\text{Ci}$$

The total uptake, U_{wt} , is the combination of U_{w1} and $U_{w2} = 6.6\text{E}-06 \text{ } \mu\text{Ci}$. The Annual Limit on Intake (ALI) for Class W Np237 is $4.8\text{E}-03 \text{ } \mu\text{Ci}$, ($2\text{E}-12 \text{ } \mu\text{Ci/cc} \times 2400\text{E}+06\text{cc}$, 10 CFR 835) which can be used to determine the workers dose with:

$$CEDE = U_{xt} * \frac{5000 \text{ mrem}}{ALI} = \frac{6.6E - 06 \mu Ci * 5000 \text{ mrem}}{4.8E - 03 \mu Ci} = 6.9 \text{ mrem}$$

This is below the design basis limit, however, it is suggested that samples not be carried in glass vials but placed in Nalgene bottles to prevent breakage.

2.6 Radiological Monitoring Systems

Per SRS Engineering Standard 01064:

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 noise level guidance is contained in Engineering Guide 01061-G.

In addition to a local station alarm, radiation 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.

Glovebox modification activities do not affect existing conditions with regards to radiation warning and alarm systems or their performance. The systems provide equivalent protection to prior operations using the same processes. The use of a manually activated alarm without removing one's arms from the glovebox was considered, but not included as the room is a large, open space and will normally be occupied by more than one person who could be called over in case of trouble.

2.6.1 Airborne Sampling and Monitoring

Per SRS Engineering Standard 01064:

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 *The Savannah River Site Workplace Air Monitoring Technical Basis Manual*. The design shall also evaluate particulate line loss as necessary between the sampling location and sample collection media.

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 Section 2.1 dose limits prior to detection by sampling. Guidance on placement of monitors, in order to comply with the SRS program, is given in *The Savannah River Site Workplace Air Monitoring Technical Basis Manual*. The design shall also evaluate particulate line loss as necessary between the monitoring location and sample collection media.

Per 10 CFR 835.403(b):

Real-time air monitoring shall be performed as necessary to detect and provide warning of airborne radioactivity concentrations that warrant immediate action to terminate inhalation of airborne radioactive material.

The laboratory gloveboxes in F003 are located in an existing radiological facility. RCO has evaluated the airflow and placed a CAM in F003. Additionally, at least one retrospective air sampler is used to provide for high-volume grab samples.

2.6.2 Personnel Contamination Monitoring

Per SRS Engineering Standard 01064:

The design shall provide for the monitoring of occupational workers in work areas where radioactive materials (other than tritium only) are stored and handled. Appropriate whole body personnel contamination monitoring equipment shall be provided at the exit from all Contamination and Radiological Buffer Areas where potential for contamination (other than tritium only) exists, to prevent the spread of contamination. 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).

The background radiation dose rate at the personnel contamination monitors are designed to meet the specifications of the unit (typically <0.02 mrem/hr for automated systems). A personnel contamination monitor (PCM-1B) is placed appropriately prior to exit from the area associated with F003.

2.6.3 Area Radiation Monitoring

Per SRS Engineering Standard 01064:

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.

Glovebox modification activities do not affect existing conditions with regards to area radiation monitors. Current practices of performing radiation dose rates and surveys daily help maintain radiation dose ALARA. All radioactive materials must be logged upon entrance to or exit from the F003 lab giving RCO the opportunity to survey the material and properly place it for ALARA considerations. No area radiation detector is required because of the restriction of no more than 400 grams of the Np material at any one time within the lab and all material must be accounted for when transferred in or out of the room giving RCO the ability to monitor the dose rates as material accumulates.

2.7 Personnel Decontamination

Per SRS Engineering Standard 01064:

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.

The F003 lab has a personnel decontamination facility close to the area that represents the source of potential contamination per DOE-HDBK-1132-99 Part I Section 1.3.4. Decontamination facility locations shall be balanced commensurate with available radiological control resources. Existing building personnel decontamination facilities will be used and are located in room E041, the RadCon office is across the hall from F003.

2.8 Facility Operations, Maintenance, Decontamination, and Decommissioning

Per SRS Engineering Standard 01064:

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

The facility design shall incorporate measures to simplify decontamination of areas that may become contaminated with radioactive or hazardous materials.

Glovebox modification activities have not affected existing facility capabilities in this area. The floor is tile, there is no suspended ceiling and the ceiling is painted. All walls are painted. The laboratory bench is the hard black slate material. The fume hoods in the room are stainless steel lined. The transfer passageways are stainless steel.

2.9 Change Rooms / Areas

Per SRS Engineering Standard 01064:

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.

Existing building facilities will be used and are located in room E035 close to the F003 area. Glovebox modification activities have not affected existing change area locations.

2.10 Breathing Air Systems

Per SRS Engineering Standard 01064:

Operations and maintenance of special facilities may lead to situations (e.g., accidents, special maintenance, spill recovery) where air-supplied respiratory protection is required. For modifications, the use of existing breathing air manifolds shall be considered.

This section is not applicable because the glovebox system does not interface with any breathing air systems. Breathing air will not be needed for work within the gloveboxes in F003. There is breathing air available outside of F003 for work such as high activity maintained.

2.11 Contamination Control

This section addresses whether engineered design features are required for contamination control in order to limit worker exposures to ALARA below the Table 2-1 exposure limits.

2.11.1 Confinement

Per SRS Engineering Standard 01064:

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 limits contained in Section 2.1.

Per 10 CFR 835.1002(c):

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.

Per HDBK-1132-99, Part I, Section 1.1.2:

Confinement system features, including confinement barriers and associated ventilation systems, are used to maintain controlled, continuous airflow from the environment into the confinement building, and then from uncontaminated areas of the building to potentially contaminated areas, and then to normally contaminated areas.

Each glovebox has separate inlet and outlet ventilation ports and is independent of all other gloveboxes. The gloveboxes are operated at a negative pressure so that any leakage of the system would be from the laboratory atmosphere into the gloveboxes. Ventilation flow in the radiohood is from the laboratory atmosphere into the hood. The gloveboxes are considered primary confinement, with the laboratory, F003, as a secondary confinement having 10 air changes per hour, and the tertiary confinement of the 773-A building.

2.11.2 Ventilation

Per SRS Engineering Standard 01064:

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

Each glovebox in F003 is able to be isolated from all of the other gloveboxes. Acceptance testing for the gloveboxes specify negative pressure testing at -1.5 inches water column. The gloveboxes contain HEPA exhaust filters and appropriate inlet filters. Inlet and outlet ventilation ports for the gloveboxes are configured in the updraft cross-flow ventilation airflow pattern. The updraft configuration was selected due to ergonomic and space considerations regarding the location of the exhaust filters. The design changes meet or exceed the applicable standard.

2.11.3 Access Ways

Per SRS Engineering Standard 01064:

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.

An airlock is used at the entry to F003 lab.

2.11.4 Transfer Pipes And Encasements

Per SRS Engineering Standard 01064:

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.

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.

There shall be no interconnection among storm water systems, the sanitary waste systems, and the radioactive or other hazardous material handling systems or areas.

Chilled water systems shall be designed to minimize the volume of water that can be contaminated.

Per HDBK-1132-99, Part II, Section 1.3.8:

The routing of piping containing radioactive materials should consider the reduction of exposure levels to ALARA.

Transfer Pipes and Encasements are not used for passage of material between the gloveboxes in F003. The existing high activity drains are double walled. Routine radiation surveys will be used to detect any unusual accumulation within the drain line.

2.12 Material Radiation Tolerance and Compatibility

Per SRS Engineering Standard 01064:

Materials inside radiation areas shall be capable of withstanding the total absorbed dose over the lifetime of the system, structure, or component. The use of Teflon or organic materials in radiological areas should be avoided.

All gloveboxes in F003 are fabricated from Stainless Steel 304L. The windows are plate glass. The gasket is neoprene 65-70 Duro. None of these materials are significantly affected by the expected radiation levels in the gloveboxes.

2.13 Radioactive Waste

Per SRS Engineering Standard 01064:

The facility design shall meet the general and facility specific waste requirements of DOE Order 420.1A Section 4.1.1.2.

Per Manual 5Q, Article 441:

Radiological operations generating radioactive waste shall be designed and developed to promote minimization and permit segregation, monitoring, treatment, storage, and disposal.

2.13.1 Waste Management

Per SRS Engineering Standard 01064:

The design requirements for storage, transfer, monitoring, surveillance, and leak detection of high-level and low-level radioactive wastes are stated in DOE Order 435.12.

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.

Solid waste will be containerized and bagged out of the bagout glovebox. Liquid waste will be disposed through a high activity waste line in the gloveboxes. Upon removal from the glovebox it will be surveyed and handled in accordance with existing, approved SRTC facility procedures

2.13.2 Mixed Waste Requirements

Per SRS Engineering Standard 01064:

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.

No hazardous waste or mixed waste will be generated under the current work scenario in F003. If it is generated it will be surveyed and handled in accordance with existing, approved SRTC facility procedures.

2.13.3 Waste Segregation

Per SRS Engineering Standard 01064:

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

Waste will be surveyed and handled in accordance with existing, approved SRTC facility procedures.

2.14 Spill Prevention And Control

Per SRS Engineering Standard 01064:

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.

Per DOE-HDBK-1132-99, Part I, Section 2.1.2:

The piping system that collects contaminated liquids should be designed so that effluents from leaks in the system can be collected without releasing the liquids into the personnel access areas or to the environment.

Per DOE-HDBK-1132-99, Part I, Section 2.8.2:

The use of multiple barriers should be emphasized when necessary to restrict the movement of radioactive liquid waste that has the potential for human contact or for reducing groundwater quality below requirements.

Spills, overflow, or leakage from storage vessels or other primary confinement structures should be collected and retained within a suitable secondary confinement structure (e.g., secondary vessel, dike or berm, elevated threshold within a storage or process building, etc.). The secondary confinement structure should be able to retain the maximum radioactive liquid waste inventory that may be released by a spill, overflow, or leak from the primary confinement structure.

The gloveboxes of F003 are sealed to prevent the leakage of any spills or overflow of liquid material. The radiohood contains a drain to the High Activity Drain System of SRTC for disposal of appropriate liquid waste.

2.15 Radiological Control Space Requirements

Per SRS Engineering Standard 01064:

The facility shall contain designated areas for radiological support functions. Specifically, space is required for a Radiological Control (RadCon) Office, instrument storage and decontamination areas, RadCon supervisors office, desk space for RadCon inspectors, counting equipment, 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.

The laboratory gloveboxes in F003 are located in an existing radiological facility where adequate space is already provided.

2.16 ALARA

Per SRS Engineering Standard 01064:

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.

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.

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 TEDE of 1000 mrem is used. If a TEDE limit less than that required in Section 2.1 is used, then the cost per person-rem can be taken from S-CLC-G-0025310. The design objective for personnel exposure from all sources of radiation is to reduce doses to ALARA and below the Table 2-1 design basis dose limits.

The projected dose for Np operations is so low that permanent modification to gloveboxes is not cost effective. The use of temporary, spot shielding within the gloveboxes is beneficial and should be continued as RadCon suggests.

SRTC Procedure 2.26, Manual L1, "Work in Radiation, High Radiation and Very high Radiation Areas specifically addresses ALARA for the facility and promotes good ALARA work practices by the workers. This is shown in the following steps from the procedure:

- 5.1.1** Prior to performing work in HRAs and VHRAs, a pre-job briefing shall be held to discuss the work taking place and how exposure may be maintained ALARA.
- 5.1.2** Exposures are to be maintained ALARA.
- 5.1.3** Personnel should be cognizant of their current radiation dose by periodic (monthly or quarterly) reports to line management or by checking with facility RPD.
- 5.1.4** A record of employee exposure is to be maintained using the RWP and the Employee Radiation Dose Record (OSR 4-27) or other individual dose records when personnel wear a Self-Reading Dosimeter per WSRC 5Q1.1, procedure 504, Radiological Work Permit, and WSRC 5Q1.1, procedure 601, Use of Dosimetry and Employee Radiation Dose Tracking Responsibilities.
- 5.1.5** The use of long-handled tools should be utilized when high extremity exposure rates are present.
- 5.1.6** Mock-ups are to be utilized, where feasible. Mock-ups must be utilized for whole body dose rates >1 rem/hr unless otherwise approved by the Facility Manager.
- 5.1.7** Fabrication of materials and components should be performed outside the RA, HRA or VHRA.
- 5.1.8** For high dose work, EPDs shall be used.

Requirements for entry to High Radiation Areas , <1 rem/hr, in addition to the requirements in step 5.3.1:

- A determination of the worker's current exposure, based on primary and supplemental dosimeter readings
- An ALARA Review performed in accordance with WSRC 5Q1.1, procedure 505, ALARA Review Procedure

- Formal Technical Work Document
- Pre-job briefing

5.3.5.2 For HRAs >1 rem/hr, additional approval by the Facility Manager and the RPD Facility Manager is required.

There currently are no very high radiation areas within SRTC.

3.0 SUMMARY AND CONCLUSIONS

The radiological design requirements specified in SRS Engineering Standard 01064, 10 CFR 835, DOE Order 420.1, WSRC Manual 5Q, and other applicable documents, have been addressed. The above sections present the technical basis for the radiological design for the Building 773-A, Lab F003 Glovebox Project for the Np mission, in meeting these radiological design requirements. Applicable controls in place in SRTC through their accountability, ALARA, RadCon and operating procedures allow the work to be done ALARA. Additionally a Radiological Design Summary Report, "Building 773-A, Lab C-159/163 Glovebox Project", has looked at similar operations with no radiological concerns and is partially applicable.

4.0 REFERENCES

- 1 DOE-HDBK-1132-99; DOE Handbook, Design Considerations
- 2 DOE Order 5400.5, Radiation Protection of the Public and the Environment
- 3 DOE Order 5480.4, Environmental Protection, Safety and Health Protection Services
- 4 SRS Engineering Practices manual, Guide 13090-G, "Hood and Glovebox Guide (U)"
- 5 SRS Engineering Standards Manual WSRC-TM-95-1, Standard Number 15889, "Confinement Ventilation Systems Requirements"
- 6 WSRC Procedure Manual 5Q, "Radiological Control"
- 7 DOE Handbook, DOE-HDBK-3010-94, December 1994, "Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities" Volume 1 – Analysis of Experimental Data
- 8 Code of Federal Regulations, Title 10 Part 835, "Occupational Radiation Protection", Appendix A, "Derived Air Concentrations (DAC) for Controlling Radiation Exposure to Workers at DOE Facilities"
- 9 WSMS-SAE-M-03-0071, "SRTC F003 Lab Glovebox Upgrade Accident Analysis; Inputs and Assumptions"
- 10 SRTC Procedure 2.26, Manual L1, "Work In Radiation, High Radiation And Very High Radiation Areas"

- 11 SRTC Procedure 2.28, Manual L1, "ALARA Implementation Procedure"
- 12 SRTC Procedure 2.32, Manual L1, "Radiological Work Practices"
- 13 SRTC Procedure 1.02, Manual L7.7, "Access Controls for Category III and IV Quantities of Nuclear Materials"
- 14 SRTC Procedure 1.17, Manual L7.7, "SRTC Nuclear Criticality Safety Program"
- 15 WSRC-TR-2002-0089, "Building 773-A, "Lab C-159/163 Glovebox Project Radiological Design Summary Report", November 2002