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Our ref:

HEM-17-59

Date:

October 3, 2017

Subject:

Westinghouse Hematite Decommissioning Project - Request for NRC Review of Final Status Survey Final Report Volume 4, Chapter 3, Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 21,

26 and 27 (License No. SNM-00033, Docket No. 070-00036)

The purpose of this letter is to provide for the U.S. Nuclear Regulatory Commission review of the Final Status Survey document Final Status Survey Final Report Volume 4, Chapter 3, Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27).

Attachment 1 contains Final Status Survey Final Report Volume 4, Chapter 3, with a CD containing Appendices.

Please contact me at 314-810-3353, should you have questions or need additional information.

Sincerely,

Kenneth E. Pallagi Licensing Manager,

Hematite Decommissioning Project

There Effer

Attachment: 1) Final Status Survey Final Report Volume 4, Chapter 6, Survey Area Release Record for Building Survey Area 01, Survey Unit 13, 14, 15, 16, 17, 18, 19, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27), with a CD containing Appendices (HDP-RPT-FSS-302)

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cc:

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J. A. Smith, NRC/DUWP/MDB

Attachment 1

Final Status Survey Final Report Volume 4, Chapter 3

Survey Area Release Record for Building Survey Area 01, Survey Unit 13, 14, 15, 16, 17, 18, 19, 21, 26 and 27 with CD containing Appendices

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036



Final Status Survey Report

Hematite Decommissioning Project

Final Status Survey Final Report Volume 4, Chapter 3

TITLE:

Survey Area Release Record for Building Survey

Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 21, 26

and 27

(BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26

and BSA 02-27)

REVISION:

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EFFECTIVE DATE: OCT 0 3 2017

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Date

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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LIST OF ACRONYMS AND SYMBOLS

ALARA As Low As Reasonably Achievable

CFR Code of Federal Regulations

cm centimeter(s)

cpm count(s) per minute
CSM Conceptual Site Model

DCGL Derived Concentration Guideline Level

DCGL_{SO} Derived Concentration Guideline Level for Small Office

DCGL for average concentrations over a survey unit, used with statistical tests.

("W" suffix denotes "Wilcoxon")

DP Hematite Decommissioning Plan

ft foot (feet)

FSS Final Status Survey

FSSFR Final Status Survey Final Report

gcpm gross count(s) per minute GPS Global Positioning System

HDP Hematite Decommissioning Project

HP Health Physics

HRCR Hematite Radiological Characterization Report

I & C Isolation and Control IAL Investigation Action Level

LSA Land Survey Area

m meter(s) m² square meter(s)

MARSSIM Multi-Agency Radiation Survey and Site Investigation Manual

MCL Maximum Concentration Limit
MDA Minimum Detectable Activity
MDC Minimum Detectable Concentration
mrem milliroentgen equivalent man

NAD North American Datum

NaI Sodium Iodide

ncpm net count(s) per minute NCS Nuclear Criticality Safety

NRC U.S. Nuclear Regulatory Commission

QC Quality Control

Ra Radium

RASS Remedial Action Support Survey

SOF Sum of Fractions

SSC Systems, Structures and Components

SU Survey Unit Tc Technetium

TEDE Total Effective Dose Equivalent

Th Thorium Uranium

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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EXECUTIVE SUMMARY

This Survey Area Release Record (SARR) presents the results of the final status radiological surveys of the Hematite Decommissioning Project (HDP) Building Survey Area (BSA) 02, Survey Unit (SU) 13 (BSA 02-13), SU 14 (BSA 02-14), SU 15 (BSA 02-15), SU 16 (BSA 02-16), SU 17 (BSA 02-17), SU 18 (BSA 02-18), SU 19 (BSA 02-19), SU 21 (BSA 02-21), SU 26 (BSA 02-26), and SU 27 (BSA 02-27). As provided in Final Status Survey Final Report (FSSFR), Volume 1, Chapter 1, Section 7.0 {ML15257A307}, the final report summary, FSSFR Volume 7, *Final Status Survey Final Report*, will be submitted at the conclusion of the post-remediation groundwater monitoring period. FSSFR Volume 7 will be submitted to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 Code of Federal Regulations (CFR) 20 Subpart E, "Criteria for License Termination."

As provided in FSSFR Volume 4, Chapter 1, Building Survey Areas (BSA) Overview, Section 1 states "Site-specific building and structural surface DCGLs were derived using the RESRAD-BUILD computer code, Version 3.4, by using the building occupancy scenario for two conceptual site models (CSM) having differing room sizes (Small Office and Large Warehouse). The Small Office CSM resulted in the most limiting DCGLs." As such, the DCGLs based on the Small Office CSM have been selected for all building surfaces regardless of room size.

The objective of the Final Status Survey (FSS) for the SUs was to obtain and document measurement results, analytical data, and other supporting information in order to demonstrate that after completion of remediation the residual radioactivity levels in BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27 meet the criteria for unrestricted release.

This SARR was prepared as described in FSSFR Volume 4, Chapter 1, Section 8.0, *Survey Area Release Record Organization*, as implemented by FSS procedure HDP-PR-FSS-722.

1.0 REPORT BACKGROUND

As a result of the U. S. Nuclear Regulatory Commission (NRC) feedback regarding the submittal of the FSSFR, Westinghouse and the NRC agreed that Westinghouse would develop an outline presenting the format and content of FSS documents required for NRC review. Westinghouse provided the outline to the NRC for discussion during the August 19, 2015, publicly noticed teleconference and the format was agreed upon {ML15238B032}.

FSSFR Volume 4, Chapter 1, Revision 1, *Building Survey Areas (BSA) Overview* provides the information common to building survey areas. This report, FSSFR Volume 4, Chapter 3, builds upon the general information provided in FSSFR Volume 4, Chapter 1, Revision 1.

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Decommissioning
Project

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2.0 HDP SITE, BSA AND SURVEY UNIT DESCRIPTIONS

2.1 HDP Site Description

A general description of the HDP site is given in FSSFR Volume 1, Chapter 1.

2.2 BSA 02 Configuration

The HDP Decommissioning Plan (DP) Chapter 14 provided the conceptual approach for the configuration of BSAs and the SUs within a BSA. BSA 02 is the structure known as Building 230. As one of the buildings indicated in the DP to remain after remediation was complete, there were no changes to the Building 230 (the building structure) the boundary of BSA 02. Figure 2-1 provides the final configuration of BSA 02 and survey units.

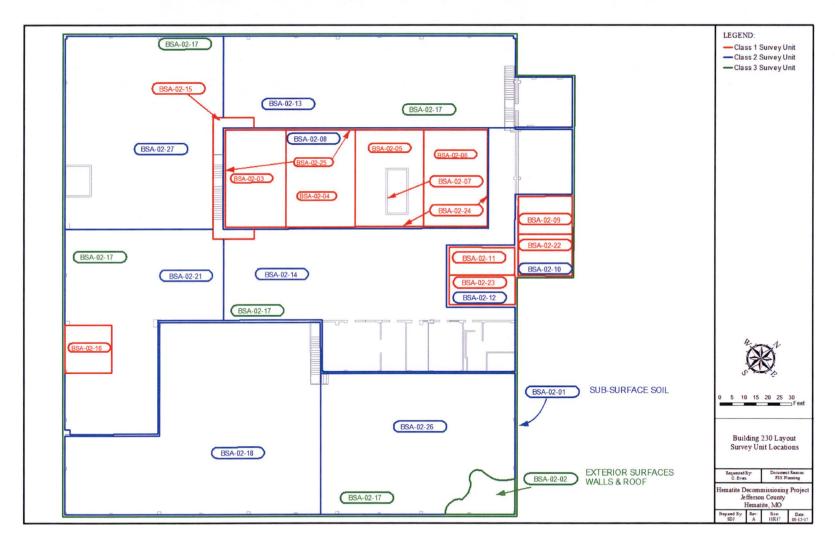
2.3 BSA 02 Survey Unit Configuration

DP Chapter 14-16 provided the conceptual approach for the SU configuration for Building 230 (BSA 02). The DP stated that it was expected that the conceptual boundaries of the SUs would be altered based on the actual configuration and condition of the SU at the time of survey design. As expected, it was necessary to modify the boundary of SUs within BSA 02 to facilitate the FSS process. Although there were changes to the SU boundaries the changes were such that no area within the conceptual boundaries as approved in the DP resulted in a reduction in classification. As such, the SUs remain compliant with the DP in regards to classification.

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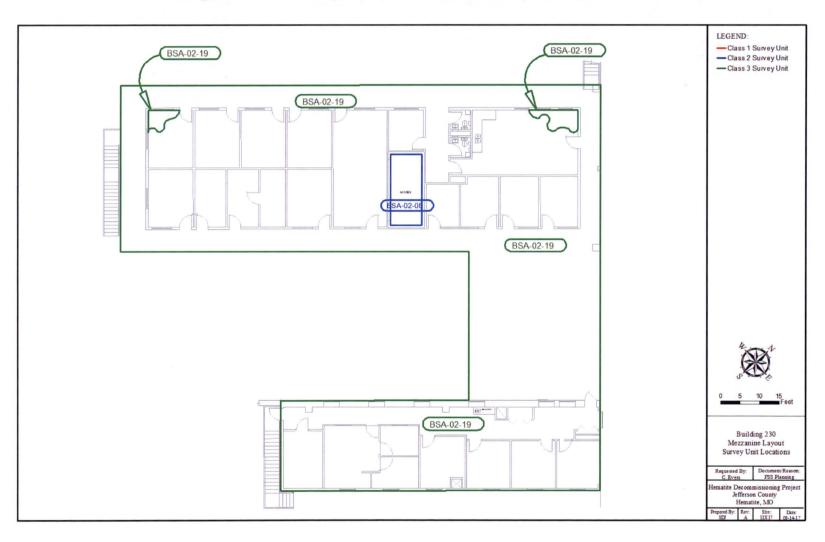
Figure 2-1
Final Configuration of Building Survey Area 02 and Survey Units (Ground Level)



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Figure 2-2
Final Configuration of Building Survey Area 02 and Survey Units (Mezzanine Level)



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2.3.1 BSA 02-13 Survey Unit Description

The BSA 02-13 SU consists of the floors, lower walls, and staircase of the Building 230 area designated as the "U-Shaped Area (NW) Section 6 Floor and Walls" as indicated in Figure 2-1. The SU area consists of a portion of the large bay and the adjacent electrical room. Figure 2-3 provides a view of portions of the concrete floor of BSA 02-13 (foreground) and BSA 02-27 (background). Figure 2-3 is representative of all the SUs discussed in this report.

The floor consists of concrete and small areas of metal decking. The walls of the SU are two meters high and consist of metal and the concrete footing.

As prepared for FSS, BSA 02-13 presents 700 m² in planar (2-dimensional) extent.

Figure 2-3 View of BSA 02-13 and BSA 02-27



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2.3.2 BSA 02-14 Survey Unit Description

The BSA 02-14 SU consists of the floors and lower walls of the Building 230 area designated as the "U-Shaped Area (SE) Section 7 Floor and Walls" as indicated in Figure 2-1. The SU area consists of a portion of the large bay, the area known as the HP offices and the HP Instrument Lab.

The floor consists of concrete. There are areas in which the concrete floor was removed to access the floor drains and associated piping which were removed for disposal (see Figure 13-1). The walls of the SU are two meters high and consist of metal and drywall. One side of each wall was removed to allow for visual and radiological inspection prior to FSS.

As prepared for FSS, BSA 02-14 presents 1,068 m² in planar (2-dimensional) extent.

2.3.3 BSA 02-15 Survey Unit Description

The BSA 02-15 SU consists of the Building 230 area designated as the "U-Shaped Area Section 8 Trench" SU as indicated in Figure 2-1. The SU area consists of a square concrete trench below floor grade which served as an electrical cable trace. All electrical components were removed from the SU prior to FSS. The bottom and walls of the trench consist of concrete.

As prepared for FSS, BSA 02-15 presents 45 m² in planar (2-dimensional) extent.

2.3.4 BSA 02-16 Survey Unit Description

The BSA 02-16 SU consists of the Building 230 area designated as the "U-Shaped Area Section 9 Spill Area" SU as indicated in Figure 2-1. This is a floor area in Building 230 identified in the conceptual SU configuration due to previously identified areas of elevated activity in the floor seams found during radiological characterization activities. As the potential exists for residual radioactivity to represent a significant fraction of the Structures, Systems, and Components (SSC) DCGL of 18,925 dpm/100 cm² the SU has been designated as a Class 1 SU. Records indicate the cause of the localized floor contamination was a spill of contaminated material in the area.

As prepared for FSS, BSA 02-16 presents 49.4 m² in planar (2-dimensional) extent.

2.3.5 BSA 02-17 Survey Unit Description

The BSA 02-17 SU consists of the upper walls of the Building 230 area designated as the "U-Shaped Area All Upper Walls Ceiling" SU as indicated in Figure 2-1. The SU consists of the metal walls, and ceiling rafters that make up the large majority of the surface area of the Building 230 interior.

As prepared for FSS, BSA 02-17 presents 7,436 m² in planar (2-dimensional) extent.

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2.3.6 BSA 02-18 Survey Unit Description

The BSA 02-18 SU consists of the lower walls and floor of the Building 230 warehouse area designated as the "Warehouse Area West" SU as indicated in Figure 2-1.

The warehouse area floor consists of concrete. There is an area in which the concrete floor was removed to access the floor drain and associated piping which were removed for disposal (see Figure 41-1). The walls of the SU are two meters high and consist of metal.

As prepared for FSS, BSA 02-18 presents 618 m² in planar (2-dimensional) extent.

2.3.7 BSA 02-19 Survey Unit Description

The BSA 02-19 SU consists of the floors, walls and ceilings of the Building 230 mezzanine level office area designated as the "Mezzanine" SU as indicated in Figure 2-2. Most floor areas which are constructed of concrete were covered with floor tile which was installed during original construction of Building 230. The walls consist of drywall.

As prepared for FSS, BSA 02-19 presents 6,901 m² in planar (2-dimensional) extent.

2.3.8 BSA 02-21 Survey Unit Description

The BSA 02-21 SU consists of the floor and lower wall of the Building 230 storage area and is designated as the "U-Shaped Area (SW) Storage Floor and Walls" SU as indicated in Figure 2-1. The floor consists of concrete.

As prepared for FSS, BSA 02-21 presents 449 m² in planar (2-dimensional) extent.

2.3.9 BSA 02-26 Survey Unit Description

The BSA 02-26 SU consists of the floor and lower wall of the Building 230 storage area and is designated as the "Warehouse Area East" SU as indicated in Figure 2-1. The floor consists of concrete and the walls of the SU are two meters high and consist of metal and the concrete footing.

As prepared for FSS, BSA 02-26 presents 586 m² in planar (2-dimensional) extent.

2.3.10 BSA 02-27 Survey Unit Description

The BSA 02-27 SU consists of the floor and lower wall of the Building 230 FSS office area and is designated as the "U-Shaped Area (NW) FSS Floor and Walls" SU as indicated in Figure 2-1. The floor consists of concrete and the walls of the SU are two meters high and consist of metal and the concrete footing.

As prepared for FSS, BSA 02-27 presents 904 m² in planar (2-dimensional) extent.

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3.0 HISTORY OF USE OF BUILDING 230

Building 230 was constructed in 1992 and housed the fuel assembly fabrication equipment. Prior to construction of Building 230, soil under this building was sampled and determined to be less than an average of 13 pCi/g Total Uranium.

Fuel fabrication operations were primarily confined to the Rod Load Room Area, Cushman Room and the Gadolinium and portions of the "U Shaped Area" of the building. The primary operation was the loading of fuel pellets, which were manufactured in the Process Building and transferred to Building 230, into fuel rods and then into fuel assemblies.

Shortly after cessation of fuel fabrication operations which occurred in 2001, Westinghouse began the process of removing the fuel inventory and the fuel fabrication equipment out of Building 230. Once all fuel pellets and fabrication equipment was removed from the building, the building was radiologically surveyed. Where necessary areas were decontaminated, and subsequently determined to be acceptable for continued office, warehousing and administrative use. To facilitate the equipment removal and termination of all activities in the Process Building the Health Physics (HP) laboratory and the HP instrumentation room were moved to Building 230.

In preparation for remediation activities Building 230 was utilized in its continued use as office, administrative and warehouse use. In the warehouse area (BSA 02-26) a containment structure was installed which supported the installation of the Water Treatment System used to process remediation excavation stormwater. At the conclusion of remediation activities the Water Treatment System and containment were removed from the building.

Upon completion of remediation activities on June 30, 2016 Building 230 was vacated with the remaining site personnel and administrative activities transferred to Building 110. Building 230 remains vacant.

As provided in the DP, the MARSSIM classification of the SU's in this report were determined in the following manner; areas that required remediation were designated as Class 1, areas where radioactive materials were handled, but no remediation was required were designated as Class 2, and areas that served administrative purposes only were designated as Class 3.

3.1 Radioactive Materials in Building 230

The radioactive materials that were present in Building 230 originated from the fuel assembly fabrication process use of the building. The radioactive material associated with Building 230 consists of the radionuclides of concern as provided in the DP Section 14.1.1 and reiterated in FSSFR Volume 1, Chapter 1, Section 5.1.

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3.2 Remediation and Remedial Action Support Surveys (RASS) Phase

The section below provides a summary of the remediation and the preparation of BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26, and BSA 02-27 SUs for FSS.

3.2.1 Remedial Actions in Building 230

As discussed in Section 3.0 above the decontamination activities performed in Building 230 at the conclusion of the removal of the fuel inventory and fuel fabrication equipment served to allow use of Building 230 without any radiological controls with exception of the sanitary drains located in the men's and women's restrooms. This allowed for the need to complete only minor remediation activities to prepare each of the SUs for FSS. The following subsections discuss the remediation activities for the SUs described in this report.

3.2.1.1 BSA 02-13

No additional remediation activities were necessary to prepare BSA 02-13 for FSS.

3.2.1.2 BSA 02-14

To prepare BSA 02-14 for FSS in locations where floor drains and associated piping and where sanitary piping existed the overlying concrete flooring was removed to allow for the removal of the drains and piping. As BSA 02-14 is designated a Class 2 survey area drywall and/or wall coverings were removed on one side of the wall to allow for radiological and visual inspection.

3.2.1.3 BSA 02-15

No additional remediation activities were necessary to prepare BSA 02-15 for FSS.

3.2.1.4 BSA 02-16

BSA 02-16 was known to contain an area of elevated fixed contamination resulting from a spill of contaminated material occurring during the fuel fabrication operational timeframe of Building 230. The contamination was primarily identified in the floor joints that connected the individual concrete pads comprising the area. The area was decontaminated prior to submittal of the DP, and BSA 02-16 was designated as MARSSIM Class 1 due to the historical knowledge of previously performed remediation. All RASS measurements indicated that previously performed remediation was successful, and that the area was ready to undergo FSS, no additional remediation was necessary.

3.2.1.5 BSA 02-17

No additional remediation activities were necessary to prepare BSA 02-17 for FSS.

3.2.1.6 BSA 02-18

To prepare BSA 02-18 for FSS in locations where trench type floor drains and associated piping existed the overlying concrete flooring was removed to allow for the removal of the piping.

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3.2.1.7 BSA 02-19

No additional remediation activities were necessary to prepare BSA 02-19 for FSS.

3.2.1.8 BSA 02-21

No additional remediation activities were necessary to prepare BSA 02-21 for FSS.

3.2.1.9 BSA 02-26

No additional remediation activities were necessary to prepare BSA 02-26 for FSS.

3.2.1.10 BSA 02-27

No additional remediation activities were necessary to prepare BSA 02-27 for FSS.

3.2.2 FSS Preparation Assessment

Remedial Action Support Surveys are conducted to determine when an area or SU had been adequately prepared for FSS, and provide updated estimates of the parameters to be used for planning the FSS. RASS of the Building 230 SUs was performed with handheld detectors, direct total surface contamination (TSC) measurements at specified intervals, biased measurements at areas of elevated activity or special areas of interest, and smear sampling for removable radioactivity.

The results used to develop the FSS plans for BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26, and BSA 02-27 are summarized in Table 3-1 below.

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Table 3-1 Summary of RASS Results for BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27

Survey Unit		easurements (Net eta-Gamma)	Max Remova	DCGL Fraction	
Survey Chit	Average	Max	Alpha		
BSA 02-13	170	450	< MDA	< MDA	0.9%
BSA 02-14	234	800	< MDA	< MDA	1.2%
BSA 02-15	343	4,025	< MDA	< MDA	1.8%
BSA 02-16	268	1,319	< MDA	< MDA	1.4%
BSA 02-17	42	360	< MDA	< MDA	0.2%
BSA 02-18	287	376	< MDA	< MDA	1.5%
BSA 02-19	213	3,850	< MDA	< MDA	1.1%
BSA 02-21	375	621	< MDA	< MDA	2.0%
BSA 02-26	287	376	< MDA	< MDA	1.5%
BSA 02-27	141	519	< MDA	< MDA	0.7%

Notes

- 1. All units are in disintegrations per 100 square centimeters (dpm/100 cm²)
- 2. Results reflect net concentrations after subtraction of ambient background.
- 3. DCGL Fraction: mean activity of all RASS direct measurements taken within the SU/SSC DCGL (18,925 dpm/100 cm²).

All results of the RASS were a fraction of the $DCGL_{SO}$ (18,925 dpm/100 cm²) and the data set was considered sufficient to support FSS design.

3.2.3 Isolation and Control

Isolation and Control of the BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27 SUs was performed through the use of postings informing the workforce that the area was undergoing FSS activities. Since the SUs are completely enclosed in an indoor facility, with no radiological remediation work performed in any adjacent area, no additional controls were required.

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4.0 BSA RELEASE CRITERIA

As the release criteria for all BSA SUs is common, FSSFR Volume 4, Chapter 1, Section 3.0, *Release Criteria*, provides a detailed discussion on the release criteria that is applicable to BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26, and BSA 02-27. Table 4-1 provides the applicable DCGLs.

 $\label{thm:continuous} Table~4-1\\ Building~and~Structural~Surfaces~Gross~Radioactivity~DCGL_W~for~Small~Office$

Radionuclide	DCGL _w (dpm/100 cm ²)	Radioactivity Fractions Based on Characterization Data ^a		
U-234	20,000	8.27E-01		
U-235 + D	19,000	3.72E-02		
U-238 + D	21,000	1.27E-01		
Tc-99	13,000,000	2.83E-03		
Th-232 + C	1,200	3.21E-03		
Np-237 + D	2,700	5.57E-05		
Pu-239/240	3,500	2.03E-06		
Am-241	3,400	2.68E-03		
	Totals:	1.0		
Gross Activity	$DCGL_{SO} (dpm/100 cm^2)^b$:	18,925		

^a Values are taken from Table 4-1 of DP Chapter 4.

^b Calculated using Equation 4-4 of MARSSIM and rounded down (truncated) to two significant figures.

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5.0 FINAL STATUS SURVEY DESIGN BSA 02-13

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-13 as well as summarizing the applicable requirements of the FSS Plan. These include the DCGL_{SO}, scan survey coverage and Investigation Action Level (IAL). The radiological instrumentation used in the FSS of BSA 02-13 and the detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-13 were driven by the type (Structure) and Class (Class 2) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 2015.

5.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-13. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

5.1.2 Scan Coverage

As a Class 2 structure SU, the scan survey requirement is a minimum of 10% of the exposed surfaces of the structure.

5.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-93 detector, paired with a Ludlum Model 2360 data logging meter.

5.1.4 Scan Minimum Detectable Concentration (MDC)

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 200 cpm (based on observed operational instrument background) for the Ludlum Model 43-93 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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$$Scan \ MDC = \frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe\ Area}{100}\right)}$$

Equation 5-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_{i} * \varepsilon_{s} * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes:

 ϵ_i = 2 pi (π) instrument efficiency for nuclide of concern ϵ_s = surface efficiency for nuclide of concern Yield = 100% for all nuclides of concern Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 5-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{200}{60} \times \frac{60}{1}}}{0.707 \times 0.0907 \times (\frac{100}{100})} = 2,351 \text{ dpm}/100 \text{ cm}^2$$

Equation 5-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-93 is given in Table 5-1.

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 5-1
Total Weighted Efficiency Calculation (Ludlum Model 43-93) for BSA 02-13

Ludlum 2360	Ludlum Model 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	Pal. Efficiency B HDP Efficiency N/A 25.50%		B Cal. Efficiency
268477	PR289424	100 cm ²	25.30%	N/A			
		TOTAL WEIG	SHTED INSTRUMENT EFF	ICIENCY CALCULATIO	N		
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ε _s)	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.2530	0.25	1.00	2.682E-03	1.70E-04
Np-237	Alpha	5.0	0.2530	0.25	1.00	5.573E-05	3.52E-06
Pu-239	Alpha	5.2	0.2530	0.25	1.00	2.027E-06	1.28E-07
Tc-99	Beta	0.294	0.2550	0.25	1.00	2.829E-03	1.80E-04
Th-232	Alpha	4.1	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-228	Beta	0.046	0.2550	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.2550	0.50	1.00	3.214E-03	4.10E-04
Th-228	Alpha	5.5	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-224	Alpha	5.8	0.2530	0.25	1.00	3.214E-03	2.03E-04
U-234	Alpha	4.9	0.2530	0.25	1.00	8.270E-01	5.23E-02
U-235	Alpha	4.7	0.2530	0.25	1.00	3.720E-02	2.35E-03
Th-231	Beta	0.390	0.2550	0.25	1.00	3.720E-02	2.37E-03
U-238	Alpha	4.3	0.2530	0.25	1.00	1.270E-01	8.03E-03
Th-234	Beta	0.270	0.2550	0.25	1.00	1.270E-01	8.10E-03
Pa-234m	Beta	2.20	0.2550	0.50	1.00	1.270E-01	1.62E-02
						Σ=	9.07%

 $Total\ Weighted\ Instrument\ Efficiency = \Sigma\ Weighted\ Instrument\ Efficiency\ for\ all\ Nuclides\ of\ Concern\ Weighted\ Instrument\ Efficiency = \epsilon_i * \epsilon_s * Yield * Activity\ Fraction$

 ϵ_i = 2 Pi Instrument Efficiency for Nuclide of Concern

 ε_s = Surface Efficiency for Nuclide of Concern

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5.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_S \left(1+\frac{t_S}{t_b}\right)}}{(\varepsilon_t)(t_S)\left(\frac{A}{100 \text{ cm}^2}\right)}$$

Equation 5-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

 $t_b = Background count time (minutes);$

 ε_t = Total weighted efficiency (2π) ; and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{200 \times 1\left(1+\frac{1}{1}\right)}}{(0.0907)(1)\left(\frac{100}{100}\right)} = 759 \text{ dpm/}100 \text{ cm}^2$$

Equation 5-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-93 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-13. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

5.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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5.1.7 BSA 02-13 FSS Design Summary

The complete FSS Plan for BSA 02-13 is provided in Appendix K. A summary table of the requirements in the FSS Plan for BSA 02-13 is presented in Table 5-2 below.

Table 5-2 FSS Design Summary for BSA 02-13

Portable Instrument Scanning:				
Scan Coverage		Minimum of 10% of BSA 02-13 total area		
Scan MDC 2,351 dpm / 100 cm ² (Ludlum 43-93) 1,193 dpm / 100 cm ² (Ludlum 43-37)				
Investigation Action Level (IAL):		2,351 dpm / 100 cm2 (Ludlum 43-93) 1,193 dpm / 100 cm2 (Ludlum 43-37)		
Total Surface Contamination (TSC)	Measurements:			
Surface	Minimum Number Measurements	of	Comments	
Building 230: U-Shaped Area – Section 6 (floor, lower walls, and stairs)	11	A total of 13 TSC measurements have been systematically designe random start point.		
TSC Investigation Action Level	18,925 dpm / 100 cm ² (Adjusted Gross DCGL)			
Removable Activity Locations:				
After each TSC measurement, at the sa	ame point as the TSC m			
smear over the surface (e.g. exterior wa 4" box.				
4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amount of the supervision for guidance on the supervision for guidance of the supervision for guidance	seams, cracks, or pene ant and specific location atic MDA, adjustments t	etration	ement, using moderate pressure swipe a cloth-shaped pattern within an approximately 4" by his, and at floor/wall interfaces. Consult FSS biased measurements. At locations where rument efficiency or volumetric sampling may	
4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amou measurements exceed the instrument sta	seams, cracks, or pene unt and specific location atic MDA, adjustments to for guidance.	etration	rshaped pattern within an approximately 4" by the series of the series o	
4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amount measurements exceed the instrument state be necessary – consult FSS supervision	seams, cracks, or pene unt and specific location atic MDA, adjustments the for guidance. Use state the state of the state	etration on soft to instructed for titic (TS	rs, and at floor/wall interfaces. Consult FSS biased measurements. At locations where	
4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amount measurements exceed the instrument state be necessary – consult FSS supervision Instrumentation:	seams, cracks, or pene unt and specific location atic MDA, adjustments to for guidance. Use state ele	etration ons of to instructed for tic (TS evated	rshaped pattern within an approximately 4" by the series of series and at floor/wall interfaces. Consult FS: biased measurements. At locations where the series of series are series of series and to obtain SC) measurements; used to investigate	

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6.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-13

FSS was performed in accordance with procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems, and Components.

6.1 Scan Survey Performance

As a Class 2 SU the FSS plan required that a minimum of 10% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover greater than the minimum requirement of 10% of the structural surfaces (provided in Appendix U).

6.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated for BSA 02-13, and a total of thirteen (13) measurements were designed by the FSS Plan. These direct, static-count measurement locations were designed in a random pattern (See Figure 6-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 6-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix K).

No systematic location exceeded the $DCGL_{SO.}$ The highest observed systematic TSC measurement was 1,306 dpm/100 cm² (7% of the $DCGL_{SO}$). No removable contamination measurement exceeded the Minimum Detectable Activity (MDA). The FSS documentation for BSA 02-13 is provided in Appendix U.

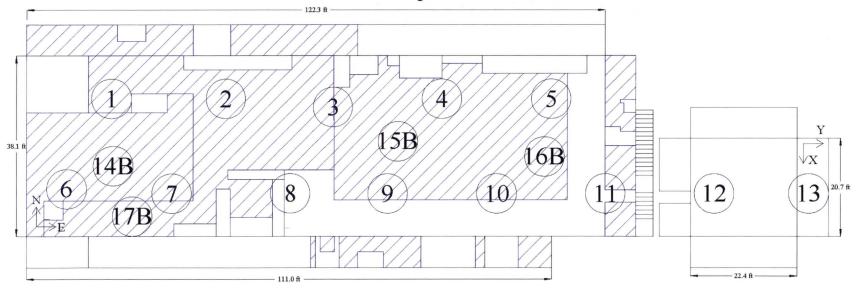
FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

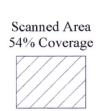
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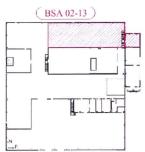
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Figure 6-1 BSA 02-13 Systematic Measurement Locations

BSA 02-13 Floor Area U-Shaped / Northeast Area







	Sample Location		X	Y	
		Surface	Coordinates	Coordinates	
			(feet)	(feet)	
	1	Floor	19.0	29.0	
	2	Floor	42.0	29.0	
	3	Floor	64.9	29.0	
	4	Floor	87.9	29.0	
	5	Floor	110.9	29.0	
	6	Floor	7.5	9.0	
	7	Floor	30.5	9.0	
	8	Floor	53.4	9.0	
	9	Floor	76.4	9.0	

Cample		X	Υ	
Sample Location	Surface	Coordinates	Coordinates	
Location		(feet)	(feet)	
10	Floor	99.4	9.0	
11	Floor	122.3	9.0	
12	Floor	oor 145.3		
13	East Wall	11.7	5.6	
14B	Floor Penetration	20.0	14.0	
15B	Diamond Plate	82.4	24.0	
16B	Floor Penetration	108.0	15.0	
17B	Floor Wall Joint	26.0	0.0	

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 6-1 FSS Measurement Locations for BSA 02-13

Hematite		Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development								
Decommission: Project	ing					Revision: 10	Appendix P-4, Page 1 of 1			
APPENDIX P-4 FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES										
Survey Area:	BSA 02		5-10 mm 15-10 mm 15-		ing Survey Area (Building 230)					
Survey Unit:					U-Shaped Area (Northeast) - Lower Walls, Floor and Stairs					
Survey Type:	FSS				2					
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes			
B02-13-01-S-F-S-00	F	S	NA	NA	29.0	19.0	Floor			
B02-13-02-S-F-S-00	F	S	NA	NA	29.0	42.0	Floor			
B02-13-03-S-F-S-00	F	S	NA	NA	29.0	64.9	Floor			
B02-13-04-S-F-S-00	F	S	NA	NA	29.0	87.9	Floor			
B02-13-05-S-F-S-00	F	S	NA	NA	29.0	110.9	Floor			
B02-13-06-S-F-S-00	F	S	NA	NA	9.0	7.5	Floor			
B02-13-07-S-F-S-00	F	S	NA	NA	5.6	30.5	Floor			
B02-13-08-S-F-S-00	F	S	NA	NA	9.0	53.4	Floor			
B02-13-09-S-F-S-00	F	S	NA	NA	9.0	76.4	Floor			
B02-13-10-S-F-S-00	F	S	NA	NA	9.0	99.4	Floor			
B02-13-11-S-F-S-00	F	S	NA	NA	9.0	122.3	Floor			
B02-13-12-S-F-S-00	F	S	NA	NA	9.0	145.3	Floor			
B02-13-13-S-W-S-00	W	S	NA	NA	5.6	11.7	East Wall			
B02-13-14-S-F-B-00	F	В	NA	NA	14.0	20.0	Floor Penetration			
B02-13-15-S-F-B-00	F	В	NA	NA	24.0	82.4	Floor Diamond Plate			
B02-13-16-S-F-B-00	F	В	NA	NA	15.0	108.0	Floor Penetration			
B02-13-17-S-F-B-00	F	В	NA	NA	0.0	26.0	Wall/Floor Joint			

*X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area)

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

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6.3 Biased Measurements

In total, four (4) areas were identified for biased measurement. These areas were both identified by scan measurements that approached or exceeded the Scan IAL, and were visually identified as cracks, or breaks in the concrete floor where there was a higher than normal potential for contamination to accumulate. No biased measurement was identified to exceed the DCGLso, the highest identified result was 1,337 dpm/100 cm² (7% of the DCGLso).

6.4 Quality Control Measurements

The Quality Control (QC) requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, no QC measurements were necessary for BSA 02-13.

7.0 FINAL STATUS SURVEY RESULTS BSA 02-13

During the performance of FSS in BSA 02-13, all scan measurements exceeding the Scan MDC of 2,250 dpm/ 100 cm^2 were identified for biased measurement. No static measurement exceeded the DCGL_{SO} of 18,925 dpm/ 100 cm^2 . No removable contamination measurement exceeded the MDA, therefore no removable contamination measurement exceeded 10% of the DCGL_{SO}. The highest observed TSC measurement was 1,337dpm/ 100 cm^2 (biased location, 7% of the DCGL_{SO}), and the average residual radioactivity based on all systematically collected measurements is 836 dpm/ 100 cm^2 (4% of the DCGL_{SO}).

The analytical data sheets used to evaluate the BSA 02-13 FSS data are provided in Appendix A. A summary table of the FSS results is presented below in Table 7-1.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 7-1 FSS Data Summary for BSA 02-13

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² (α+β)	Corrected Net dpm/100cm ²	Fraction of DCGL Step 8.4.3
B02-13-01-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	243	160	83	861	861	5%
B02-13-02-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	233	160	73	757	757	4%
B02-13-03-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	207	160	47	487	487	3%
B02-13-04-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	240	160	80	829	829	4%
B02-13-05-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	258	160	98	1016	1016	5%
B02-13-06-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	234	160	74	767	767	4%
B02-13-07-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	250	160	90	933	933	5%
B02-13-08-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	238	160	78	809	809	4%
B02-13-09-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	242	160	82	850	850	4%
B02-13-10-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	260	160	100	1037	1037	5%
B02-13-11-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	256	160	96	995	995	5%
B02-13-12-S-F-S-00	Floor	1/11/2016	alpha + beta TSC	286	160	126	1306	1306	7%
B02-13-13-S-W-S-00	East Wall	1/11/2016	alpha + beta TSC	181	160	21	218	218	1%
B02-13-14-S-F-B-00	Floor Penetration	1/11/2016	alpha + beta TSC	289	160	129	1337	1337	7%
B02-13-15-S-F-B-00	Floor Diamond Plate	1/11/2016	alpha + beta TSC	231	160	71	736	736	4%
B02-13-16-S-F-B-00	Floor Penetration	1/11/2016	alpha + beta TSC	245	160	85	881	881	5%
B02-13-17-S-F-B-00	Wall/Floor Joint	1/11/2016	alpha + beta TSC	172	160	12	124	124	1%

Max 1306 836 Mean **DCGL**so 850 Median 1.00 Stdev 265.4

mrem/year

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8.0 ALARA EVALUATION BSA 02-13

All measurements collected within BSA 02-13 were evaluated against the DCGL $_{\rm SO}$. For BSA 02-13 no measurement result exceeded the DCGL $_{\rm SO}$. The average result, based on all systematically collected measurements was 4% of DCGL $_{\rm SO}$ for BSA 02-13. The average of all measurements equates to residual activity contribution from the SU area of 1.0 mrem/year for BSA 02-13. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the DCGL $_{\rm SO}$.

As the estimated Total Effective Dose Equivalent (TEDE) for BSA 02-13 is below the regulatory release criterion of 25 mrem/year, the conclusion of the As Low As Reasonably Achievable (ALARA) evaluation is that the FSS of BSA 02-13 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-13.

9.0 FSS PLAN DEVIATIONS BSA 02-13

There were no deviations from the FSS Plan as written.

9.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-13.

10.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

10.1 Data Quality Assessment for BSA 02-13

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-13 (see Figure 10-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (Operation of the Ludlum 2360 for Final Status Survey), and HDP-PR-HP-411 (Radiological Instrumentation).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.

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- The TSC systematic measurements that were collected (on a systematic pattern) and the scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems and Components*.
- Quality Control sample results were not necessary for BSA 02-13. However a Quality Control Replicate Survey was performed for BSA 02-16 and BSA 02-18, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-13 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Thirteen (13) systematic measurements were collected in BSA 02-13. None of the 13 measurements exceeded the DCGL_{SO} resulting in a systematic average result of 4% of the DCGL_{SO}. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 10-1. The Sign Test was successful as the total number of systematic measurements (13), exceeded the minimum requirement of 9 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-13 was 7% of the DCGL_{SO}. The average residual radioactivity concentration fraction based on the systematically collected measurements was 4% of the DCGL_{SO}, resulting in a residual dose contribution of 1.0 mrem/year.
- No FSS measurement result in BSA 02-13 exceeded the DCGL_{SO}, therefore an
 elevated measurement comparisons (EMC) or hot spot averaging was not
 required.
 - HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-13 was completed prior to and after the performance of the FSS. BSA 02-13 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

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 $\alpha = 0.05$

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Table 10-1 Sign Test for BSA 02-13

Sign Test							
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference		
B02-13-01-S-F-S-00	Floor	861	0.045	0.955	0.955		
B02-13-02-S-F-S-00	Floor	757	0.040	0.960	0.960		
B02-13-03-S-F-S-00	Floor	487	0.026	0.974	0.974		
B02-13-04-S-F-S-00	Floor	829	0.044	0.956	0.956		
B02-13-05-S-F-S-00	Floor	1016	0.054	0.946	0.946		
B02-13-06-S-F-S-00	Floor	767	0.041	0.959	0.959		
B02-13-07-S-F-S-00	Floor	933	0.049	0.951	0.951		
B02-13-08-S-F-S-00	Floor	809	0.043	0.957	0.957		
B02-13-09-S-F-S-00	Floor	850	0.045	0.955	0.955		
B02-13-10-S-F-S-00	Floor	1037	0.055	0.945	0.945		
B02-13-11-S-F-S-00	Floor	995	0.053	0.947	0.947		
B02-13-12-S-F-S-00	Floor	1306	0.069	0.931	0.931		
B02-13-13-S-W-S-00	East Wall	218	0.012	0.988	0.988		
			Number of Positive D	ifferences (S+)	13		
		Sign To	est Critical Value (MAR	SSIM Table I-3)	9		

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST:

PASS

Critical V	IM Table I-3 alues for the t Statistic S+	MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+			
N	Alpha = 0.05	N	Alpha = 0.05		
4	4	28	18		
5	4	29	19		
6	5	30	19		
7	6	31	20		
8	6	32	21		
9	7	33	21		
10	8	34	22		
11	8	35	22		
12	9	36	23		
13	9	37	23		
14	10	38	24		
15	11	39	25		
16	11	40	25		
17	12	41	26		
18	12	42	26		
19	13	43	27		
20	14	44	27		
21	14	45	28		
22	15	46	29		
23	15	47	29		
24	16	48	30		
25	17	49	30		
26	17	50	31		
27	18				

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Figure 10-1 Data Evaluation Checklists prepared for BSA 02-13 (page 1 of 2)

Hematite	Procedure: HDP-PF	R-FSS-721, Final Statu	s Survey Data Eval	uation				
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APPENDIX G-1 FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST								
Survey U		Description: Description:	Building Survey A U-Shaped Area (Northea					
to dat	all measurements and/or a analysis for FSS been idance with Section 8.1 of	individually reviewed		Yes 🛛 N	io 🗌			
acqui	all systematic measurer red at the locations speci ctions?			Yes 🛛 N	lo 🗌			
	all scans surveys been red in the FSSP and the FS			Yes 🛛 N	lo 🗌			
	all biased measurements locations specified in the			Yes 🛛 N	lo 🗌 NA 🗌			
	duplicate and/or split sar red at each location design		ts been taken or	Yes 🗌 N	lo 🗌 NA 🖂			
capab	the instruments used to le of detecting the ROCs propriate investigation le	s or gross activity at a		Yes 🛛 N	Іо 🗌			
analy	the calibration of all inst ze data, current at the tir rmed using a NIST traceal	me of use and were th		Yes 🛛 N	ło 🗌			
	the instruments successfe required, after use on the			Yes 🛛 N	No 🗌			
9. Do th	e samples match those ide	entified on the chain of	custody?	Yes N	lo 🗌 NA 🖂			
	e QC Sample Results mee PR-FSS-703, Final Status			Yes 🗌 N	No NA 🖂			
11. Are a	ll Laboratory QC paramet	ters within acceptable l	imits?	Yes 🗌 N	No NA 🛛			
	If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.							
Comment	s: N/A							
Quality Rec	ord							

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Figure 10-1
Data Evaluation Checklists prepared for BSA 02-13 (page 2 of 2)

Hematite	Procedure: HDF	2-PR-FSS-721, Final Status Survey Data Evaluation	
commissioning Project		Revision: 10	Appendix G-1, Page 2 of 2
FINAL	STATUS SURV	APPENDIX G-1 EY DATA QUALITY OBJECTIVES REVIEW CHEC	KLIST
Survey Area: Survey Unit:	No. BSA 02 No. 13	Description: Building Survey Area (Building Description: U-Shaped Area (Northeast)-Lower Walls	*
Discrepancy:	None		
Corrective Acti	ons Taken: No	ne	
			No 🗌 NA 🖂
a. If "No	, then forward th	is form to the RSO.	No 🗌 NA 🖂
a. If "No"	", then forward the wing questions with mswer to question	is form to the RSO. If be answered by the RSO.	No □ NA ⊠
a. If "No" 12. The follow a. If the a still va b. If "No"	", then forward the wing questions with this wer to question lid? ", then are the exi	is form to the RSO. Il be answered by the RSO. 11 was "No", then is the affected data Yes The sting valid measurements or samples.	
a. If "No" 12. The follow a. If the a still va b. If "No" sufficie c. If "No"	", then forward the wing questions with the same to question lid?", then are the existent to demonstrate ", then direct the a	is form to the RSO. Il be answered by the RSO. 11 was "No", then is the affected data Yes sting valid measurements or samples	No □ NA ☒
a. If "No" 12. The follow a. If the a still va b. If "No" sufficience. If "No" demon	", then forward the wing questions with the same to question lid?", then are the existent to demonstrate ", then direct the a	is form to the RSO. Il be answered by the RSO. In 11 was "No", then is the affected data Yes Yes Yes Recompliance for the survey unit? Recompliance for additional measurements or samples as necessary.	No □ NA ☒

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11.0 CONCLUSION BSA 02-13

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-13 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 11-1
BSA 02-13 DCGL_{SO} and Dose Summation

AVE. SU	RESIDUAL
RADIO	ACTIVITY
DCGL _{so}	4%
Dose	1.0 mrem/year

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12.0 FINAL STATUS SURVEY DESIGN BSA 02-14

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-14 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_{SO}$, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-14 and the detection sensitivities are also discussed.

12.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-14 were driven by the type (Structure) and Class (Class 2) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 2015.

12.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-14. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

12.1.2 Scan Coverage

As a Class 2 structure SU, the scan survey requirement is a minimum of 10% of the exposed surfaces of the structure.

12.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-93 detector, paired with a Ludlum Model 2360 data logging meter.

12.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 200 cpm (based on observed operational instrument background) for the Ludlum Model 43-93 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe\ Area}{100}\right)}$$

Equation 12-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_i * \varepsilon_s * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes:

 ε_i = 2 pi (π) instrument efficiency for nuclide of concern ε_s = surface efficiency for nuclide of concern Yield = 100% for all nuclides of concern Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 12-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{200}{60}} \times \frac{60}{1}}{0.707 \times 0.0907 \times \left(\frac{100}{100}\right)} = 2,351 \text{ dpm/}100 \text{ cm}^2$$

Equation 12-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-93 is given in Table 12-1.

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Table 12-1
Total Weighted Efficiency Calculation (Ludlum Model 43-93) for BSA 02-14

Ludlum 2360	Ludlum Model 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDI	Efficiency	ß Cal. Efficiency		
268477	PR289424	100 cm ²	25.30%	N/A	25.50%		N/A		
	TOTAL WEIGHTED INSTRUMENT EFFICIENCY CALCULATION								
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ε _s)	Yield 100%	Activity Fraction	Weighted Efficiency		
Am-241	Alpha	5.6	0.2530	0.25	1.00	2.682E-03	1.70E-04		
Np-237	Alpha	5.0	0.2530	0.25	1.00	5.573E-05	3.52E-06		
Pu-239	Alpha	5.2	0.2530	0.25	1.00	2.027E-06	1.28E-07		
Tc-99	Beta	0.294	0.2550	0.25	1.00	2.829E-03	1.80E-04		
Th-232	Alpha	4.1	0.2530	0.25	1.00	3.214E-03	2.03E-04		
Ra-228	Beta	0.046	0.2550	0.00	1.00	3.214E-03	0.00E+00		
Ac-228	Beta	2.13	0.2550	0.50	1.00	3.214E-03	4.10E-04		
Th-228	Alpha	5.5	0.2530	0.25	1.00	3.214E-03	2.03E-04		
Ra-224	Alpha	5.8	0.2530	0.25	1.00	3.214E-03	2.03E-04		
U-234	Alpha	4.9	0.2530	0.25	1.00	8.270E-01	5.23E-02		
U-235	Alpha	4.7	0.2530	0.25	1.00	3.720E-02	2.35E-03		
Th-231	Beta	0.390	0.2550	0.25	1.00	3.720E-02	2.37E-03		
U-238	Alpha	4.3	0.2530	0.25	1.00	1.270E-01	8.03E-03		
Th-234	Beta	0.270	0.2550	0.25	1.00	1.270E-01	8.10E-03		
Pa-234m	Beta	2.20	0.2550	0.50	1.00	1.270E-01	1.62E-02		
				·		Σ=	9.07%		

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern Weighted Instrument Efficiency = $\epsilon_i * \epsilon_s * \text{Yield * Activity Fraction}$

 $\varepsilon_i = 2$ Pi Instrument Efficiency for Nuclide of Concern

 ε_s = Surface Efficiency for Nuclide of Concern

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12.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_S \left(1+\frac{t_S}{t_b}\right)}}{(\varepsilon_t)(t_S)\left(\frac{A}{100 \text{ cm}^2}\right)}$$

Equation 12-4

where:

 $R_B = Background count rate (cpm);$

 t_S = Sample or measurement count time (minutes);

 $t_b = Background count time (minutes);$

 ε_t = Total weighted efficiency (2π) ; and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{200 \times 1\left(1+\frac{1}{1}\right)}}{(0.0907)(1)\left(\frac{100}{100}\right)} = 759 \text{ dpm/}100 \text{ cm}^2$$

Equation 12-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-93 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-14. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

12.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

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12.1.7 BSA 02-14 FSS Design Summary

The complete FSS Plan for BSA 02-14 is provided in Appendix L. A summary table of the requirements in the FSS Plan for BSA 02-14 is presented in Table 12-2 below.

Table 12-2 FSS Design Summary for BSA 02-14

Portable Instrument Scanning:						
Scan Coverage	M	1 Inimum 10% of BSA 02-14 total area				
Scan MDC	2,	2,351 dpm / 100 cm ² (Ludlum 43-93) 1,193 dpm / 100 cm ² (Ludlum 43-37)				
Investigation Action Level (IAL):	2,	2,250 dpm / 100 cm2 (Ludlum 43-93) 1,072 dpm / 100 cm2 (Ludlum 43-37)				
Total Surface Contamination (TSC) M	Teasurements:					
Surface	Minimum Number of Measurements	Comments				
Building 230: U-Shaped Area – Section 7 (floor, lower walls)	11	A total of 14 TSC measurements location have been systematically designed from random start point.				
TSC Investigation Action Level	TSC Investigation Action Level 18,925 dpm / 100 cm ² (Adjusted Gross DCGL)					
Removable Activity Locations: After each TSC measurement, at the same	ame point as the TSC mea	acurament, using moderate pressure swine a clo				
smear over the surface (e.g. exterior wa 4" box.		in S-shaped pattern within an approximately 4" l				
4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amo	r seams, cracks, or penetra unt and specific locations atic MDA, adjustments to					
4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amo measurements exceed the instrument st	r seams, cracks, or penetra unt and specific locations atic MDA, adjustments to for guidance.	ations, and at floor/wall interfaces. Consult FS of biased measurements. At locations whe instrument efficiency or volumetric sampling m				
4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amo measurements exceed the instrument st be necessary – consult FSS supervision	r seams, cracks, or penetra unt and specific locations atic MDA, adjustments to for guidance. Used static	ations, and at floor/wall interfaces. Consult FS s of biased measurements. At locations whe				
4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amo measurements exceed the instrument st be necessary – consult FSS supervision Instrumentation:	r seams, cracks, or penetra unt and specific locations atic MDA, adjustments to for guidance. Used static eleva	ations, and at floor/wall interfaces. Consult FS s of biased measurements. At locations whe instrument efficiency or volumetric sampling measurements and to obtain the control of the con				

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13.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-14

FSS was performed in accordance with procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems, and Components.

13.1 Scan Survey Performance

As a Class 2 SU the FSS plan required that a minimum of 10% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover more than 10% of the structural surfaces (provided in Appendix V).

13.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated for BSA 02-14, and a total of fourteen (14) measurements were designed by the FSS Plan. These direct, static-count measurement locations were designed in a random start, systematic pattern (See Figure 13-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

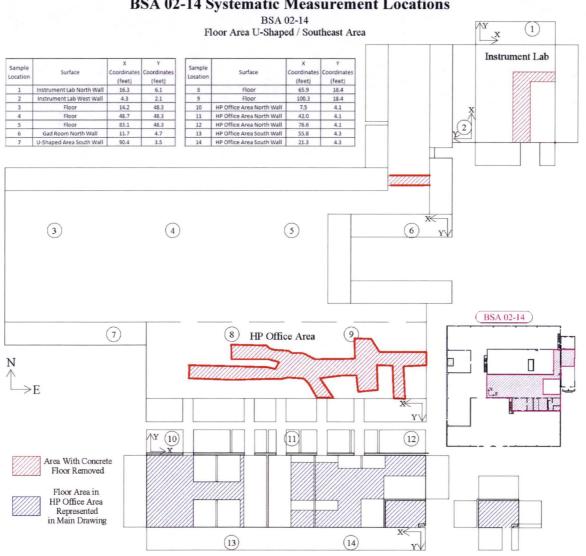
Table 13-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix L).

No systematic location exceeded the $DCGL_{SO.}$ The highest observed systematic TSC measurement was 975 dpm/100 cm² (5% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-14 is provided in Appendix V.

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Figure 13-1 BSA 02-14 Systematic Measurement Locations



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Table 13-1 FSS Measurement Locations for BSA 02-14

Hematite	Hematite Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development						
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APPENDIX P-4							
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES							
Survey Area:	BSA 02			Description:	Buildi	ng Survey Area (Buildin	ng 230)
Survey Unit:	14			Description:	U-Sha	ped Area (Southeast) –	Lower Walls, Floor and Stairs
Survey Type:	FSS			Classification:	Class	2	
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes
B02-14-01-S-W-S-00	W	S	NA	NA	6.1	16.3	Instrument Lab North Wall
B02-14-02-S-W-S-00	W	S	NA	NA	2.1	4.3	Instrument Lab West Wall
B02-14-03-S-W-S-00	F	S	NA	NA	48.3	14.2	U-Shaped Area Floor
B02-14-04-S-W-S-00	F	S	NA	NA	48.3	48.7	U-Shaped Area Floor
B02-14-05-S-W-S-00	F	S	NA	NA	48.3	83.1	U-Shaped Area Floor
B02-14-06-S-W-S-00	W	S	NA	NA	4.7	11.7	Gad Room North Wall
B02-14-07-S-W-S-00	W	S	NA	NA	3.5	90.4	U-Shaped Area South Wall
B02-14-08-S-W-S-00	F	S	NA	NA	18.4	65.9	U-Shaped Area Floor
B02-14-09-S-W-S-00	F	S	NA	NA	18.4	100.3	U-Shaped Area Floor
B02-14-10-S-W-S-00	W	S	NA	NA	4.1	7.5	HP Area North Wall
B02-14-11-S-W-S-00	W	S	NA	NA	4.1	42.0	HP Area North Wall
B02-14-12-S-W-S-00	W	S	NA	NA	4.1	76.6	HP Area North Wall
B02-14-13-S-W-S-00	W	S	NA	NA	4.3	55.8	HP Area South Wall
B02-14-14-S-W-S-00	W	S	NA	NA	4.3	21.3	HP Area South Wall
B02-14-15-S-F-B-00	F	S	NA	NA	17.8	13.4	Instrument Lab Floor
B02-14-16-S-F-B-00	F	S	NA	NA	111	7.3	HP Area North Floor
B02-14-17-S-F-B-00	F	S	NA	NA	72.4	10.1	HP Area North Floor
B02-14-18-S-F-B-00	F	S	NA	NA	73.4	32.2	U-Shaped Area Floor
B02-14-19-S-F-B-00	F	S	NA	NA	22.7	33.8	U-Shaped Area Floor
B02-14-20-S-W-B-00	W	S	NA	NA	11.7	4.3	U-Shaped Area North Wall

*X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area)

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

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13.3 Biased Measurements

In total, six (6) areas were identified for biased measurement. These areas were identified by scan measurements that approached or exceeded the Scan IAL. No biased measurement was identified to exceed the DCGL $_{SO}$, the highest identified result was 1,286 dpm/100 cm 2 (7% of the DCGL $_{SO}$).

13.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, no QC measurements were necessary for BSA 02-14.

14.0 FINAL STATUS SURVEY RESULTS BSA 02-14

During the performance of FSS in BSA 02-14, all scan measurements exceeding the Scan MDC of $2,250 \text{ dpm}/100 \text{ cm}^2$ were identified for biased measurement. No static measurement exceeded the DCGL_{SO} of $18,925 \text{ dpm}/100 \text{ cm}^2$. No removable contamination measurement exceeded the MDA, therefore no removable contamination measurement exceeded 10% of the DCGL_{SO}. The highest observed TSC measurement was $1,286 \text{ dpm}/100 \text{ cm}^2$ (biased location, 7% of the DCGL_{SO}), and the average residual radioactivity based on all systematically collected measurements is $321 \text{ dpm}/100 \text{ cm}^2$ (2% of the DCGL_{SO}).

The analytical data sheets used to evaluate the BSA 02-14 FSS data are provided in Appendix B. A summary table of the FSS results is presented below in Table 14-1.

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Table 14-1 FSS Data Summary for BSA 02-14

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² (α+β)	Corrected Net dpm/100cm ²	Fraction of DCGL
B02-14-01-S-W-S-00	Instrument Lab North Wall	11/4/2015	alpha + beta TSC	275	182	93	964	964	5%
B02-14-02-S-W-S-00	Instrument Lab West Wall	11/4/2015	alpha + beta TSC	276	182	94	975	975	5%
B02-14-03-S-W-S-00	U-Shaped Area Floor	11/4/2015	alpha + beta TSC	218	182	36	373	373	2%
B02-14-04-S-W-S-00	U-Shaped Area Floor	11/4/2015	alpha + beta TSC	191	182	9	93	93	0%
B02-14-05-S-W-S-00	U-Shaped Area Floor	11/4/2015	alpha + beta TSC	255	182	73	757	757	4%
B02-14-06-S-W-S-00	Gad Room North Wall	11/4/2015	alpha + beta TSC	154	182	-28	-290	0	0%
B02-14-07-S-W-S-00	U-Shaped Area South Wall	11/4/2015	alpha + beta TSC	141	182	-41	-425	0	0%
B02-14-08-S-W-S-00	U-Shaped Area Floor	11/4/2015	alpha + beta TSC	237	182	55	570	570	3%
B02-14-09-S-W-S-00	U-Shaped Area Floor	11/4/2015	alpha + beta TSC	245	182	63	653	653	3%
B02-14-10-S-W-S-00	HP Area North Wall	11/4/2015	alpha + beta TSC	171	182	-11	-114	0	0%
B02-14-11-S-W-S-00	HP Area North Wall	11/4/2015	alpha + beta TSC	152	182	-30	-311	0	0%
B02-14-12-S-W-S-00	HP Area North Wall	11/4/2015	alpha + beta TSC	193	182	11	114	114	1%
B02-14-13-S-W-S-00	HP Area South Wall	11/4/2015	alpha + beta TSC	168	182	-14	-145	0	0%
B02-14-14-S-W-S-00	HP Area South Wall	11/4/2015	alpha + beta TSC	162	182	-20	-207	0	0%
B02-14-15-S-F-B-00	Instrument Lab Floor	11/4/2015	alpha + beta TSC	272	182	90	933	933	5%
B02-14-16-S-F-B-00	HP Area North Floor	11/4/2015	alpha + beta TSC	264	182	82	850	850	4%
B02-14-17-S-F-B-00	HP Area North Floor	11/4/2015	alpha + beta TSC	237	182	55	570	570	3%
B02-14-18-S-F-B-00	U-Shaped Area Floor	11/4/2015	alpha + beta TSC	239	182	57	591	591	3%
B02-14-19-S-F-B-00	U-Shaped Area Floor	11/4/2015	alpha + beta TSC	242	182	60	622	622	3%
B02-14-20-S-W-B-00	U-Shaped Area North Wall	11/4/2015	alpha + beta TSC	306	182	124	1286	1286	7%

*NOTE: Differences from documented survey results are due to rounding in Excel

Min	0	2%
Max	975	270
Mean	321	DCGLso
Median	104	0.50
Stdev	384.2	0.50

mrem/year

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15.0 ALARA EVALUATION BSA 02-14

All measurements collected within BSA 02-14 were evaluated against the DCGL $_{\rm SO}$. For BSA 02-14 no measurement result exceeded the DCGL $_{\rm SO}$. The average result, based on all systematically collected measurements was 2% of DCGL $_{\rm SO}$ for BSA 02-14. The average of all measurements equates to residual activity contribution from the SU area of 0.5 mrem/year for BSA 02-14. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the DCGL $_{\rm SO}$.

As the estimated TEDE for BSA 02-14 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-14 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-14.

16.0 FSS PLAN DEVIATIONS BSA 02-14

There were no deviations from the FSS Plan as written.

16.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-14.

17.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

17.1 Data Quality Assessment for BSA 02-14

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-14 (see Figure 17-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (Operation of the Ludlum 2360 for Final Status Survey), and HDP-PR-HP-411 (Radiological Instrumentation).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected (on a systematic pattern) and the scan surveys that were conducted were performed in accordance with

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procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- Quality Control sample results were not necessary for BSA 02-14. However a Quality Control Replicate Survey was performed for BSA 02-16 and BSA 02-18, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-14 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Fourteen (14) systematic measurements were collected in BSA 02-14. None of the 14 measurements exceeded the DCGL_{SO} resulting in a systematic average result of 2% of the DCGL_{SO}. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 17-1. The Sign Test was successful as the total number of systematic measurements (14), exceeded the minimum requirement of 10 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-14 was 5% of the DCGL_{SO}. The average residual radioactivity concentration fraction based on the systematically collected measurements was 2% of the DCGL_{SO}, resulting in a residual dose contribution of 0.5 mrem/year.
- No FSS measurement result in BSA 02-14 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-14 was completed prior to and after the performance of the FSS. BSA 02-14 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

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 $\alpha = 0.05$

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Table 17-1 Sign Test for BSA 02-14

Sign Test						
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference	
B02-14-01-S-W-S-00	Instrument Lab North Wall	964	0.051	0.949	0.949	
B02-14-02-S-W-S-00	Instrument Lab West Wall	975	0.051	0.949	0.949	
B02-14-03-S-W-S-00	U-Shaped Area Floor	373	0.020	0.980	0.980	
B02-14-04-S-W-S-00	U-Shaped Area Floor	93	0.005	0.995	0.995	
B02-14-05-S-W-S-00	U-Shaped Area Floor	757	0.040	0.960	0.960	
B02-14-06-S-W-S-00	Gad Room North Wall	0	0.000	1.000	1.000	
B02-14-07-S-W-S-00	U-Shaped Area South Wall	0	0.000	1.000	1.000	
B02-14-08-S-W-S-00	U-Shaped Area Floor	570	0.030	0.970	0.970	
B02-14-09-S-W-S-00	U-Shaped Area Floor	653	0.035	0.965	0.965	
B02-14-10-S-W-S-00	HP Area North Wall	0	0.000	1.000	1.000	
B02-14-11-S-W-S-00	HP Area North Wall	0	0.000	1.000	1.000	
B02-14-12-S-W-S-00	HP Area North Wall	114	0.006	0.994	0.994	
B02-14-13-S-W-S-00	HP Area South Wall	0	0.000	1.000	1.000	
B02-14-14-S-W-S-00	HP Area South Wall	0	0.000	1.000	1.000	
			Number of Positive D	ifferences (S+)	14	
		Sign To	est Critical Value (MAR	SSIM Table I-3)	10	

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST:

PASS

Critical V	IM Table I-3 alues for the t Statistic S+	Critical V	I Table I-3 'alues for In Test tic S+
N	Alpha = 0.05	N	Alpha = 0.05
4	4	28	18
5	4	29	19
6	5	30	19
7	6	31	20
8	6	32	21
9	7	33	21
10	8	34	22
11	8	35	22
12	9	36	23
13	9	37	23
14	10	38	24
15	11	39	25
16	11	40	25
17	12	41	26
18	12	42	26
19	13	43	27
20	14	44	27
21	14	45	28
22	15	46	29
23	15	47	29
24	16	48	30
25	17	49	30
26	17	50	31
27	18		

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 17-1 Data Evaluation Checklists prepared for BSA 02-14 (page 1 of 2)

Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation Hematite					
ecommissioning Project]	Revision: 1	Appendix G-1 Page 1 of 2	
FINA	APPENDIX G-1 STATUS SURVEY DATA QUALITY OBJECT	IVES REVI	EW CHE	CKLIST	
Survey Area Survey Unit:		ng Survey Are d Area (Southeast		ng 230) s, Floor and Stairs	
to data a	measurements and/or analysis results that will be s nalysis for FSS been individually reviewed and vali- ce with Section 8.1 of this procedure?		Yes 🖂	No 🗌	
2. Have all	systematic measurements and/or samples been tat the locations specified in the FSSP and the FSS	aken or Sample	Yes 🖂	No 🗌	
	scans surveys been performed of the areas specin the FSSP and the FSS Sample Instructions?	cified as	Yes 🖂	No 🗌	
4. Have all at the loc	biased measurements and/or samples been taken or ations specified in the FSSP & the FSS Sample Instr	acquired uctions?	Yes 🖂	No 🗌 NA 🗌	
	plicate and/or split samples or measurements been at each location designated as a QC sample?	taken or	Yes 🗌	No 🗌 NA 🖂	
capable	of detecting the ROCs or gross activity at a MDC less than Yes No Depriate investigation level?				
analyze	Vas the calibration of all instruments that were used to measure or nalyze data, current at the time of use and were those calibrations Yes No No erformed using a NIST traceable source?				
8. Were th	e instruments successfully response-checked before quired, after use on the day the data was measured?	use and,	Yes 🖂	No 🗌	
9. Do the s	amples match those identified on the chain of custody	y?	Yes [No 🗌 NA 🖂	
10. Do the O	C Sample Results meet the acceptance criteria as spe-FSS-703, Final Status Survey Quality Control?	ecified in	Yes 🗌	No 🗌 NA 🖂	
	aboratory QC parameters within acceptable limits?		Yes	No 🗌 NA 🖂	
If "No" was corrective ac	the response to any of the questions above, then constituted that were taken to resolve the discrepancy.	document the	e discrepan	acy as well as an	
Comments: N	7/A				
Quality Record					

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 17-1 Data Evaluation Checklists prepared for BSA 02-14 (page 2 of 2)

Hematite	Procedure: HI	DP-PR-FSS-721, Fin	al Status Sı	urvey Data Eva	luation	
Decommissioning Project					Revision: 10	Appendix G-1, Page 2 of 2
FINAL	STATUS SUR	APPE VEY DATA QUAL	NDIX G-1 .ITY OBJI	ECTIVES RE	VIEW CHECI	KLIST
Survey Area: Survey Unit:	No. BSA 02 No. 14		-		Area (Building heast)-Lower Walls.	
Discrepancy:	None					
Corrective Acti	ons Taken: _N	one				
		ns resolved the discre		h the data?	Yes N	lo 🗌 NA 🖂
		this form to the RSO will be answered by				
	nswer to questi	on 11 was "No", then		ected data	Yes 🗌 N	lo 🗌 NA 🖂
		xisting valid measure ate compliance for th			Yes 🗌 N	lo 🗌 NA 🖂
		e acquisition of addit ce for the survey uni		urements or sa	mples as necess	sary to
	(HP Staff):	Thomas Yardy (Print Nan		(Signat	ures	8-21-17 (Date)
Approved b	y (RSO):	Clark Evers (Print Nan	ne)	(Signat	ure)	(Date)
Quality Record						

Hematite Decommissioning	FSSFR Volume 4, Chapter 3: Survey Area Release Record for B Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, 27)	13, BSA 02-14, BSA 02-
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18.0 CONCLUSION BSA 02-14

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-14 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

 $\begin{tabular}{ll} Table 18-1 \\ BSA 02-14 DCGL_{SO} \ and \ Dose \ Summation \\ \end{tabular}$

AVE. SU RESIDUAL RADIOACTIVITY				
DCGL _{so}	2%			
Daga	0.5			
Dose	mrem/year			

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19.0 FINAL STATUS SURVEY DESIGN BSA 02-15

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-15 as well as summarizing the applicable requirements of the FSS Plan. These include the DCGL_{SO}, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-15 and the detection sensitivities are also discussed.

19.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-15 were driven by the type (Structure) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 6, *Final Status Survey Plan Development*, March 2015.

19.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-15. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

19.1.2 Scan Coverage

As a Class 1 structure SU, the scan survey requirement is 100% of the exposed surfaces of the structure.

19.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-93 detector, paired with a Ludlum Model 2360 data logging meter.

19.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 200 cpm (based on observed operational instrument background) for the Ludlum Model 43-93 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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$$Scan \ MDC = \frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe\ Area}{100}\right)}$$

Equation 19-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_i * \varepsilon_s * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

 $\varepsilon_i = 2 \text{ pi } (\pi) \text{ instrument efficiency for nuclide of concern}$ ε_s = surface efficiency for nuclide of concern Yield = 100% for all nuclides of concern

Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 19-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.97% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{200}{60}} \times \frac{60}{1}}{0.707 \times 0.0997 \times (\frac{100}{100})} = 2,250 \text{ dpm/}100 \text{ cm}^2$$

Equation 19-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-93 is given in Table 19-1.

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Table 19-1
Total Weighted Efficiency Calculation (Ludlum Model 43-93) for BSA 02-15

Ludlum 2360	Ludlum Model 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDI	Efficiency	ß Cal. Efficiency				
278647	311685	125 cm ²	27.5%	N/A	28.7%		N/A				
	TOTAL WEIGHTED INSTRUMENT EFFICIENCY CALCULATION										
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ε _s)	Yield 100%	Activity Fraction	Weighted Efficiency				
Am-241	Alpha	5.6	0.2750	0.25	1.00	2.682E-03	1.84E-04				
Np-237	Alpha	5.0	0.2750	0.25	1.00	5.573E-05	3.83E-06				
Pu-239	Alpha	5.2	0.2750	0.25	1.00	2.027E-06	1.39E-07				
Tc-99	Beta	0.294	0.2870	0.25	1.00	2.829E-03	2.03E-04				
Th-232	Alpha	4.1	0.2750	0.25	1.00	3.214E-03	2.21E-04				
Ra-228	Beta	0.046	0.2870	0.00	1.00	3.214E-03	0.00E+00				
Ac-228	Beta	2.13	0.2870	0.50	1.00	3.214E-03	4.61E-04				
Th-228	Alpha	5.5	0.2750	0.25	1.00	3.214E-03	2.21E-04				
Ra-224	Alpha	5.8	0.2750	0.25	1.00	3.214E-03	2.21E-04				
U-234	Alpha	4.9	0.2750	0.25	1.00	8.270E-01	5.69E-02				
U-235	Alpha	4.7	0.2750	0.25	1.00	3.720E-02	2.56E-03				
Th-231	Beta	0.390	0.2870	0.25	1.00	3.720E-02	2.67E-03				
U-238	Alpha	4.3	0.2750	0.25	1.00	1.270E-01	8.73E-03				
Th-234	Beta	0.270	0.2870	0.25	1.00	1.270E-01	9.11E-03				
Pa-234m	Beta	2.20	0.2870	0.50	1.00	1.270E-01	1.82E-02				
						Σ=	9.97%				

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern Weighted Instrument Efficiency = $\epsilon_i * \epsilon_s * \text{Yield} * \text{Activity Fraction}$

 $\varepsilon_i = 2$ Pi Instrument Efficiency for Nuclide of Concern

 ε_s = Surface Efficiency for Nuclide of Concern

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19.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_S \left(1+\frac{t_S}{t_b}\right)}}{(\varepsilon_t)(t_S)\left(\frac{A}{100 \ cm^2}\right)}$$

Equation 19-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

t_b = Background count time (minutes);

 ε_t = Total weighted efficiency (2 π); and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.97% is calculated to be:

Static MDC
$$(dpm/100 \text{ cm}^2) = \frac{3+3.29\sqrt{200 \text{ x } 1\left(1+\frac{1}{1}\right)}}{(0.0997)(1)\left(\frac{100}{100}\right)} = 690 \text{ dpm}/100 \text{ cm}^2$$

Equation 19-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-93 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-15. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey. Also note that the FSS Plan listed the instrument Scan MDC in error originally. The Scan MDC presented in this report has been corrected to reflect the correct prospective instrument Scan MDC.

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19.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

19.1.7 BSA 02-15 FSS Design Summary

The complete FSS Plan for BSA 02-15 is provided in Appendix M. A summary table of the requirements in the FSS Plan for BSA 02-15 is presented in Table 19-2 below.

Table 19-2 FSS Design Summary for BSA 02-15

Portable Instrument Scanning:						
Scan Coverage			100% of BSA 02-15 total area			
Scan MDC			0 dpm / 100 cm ²			
Investigation Action Level (IAL)		9,46	3 dpm / 100 cm ² (50% of the DCGL)			
Total Surface Contamination (TS	C) Measurement	ts:				
Surface	Minimum Nu Measurem		Comments			
Building 230: U-Shaped Area, Section 8 Trench			A total of 14 TSC measurements locations have been systematically designed from a random start point. One of these locations will be selected for the 5% QC measurement requirement.			
Removable Activity Locations:						
			easurement, using moderate pressure vindow, etc.) in an S-shaped pattern within			
Instrumentation						
Ludium 2000 with 40-90 Scintillation defector.			Used for scanning and to obtain static (TSC) measurements.			
Ludlum 2929 with 43-10-1 scintillation detector.			or counting of swipe (smear) samples.			

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20.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-15

FSS was performed in accordance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems, and Components*.

20.1 Scan Survey Performance

As a Class 1 SU the FSS plan required that 100% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover 100% of the structural surfaces (provided in Appendix W).

20.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated for BSA 02-15, and a total of fourteen (14) measurements were designed by the FSS Plan. These direct, static-count measurement locations were designed in a random start, systematic pattern (See Figure 20-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 20-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix M).

No systematic location exceeded the $DCGL_{SO.}$ The highest observed systematic TSC measurement was 349 dpm/100 cm² (2% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-15 is provided in Appendix W.

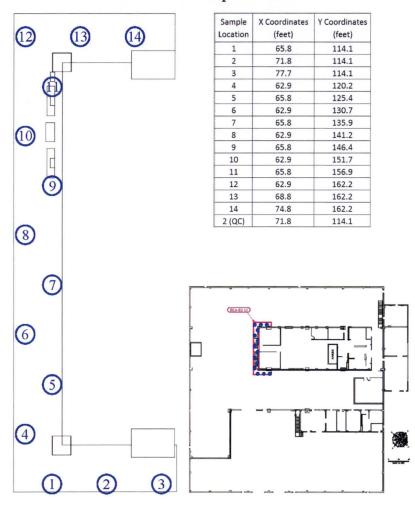
FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 20-1 BSA 02-15 Systematic Measurement Locations

BSA 02-15 Sample Locations



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Table 20-1 FSS Measurement Locations for BSA 02-15

Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development

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		FSS SAN		ENDIX P-4	OORDINAT	FS	
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES Survey Area: BSA 02 Description: Building Survey Area (Building 230)							
Survey Unit:	15		-	Description:	U-S	haped Area - Sec	tion 8 Trench
Survey Type:	FSS		-	Classification:	Clas	s 1	
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes
B02-15-01-S-F-S-00	F	S	NA	NA	0.4	4.4	Trench Floor
B02-15-02-S-W-S-00	W	S	NA	NA	0.4	10.4	Trench Wall
B02-15-03-S-F-S-00	F	S	NA	NA	0.4	16.3	Trench Floor
B02-15-04-S-W-S-00	W	S	NA	NA	6.5	1.5	Trench Wall
B02-15-05-S-F-S-00	F	S	NA	NA	11.7	4.4	Trench Floor
B02-15-06-S-W-S-00	W	S	NA	NA	17	1.5	Trench Wall
B02-15-07-S-F-S-00	F	S	NA	NA	22.2	4.4	Trench Floor
B02-15-08-S-W-S-00	W	S	NA	NA	27.5	1.5	Trench Wall
B02-15-09-S-F-S-00	F	S	NA	NA	32.7	4.4	Trench Floor
B02-15-10-S-F-S-00	F	S	NA	NA	38	1.5	Trench Floor
B02-15-11-S-W-S-00	W	S	NA	NA	43.2	4.4	Trench Wall

NA

NA

NA

NA

48.5

48.5

48.5

21.2

1.5

7.4

13.4

4.9

Trench Floor

Trench Floor

Trench Floor

Trench Floor

*X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area)

NA

NA

NA

NA

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R CSM: Three-Layer (Surface-Root-Deep) or Uniform

B02-15-12-S-F-S-00

B02-15-13-S-F-S-00

B02-15-14-S-F-S-00

B02-15-15-S-F-B-00

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

F

F

S

S

S

В

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20.3 Biased Measurements

One (1) area was identified for biased measurement. The area was identified by scan measurements that approached or exceeded the Scan IAL. No biased measurement was identified to exceed the DCGL $_{\rm SO}$, the highest identified result was 4,025 dpm/100 cm 2 (21% of the DCGL $_{\rm SO}$).

20.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, no QC measurements were necessary for BSA 02-15.

21.0 FINAL STATUS SURVEY RESULTS BSA 02-15

During the performance of FSS in BSA 02-15, all scan measurements exceeding the Scan MDC of 2,187 dpm/100 cm² were identified for biased measurement. No static measurement exceeded the DCGL_{SO} of 18,925 dpm/100 cm². No removable contamination measurement exceeded the MDA, therefore no removable contamination measurement exceeded 10% of the DCGL_{SO}. The highest observed TSC measurement was 4,025 dpm/100 cm² (biased location, 21% of the DCGL_{SO}), and the average residual radioactivity based on all systematically collected measurements is 83 dpm/100 cm² (0.4% of the DCGL_{SO}),

The analytical data sheets used to evaluate the BSA 02-15 FSS data are provided in Appendix C. A summary table of the FSS results is presented below in Table 21-1.

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Table 21-1 FSS Data Summary for BSA 02-15

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² $(\alpha+\beta)$	Corrected Net dpm/100cm ²	Fraction of DCGL
B02-15-01-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	146	145	1	11	11	0%
B02-15-02-S-W-S-00	Trench Wall	6/15/2015	alpha + beta TSC	142	145	-3	-34	0	0%
B02-15-03-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	135	145	-10	-113	0	0%
B02-15-04-S-W-S-00	Trench Wall	6/15/2015	alpha + beta TSC	165	145	20	225	225	1%
B02-15-05-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	141	145	-4	-45	0	0%
B02-15-06-S-W-S-00	Trench Wall	6/15/2015	alpha + beta TSC	132	145	-13	-147	0	0%
B02-15-07-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	140	145	-5	-56	0	0%
B02-15-08-S-W-S-00	Trench Wall	6/15/2015	alpha + beta TSC	145	145	0	0	0	0%
B02-15-09-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	130	145	-15	-169	0	0%
B02-15-10-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	162	145	17	192	192	1%
B02-15-11-S-W-S-00	Trench Wall	6/15/2015	alpha + beta TSC	161	145	16	180	180	1%
B02-15-12-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	176	145	31	349	349	2%
B02-15-13-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	147	145	2	23	23	0%
B02-15-14-S-F-S-00	Trench Floor	6/15/2015	alpha + beta TSC	161	145	16	180	180	1%
B02-15-15-S-F-B-00	Trench Floor	6/15/2015	alpha + beta TSC	502	145	357	4025	4025	21%

*NOTE: Differences from documented survey results are due to rounding in Excel

 Min
 0
 0.4%

 Max
 349
 ...

 Mean
 83
 DCGLso

 Median
 6
 0.10

 Stdev
 117.4

mrem/year

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22.0 ALARA EVALUATION BSA 02-15

All measurements collected within BSA 02-15 were evaluated against the DCGL $_{\rm SO}$. For BSA 02-15 no measurement result exceeded the DCGL $_{\rm SO}$. The average result, based on all systematically collected measurements was 0.4% of DCGL $_{\rm SO}$ for BSA 02-15. The average of all measurements equates to residual activity contribution from the SU area of 0.1 mrem/year for BSA 02-15. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the DCGL $_{\rm SO}$.

As the estimated TEDE for BSA 02-15 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-15 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-15.

23.0 FSS PLAN DEVIATIONS BSA 02-15

There were no deviations from the FSS Plan as written.

23.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-15.

24.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

24.1 Data Quality Assessment for BSA 02-15

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-15 (see Figure 24-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (Operation of the Ludlum 2360 for Final Status Survey), and HDP-PR-HP-411 (Radiological Instrumentation).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected(on a systematic pattern) and the scan surveys that were conducted were performed in accordance with

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procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- Quality Control sample results were not necessary for BSA 02-15. However a Quality Control Replicate Survey was performed for BSA 02-16 and BSA 02-18, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-15 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Fourteen (14) systematic measurements were collected in BSA 02-15. None of the 14 measurements exceeded the DCGL_{SO} resulting in a systematic average result of 0.4% of the DCGL_{SO}. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 24-1. The Sign Test was successful as the total number of systematic measurements (14), exceeded the minimum requirement of 10 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-15 was 21% of the DCGL $_{\rm SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 0.4% of the DCGL $_{\rm SO}$, resulting in a residual dose contribution of 0.1 mrem/year.
- No FSS measurement result in BSA 02-15 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-15 was completed prior to and after the performance of the FSS. BSA 02-15 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

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Table 24-1 Sign Test for BSA 02-15

		Sign Test				
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference	
B02-15-01-S-F-S-00	Trench Floor	11	0.001	0.999	0.999	$\alpha = 0$.
B02-15-02-S-W-S-00	Trench Wall	0	0.000	1.000	1.000	
B02-15-03-S-F-S-00	Trench Floor	0	0.000	1.000	1.000	
B02-15-04-S-W-S-00	Trench Wall	225	0.012	0.988	0.988	
B02-15-05-S-F-S-00	Trench Floor	0	0.000	1.000	1.000	
B02-15-06-S-W-S-00	Trench Wall	0	0.000	1.000	1.000	
B02-15-07-S-F-S-00	Trench Floor	0	0.000	1.000	1.000	
B02-15-08-S-W-S-00	Trench Wall	0	0.000	1.000	1.000	
B02-15-09-S-F-S-00	Trench Floor	0	0.000	1.000	1.000	
B02-15-10-S-F-S-00	Trench Floor	192	0.010	0.990	0.990	
B02-15-11-S-W-S-00	Trench Wall	180	0.010	0.990	0.990	
B02-15-12-S-F-S-00	Trench Floor	349	0.018	0.982	0.982	
B02-15-13-S-F-S-00	Trench Floor	23	0.001	0.999	0.999	
B02-15-14-S-F-S-00	Trench Floor	180	0.010	0.990	0.990	
	MEDICAL PARTY		Number of Positive D	ifferences (S+)	14	
		Sign T	est Critical Value (MAR	SSIM Table I-3)	10	

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST:

PASS

Critical V	IM Table I-3 alues for the t Statistic S+	Critical V	I Table I-3 'alues for yn Test tic S+
N	Alpha = 0.05	N	Alpha = 0.05
4	4	28	18
5	4	29	19
6	5	30	19
7	6	31	20
8	6	32	21
9	7	33	21
10	8	34	22
11	8	35	22
12	9	36	23
13	9	37	23
14	10	38	24
15	11	39	25
16	11	40	25
17	12	41	26
18	12	42	26
19	13	43	27
20	14	44	27
21	14	45	28
22	15	46	29
23	15	47	29
24	16	48	30
25	17	49	30
26	17	50	31
27	18		

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Figure 24-1 Data Evaluation Checklists prepared for BSA 02-15 (page 1 of 2)

Hem	natite	Procedure: HDP-PF	R-FSS-721, Final Statu	s Survey Data Eval	uation	
	Decommissioning Project			Revision: 1	Appendix G-1, Page 1 of 2	
	APPENDIX G-1 FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST					
Surv	ey Area:	BSA 02	Description:	Building Survey A	rea (Buildin	g 230)
	ey Unit:	15		U-Shaped Area – S		
1					No 🗌	
					No 🗌	
	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions? Yes ⋈ No □				No 🗌	
		ve all biased measurements and/or samples been taken or acquired he locations specified in the FSSP & the FSS Sample Instructions?				No 🗌 NA 🗍
		e duplicate and/or split samples or measurements been taken or Yes No NA NA ired at each location designated as a QC sample?				No 🗌 NA 🖾
	capable of	of detecting the ROCs or gross activity at a MDC less than Yes No ropriate investigation level?				No 🗌
	analyze da	e calibration of all instruments that were used to measure or data, current at the time of use and were those calibrations Yes No ned using a NIST traceable source?			No 🗌	
		ne instruments successfully response-checked before use and, equired, after use on the day the data was measured?		No 🗌		
9.	Do the san	aples match those ide	entified on the chain o	f custody?	Yes 🗌	No 🗌 NA 🖂
		e QC Sample Results meet the acceptance criteria as specified in PR-FSS-703, Final Status Survey Quality Control?		No 🗌 NA 🔯		
11.	Are all Lal	e all Laboratory QC parameters within acceptable limits?				No 🗌 NA 🔀
			of the questions above resolve the discrepand		ne discrepano	ey as well as any
Com	ments: N/A	Λ.				
Quality	y Record					

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Figure 24-1 Data Evaluation Checklists prepared for BSA 02-15 (page 2 of 2)

Hematite	Procedure: HDP-P	R-FSS-721, Final Status	s Survey Data Ev	valuation	
ecommissioning Project				Revision: 10	Appendix G-1, Page 2 of 2
FINAL	STATUS SURVEY	APPENDIX O Y DATA QUALITY O	G-1 BJECTIVES RI	EVIEW CHECK	KLIST
Survey Area:	No. BSA 04			ey Area (Building	
Survey Unit:	No. 15	Description:	U-Shaped Area	a – Section 8 Tre	nch
Discrepancy:	None				
Corrective Ac	ions Taken: None				
11. Have the	corrective actions re	esolved the discrepancy	with the data?	Yes \(\sqrt{N}	io 🗌 NA 🖂
	corrective actions re		with the data?	Yes 🗌 N	io 🗌 NA 🖂
a. If "No	", then forward this			Yes \(\) N	io 🗌 NA 🖂
a. If "No 12. The follo	", then forward this wing questions will answer to question 1	form to the RSO.	Э.		io □ NA ⊠
a. If "No 12. The follo a. If the still v b. If "No	", then forward this wing questions will answer to question 1 alid? ", then are the existi	form to the RSO. be answered by the RSO	O. affected data or samples	Yes 🗌 N	
a. If "No 12. The follo a. If the still v b. If "No suffic c. If "No	", then forward this wing questions will answer to question 1 alid? ", then are the existient to demonstrate of	form to the RSO. be answered by the RSO. I was "No", then is the ing valid measurements compliance for the surve quisition of additional m	O. affected data or samples y unit?	Yes N	No NA NA NA NA NA NA NA NA NA
a. If "No 12. The follo a. If the still v b. If "No suffic c. If "No demo	", then forward this wing questions will answer to question 1 alid? ", then are the existion to demonstrate co,", then direct the according to the direct the direct the according to the direct the direct the direct the direct the according to the direct	form to the RSO. be answered by the RSO. I was "No", then is the ing valid measurements compliance for the surve quisition of additional m	O. affected data or samples y unit?	Yes N	No NA NA NA NA NA NA NA NA NA
a. If "No 12. The follo a. If the still v b. If "No suffic c. If "No demo	", then forward this wing questions will answer to question 1 alid? ", then are the existient to demonstrate compliance for the account of the compliance for the comp	form to the RSO. be answered by the RSO. 1 was "No", then is the ing valid measurements compliance for the surve quisition of additional more the survey unit. Thomas Yardy	affected data or samples y unit? neasurements or s	Yes N Yes N Samples as necess	No NA NA NA NA NA NA NA NA NA
a. If "No 12. The follo a. If the still v b. If "No suffic c. If "No demo	", then forward this wing questions will answer to question 1 alid? ", then are the existient to demonstrate compliance for the strate compliance for the strategy of	form to the RSO. be answered by the RSO. 1 was "No", then is the ing valid measurements compliance for the surve quisition of additional mor the survey unit. Thomas Yardy (Print Name) Clark Evers	affected data or samples y unit? neasurements or s	Yes N Yes N Samples as necess	Jo □ NA ☒

Hematite Decommissioning	FSSFR Volume 4, Chapter 3: Survey Area Release Record for Bu Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-1 15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, E 27)	3, BSA 02-14, BSA 02-
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25.0 CONCLUSION BSA 02-15

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-15 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

 $\begin{tabular}{ll} Table 25-1 \\ BSA 02-15 DCGL_{SO} \ and \ Dose \ Summation \\ \end{tabular}$

AVE. SU	RESIDUAL
RADIO	ACTIVITY
DCGL _{so}	0.4%
Dose	0.1 mrem/year

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26.0 FINAL STATUS SURVEY DESIGN BSA 02-16

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-16 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_{SO}$, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-16 and the detection sensitivities are also discussed.

26.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-16 were driven by the type (Structure) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 2015.

26.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-16. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

26.1.2 Scan Coverage

As a Class 1 structure SU, the scan survey requirement is 100% of the exposed surfaces of the structure.

26.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-93 detector, paired with a Ludlum Model 2360 data logging meter.

26.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 200 cpm (based on observed operational instrument background) for the Ludlum Model 43-93 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe\ Area}{100}\right)}$$

Equation 26-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_i * \varepsilon_s * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes:

 ϵ_i = 2 pi (π) instrument efficiency for nuclide of concern ϵ_s = surface efficiency for nuclide of concern Yield = 100% for all nuclides of concern Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 26-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{200}{60}} \times \frac{60}{1}}{0.707 \times 0.0907 \times (\frac{100}{100})} = 2,351 \text{ dpm}/100 \text{ cm}^2$$

Equation 26-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-93 is given in Table 26-1.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 26-1
Total Weighted Efficiency Calculation (Ludlum Model 43-93) for BSA 02-16

Ludlum 2360	Ludlum Model 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency		B Cal. Efficiency
268477	289424	125 cm ²	25.3%	N/A	2	25.5%	N/A
		TOTAL WEIG	HTED INSTRUMENT EFF	CICIENCY CALCULATIO	N		
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ε _s)	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.2530	0.25	1.00	2.682E-03	1.70E-04
Np-237	Alpha	5.0	0.2530	0.25	1.00	5.573E-05	3.52E-06
Pu-239	Alpha	5.2	0.2530	0.25	1.00	2.027E-06	1.28E-07
Tc-99	Beta	0.294	0.2550	0.25	1.00	2.829E-03	1.80E-04
Th-232	Alpha	4.1	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-228	Beta	0.046	0.2550	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.2550	0.50	1.00	3.214E-03	4.10E-04
Th-228	Alpha	5.5	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-224	Alpha	5.8	0.2530	0.25	1.00	3.214E-03	2.03E-04
U-234	Alpha	4.9	0.2530	0.25	1.00	8.270E-01	5.23E-02
U-235	Alpha	4.7	0.2530	0.25	1.00	3.720E-02	2.35E-03
Th-231	Beta	0.390	0.2550	0.25	1.00	3.720E-02	2.37E-03
U-238	Alpha	4.3	0.2530	0.25	1.00	1.270E-01	8.03E-03
Th-234	Beta	0.270	0.2550	0.25	1.00	1.270E-01	8.10E-03
Pa-234m	Beta	2.20	0.2550	0.50	1.00	1.270E-01	1.62E-02
						Σ=	9.07%

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern Weighted Instrument Efficiency = $\epsilon_i * \epsilon_s * \text{Yield} * \text{Activity Fraction}$

 ϵ_i = 2 Pi Instrument Efficiency for Nuclide of Concern

 ε_s = Surface Efficiency for Nuclide of Concern

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26.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_S \left(1+\frac{t_S}{t_b}\right)}}{(\varepsilon_t)(t_S)\left(\frac{A}{100 \ cm^2}\right)}$$

Equation 26-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

t_b = Background count time (minutes);

 ε_t = Total weighted efficiency (2 π); and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{200 \times 1\left(1+\frac{1}{1}\right)}}{(0.0907)(1)\left(\frac{100}{100}\right)} = 759 \text{ dpm/}100 \text{ cm}^2$$

Equation 26-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-93 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-16. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

26.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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26.1.7 BSA 02-16 FSS Design Summary

The complete FSS Plan for BSA 02-16 is provided in Appendix N. A summary table of the requirements in the FSS Plan for BSA 02-16 is presented in Table 26-2 below.

Table 26-2 FSS Design Summary for BSA 02-16

Portable Instrument Scanning:				
Scan Coverage		100% of BSA 02-16 total area		
Scan MDC		2,351 dpm / 100 cm ² (Ludlum 43-93)		
		1,193 dpm / 100 cm ² (Ludlum 43-37)		
Investigation Action Level (IAL): gener	ral area	9,463	$3 \text{ dpm} / 100 \text{ cm}^2 (50\% \text{ of the DCGL})$	
Scan IAL: (expansion joints, stress crac	ks, floor/wall	2,351	1 dpm / 100 cm2 (Ludlum 43-93)	
interface, small holes and penetrations into floors)		1,193 dpm / 100 cm2 (Ludlum 43-37)		
Total Surface Contamination (TSC)	Measurements:	,		
Surface	Minimum Number	of	Comments	
	Measurements			
			A total of 11 TSC measurements locations	
Building 230: U-Shaped Area –		have been systematically designed from		
Section 9 (floor and lower wall)			random start point.	
			2	
TSC Investigation Action Level	18,925	dpm /	100 cm ² (Adjusted Gross DCGL)	

Removable Activity Locations:

After each TSC measurement, at the same point as the TSC measurement, using moderate pressure swipe a cloth smear over the surface (e.g. exterior wall, roof, window, etc.) in an S-shaped pattern within an approximately 4" by 4" box.

Biased Measurement Locations:

Perform biased measurements on floor seams, cracks, penetrations, and the floor/wall interface. Consult FSS supervision for guidance on the amount and specific locations of biased measurements. At locations where remediation has taken place or where measurements exceed the instrument MDA, adjustments to instrument efficiency or volumetric sampling may be necessary – consult FSS supervision for guidance.

Instrumentation:	
Ludlum 2360 with 43-93 scintillation detector.	Used for scanning "tight" areas and to obtain static (TSC) measurements; used to investigate elevated areas found with the floor monitor.
Ludlum 2360 with 43-37 gas proportional detector.	Used for scanning floors.
Ludlum 2929 with 43-10-1 scintillation detector.	Used for counting of swipe (smear) samples.

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27.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-16

FSS was performed in accordance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems, and Components*.

27.1 Scan Survey Performance

As a Class 1 SU the FSS plan required that 100% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover 100% of the structural surfaces (provided in Appendix X).

27.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated and designed for BSA 02-16. These direct, static-count measurement locations were designed in a random start, systematic pattern (See Figure 27-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 27-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix N).

No systematic location exceeded the $DCGL_{SO.}$ The highest observed systematic TSC measurement was 595 dpm/100 cm² (3% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-16 is provided in Appendix X.

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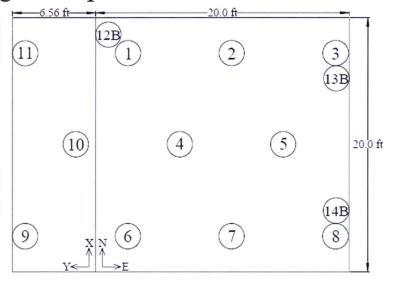
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Figure 27-1 BSA 02-16 Systematic Measurement Locations

BSA 02-16 Building 230 Spill Area



Camala	X	Y
Sample	Coordinates	Coordinates
Location	(feet)	(feet)
1	2.5	17.2
2	10.7	17.2
3	18.9	17.2
4	6.6	10.0
5	14.8	10.0
6	2.5	2.8
7	10.7	2.8
8	18.9	2.8
9	2.8	5.7
10	10.0	1.6
11	17.2	5.7



FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 27-1 FSS Measurement Locations for BSA 02-16

Hematite		Procedure:	HDP-PR-FSS-701, Fin	al Status Survey Plan D	evelopment		
Decommissioni Project	ng					Revision: 10	Appendix P-4, Page 1 of
		FSS SAM		PENDIX P-4 IENT LOCATIONS &	coordina	TES	
Survey Area:	BSA 02			Description:	Build	ling Survey Area (I	Building 230)
Survey Unit:	16			Description:	U-Sh	aped Area - Section	n 9 Floor/Lower Wall
Survey Type:	FSS			Classification:	Class	1	
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes
B02-16-01-S-F-S-00	F	S	NA	NA	17.2	2.5	Floor
B02-16-02-S-F-S-00	F	S	NA	NA	17.2	10.7	Floor
B02-16-03-S-F-S-00	F	S	NA	NA	17.2	18.9	Floor
B02-16-04-S-F-S-00	F	S	NA	NA	10.0	6.6	Floor
B02-16-05-S-F-S-00	F	S	NA	NA	10.0	14.8	Floor
B02-16-06-S-F-S-00	F	S	NA	NA	2.8	2.5	Floor
B02-16-07-S-F-S-00	F	S	NA	NA	2.8	10.7	Floor
B02-16-08-S-F-S-00	F	S	NA	NA	2.8	18.9	Floor
B02-16-09-S-W-S-00	W	S	NA	NA	5.7	2.8	West Wall
B02-16-10-S-W-S-00	W	S	NA	NA	1.6	10	West Wall
B02-16-11-S-W-S-00	W	S	NA	NA	5.7	17.2	West Wall
B02-16-12-S-F-B-00	F	В	NA	NA	19.5	0.3	Floor
B02-16-13-S-F-B-00	F	В	NA	NA	19.8	19.8	Floor
D00 14 14 0 D D 00	_					10.0	

*X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area)

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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27.3 Biased Measurements

In total, three (3) areas were identified for biased measurement. These areas were identified by scan measurements that approached or exceeded the Scan IAL. No biased measurement was identified to exceed the DCGL $_{SO}$, the highest identified result was 1,047 dpm/100 cm 2 (6% of the DCGL $_{SO}$).

27.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, BSA 02-16 was subject to a QC Replicate Survey.

Per HDP-PR-FSS-703, QC replicate survey requirements for structural SUs require that 5% of all Class 1, Class 2, and Class 3 SSC SUs are randomly selected to undergo a replicate survey of the entire SU area. The replicate survey is to be performed by an HP Technician other than the one who performed the initial survey using similar instrumentation. BSA 02-16 has been randomly selected as an SU for which a replicate survey has been required. Therefore, all FSS actions will be performed by two separate qualified individuals.

FSS of the SU is performed and the results are compared to release criteria. The replicate FSS of the SU is also compared to the release criteria. If the replicate survey agrees with the first FSS of the SU that the release criteria has been meet, then the replicate survey will be considered successful. If the replicate survey does not indicate that release criteria have been met, an investigation will be conducted.

For BSA 02-16, both the FSS and the replicate FSS produced similar results, both demonstrating that the release criteria was met, and therefore the QC replicate survey is considered successful.

28.0 FINAL STATUS SURVEY RESULTS BSA 02-16

During the performance of FSS in BSA 02-16, all scan measurements exceeding the Scan MDC of 2,187 dpm/100 cm² were identified for biased measurement. No static measurement exceeded the DCGL $_{SO}$ of 18,925 dpm/100 cm². No removable contamination measurement exceeded the MDA, therefore no removable contamination measurement exceeded 10% of the DCGL $_{SO}$. The highest observed TSC measurement was 1,047 dpm/100 cm² (biased location, 6% of the DCGL $_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 302 dpm/100 cm² (2% of the DCGL $_{SO}$).

The analytical data sheets used to evaluate the BSA 02-16 FSS data are provided in Appendix D. A summary table of the FSS results is presented below in Table 28-1.

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Table 28-1 FSS Data Summary for BSA 02-16

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² (α+β)	Corrected Net dpm/100cm ²	Fraction of DCGL
B02-16-01-S-F-S-00	Floor	9/10/2015	alpha + beta TSC	234	178	56	565	565	3%
B02-16-02-S-F-S-00	Floor	9/10/2015	alpha + beta TSC	207	178	29	294	294	2%
B02-16-03-S-F-S-00	Floor	9/10/2015	alpha + beta TSC	204	178	26	264	264	1%
B02-16-04-S-F-S-00	Floor	9/10/2015	alpha + beta TSC	237	178	59	595	595	3%
B02-16-05-S-F-S-00	Floor	9/10/2015	alpha + beta TSC	207	178	29	294	294	2%
B02-16-06-S-F-S-00	Floor	9/10/2015	alpha + beta TSC	216	178	38	385	385	2%
B02-16-07-S-F-S-00	Floor	9/10/2015	alpha + beta TSC	214	178	36	364	364	2%
B02-16-08-S-F-S-00	Floor	9/10/2015	alpha + beta TSC	233	178	55	555	555	3%
B02-16-09-S-W-S-00	West Wall	9/10/2015	alpha + beta TSC	169	178	-9	-87	0	0%
B02-16-10-S-W-S-00	West Wall	9/10/2015	alpha + beta TSC	157	178	-21	-208	0	0%
B02-16-11-S-W-S-00	West Wall	9/10/2015	alpha + beta TSC	157	178	-21	-208	0	0%
B02-16-12-S-F-B-00	Floor	9/10/2015	alpha + beta TSC	256	178	78	786	786	4%
B02-16-13-S-F-B-00	Floor	9/10/2015	alpha + beta TSC	247	178	69	696	696	4%
B02-16-14-S-F-B-00	Floor	9/10/2015	alpha + beta TSC	282	178	104	1047	1047	6%

*NOTE: Differences from documented survey results are due to rounding in Excel

0	2%
595	270
302	DCGLso
294	0.50
224.8	0.00
	595 302 294

mrem/year

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29.0 ALARA EVALUATION BSA 02-16

All measurements collected within BSA 02-16 were evaluated against the $DCGL_{SO}$. For BSA 02-16 no measurement result exceeded the $DCGL_{SO}$. The average result, based on all systematically collected measurements was 2% of $DCGL_{SO}$ for BSA 02-16. The average of all measurements equates to residual activity contribution from the SU area of 0.5 mrem/year for BSA 02-16. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the $DCGL_{SO}$.

As the estimated TEDE for BSA 02-16 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-16 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-16.

30.0 FSS PLAN DEVIATIONS BSA 02-16

There were no deviations from the FSS Plan as written.

30.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-16.

31.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

31.1 Data Quality Assessment for BSA 02-16

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-16 (see Figure 31-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (*Operation of the Ludlum 2360 for Final Status Survey*), and HDP-PR-HP-411 (*Radiological Instrumentation*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected (on a random start, systematic pattern) and the scan surveys that were conducted were performed in

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accordance with procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- A Quality Control Replicate Survey was performed for BSA 02-16, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-16 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Eleven (11) systematic measurements were collected in BSA 02-16. None of the 11 measurements exceeded the DCGL_{SO} resulting in a systematic average result of 2% of the DCGL_{SO}. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 31-1. The Sign Test was successful as the total number of systematic measurements (11), exceeded the minimum requirement of 8 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-16 was 3% of the DCGL $_{\rm SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 3% of the DCGL $_{\rm SO}$, resulting in a residual dose contribution of 0.5 mrem/year.
- No FSS measurement result in BSA 02-16 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
 - HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-16 was completed prior to and after the performance of the FSS. BSA 02-16 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

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 $\alpha = 0.05$

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Table 31-1 Sign Test for BSA 02-16

		Sign Test			
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference
B02-16-01-S-F-S-00	Floor	565	0.030	0.970	0.970
B02-16-02-S-F-S-00	Floor	294	0.016	0.984	0.984
B02-16-03-S-F-S-00	Floor	264	0.014	0.986	0.986
B02-16-04-S-F-S-00	Floor	595	0.031	0.969	0.969
B02-16-05-S-F-S-00	Floor	294	0.016	0.984	0.984
B02-16-06-S-F-S-00	Floor	385	0.020	0.980	0.980
B02-16-07-S-F-S-00	Floor	364	0.019	0.981	0.981
B02-16-08-S-F-S-00	Floor	555	0.029	0.971	0.971
B02-16-09-S-W-S-00	West Wall	0	0.000	1.000	1.000
B02-16-10-S-W-S-00	West Wall	0	0.000	1.000	1.000
B02-16-11-S-W-S-00	West Wall	0	0.000	1.000	1.000
			Number of Positive D	ifferences (S+)	11
		Sign To	est Critical Value (MAR	SSIM Table I-3)	8

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST:

PASS

Critical V	IM Table I-3 alues for the t Statistic S+	Critical V	Table I-3 /alues for gn Test stic S+
N	Alpha = 0.05	N	Alpha = 0.05
4	4	28	18
5	4	29	19
6	5	30	19
7	6	31	20
8	6	32	21
9	7	33	21
10	8	34	22
11	8	35	22
12	9	36	23
13	9	37	23
14	10	38	24
15	11	39	25
16	11	40	25
17	12	41	26
18	12	42	26
19	13	43	27
20	14	44	27
21	14	45	28
22	15	46	29
23	15	47	29
24	16	48	30
25	17	49	30
26	17	50	31
27	18		

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Figure 31-1 Data Evaluation Checklists prepared for BSA 02-16 (page 1 of 2)

Hematite	Procedure: HDP-PR-FSS-721, Final Status Survey Data Eval	uation	
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FINIAL	APPENDIX G-1	JEW CHECK	LIST
FINAL	STATUS SURVEY DATA QUALITY OBJECTIVES REV	TEW CHECK	LIST
Survey Area:	BSA 02 Description: Building Survey A	Area (Building	230)
Survey Unit:	16 Description: U-Shaped Area –		
to data and	neasurements and/or analysis results that will be subjected alysis for FSS been individually reviewed and validated in e with Section 8.1 of this procedure?	Yes No	
	systematic measurements and/or samples been taken or it the locations specified in the FSSP and the FSS Sample is?	Yes 🛛 No	
	scans surveys been performed of the areas specified as a the FSSP and the FSS Sample Instructions?	Yes 🛛 No	
	iased measurements and/or samples been taken or acquired tions specified in the FSSP & the FSS Sample Instructions?	Yes 🛛 No	NA 🗌
	licate and/or split samples or measurements been taken or t each location designated as a QC sample?	Yes No	o □ NA ⊠
capable of	instruments used to measure or analyze the survey data of detecting the ROCs or gross activity at a MDC less than priate investigation level?	Yes 🛛 No	
analyze da	ralibration of all instruments that were used to measure or ata, current at the time of use and were those calibrations using a NIST traceable source?	Yes No	o 🗌
	instruments successfully response-checked before use and, uired, after use on the day the data was measured?	Yes No	0
9. Do the sar	mples match those identified on the chain of custody?	Yes N	o 🗌 NA 🖂
	C Sample Results meet the acceptance criteria as specified in FSS-703, Final Status Survey Quality Control?	Yes N	o 🗌 NA 🖂
11. Are all La	boratory QC parameters within acceptable limits?	Yes N	o 🗌 NA 🖂
If "No" was the corrective action	ne response to any of the questions above, then document the ons that were taken to resolve the discrepancy.	he discrepancy	as well as any
Comments: N/	A		
Quality Record			

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 31-1
Data Evaluation Checklists prepared for BSA 02-16 (page 2 of 2)

					Survey Data Ev	valuation	C 2 01 2)
Hematite	Proc	edure: HDP-	PK-F55-721.	, Final Status	Survey Data Ev	aluation	
Decommissionin Project	g					Revision: 10	Appendix G-1, Page 2 of 2
FINA	L STAT	TUS SURVE		PPENDIX G UALITY OI		EVIEW CHECK	KLIST
Survey Area	: No.	BSA 02	D	escription:	Building Surve	y Area (Building	(230)
Survey Unit	No.	16	D	escription:	U-Shaped Area	a – Section 9 Floo	or/Lower Wall
Discrepancy	None						
Corrective A				discrepancy	with the data?	Yes \(\) N	fo NA 🖂
			s form to the		with the data.	100	
			l be answered).		
a. If th			11 was "No"			Yes 🗌 N	lo 🗌 NA 🖂
			ting valid me compliance			Yes N	lo 🗌 NA 🖂
			equisition of for the survey		easurements or s	samples as necess	sary to
Prepared	by (HP	Staff):	Thomas \(\frac{1}{(Pr)}\)	(ardy	Thu (Sign	hature)	5-2/-/7 (Date)
Approve	d by (RS	SO):	Clark Eve	ers int Name)	W. Ch	nature)	8/24/17 (Date)
Quality Recor	d						

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32.0 CONCLUSION BSA 02-16

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-16 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

 $\begin{tabular}{ll} Table 32-1\\ BSA 02-16 DCGL_{SO} and Dose Summation \\ \end{tabular}$

	RESIDUAL ACTIVITY
DCGL _{so}	2%
Daga	0.5
Dose	mrem/year

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33.0 FINAL STATUS SURVEY DESIGN BSA 02-17

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-17 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_{SO}$, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-17 and the detection sensitivities are also discussed.

33.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-17 were driven by the type (Structure) and Class (Class 3) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 2015.

33.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-17. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

33.1.2 Scan Coverage

As a Class 3 structure SU, the scan survey requirement is 1-10% of the exposed surfaces of the structure.

33.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-89 detector, paired with a Ludlum Model 2360 data logging meter. Note that the FSS Plan prepared for BSA 02-17 referenced a Ludlum 43-93 detector instead of a Ludlum 43-89, however these two probes are considered equivalent. The MDC's provided below are those that were determined during the FSS planning stage, and therefore reference the Ludlum 43-93 detector.

33.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 200 cpm (based on observed operational instrument background) for the Ludlum Model 43-93 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

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$$Scan \ MDC = \frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe\ Area}{100}\right)}$$

Equation 33-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_i * \varepsilon_s * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes:

 $\varepsilon_i = 2$ pi (π) instrument efficiency for nuclide of concern $\varepsilon_s = \text{surface efficiency for nuclide of concern}$

Yield = 100% for all nuclides of concern

Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 33-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.97% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{200}{60} \times \frac{60}{1}}}{0.707 \times 0.0975 \times (\frac{100}{100})} = 2,351 \text{ dpm}/100 \text{ cm}^2$$

Equation 33-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-93 is given in Table 33-1.

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Table 33-1
Total Weighted Efficiency Calculation (Ludlum Model 43-93) for BSA 02-17

Ludlum 2360	Ludlum Model 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency 25.5%		ß Cal. Efficiency	
268477	289424	125 cm ²	25.3%	N/A			N/A	
	TOTAL WEIGHTED INSTRUMENT EFFICIENCY CALCULATION							
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ε _s)	Yield 100%	Activity Fraction	Weighted Efficiency	
Am-241	Alpha	5.6	0.2530	0.25	1.00	2.682E-03	1.70E-04	
Np-237	Alpha	5.0	0.2530	0.25	1.00	5.573E-05	3.52E-06	
Pu-239	Alpha	5.2	0.2530	0.25	1.00	2.027E-06	1.28E-07	
Tc-99	Beta	0.294	0.2550	0.25	1.00	2.829E-03	1.80E-04	
Th-232	Alpha	4.1	0.2530	0.25	1.00	3.214E-03	2.03E-04	
Ra-228	Beta	0.046	0.2550	0.00	1.00	3.214E-03	0.00E+00	
Ac-228	Beta	2.13	0.2550	0.50	1.00	3.214E-03	4.10E-04	
Th-228	Alpha	5.5	0.2530	0.25	1.00	3.214E-03	2.03E-04	
Ra-224	Alpha	5.8	0.2530	0.25	1.00	3.214E-03	2.03E-04	
U-234	Alpha	4.9	0.2530	0.25	1.00	8.270E-01	5.23E-02	
U-235	Alpha	4.7	0.2530	0.25	1.00	3.720E-02	2.35E-03	
Th-231	Beta	0.390	0.2550	0.25	1.00	3.720E-02	2.37E-03	
U-238	Alpha	4.3	0.2530	0.25	1.00	1.270E-01	8.03E-03	
Th-234	Beta	0.270	0.2550	0.25	1.00	1.270E-01	8.10E-03	
Pa-234m	Beta	2.20	0.2550	0.50	1.00	1.270E-01	1.62E-02	
						Σ=	9.07%	

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern Weighted Instrument Efficiency = $\epsilon_i * \epsilon_s * \text{Yield} * \text{Activity Fraction}$

 $\varepsilon_i = 2$ Pi Instrument Efficiency for Nuclide of Concern

ε_s = Surface Efficiency for Nuclide of Concern

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33.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_S \left(1+\frac{t_S}{t_b}\right)}}{(\varepsilon_t)(t_S)\left(\frac{A}{100 \text{ cm}^2}\right)}$$

Equation 33-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

t_b = Background count time (minutes);

 ε_t = Total weighted efficiency (2π) ; and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.97% is calculated to be:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{200 \times 1\left(1+\frac{1}{1}\right)}}{(0.0997)(1)\left(\frac{100}{100}\right)} = 690 \text{ dpm/}100 \text{ cm}^2$$

Equation 33-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-93 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-17. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

33.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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33.1.7 BSA 02-17 FSS Design Summary

The complete FSS Plan for BSA 02-17 is provided in Appendix O. A summary table of the requirements in the FSS Plan for BSA 02-17 is presented in Table 33-2 below.

Table 33-2 FSS Design Summary for BSA 02-17

Portable Instrument Scanning:					
Scan Coverage			1-10% of BSA 02-17 total area		
Scan MDC			1 dpm / 100 cm ² (Ludlum 43-93)		
Investigation Action Level (IAL)		2,35	l dpm / 100 cm ² (Ludlum 43-93)		
Total Surface Contamination (TS	C) Measurements:				
Surface	Minimum Number Measurements		Comments		
Building 230: U-Shaped Area & Warehouse Area -All sections (upper walls and ceiling)	11	-	A total of 12 TSC measurements locations have been systematically designed from a random start point.		
Investigation Action Level	9,463 dpm / 100 cm ² (50% of Adjusted Gross DCGL)				
Removable Activity Locations:					
After each TSC measurement, at t			C measurement, using moderate pressure vindow, etc.) in an S-shaped pattern within		
After each TSC measurement, at t swipe a cloth smear over the surface					
After each TSC measurement, at a swipe a cloth smear over the surface an approximately 4" by 4" box. Biased Measurement Locations: Biased measurements may be coll	e (e.g. exterior wall, r	on of	the HP Technician performing the FSS in surface features such as cracks, smal		
After each TSC measurement, at a swipe a cloth smear over the surface an approximately 4" by 4" box. Biased Measurement Locations: Biased measurements may be coll Based on the RASS data, there are	e (e.g. exterior wall, rected at the discretice no indications that more elevated than a	on of t certa	the HP Technician performing the FSS in surface features such as cracks, smalnt surfaces.		
After each TSC measurement, at a swipe a cloth smear over the surface an approximately 4" by 4" box. Biased Measurement Locations: Biased measurements may be coll Based on the RASS data, there are holes, conduit penetrations, etc., are	e (e.g. exterior wall, rected at the discretice no indications that more elevated than a condetector.	ion of t certa adjace	the HP Technician performing the FSS in surface features such as cracks, small		

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34.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-17

FSS was performed in accordance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems, and Components*.

34.1 Scan Survey Performance

As a Class 3 SU the FSS plan required that 1-10% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover greater than 10% of the structural surfaces (provided in Appendix Y).

34.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated for BSA 02-17, and a total of twelve (12) measurements were designed by the FSS Plan. These direct, static-count measurement locations were designed in a random pattern (See Figure 34-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 34-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix O).

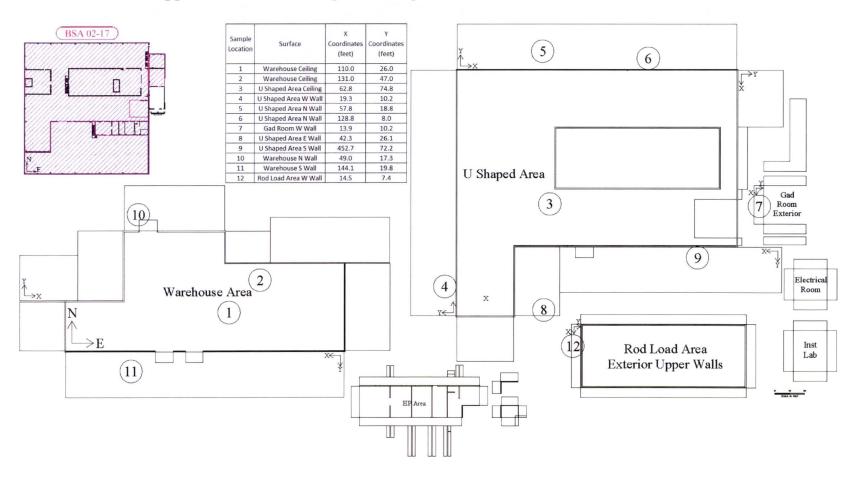
No systematic location exceeded the $DCGL_{SO}$. The highest observed systematic TSC measurement was 287 dpm/100 cm² (2% of the DCGLso). One removable contamination measurement exceeded the instrument MDA with a result of 14 dpm/100 cm² alpha (compared to an MDA of 12.4 dpm/100 cm²). However no removable contamination measurement exceeded 10% of the DCGL_{SO}. The FSS documentation for BSA 02-17 is provided in Appendix Y.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 34-1 BSA 02-17 Systematic Measurement Locations

BSA 02-17 Upper Walls and Ceiling of U Shaped Area and Warehouse in B230



FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 34-1 FSS Measurement Locations for BSA 02-17

Homotito	Procedure	e: HDP-PR-FSS-	701, Final Status S	urvey Plan De	velopment			
Hematite Decommissionin Project	g					Revision: 10	Appendix P-4, Page 1 of 1	
		P00 0						
		FSS SA	COORDINATES					
Survey Area:	BSA 02			Description:		g Survey Area (Building 23 tions and Warehouse, Upper		
Survey Unit:	_17			Description:	Exterior		- Walls, Coming and Duck	
Survey Type:	FSS			Classification:	Class 3			
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis) *	Easting (feet) (X Axis) *	Remarks / Notes	
B02-17-01-S-C-S-00	С	S	NA	NA	26.0	110.0	Warehouse Ceiling	
B02-17-02-S-C-S-00	С	S	NA	NA	47.0	131.0	Warehouse Ceiling	
B02-17-03-S-C-S-00	С	S	NA	NA	74.8	62.8	U-Shaped Area Ceiling	
B02-17-04-S-W-S-00	W	S	NA	NA	10.2	19.3	U-Shaped Area West Wall	
B02-17-05-S-W-S-00	W	S	NA	NA	18.8	57.8	U-Shaped Area North Wall	
B02-17-06-S-W-S-00	W	S	NA	NA	8.0	128.8	U-Shaped Area North Wall	
B02-17-07-S-W-S-00	W	S	NA	NA	10.2	13.9	Gad Room West Ext. Wall	
B02-17-08-S-W-S-00	W	S	NA	NA	26.1	42.3	U-Shaped Area East Wall	
B02-17-09-S-W-S-00	W	S	NA	NA	72.2	452.7	U-Shaped Area South Wall	
B02-17-10-S-W-S-00	W	S	NA	NA	17.3	49.0	Warehouse North Wall	
B02-17-11-S-W-S-00	W	S	NA	NA	19.8	144.1	Warehouse South Wall	
B02-17-12-S-W-S-00	W	S	NA	NA	7.4	14.5	Rod Load West Ext. Wall	
*X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area) Surface: Floor = F; Wall = W; Ceiling = C; Roof = R CSM: Three-Layer (Surface-Root-Deep) or Uniform								

34.3 Biased Measurements

Quality Record

Systematic = S, Biased = B; QC =Q; Investigation = I

Type:

No elevated areas were identified during scan measurements of BSA 02-17, therefore no biased measurements were determined to be necessary.

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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34.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, no QC measurements were necessary for BSA 02-17.

35.0 FINAL STATUS SURVEY RESULTS BSA 02-17

During the performance of FSS in BSA 02-17, no scan measurements exceeding the Scan MDC of $2,187 \text{ dpm}/100 \text{ cm}^2$ were identified for biased measurement. No static measurement exceeded the DCGL_{SO} of $18,925 \text{ dpm}/100 \text{ cm}^2$. Only one removable contamination measurement exceeded the instrument MDA, and no removable contamination measurement exceeded 10% of the DCGL_{SO}. The highest observed TSC measurement was $287 \text{ dpm}/100 \text{ cm}^2$ (systematic location, 2% of the DCGL_{SO}), and the average residual radioactivity based on all systematically collected measurements is $82 \text{ dpm}/100 \text{ cm}^2$ (0.4% of the DCGL_{SO}),

The analytical data sheets used to evaluate the BSA 02-17 FSS data are provided in Appendix E. A summary table of the FSS results is presented below in Table 35-1.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 35-1 FSS Data Summary for BSA 02-17

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm² (α+β)	Corrected Net	Fraction of DCGL
B02-17-01-S-C-S-00	Warehouse Ceiling	6/16/2016	alpha + beta TSC	175	153	22	253	253	1%
B02-17-02-S-C-S-00	Warehouse Ceiling	6/16/2016	alpha + beta TSC	173	153	20	230	230	1%
B02-17-03-S-C-S-00	U-Shaped Area Ceiling	6/16/2016	alpha + beta TSC	154	153	1	11	11	0%
B02-17-04-S-W-S-00	U-Shaped Area West Wall	6/16/2016	alpha + beta TSC	178	153	25	287	287	2%
B02-17-05-S-W-S-00	U-Shaped Area North Wall	6/16/2016	alpha + beta TSC	158	153	5	57	57	0%
B02-17-06-S-W-S-00	U-Shaped Area North Wall	6/16/2016	alpha + beta TSC	166	153	13	149	149	1%
B02-17-07-S-W-S-00	Gad Room West Ext. Wall	6/16/2016	alpha + beta TSC	128	153	-25	-287	0	0%
B02-17-08-S-W-S-00	U-Shaped Area East Wall	6/16/2016	alpha + beta TSC	136	153	-17	-195	0	0%
B02-17-09-S-W-S-00	U-Shaped Area South Wall	6/16/2016	alpha + beta TSC	130	153	-23	-264	0	0%
B02-17-10-S-W-S-00	Warehouse North Wall	6/16/2016	alpha + beta TSC	129	153	-24	-276	0	0%
B02-17-11-S-W-S-00	Warehouse South Wall	6/16/2016	alpha + beta TSC	143	153	-10	-115	0	0%
B02-17-12-S-W-S-00	Rod Load West Ext. Wall	6/16/2016	alpha + beta TSC	136	153	-17	-195	0	0%

*NOTE: Differences from documented survey results are due to rounding in Excel

Min	0	0.4%
Max	287	0.470
Mean	82	DCGLso
Median	6	0.10
Stdev	114.3	0.10

mrem/year

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36.0 ALARA EVALUATION BSA 02-17

All measurements collected within BSA 02-17 were evaluated against the DCGL_{SO}. For BSA 02-17 no measurement result exceeded the DCGL_{SO}. The average result, based on all systematically collected measurements was 0.4% of DCGL_{SO} for BSA 02-17. The average of all measurements equates to residual activity contribution from the SU area of 0.1 mrem/year for BSA 02-17. Only one removable contamination measurement was identified to exceed the instrument MDA, and no removable contamination measurement exceeded 10% of the DCGL_{SO}.

As the estimated TEDE for BSA 02-17 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-17 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-17.

37.0 FSS PLAN DEVIATIONS BSA 02-17

There were no deviations from the FSS Plan as written.

37.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-17.

38.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

38.1 Data Quality Assessment for BSA 02-17

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-17 (see Figure 38-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (Operation of the Ludlum 2360 for Final Status Survey), and HDP-PR-HP-411 (Radiological Instrumentation).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected(on a random pattern) and the scan surveys that were conducted were performed in accordance with

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procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- Quality Control sample results were not necessary for BSA 02-17. However a Quality Control Replicate Survey was performed for BSA 02-16 and BSA 02-18, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-17 survey and measurement results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Twelve (12) systematic measurements were collected in BSA 02-17. None of the 12 measurements exceeded the DCGL_{SO} resulting in a systematic average result of 0.4% of the DCGL_{SO}. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 38-1. The Sign Test was successful as the total number of systematic measurements (12), exceeded the minimum requirement of 9 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. Only one removable smear sample exceeded the instrument MDA, and no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-17 was 2% of the DCGL $_{\rm SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 0.4% of the DCGL $_{\rm SO}$, resulting in a residual dose contribution of 0.1 mrem/year.
- No FSS measurement result in BSA 02-17 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-17 was completed prior to and after the performance of the FSS. BSA 02-17 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

 $\alpha = 0.05$

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Table 38-1 Sign Test for BSA 02-17

Sign Test							
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference		
B02-17-01-S-C-S-00	Warehouse Ceiling	253	0.013	0.987	0.987		
B02-17-02-S-C-S-00	Warehouse Ceiling	230	0.012	0.988	0.988		
B02-17-03-S-C-S-00	U-Shaped Area Ceiling	11	0.001	0.999	0.999		
B02-17-04-S-W-S-00	U-Shaped Area West Wall	287	0.015	0.985	0.985		
B02-17-05-S-W-S-00	U-Shaped Area North Wall	57	0.003	0.997	0.997		
B02-17-06-S-W-S-00	U-Shaped Area North Wall	149	0.008	0.992	0.992		
B02-17-07-S-W-S-00	Gad Room West Ext. Wall	0	0.000	1.000	1.000		
B02-17-08-S-W-S-00	U-Shaped Area East Wall	0	0.000	1.000	1.000		
B02-17-09-S-W-S-00	U-Shaped Area South Wall	0	0.000	1.000	1.000		
B02-17-10-S-W-S-00	Warehouse North Wall	0	0.000	1.000	1.000		
B02-17-11-S-W-S-00	Warehouse South Wall	0	0.000	1.000	1.000		
B02-17-12-S-W-S-00	Rod Load West Ext. Wall	0	0.000	1.000	1.000		
			Number of Positive D	ifferences (S+)	12		
		Sign To	est Critical Value (MAR	SSIM Table I-3)	9		

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST: PASS

Critical V	IM Table I-3 alues for the t Statistic S+	Critical V	Table I-3 /alues for gn Test tic S+
N	Alpha = 0.05	N	Alpha = 0.05
4	4	28	18
5	4	29	19
6	5	30	19
7	6	31	20
8	6	32	21
9	7	33	21
10	8	34	22
11	8	35	22
12	9	36	23
13	9	37	23
14	10	38	24
15	11	39	25
16	11	40	25
17	12	41	26 .
18	12	42	26
19	13	43	27
20	14	44	27
21	14	45	28
22	15	46	29
23	15	47	29
24	16	48	30
25	17	49	30
26	17	50	31
27	18		

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 38-1 Data Evaluation Checklists prepared for BSA 02-17 (page 1 of 2)

		1				1	
Hematite Decommissioning Project		Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation					
					Revision: 1	O Appendix G-1, Page 1 of 2	
	FINAL	STATUS SURVEY	APPENDIX O DATA QUALITY O		IEW CHEC	CKLIST	
Sur	vey Area:	BSA 02	Description:	Building Survey A	Area (Buildin	g 230)	
Sur	vey Unit:	17	Description:	All Sections and War Duct Exteriors	ehouse, Upper V	Walls, Ceiling and	
1.	to data ana		analysis results that v ndividually reviewed this procedure?	will be subjected	Yes 🖂 🗋	No 🗌	
2.		t the locations specif	nents and/or samples fied in the FSSP and		Yes 🖂	No 🗌	
3.			performed of the ar S Sample Instructions		Yes 🖂	No 🗌	
4.		biased measurements and/or samples been taken or acquired tions specified in the FSSP & the FSS Sample Instructions?				No 🗌 NA 🖂	
5.		licate and/or split samples or measurements been taken or Yes No NA NA teach location designated as a QC sample?				No 🗌 NA 🖂	
6.	capable of		measure or analyze or gross activity at a rel?		Yes 🖂	No 🗌	
7.	analyze da		ruments that were use ne of use and were the ole source?		Yes 🖂	No 🗌	
8.			ally response-checked day the data was mea		Yes 🖂	No 🗌	
9.	Do the san	nples match those ide	ntified on the chain of	f custody?	Yes 🗌	No 🗌 NA 🖂	
10.			t the acceptance criter Survey Quality Contr		Yes 🗌	No 🗌 NA 🖂	
11.	Are all La	boratory QC paramet	ers within acceptable	limits?	Yes 🗌	No 🗌 NA 🖂	
			f the questions above resolve the discrepand		he discrepand	cy as well as any	
Cor	mments: N/A	4					
Quali	ty Record						

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 38-1 Data Evaluation Checklists prepared for BSA 02-17 (page 2 of 2)

Hematite	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation						
commissioning Project				Revision: 10	Appendix G-1, Page 2 of 2		
FINAL	STATUS SURV	APPENDIX G EY DATA QUALITY OF		VIEW CHECK	LIST		
Survey Area: Survey Unit:	No. BSA 02 No. 17	Description: Description:	Building Survey All Sections and W Duct Exteriors	Area (Building arehouse, Upper W			
Discrepancy:	None						
Corrective Act	ions Taken: No	ne					
		resolved the discrepancy is form to the RSO.	with the data?	Yes N	o 🗌 NA 🖂		
12. The follo	wing questions w	ill be answered by the RSC).				
a. If the a		n 11 was "No", then is the	affected data	Yes N	o 🗌 NA 🖂		
		sting valid measurements of ecompliance for the survey		Yes N	o 🗌 NA 🖂		
		C 1127 1	easurements or sa	amples as necess			
suffici c. If "No		acquisition of additional me for the survey unit.		impres as necess	ary to		
suffici c. If "No demor			Am Sight	med to	9-21-/7 (Date)		

Hematite Decommissioning Project	FSSFR Volume 4, Chapter 3: Survey Area Release Record for Bassarvey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, E27)	3, BSA 02-14, BSA 02-
Project	Revision: 0	Page 92 of 174

39.0 CONCLUSION BSA 02-17

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-17 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 39-1 BSA 02-17 DCGL_{SO} and Dose Summation

	RESIDUAL
RADIO	ACTIVITY
DCGL _{so}	0.4%
Dose	0.1 mrem/year

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40.0 FINAL STATUS SURVEY DESIGN BSA 02-18

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-18 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_{SO}$, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-18 and the detection sensitivities are also discussed.

40.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-18 were driven by the type (Structure) and Class (Class 2) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

40.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-18. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

40.1.2 Scan Coverage

As a Class 2 structure SU, the scan survey requirement is a minimum of 10% of the exposed surfaces of the structure.

40.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-89 detector, paired with a Ludlum Model 2360 data logging meter.

40.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 179 cpm (based on observed operational instrument background) for the Ludlum Model 43-89 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe\ Area}{100}\right)}$$

Equation 40-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_i * \varepsilon_s * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes

 $\varepsilon_i = 2 \text{ pi }(\pi) \text{ instrument efficiency for nuclide of concern}$ $\varepsilon_s = \text{surface efficiency for nuclide of concern}$

Yield = 100% for all nuclides of concern

Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 40-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-89), a nominal background rate of 176 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.58% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{179}{60}} \times \frac{60}{1}}{0.707 \times 0.0958 \times \left(\frac{125}{100}\right)} = 1,676 \text{ dpm/}100 \text{ cm}^2$$

Equation 40-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-89 is given in Table 40-1.

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Table 40-1 Total Weighted Efficiency Calculation (Ludlum Model 43-89) for BSA 02-18

Ludlum 2360	Ludlum Model 43-89	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency		B Cal. Efficiency
275770	19206	125 cm ²	30.2%	N/A			N/A
		TOTAL WEIG	HTED INSTRUMENT EFF	FICIENCY CALCULATIO	N		
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ε _s)	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.3020	0.25	1.00	2.682E-03	2.02E-04
Np-237	Alpha	5.0	0.3020	0.25	1.00	5.573E-05	4.21E-06
Pu-239	Alpha	5.2	0.3020	0.25	1.00	2.027E-06	1.53E-07
Tc-99	Beta	0.294	0.1870	0.25	1.00	2.829E-03	1.32E-04
Th-232	Alpha	4.1	0.3020	0.25	1.00	3.214E-03	2.43E-04
Ra-228	Beta	0.046	0.1870	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.1870	0.50	1.00	3.214E-03	3.01E-04
Th-228	Alpha	5.5	0.3020	0.25	1.00	3.214E-03	2.43E-04
Ra-224	Alpha	5.8	0.3020	0.25	1.00	3.214E-03	2.43E-04
U-234	Alpha	4.9	0.3020	0.25	1.00	8.270E-01	6.24E-02
U-235	Alpha	4.7	0.3020	0.25	1.00	3.720E-02	2.81E-03
Th-231	Beta	0.390	0.1870	0.25	1.00	3.720E-02	1.74E-03
U-238	Alpha	4.3	0.3020	0.25	1.00	1.270E-01	9.59E-03
Th-234	Beta	0.270	0.1870	0.25	1.00	1.270E-01	5.94E-03
Pa-234m	Beta	2.20	0.1870	0.50	1.00	1.270E-01	1.19E-02
						Σ=	9.58%

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern Weighted Instrument Efficiency = $\epsilon_i * \epsilon_s * \text{Yield} * \text{Activity Fraction}$

 $\varepsilon_i = 2$ Pi Instrument Efficiency for Nuclide of Concern

 ε_s = Surface Efficiency for Nuclide of Concern

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40.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_S \left(1+\frac{t_S}{t_b}\right)}}{(\varepsilon_t)(t_S)\left(\frac{A}{100 cm^2}\right)}$$

Equation 40-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

 $t_b = Background count time (minutes);$

 ε_t = Total weighted efficiency (2 π); and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-89), a nominal background rate of 179 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.58% is calculated to be:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{179 \times 1\left(1+\frac{1}{1}\right)}}{(0.0958)(1)\left(\frac{125}{100}\right)} = 545 \text{ dpm/}100 \text{ cm}^2$$

Equation 40-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-89 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-18. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

40.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

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40.1.7 BSA 02-18 FSS Design Summary

The complete FSS Plan for BSA 02-18 is provided in Appendix P. A summary table of the requirements in the FSS Plan for BSA 02-18 is presented in Table 40-2 below.

Table 40-2

Portable Instrument Scanning:						
Scan Coverage		Mi	inimum 10% of BSA 02-18 total area			
Scan MDC			1,676 dpm/100cm ² (Ludlum 43-89) 961 dpm/100cm ² (Ludlum 43-37)			
Investigation Action Level (IAL): g	general area		576 dpm/100cm ² (Ludlum 43-89) 1 dpm/100cm ² (Ludlum 43-37)			
Total Surface Contamination (TS	C) Measurements:					
Surface			Comments			
BSA 02-18 Surfaces (Lower floor and walls)			A total of 11 TSC measurements locations have been systematically designed from a random start point.			
Removable Activity Locations:						
Using moderate pressure swipe a cl an S-shaped pattern within an appro			(e.g. exterior wall, roof, window, etc.) in ach TSC location.			
Biased Measurement Locations:						
or seams where the Scan MDC wa amount and specific locations of bi	as exceeded. Consult ased measurements. A stments to instrument	Radi t loc effi	and asphalt surfaces such as cracks, holes iological Engineering for guidance on the ations where biased measurements exceed iciency or volumetric sampling may be			

necessary – consult Radiological Engineering for guidance.

Instrumentation							
Ludlum 2360 with 43-89 scintillation detector.	Used for scanning and to obtain static (TSC) measurements.						
Ludlum 2360 with 43-37 gas proportional detector.	Used for scanning floors.						
Tennelec or Ludlum 3030 with 43-10-1 scintillation detector.	Used for counting of swipe (smear) samples.						

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41.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-18

FSS was performed in accordance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems, and Components*.

41.1 Scan Survey Performance

As a Class 2 SU the FSS plan required that a minimum of 10% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact meet the minimum requirement of 50% of the structural surfaces (provided in Appendix Z).

41.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated and designed for BSA 02-18 by the FSS Plan. These direct, static-count measurement locations were designed in a random start, systematic pattern (See Figure 41-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 41-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix P).

No systematic location exceeded the $DCGL_{SO.}$ The highest observed systematic TSC measurement was 546 dpm/100 cm² 3% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-18 is provided in Appendix Z.

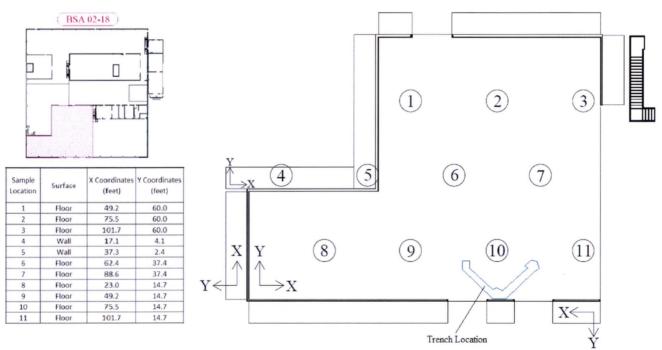
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Figure 41-1 BSA 02-18 Systematic Measurement Locations

BSA 02-18 Lower Walls and Floor of West Warehouse in B230



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Table 41-1 FSS Measurement Locations for BSA 02-18

	Procedure:	HDP-PR-FSS-701, Fin	al Status Survey Plan De	evelopment				
ning		,			Revision: 10	Appendix P-4, Page 1 of 1		
	FSS SA			& COORDIN	ATES			
BSA 02			Description:			Building 230)		
18			Description:	Build	Building 230 Bay Warehouse (former WTS are			
FSS			Classification:	Class	2			
Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes		
F	S	NA	NA	60.0	49.2	Floor		
F	S	NA	NA	60.0	75.5	Floor		
F	S	NA	NA	60.0	101.7	Floor		
W	S	NA	NA	4.1	17.1	Wall		
W	S	NA	NA	2.4	37.3	Wall		
F	S	NA	NA	37.4	62.4	Floor		
F	S	NA	NA	37.4	88.6	Floor		
F	S	NA	NA	14.7	23.0	Floor		
F	S	NA	NA	14.7	49.2	Floor		
F	S	NA	NA	14.7	75.5	Floor		
F	S	NA	NA	14.7	101.7	Floor		
F	В	NA	NA	20	20	Floor		
F	В	NA	NA	10	30	Floor		
	BSA 02 18 FSS Surface or CSM F F F F F F F F F F F F F F F F F F	FSS SAI BSA 02 18 FSS Surface or CSM F S F S W S W S F B	Sample & Measure	Surface Or CSM Type Start Elevation End Elevation	Surface or CSM	Revision: 10 Revision: 10 Revision: 10 Revision: 10 Revision: 10 Revision: 10 Revision: 10 Revision: 10 Revisio		

 $*X and \ Y \ coordinates \ are \ provided \ using \ Missouri - East \ State \ Plane \ Coordinates \ [North \ American \ Datum \ (NAD) \ 1983] \ (Open \ Land \ Area)$

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

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41.3 Biased Measurements

In total, two (2) areas were identified for biased measurement. During remediation operation BSA 02-18 housed the former Water Treatment System which was dismantled at the conclusion of remediation operations. Subsequently a smaller chemical Water Treatment System was installed in a small portion of BSA 02-18 to support site operations after termination of the NRC License SNM-33. The area where the smaller chemical only water treatment system was to be placed was surveyed. Two fixed measurements were collected in this area prior to the installation of the new water treatment system, and for the purposes of this FSS report, these measurements are considered biased measurements. The higher of the two measurements was $767 \text{ dpm}/100 \text{ cm}^2$ (4% of the DCGL_{SO}).

41.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, BSA 02-18 was subject to a QC Replicate Survey.

Per HDP-PR-FSS-703, QC replicate survey requirements for structural SUs require that 5% of all Class 1, Class 2, and Class 3 SSC SUs are randomly selected to undergo a replicate survey of the entire SU area. The replicate survey is to be performed by an HP Technician other than the one who performed the initial survey using similar instrumentation. BSA 02-18 has been randomly selected as an SU for which a replicate survey has been required. Therefore, all FSS actions will be performed by two separate qualified individuals.

FSS of the SU is performed and the results are compared to release criteria. The replicate FSS of the SU is also compared to the release criteria. If the replicate survey agrees with the first FSS of the SU that the release criteria has been meet, then the replicate survey will be considered successful. If the replicate survey does not indicate that release criteria have been met, an investigation will be conducted.

For BSA 02-18, both the FSS and the replicate FSS produced similar results, both demonstrating that the release criteria was met, and therefore the QC replicate survey is considered successful.

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42.0 FINAL STATUS SURVEY RESULTS BSA 02-18

During the performance of FSS in BSA 02-18, no scan measurements exceeding the Scan MDC of 2,187 dpm/100 cm² were identified for biased measurement, however two judgmental biased measurements were collected (prior to the installation of the new water treatment system). No static measurement exceeded the DCGL $_{SO}$ of 18,925 dpm/100 cm². No removable contamination measurement exceeded the instrument MDA, therefore no removable contamination measurement exceeded 10% of the DCGL $_{SO}$. The highest observed TSC measurement was 762 dpm/100 cm² (biased location, 4% of the DCGL $_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 230 dpm/100 cm² (1% of the DCGL $_{SO}$),

The analytical data sheets used to evaluate the BSA 02-18 FSS data are provided in Appendix F. A summary table of the FSS results is presented below in Table 42-1.

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Table 42-1 FSS Data Summary for BSA 02-18

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² $(\alpha+\beta)$	Corrected Net dpm/100cm ²	Fraction of DCGL
P02-18-01-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	228	182	46	387	387	2%
P02-18-02-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	247	182	65	546	546	3%
P02-18-03-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	226	182	44	371	371	2%
P02-18-04-S-W-S-00	Wall	6/16/2016	alpha + beta TSC	148	182	-34	-281	0	0%
P02-18-05-S-W-S-00	Wall	6/16/2016	alpha + beta TSC	160	182	-22	-181	0	0%
P02-18-06-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	200	182	18	153	153	1%
P02-18-07-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	218	182	36	304	304	2%
P02-18-08-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	224	182	42	354	354	2%
P02-18-09-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	210	182	28	237	237	1%
P02-18-10-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	188	182	6	53	53	0%
P02-18-11-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	196	182	14	120	120	1%
B02-18-12-S-F-B-00	Floor	6/16/2016	alpha + beta TSC	177	167	10	110	110	1%
B02-18-13-S-F-B-00	Floor	6/16/2016	alpha + beta TSC	234	167	67	762	762	4%

*NOTE: Differences from documented survey results are due to rounding in Excel

 Min
 0
 1%

 Max
 546

 Mean
 230
 DCGL_{so}

 Median
 237
 0.25

 Stdev
 179.0

mrem/year

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43.0 ALARA EVALUATION BSA 02-18

All measurements collected within BSA 02-18 were evaluated against the DCGL $_{\rm SO}$. For BSA 02-18 no measurement result exceeded the DCGL $_{\rm SO}$. The average result, based on all systematically collected measurements was 1% of DCGL $_{\rm SO}$ for BSA 02-18. The average of all measurements equates to residual activity contribution from the SU area of 0.25 mrem/year for BSA 02-18. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the DCGL $_{\rm SO}$.

As the estimated TEDE for BSA 02-18 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-18 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-18.

44.0 FSS PLAN DEVIATIONS BSA 02-18

There were no deviations from the FSS Plan as written.

44.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-18.

45.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

45.1 Data Quality Assessment for BSA 02-18

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-18 (see Figure 45-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (Operation of the Ludlum 2360 for Final Status Survey), and HDP-PR-HP-411 (Radiological Instrumentation).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected (on a random start, systematic pattern) and the scan surveys that were conducted were performed in

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accordance with procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- A Quality Control Replicate Survey was performed for BSA 02-18, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-18 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Eleven (11) systematic measurements were collected in BSA 02-18. None of the 11 measurements exceeded the DCGL_{SO} resulting in a systematic average result of 2% of the DCGL_{SO}. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 45-1. The Sign Test was successful as the total number of systematic measurements (11), exceeded the minimum requirement of 8 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-18 was 3% of the DCGL $_{\rm SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 1% of the DCGL $_{\rm SO}$, resulting in a residual dose contribution of 0.25 mrem/year.
- No FSS measurement result in BSA 02-18 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-18 was completed prior to and after the performance of the FSS. BSA 02-18 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

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 $\alpha = 0.05$

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Table 45-1 Sign Test for BSA 02-18

Sign Test								
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference			
P02-18-01-S-F-S-00	Floor	387	0.020	0.980	0.980			
P02-18-02-S-F-S-00	Floor	546	0.029	0.971	0.971			
P02-18-03-S-F-S-00	Floor	371	0.020	0.980	0.980			
P02-18-04-S-W-S-00	Wall	0	0.000	1.000	1.000			
P02-18-05-S-W-S-00	Wall	0	0.000	1.000	1.000			
P02-18-06-S-F-S-00	Floor	153	0.008	0.992	0.992			
P02-18-07-S-F-S-00	Floor	304	0.016	0.984	0.984			
P02-18-08-S-F-S-00	Floor	354	0.019	0.981	0.981			
P02-18-09-S-F-S-00	Floor	237	0.013	0.987	0.987			
P02-18-10-S-F-S-00	Floor	53	0.003	0.997	0.997			
P02-18-11-S-F-S-00	Floor	120	0.006	0.994	0.994			
			Number of Positive Di	fferences (S+)	11			
		Sign Te	est Critical Value (MARS	SSIM Table I-3)	8			

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST: PASS

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Figure 45-1 Data Evaluation Checklists prepared for BSA 02-18 (page 1 of 2)

LI ₂ .	matite	Procedure: HDP-PR-F	FSS-721, Final Statu	s Survey Data Eva	luation						
Decomr	matite missioning roject				Revision: 10	Appendix G-1, Page 1 of 2					
APPENDIX G-1 FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST											
	vey Area: vey Unit:	BSA 02	-	Building Survey Building 230 Bay							
1.	1. Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure? No □										
2.											
3.		scans surveys been per the FSSP and the FSS			Yes 🛛 N	0					
4.		iased measurements an tions specified in the FS			Yes 🛛 N	o 🗌 NA 🗌					
5.			cate and/or split samples or measurements been taken or each location designated as a QC sample?								
6.	capable of	e instruments used to measure or analyze the survey data of detecting the ROCs or gross activity at a MDC less than Yes No priate investigation level?									
7.	analyze da	e calibration of all instruments that were used to measure or data, current at the time of use and were those calibrations Yes No need using a NIST traceable source?									
8.		instruments successfull uired, after use on the d			Yes 🛛 N	о					
9.	Do the san	nples match those ident	ified on the chain of	custody?	Yes N	o 🗌 NA 🖂					
10.		Sample Results meet t FSS-703, Final Status S			Yes N	o 🗌 NA 🖂					
11.	Are all La	boratory QC parameter	s within acceptable	imits?	Yes N	o 🗌 NA 🖂					
If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.											
Comments: N/A											
Quali	ty Record										

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02*, *Survey Unit 13*, *14*, *15*, *16*, *17*, *18*, *19*, *20*, *21*, *26 and 27* (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 45-1 Data Evaluation Checklists prepared for BSA 02-18 (page 2 of 2)

Hematite	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation							
Project					Revision: 10	Appendix G-1, Page 2 of 2		
FINAL	STATUS S	URVEY DA	APPENDIX G ATA QUALITY OI		VIEW CHECK	KLIST		
Survey Area:	No. BSA	. 04		Building Survey				
Survey Unit:	No. <u>18</u>		Description:	Building 230 Bay	Warehouse (For	mer WTS Area)		
Discrepancy:	None							
			ed the discrepancy v	with the data?	Yes N	o NA		
			to the RSO.					
	nswer to que		nswered by the RSO as "No", then is the a		Yes N	o 🗌 NA 🖂		
			alid measurements of liance for the survey		Yes N	Io □ NA ⊠		
			tion of additional me survey unit.	easurements or sa	amples as necess	ary to		
Prepared by	(HP Staff):	Th	omas Yardy (Print Name)	Signa	Sul 5	(Date)		
Approved b	by (RSO):	Cla	ark Evers (Print Name)	NCM_	de d	(Date)		
Quality Record								

Hematite Decommissioning	FSSFR Volume 4, Chapter 3: Survey Area Release Record for Basel Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, E 27)	13, BSA 02-14, BSA 02-
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46.0 CONCLUSION BSA 02-18

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-18 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

 $\begin{tabular}{ll} Table~46-1\\ BSA~02-18~DCGL_{SO}~and~Dose~Summation \end{tabular}$

AVE. SU I	RESIDUAL
RADIOA	CTIVITY
DCGL _{SO}	1%
	0.25
Dose	mrem/year

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47.0 FINAL STATUS SURVEY DESIGN BSA 02-19

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-19 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_{SO}$, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-19 and the detection sensitivities are also discussed.

47.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-19 were driven by the type (Structure) and Class (Class 3) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 2015.

47.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-19. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

47.1.2 Scan Coverage

As a Class 3 structure SU, the scan survey requirement is 1-10% of the exposed surfaces of the structure.

47.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-89 detector, paired with a Ludlum Model 2360 data logging meter. Note that the FSS Plan prepared for BSA 02-19 referenced a Ludlum 43-93 detector instead of a Ludlum 43-89, however these two probes are considered equivalent. The MDC's provided below are those that were determined during the FSS planning stage, and therefore reference the Ludlum 43-93 detector.

47.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 200 cpm (based on observed operational instrument background) for the Ludlum Model 43-93 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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$$Scan \ MDC = \frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe \ Area}{100}\right)}$$

Equation 47-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_i * \varepsilon_s * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes:

 ϵ_i = 2 pi (π) instrument efficiency for nuclide of concern ϵ_s = surface efficiency for nuclide of concern Yield = 100% for all nuclides of concern Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 47-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{200}{60}} \times \frac{60}{1}}{0.707 \times 0.0975 \times \left(\frac{100}{100}\right)} = 2,351 \text{dpm}/100 \text{ cm}^2$$

Equation 47-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-93 is given in Table 47-1.

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Table 47-1
Total Weighted Efficiency Calculation (Ludlum Model 43-93) for BSA 02-19

Ludlum 2360	Ludlum Model 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDI	Efficiency	ß Cal. Efficiency	
278647	311685	100 cm ²	25.3%	N/A	25.5%		N/A	
		TOTAL WEIG	GHTED INSTRUMENT EFF	ICIENCY CALCULATIO	N			
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ε _s)	Yield 100%	Activity Fraction	Weighted Efficiency	
Am-241	Alpha	5.6	0.2530	0.25	1.00	2.682E-03	1.70E-04	
Np-237	Alpha	5.0	0.2530	0.25	1.00	5.573E-05	3.52E-06	
Pu-239	Alpha	5.2	0.2530	0.25	1.00	2.027E-06	1.28E-07	
Tc-99	Beta	0.294	0.2550	0.25	1.00	2.829E-03	1.80E-04	
Th-232	Alpha	4.1	0.2530	0.25	1.00	3.214E-03	2.03E-04	
Ra-228	Beta	0.046	0.2550	0.00	1.00	3.214E-03	0.00E+00	
Ac-228	Beta	2.13	0.2550	0.50	1.00	3.214E-03	4.10E-04	
Th-228	Alpha	5.5	0.2530	0.25	1.00	3.214E-03	2.03E-04	
Ra-224	Alpha	5.8	0.2530	0.25	1.00	3.214E-03	2.03E-04	
U-234	Alpha	4.9	0.2530	0.25	1.00	8.270E-01	5.23E-02	
U-235	Alpha	4.7	0.2530	0.25	1.00	3.720E-02	2.35E-03	
Th-231	Beta	0.390	0.2550	0.25	1.00	3.720E-02	2.37E-03	
U-238	Alpha	4.3	0.2530	0.25	1.00	1.270E-01	8.03E-03	
Th-234	Beta	0.270	0.2550	0.25	1.00	1.270E-01	8.10E-03	
Pa-234m	Beta	2.20	0.2550	0.50	1.00	1.270E-01	1.62E-02	
			•			Σ=	9.07%	

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern Weighted Instrument Efficiency = $\epsilon_i * \epsilon_s * \text{Yield * Activity Fraction}$

 $\varepsilon_i = 2$ Pi Instrument Efficiency for Nuclide of Concern

 ε_s = Surface Efficiency for Nuclide of Concern

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47.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_S \left(1+\frac{t_S}{t_b}\right)}}{(\varepsilon_t)(t_S)\left(\frac{A}{100 \ cm^2}\right)}$$

Equation 47-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

t_b = Background count time (minutes);

 ε_t = Total weighted efficiency (2π) ; and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{200 \times 1\left(1+\frac{1}{1}\right)}}{(0.0907)(1)\left(\frac{100}{100}\right)} = 759 \text{ dpm/}100 \text{ cm}^2$$

Equation 47-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-89 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-19. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

47.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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47.1.7 BSA 02-19 FSS Design Summary

The complete FSS Plan for BSA 02-19 is provided in Appendix Q. A summary table of the requirements in the FSS Plan for BSA 02-19 is presented in Table 47-2 below.

Table 47-2 FSS Design Summary for BSA 02-19

Portable Instrument Scanning:						
Scan Coverage			1-10% of BSA 02-19 total area			
Scan MDC		2,351 dpm / 100 cm ² (Ludlum 43-93)				
		1,19	3 dpm / 100 cm ² (Ludlum 43-37)			
Investigation Action Level (IAL)		2,35	1 dpm / 100 cm ² (Ludlum 43-93)			
		1,19	93 dpm / 100 cm ² (Ludlum 43-37)			
Total Surface Contamination (TS		1				
Surface	Minimum Numbe		Comments			
	Measurements	5	A 1 C10 TCC			
Building 230: Mezzanine Area -			A total of 12 TSC measurements			
All surfaces (except stairs)	11		locations have been systematically designed from a random start point.			
(· F · ·)			designed from a random start point.			
Investigation Action Level 9,463 dpm			/ 100 cm ² (50% of Adjusted Gross DCGL)			
Removable Activity Locations:						
After each TSC measurement, at t						
After each TSC measurement, at t swipe a cloth smear over the surface			C measurement, using moderate pressur vindow, etc.) in an S-shaped pattern within			
After each TSC measurement, at a swipe a cloth smear over the surface an approximately 4" by 4" box. Biased Measurement Locations: Biased measurements may be coll	e (e.g. exterior wall, r	on of	the HP Technician performing the FSS in surface features such as cracks, sma			
After each TSC measurement, at a swipe a cloth smear over the surface an approximately 4" by 4" box. Biased Measurement Locations: Biased measurements may be coll. Based on the RASS data, there are	e (e.g. exterior wall, r	on of	the HP Technician performing the FSS in surface features such as cracks, sma			
After each TSC measurement, at a swipe a cloth smear over the surface an approximately 4" by 4" box. Biased Measurement Locations: Biased measurements may be coll Based on the RASS data, there are holes, conduit penetrations, etc., are	ected at the discretice no indications that more elevated than a unique on detector.	on of t certa adjace	the HP Technician performing the FSS in surface features such as cracks, sma			
After each TSC measurement, at a swipe a cloth smear over the surface an approximately 4" by 4" box. Biased Measurement Locations: Biased measurements may be coll Based on the RASS data, there are holes, conduit penetrations, etc., are Instrumentation:	e (e.g. exterior wall, rected at the discretice no indications that more elevated than a condition on detector.	on of t certa adjace Used for btain so investige	the HP Technician performing the FSS in surface features such as cracks, smant surfaces. or scanning walls, ceilings, roof and to static (TSC) measurements; used to			

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48.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-19

FSS was performed in accordance with procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems, and Components.

48.1 Scan Survey Performance

As a Class 3 SU the FSS plan required that 1-10% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover greater than 10% of the structural surfaces (provided in Appendix AA).

48.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated for BSA 02-19, and a total of twelve (12) measurements were designed by the FSS Plan. These direct, static-count measurement locations were designed in a random pattern (See Figure 48-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

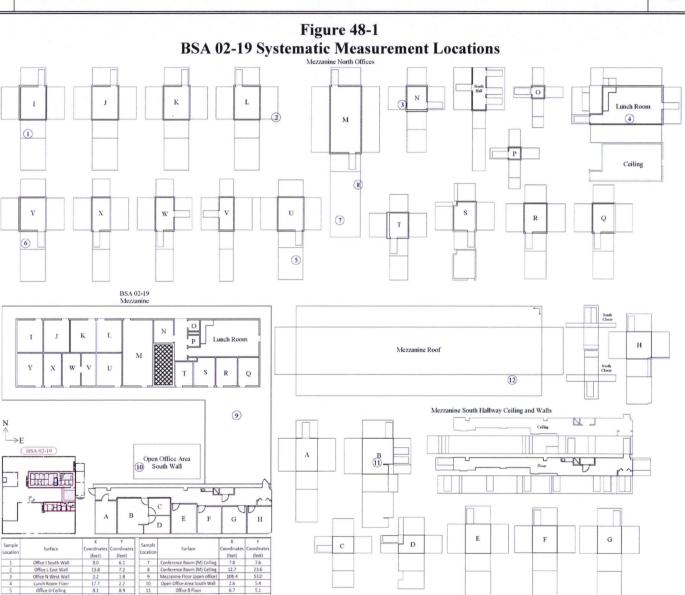
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 48-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix Q).

No systematic location exceeded the $DCGL_{SO.}$ The highest systematic TSC measurement collected was 254 dpm/100 cm² (1% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-19 is provided in Appendix AA.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 48-1 FSS Measurement Locations for BSA 02-19

TT		Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development								
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APPENDIX P-4 FSS SAMPLE & MEASUREMENT LOCATIONS & COOF										
Survey Area:	BSA 02	155	SAMI EE & MEASOI	Description:		ling Survey Area	(Building 230)			
Survey Unit:	18			Description:	2nd F	Floor Mezzanine I	Floor, Walls, Ceiling and Roof			
Survey Type:	FSS		Classification: Class			3				
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes			
B02-19-01-S-W-S-00	W	S	NA	NA	6.1	8.0	Office I South Wall			
B02-19-02-S-W-S-00	W	S	NA	NA	7.2	13.8	Office L East Wall			
B02-19-03-S-W-S-00	W	S	NA	NA	1.8	2.2	Office N West Wall			
B02-19-04-S-F-S-00	F	S	NA	NA	2.2	17.7	Lunch Room Floor			
B02-19-05-S-C-S-00	С	S	NA	NA	8.9	8.1	Office U Ceiling			
B02-19-06-S-W-S-00	W	S	NA	NA	5.3	9.0	Office Y South Wall			
B02-19-07-S-C-S-00	С	S	NA	NA	7.6	7.0	Conference Room (M) Ceiling			
B02-19-08-S-C-S-00	С	S	NA	NA	23.6	12.7	Conference Room (M) Ceiling			
B02-19-09-S-F-S-00	F	S	NA	NA	53.0	106.4	Mezzanine Floor (open office)			
B02-19-10-S-W-S-00	W	S	NA	NA	5.4	2.6	Open Office Area South Wall			
B02-19-11-S-F-S-00	F	S	NA	NA	5.1	6.7	Office B Floor			
B02-19-12-S-W-S-00	W	S	NA	NA	7.1	97.6	Mezzanine Outer Wall South			

*X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area)

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

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48.3 Biased Measurements

During the scan measurements of BSA 02-19, no areas were identified to be elevated above the Scan IAL, and therefore no biased measurement locations were determined to be necessary.

48.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, no QC measurements were necessary for BSA 02-19.

49.0 FINAL STATUS SURVEY RESULTS BSA 02-19

During the performance of FSS in BSA 02-19, no scan measurements exceeding the Scan MDC of $2,187 \text{ dpm}/100 \text{ cm}^2$ were identified for biased measurement. No static measurement exceeded the DCGL_{SO} of $18,925 \text{ dpm}/100 \text{ cm}^2$. No removable contamination measurement exceeded the MDA, therefore no removable contamination measurement exceeded 10% of the DCGL_{SO}. The highest observed TSC measurement was $254 \text{ dpm}/100 \text{ cm}^2$ (systematic location, 1% of the DCGL_{SO}), and the average residual radioactivity based on all systematically collected measurements is $58 \text{ dpm}/100 \text{ cm}^2$ (0.3% of the DCGL_{SO}),

The analytical data sheets used to evaluate the BSA 02-19 FSS data are provided in Appendix G. A summary table of the FSS results is presented below in Table 49-1.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 49-1 FSS Data Summary for BSA 02-19

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² $(\alpha+\beta)$	Corrected Net dpm/100cm ²	Fraction of DCGL
B02-19-01-S-W-S-00	Office I South Wall	3/15/2016	alpha + beta TSC	173	194	-21	-222	0	0%
B02-19-02-S-W-S-00	Office L East Wall	3/15/2016	alpha + beta TSC	166	194	-28	-296	0	0%
B02-19-03-S-W-S-00	Office N West Wall	3/15/2016	alpha + beta TSC	174	194	-20	-211	0	0%
B02-19-04-S-F-S-00	Lunch Room Floor	3/15/2016	alpha + beta TSC	152	194	-42	-444	0	0%
B02-19-05-S-C-S-00	Office U Ceiling	3/15/2016	alpha + beta TSC	161	194	-33	-349	0	0%
B02-19-06-S-W-S-00	Office Y South Wall	3/15/2016	alpha + beta TSC	159	194	-35	-370	0	0%
B02-19-07-S-C-S-00	Conference Room (M) Ceiling	3/15/2016	alpha + beta TSC	181	194	-13	-137	0	0%
B02-19-08-S-C-S-00	Conference Room (M) Ceiling	3/15/2016	alpha + beta TSC	203	194	9	95	95	1%
B02-19-09-S-F-S-00	Mezzanine Floor (open office)	3/15/2016	alpha + beta TSC	217	194	23	243	243	1%
B02-19-10-S-W-S-00	Open Office Area South Wall	3/15/2016	alpha + beta TSC	218	194	24	254	254	1%
B02-19-11-S-F-S-00	Office B Floor	3/15/2016	alpha + beta TSC	204	194	10	106	106	1%
B02-19-12-S-W-S-00	Mezzanine Outer Wall South	3/15/2016	alpha + beta TSC	172	194	-22	-232	0	0%

*NOTE: Differences from documented survey results are due to rounding in Excel

Min	0	0.3%
Max	254	0.070
Mean	58	DCGLso
Median	0	0.08
Stdev	96.8	0.00

mrem/year

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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50.0 ALARA EVALUATION BSA 02-19

All measurements collected within BSA 02-19 were evaluated against the $DCGL_{SO}$. For BSA 02-19 no measurement result exceeded the $DCGL_{SO}$. The average result, based on all systematically collected measurements was 0.3% of $DCGL_{SO}$ for BSA 02-19. The average of all measurements equates to residual activity contribution from the SU area of 0.08 mrem/year for BSA 02-19. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the $DCGL_{SO}$.

As the estimated TEDE for BSA 02-19 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-19 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-19.

51.0 FSS PLAN DEVIATIONS BSA 02-19

There were no deviations from the FSS Plan as written.

51.1 Remedial Actions During FSS

There were no remedial actions required for BSA 02-19.

52.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

52.1 Data Quality Assessment for BSA 02-19

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-19 (see Figure 52-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (Operation of the Ludlum 2360 for Final Status Survey), and HDP-PR-HP-411 (Radiological Instrumentation).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected (on a random pattern) and the scan surveys that were conducted were performed in accordance with

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procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- Quality Control sample results were not necessary for BSA 02-19. However a Quality Control Replicate Survey was performed for BSA 02-16 and BSA 02-18, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-19 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Twelve (12) systematic measurements were collected in BSA 02-19. None of the 12 measurements exceeded the DCGL_{SO} resulting in a systematic average result of 0.3% of the DCGL_{SO}. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 52-1. The Sign Test was successful as the total number of systematic measurements (12), exceeded the minimum requirement of 9 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-19 was 1% of the DCGL_{SO}. The average residual radioactivity concentration fraction based on the systematically collected measurements was 0.3% of the DCGL_{SO}, resulting in a residual dose contribution of 0.08 mrem/year.
- No FSS measurement result in BSA 02-19 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-19 was completed prior to and after the performance of the FSS. BSA 02-19 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

 $\alpha = 0.05$

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MARSSIM Table I-3

Table 52-1 Sign Test for BSA 02-19

		Sign Test			
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference
B02-19-01-S-W-S-00	Office I South Wall	0	0.000	1.000	1.000
B02-19-02-S-W-S-00	Office L East Wall	0	0.000	1.000	1.000
B02-19-03-S-W-S-00	Office N West Wall	0	0.000	1.000	1.000
B02-19-04-S-F-S-00	Lunch Room Floor	0	0.000	1.000	1.000
B02-19-05-S-C-S-00	Office U Ceiling	0	0.000	1.000	1.000
B02-19-06-S-W-S-00	Office Y South Wall	0	0.000	1.000	1.000
B02-19-07-S-C-S-00	Conference Room (M) Ceiling	0	0.000	1.000	1.000
B02-19-08-S-C-S-00	Conference Room (M) Ceiling	95	0.005	0.995	0.995
B02-19-09-S-F-S-00	Mezzanine Floor (open office)	243	0.013	0.987	0.987
B02-19-10-S-W-S-00	Open Office Area South Wall	254	0.013	0.987	0.987
B02-19-11-S-F-S-00	Office B Floor	106	0.006	0.994	0.994
B02-19-12-S-W-S-00	Mezzanine Outer Wall South	0	0.000	1.000	1.000
			Number of Positive Di	ifferences (S+)	12
		Sign Test	Critical Value (MARS	SSIM Table I-3)	9

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST: PASS

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Figure 52-1 Data Evaluation Checklists prepared for BSA 02-19 (page 1 of 2)

Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation									
Decomi	missioning roject				Revision: 10	Appendix G-1, Page 1 of 2			
	APPENDIX G-1 FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST								
	Survey Area: BSA 02 Description: Building Survey Area (Building 230) Survey Unit: 19 Description: 2nd Floor Mezzanine Floor, Walls, Ceiling and Roof								
1.	1. Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in Yes ⊠ No ☐ accordance with Section 8.1 of this procedure?								
2.		t the locations specif	ments and/or samples fied in the FSSP and		Yes 🛭 N	To [
3.		we all scans surveys been performed of the areas specified as uired in the FSSP and the FSS Sample Instructions? Yes ⊠ No □							
4.		Il biased measurements and/or samples been taken or acquired occations specified in the FSSP & the FSS Sample Instructions?							
5.		plicate and/or split samples or measurements been taken or at each location designated as a QC sample?							
6.	capable of	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than Yes ⊠ No ☐ the appropriate investigation level?							
7.	analyze da	s the calibration of all instruments that were used to measure or yze data, current at the time of use and were those calibrations Yes No No ormed using a NIST traceable source?							
8.			ully response-checked day the data was mea		Yes 🛛 N	lo 🗌			
9.	Do the san	nples match those ide	entified on the chain of	custody?	Yes N	lo 🗌 NA 🖂			
10.		C Sample Results meet the acceptance criteria as specified in Yes No NA Service Na NA Service NA Service Na NA Ser							
11.	11. Are all Laboratory QC parameters within acceptable limits? Yes No NA								
	If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.								
Cor	nments: N/A	4							
Quali	ty Record								

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 52-1 Data Evaluation Checklists prepared for BSA 02-19 (page 2 of 2)

Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation							
Hematite Decommissioning Project				Revision: 10	Appendix G-1, Page 2 of 2		
FINAL	STATUS SURVEY	APPENDIX G Y DATA QUALITY OI		VIEW CHECK	KLIST		
Survey Area: Survey Unit:	No. BSA 04 No. 19	Description:	Building Survey 2 nd Floor Mezzanine				
Discrepancy:	None						
Corrective Acti	ions Taken: None						
		solved the discrepancy v	with the data?	Yes N	o 🗌 NA 🖂		
	", then forward this t						
		be answered by the RSC					
still va	lid?	1 was "No", then is the		Yes N	o 🗌 NA 🛛		
		ng valid measurements of ompliance for the survey		Yes N	o 🗌 NA 🖂		
	", then direct the acquistrate compliance for	quisition of additional more the survey unit.	easurements or sar	mples as necess	ary to		
Prepared by	y (HP Staff):	Thomas Yardy (Print Name)	The Company	(fre) / S	-22-17 (Date)		
Approved b	by (RSO):	Clark Evers (Print Name)	NUM (Signate	ure)	(Date)		
Quality Record							

Hematite Decommissioning	FSSFR Volume 4, Chapter 3: Survey Area Release Record for Bu Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-115, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, E 27)	3, BSA 02-14, BSA 02-
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53.0 CONCLUSION BSA 02-19

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-19 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

 $\begin{tabular}{ll} Table 53-1 \\ BSA 02-19 DCGL_{SO} \ and \ Dose \ Summation \\ \end{tabular}$

	RESIDUAL CTIVITY
DCGL _{so}	0.3%
D	0.08
Dose	mrem/year

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54.0 FINAL STATUS SURVEY DESIGN BSA 02-21

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-21 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_{SO}$, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-21 and the detection sensitivities are also discussed.

54.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-21 were driven by the type (Structure) and Class (Class 2) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 7, *Final Status Survey Plan Development*, June 2015.

54.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-21. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

54.1.2 Scan Coverage

As a Class 2 structure SU, the scan survey requirement is a minimum of 10% of the exposed surfaces of the structure.

54.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-93 detector, paired with a Ludlum Model 2360 data logging meter.

54.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 200 cpm (based on observed operational instrument background) for the Ludlum Model 43-93 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{\text{bkgd}}{60}} \times \frac{60}{1}}{0.707 \times \text{eff}_{\text{total}} \times \left(\frac{\text{Probe Area}}{100}\right)}$$

Equation 54-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_{i} * \varepsilon_{s} * \textit{Yield} * \textit{Activity Fraction}$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes:

 $\epsilon_i = 2$ pi (π) instrument efficiency for nuclide of concern $\epsilon_s = \text{surface}$ efficiency for nuclide of concern Yield = 100% for all nuclides of concern Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 54-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{200}{60} \times \frac{60}{1}}}{0.707 \times 0.0975 \times \left(\frac{100}{100}\right)} = 2,351 \text{ dpm/}100 \text{ cm}^2$$

Equation 54-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-93 is given in Table 54-1.

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 54-1 Total Weighted Efficiency Calculation (Ludlum Model 43-93) for BSA 02-21

Ludlum 2360	Ludlum Model 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDI	PEfficiency	ß Cal. Efficiency
268477	289424	100 cm ²	25.3%	N/A	25.5%		N/A
TOTAL WEIGHTED INSTRUMENT EFFICIENCY CALCULATION							
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ε _s)	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.2530	0.25	1.00	2.682E-03	1.70E-04
Np-237	Alpha	5.0	0.2530	0.25	1.00	5.573E-05	3.52E-06
Pu-239	Alpha	5.2	0.2530	0.25	1.00	2.027E-06	1.28E-07
Tc-99	Beta	0.294	0.2550	0.25	1.00	2.829E-03	1.80E-04
Th-232	Alpha	4.1	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-228	Beta	0.046	0.2550	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.2550	0.50	1.00	3.214E-03	4.10E-04
Th-228	Alpha	5.5	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-224	Alpha	5.8	0.2530	0.25	1.00	3.214E-03	2.03E-04
U-234	Alpha	4.9	0.2530	0.25	1.00	8.270E-01	5.23E-02
U-235	Alpha	4.7	0.2530	0.25	1.00	3.720E-02	2.35E-03
Th-231	Beta	0.390	0.2550	0.25	1.00	3.720E-02	2.37E-03
U-238	Alpha	4.3	0.2530	0.25	1.00	1.270E-01	8.03E-03
Th-234	Beta	0.270	0.2550	0.25	1.00	1.270E-01	8.10E-03
Pa-234m	Beta	2.20	0.2550	0.50	1.00	1.270E-01	1.62E-02
						Σ=	9.07%

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern Weighted Instrument Efficiency = $\epsilon_i * \epsilon_s * \text{Yield} * \text{Activity Fraction}$

 $\varepsilon_i = 2$ Pi Instrument Efficiency for Nuclide of Concern

ε_s = Surface Efficiency for Nuclide of Concern

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54.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_s \left(1+\frac{t_s}{t_b}\right)}}{(\varepsilon_t)(t_s)\left(\frac{A}{100 \text{ cm}^2}\right)}$$

Equation 54-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

t_b = Background count time (minutes);

 ε_t = Total weighted efficiency (2 π); and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{200 \times 1\left(1+\frac{1}{1}\right)}}{(0.0907)(1)\left(\frac{100}{100}\right)} = 759 \text{ dpm/}100 \text{ cm}^2$$

Equation 54-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-93 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-21. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

54.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

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54.1.7 BSA 02-21 FSS Design Summary

The complete FSS Plan for BSA 02-21 is provided in Appendix R. A summary table of the requirements in the FSS Plan for BSA 02-21 is presented in Table 54-2 below.

Table 54-2 FSS Design Summary for BSA 02-21

Portable Instrument Scanning:					
Scan Coverage			Minimum 10% of BSA 02-21 total area		
Scan MDC			1 dpm / 100 cm ² (Ludlum 43-93)		
Scali MBC		1,19	3 dpm / 100 cm ² (Ludlum 43-37)		
Investigation Action Level (IAL)			1 dpm / 100 cm ² (Ludlum 43-93)		
Table 6 Carrier (TCC)	14	1,19.	3 dpm / 100cm ² (Ludlum 43-37)		
Total Surface Contamination (TSC) In Surface	Minimum Numbe	or of	Comments		
Surface	Measurements		Comments		
	Wicasurements	3	A total of 11 TSC measurements locations		
Building 230: U-Shaped Area,			have been systematically designed from a		
Southwest (floor and lower walls)	11		random start point.		
After each TSC measurement, at the sa smear over the surface (e.g. exterior wa					
After each TSC measurement, at the sa smear over the surface (e.g. exterior wa 4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amount of the supervision for guidance on	r seams, cracks, or per unt and specific local atic MDA, adjustments	netratio	rement, using moderate pressure swipe a clot -shaped pattern within an approximately 4" b ons, and at floor/wall interfaces. Consult FS f biased measurements. At locations where trument efficiency or volumetric sampling ma		
After each TSC measurement, at the sa smear over the surface (e.g. exterior wa 4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amor measurements exceed the instrument sta	r seams, cracks, or per unt and specific local atic MDA, adjustments for guidance.	netrations of to inst	ons, and at floor/wall interfaces. Consult FS f biased measurements. At locations when trument efficiency or volumetric sampling ma		
After each TSC measurement, at the sa smear over the surface (e.g. exterior wa 4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amor measurements exceed the instrument stable necessary – consult FSS supervision	r seams, cracks, or per unt and specific local atic MDA, adjustments for guidance.	netratio tions o s to inst	ns, and at floor/wall interfaces. Consult FS f biased measurements. At locations wher		
After each TSC measurement, at the samear over the surface (e.g. exterior wa 4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amor measurements exceed the instrument stable necessary – consult FSS supervision Instrumentation:	r seams, cracks, or per unt and specific local atic MDA, adjustments for guidance.	netration tions of s to inst	ns, and at floor/wall interfaces. Consult FS f biased measurements. At locations where trument efficiency or volumetric sampling materials are scanning lower walls and to obtain static measurements; used to investigate elevated		

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55.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-21

FSS was performed in accordance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems, and Components*.

55.1 Scan Survey Performance

As a Class 2 SU the FSS plan required that a minimum of 10% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover greater than 10% of the structural surfaces (provided in Appendix BB).

55.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated and designed for BSA 02-21 by the FSS Plan. These direct, static-count measurement locations were designed in a random start, systematic pattern (See Figure 62-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 62-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix R).

No systematic location exceeded the $DCGL_{SO}$. The highest systematic TSC location result was 1,389 dpm/100 cm² (7% of the $DCGL_{SO}$). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-21 is provided in Appendix BB.

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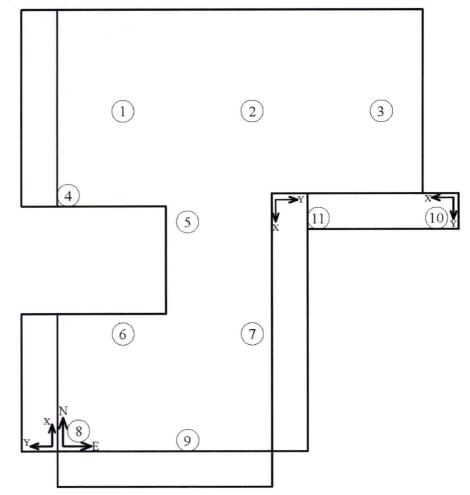
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Figure 55-1 BSA 02-21 Systematic Measurement Locations

BSA 02-21 U Shaped Area Floor and Walls SW



Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
1	Floor	12.0	62.0
2	Floor	35.6	62.0
3	Floor	59.2	62.0
4	Floor	0.2	46.6
5	Floor	23.8	41.7
6	Floor	12.0	21.3
7	Floor	35.6	21.3
8	Floor	0.2	1.0
9	Floor	23.8	1.0
10	South Wall	2.1	5.2
11	South Wall	25.8	5.2



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Table 55-1 FSS Measurement Locations for BSA 02-21

Hematite		Procedure:	HDP-PR-FSS-701, F	inal Status Survey Pla	n Developmer	nt			
Decommission Project	ing					Revision: 10 Appendix P-4, Page 1			
	.7	FSS	SAMPLE & MEAS	APPENDIX P-4 UREMENT LOCAT	TONS & CO	ORDINATES			
Survey Area:	BSA 02			Description:	Buildi	ng Survey Area (Buildin	g 230)		
Survey Unit:	14			Description:	U-Sha	ped Area (Southeast) – L	ower Walls, Floor and Stairs		
Survey Type:	FSS			Classification:	Class	2			
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes		
B02-21-01-S-F-S-00	F	S	NA	NA	62.0	12.0	Floor		
B02-21-02-S-F-S-00	F	S	NA	NA	62.0	35.6	Floor		
B02-21-03-S-F-S-00	F	S	NA	NA	62.0	59.2	Floor		
B02-21-04-S-F-S-00	F	S	NA	NA	46.6	0.2	Floor		
B02-21-05-S-F-S-00	F	S	NA	NA	41.7	23.8	Floor		
B02-21-06-S-F-S-00	F	S	NA	NA	21.3	12.0	Floor		
B02-21-07-S-F-S-00	F	S	NA	NA	21.3	35.6	Floor		
B02-21-08-S-F-S-00	F	S	NA	NA	1.0	0.2	Floor		
B02-21-09-S-F-S-00	F	S	NA	NA	1.0	23.8	Floor		
B02-21-10-S-W-S-00	W	S	NA	NA	5.2	2.1	South Wall		
B02-21-11-S-W-S-00	W	S	NA	NA	5.2	25.8	South Wall		
B02-21-12-S-F-B-00	F	В	NA	NA	42.0	24.0	Floor		
B02-21-13-S-F-B-00	F	В	NA	NA	22.0	38.0	Floor		
B02-21-14-S-F-B-00	F	В	NA	NA	1.0	4.0	Floor		
B02-21-15-S-F-B-00	F	В	NA	NA	62.0	15.0	Floor		
B02-21-16-S-F-B-00	F	В	NA	NA	60.0	58.0	Floor		

 $*X \ and \ Y \ coordinates \ are \ provided \ using \ Missouri - East \ State \ Plane \ Coordinates \ [North \ American \ Datum \ (NAD) \ 1983] \ (Open \ Land \ Area)$

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

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55.3 Biased Measurements

In total, five (5) areas were identified for biased measurement. These areas were identified by scan measurements that approached or exceeded the Scan IAL. No biased measurement was identified to exceed the DCGL_{SO}, the highest identified result was 1,286 dpm/100 cm² (7% of the DCGL_{SO}).

55.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, no QC measurements were necessary for BSA 02-21.

56.0 FINAL STATUS SURVEY RESULTS BSA 02-21

During the performance of FSS in BSA 02-21, all scan measurements exceeding the Scan MDC of $2,187 \text{ dpm}/100 \text{ cm}^2$ were identified for biased measurement. No static measurement exceeded the DCGL_{SO} of $18,925 \text{ dpm}/100 \text{ cm}^2$. No removable contamination measurement exceeded the MDA, therefore no removable contamination measurement exceeded 10% of the DCGL_{SO}. The highest observed TSC measurement was $1,390 \text{ dpm}/100 \text{ cm}^2$ (systematic location, 7% of the DCGL_{SO}), and the average residual radioactivity based on all systematically collected measurements is $783 \text{ dpm}/100 \text{ cm}^2$ (4% of the DCGL_{SO}),

The analytical data sheets used to evaluate the BSA 02-21 FSS data are provided in Appendix H. A summary table of the FSS results is presented below in Table 56-1.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 56-1 FSS Data Summary for BSA 02-21

MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm ² $(\alpha+\beta)$	Corrected Net dpm/100cm ²	Fraction of DCGL
Floor	11/4/2015	alpha + beta TSC	246	161	85	881	881	5%
Floor	11/4/2015	alpha + beta TSC	295	161	134	1389	1389	7%
Floor	11/4/2015	alpha + beta TSC	254	161	93	964	964	5%
Floor	11/4/2015	alpha + beta TSC	248	161	87	902	902	5%
Floor	11/4/2015	alpha + beta TSC	236	161	75	778	778	4%
Floor	11/4/2015	alpha + beta TSC	221	161	60	622	622	3%
Floor	11/4/2015	alpha + beta TSC	249	161	88	912	912	5%
Floor	11/4/2015	alpha + beta TSC	294	161	133	1379	1379	7%
Floor	11/4/2015	alpha + beta TSC	237	161	76	788	788	4%
South Wall	11/4/2015	alpha + beta TSC	150	161	-11	-114	0	0%
South Wall	11/4/2015	alpha + beta TSC	133	161	-28	-290	0	0%
Floor	11/4/2015	alpha + beta TSC	237	161	76	788	788	4%
Floor	11/4/2015	alpha + beta TSC	285	161	124	1286	1286	7%
Floor	11/4/2015	alpha + beta TSC	212	161	51	529	529	3%
Floor	11/4/2015	alpha + beta TSC	258	161	97	1006	1006	5%
Floor	11/4/2015	alpha + beta TSC	230	161	69	715	715	4%
	Floor Floor Floor Floor Floor Floor Floor Floor Floor South Wall Floor	Floor 11/4/2015 South Wall 11/4/2015 Floor 11/4/2015	Floor 11/4/2015 alpha + beta TSC South Wall 11/4/2015 alpha + beta TSC South Wall 11/4/2015 alpha + beta TSC Floor 11/4/2015 alpha + beta TSC	MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm (α+β) Floor 11/4/2015 alpha + beta TSC 246 Floor 11/4/2015 alpha + beta TSC 295 Floor 11/4/2015 alpha + beta TSC 254 Floor 11/4/2015 alpha + beta TSC 248 Floor 11/4/2015 alpha + beta TSC 236 Floor 11/4/2015 alpha + beta TSC 221 Floor 11/4/2015 alpha + beta TSC 249 Floor 11/4/2015 alpha + beta TSC 294 Floor 11/4/2015 alpha + beta TSC 150 South Wall 11/4/2015 alpha + beta TSC 133 Floor 11/4/2015 alpha + beta TSC 237 Floor 11/4/2015 alpha + beta TSC 285 Floor 11/4/2015 alpha + beta TSC 285 Floor 11/4/2015 alpha + beta TSC 258	MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm (α+β) (α+β) cpm (α+β) Floor 11/4/2015 alpha + beta TSC 246 161 Floor 11/4/2015 alpha + beta TSC 295 161 Floor 11/4/2015 alpha + beta TSC 254 161 Floor 11/4/2015 alpha + beta TSC 248 161 Floor 11/4/2015 alpha + beta TSC 236 161 Floor 11/4/2015 alpha + beta TSC 221 161 Floor 11/4/2015 alpha + beta TSC 249 161 Floor 11/4/2015 alpha + beta TSC 294 161 Floor 11/4/2015 alpha + beta TSC 237 161 South Wall 11/4/2015 alpha + beta TSC 133 161 Floor 11/4/2015 alpha + beta TSC 237 161 Floor 11/4/2015 alpha + beta TSC 237 161 Floor 11/4/2015 alpha + beta TSC 285 <td< td=""><td>MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm (α+β) cpm (α+β) cpm (α+β) Floor 11/4/2015 alpha + beta TSC 246 161 85 Floor 11/4/2015 alpha + beta TSC 295 161 134 Floor 11/4/2015 alpha + beta TSC 254 161 93 Floor 11/4/2015 alpha + beta TSC 248 161 87 Floor 11/4/2015 alpha + beta TSC 236 161 75 Floor 11/4/2015 alpha + beta TSC 221 161 60 Floor 11/4/2015 alpha + beta TSC 249 161 88 Floor 11/4/2015 alpha + beta TSC 294 161 133 Floor 11/4/2015 alpha + beta TSC 237 161 76 South Wall 11/4/2015 alpha + beta TSC 133 161 -28 Floor 11/4/2015 alpha + beta TSC 237 161 76 Floor</td><td>MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm (α+β) cpm (α+β) cpm (α+β) cpm (α+β) dpm/100 cm² (α+β) Floor 11/4/2015 alpha + beta TSC 246 161 85 881 Floor 11/4/2015 alpha + beta TSC 295 161 134 1389 Floor 11/4/2015 alpha + beta TSC 254 161 93 964 Floor 11/4/2015 alpha + beta TSC 248 161 87 902 Floor 11/4/2015 alpha + beta TSC 236 161 75 778 Floor 11/4/2015 alpha + beta TSC 221 161 60 622 Floor 11/4/2015 alpha + beta TSC 249 161 88 912 Floor 11/4/2015 alpha + beta TSC 294 161 133 1379 Floor 11/4/2015 alpha + beta TSC 237 161 76 788 South Wall 11/4/2015 alpha + beta TSC <td< td=""><td>MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm ($α+β$) cpm ($α+β$) dpm/100 cm² ($α+β$) Corrected Net dpm/100cm² Floor 11/4/2015 alpha + beta TSC 246 161 85 881 881 Floor 11/4/2015 alpha + beta TSC 295 161 134 1389 1389 Floor 11/4/2015 alpha + beta TSC 254 161 93 964 964 Floor 11/4/2015 alpha + beta TSC 248 161 87 902 902 Floor 11/4/2015 alpha + beta TSC 236 161 75 778 778 Floor 11/4/2015 alpha + beta TSC 221 161 60 622 622 Floor 11/4/2015 alpha + beta TSC 249 161 88 912 912 Floor 11/4/2015 alpha + beta TSC 294 161 133 1379 1379 Floor 11/4/2015 alpha + beta TSC 237 161<</td></td<></td></td<>	MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm (α+β) cpm (α+β) cpm (α+β) Floor 11/4/2015 alpha + beta TSC 246 161 85 Floor 11/4/2015 alpha + beta TSC 295 161 134 Floor 11/4/2015 alpha + beta TSC 254 161 93 Floor 11/4/2015 alpha + beta TSC 248 161 87 Floor 11/4/2015 alpha + beta TSC 236 161 75 Floor 11/4/2015 alpha + beta TSC 221 161 60 Floor 11/4/2015 alpha + beta TSC 249 161 88 Floor 11/4/2015 alpha + beta TSC 294 161 133 Floor 11/4/2015 alpha + beta TSC 237 161 76 South Wall 11/4/2015 alpha + beta TSC 133 161 -28 Floor 11/4/2015 alpha + beta TSC 237 161 76 Floor	MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm (α+β) cpm (α+β) cpm (α+β) cpm (α+β) dpm/100 cm² (α+β) Floor 11/4/2015 alpha + beta TSC 246 161 85 881 Floor 11/4/2015 alpha + beta TSC 295 161 134 1389 Floor 11/4/2015 alpha + beta TSC 254 161 93 964 Floor 11/4/2015 alpha + beta TSC 248 161 87 902 Floor 11/4/2015 alpha + beta TSC 236 161 75 778 Floor 11/4/2015 alpha + beta TSC 221 161 60 622 Floor 11/4/2015 alpha + beta TSC 249 161 88 912 Floor 11/4/2015 alpha + beta TSC 294 161 133 1379 Floor 11/4/2015 alpha + beta TSC 237 161 76 788 South Wall 11/4/2015 alpha + beta TSC <td< td=""><td>MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm ($α+β$) cpm ($α+β$) dpm/100 cm² ($α+β$) Corrected Net dpm/100cm² Floor 11/4/2015 alpha + beta TSC 246 161 85 881 881 Floor 11/4/2015 alpha + beta TSC 295 161 134 1389 1389 Floor 11/4/2015 alpha + beta TSC 254 161 93 964 964 Floor 11/4/2015 alpha + beta TSC 248 161 87 902 902 Floor 11/4/2015 alpha + beta TSC 236 161 75 778 778 Floor 11/4/2015 alpha + beta TSC 221 161 60 622 622 Floor 11/4/2015 alpha + beta TSC 249 161 88 912 912 Floor 11/4/2015 alpha + beta TSC 294 161 133 1379 1379 Floor 11/4/2015 alpha + beta TSC 237 161<</td></td<>	MEASUREMENT LOCATION DATE MEAS MEASUREMENT cpm ($α+β$) cpm ($α+β$) dpm/100 cm² ($α+β$) Corrected Net dpm/100cm² Floor 11/4/2015 alpha + beta TSC 246 161 85 881 881 Floor 11/4/2015 alpha + beta TSC 295 161 134 1389 1389 Floor 11/4/2015 alpha + beta TSC 254 161 93 964 964 Floor 11/4/2015 alpha + beta TSC 248 161 87 902 902 Floor 11/4/2015 alpha + beta TSC 236 161 75 778 778 Floor 11/4/2015 alpha + beta TSC 221 161 60 622 622 Floor 11/4/2015 alpha + beta TSC 249 161 88 912 912 Floor 11/4/2015 alpha + beta TSC 294 161 133 1379 1379 Floor 11/4/2015 alpha + beta TSC 237 161<

*NOTE: Differences from documented survey results are due to rounding in Excel

Min	0	4%
Max	1389	770
Mean	783	DCGLso
Median	881	1.00
Stdev	452.6	1.00

mrem/year

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57.0 ALARA EVALUATION BSA 02-21

All measurements collected within BSA 02-21 were evaluated against the DCGL $_{SO}$. For BSA 02-21 no measurement result exceeded the DCGL $_{SO}$. The average result, based on all systematically collected measurements was 4% of DCGL $_{SO}$ for BSA 02-21. The average of all measurements equates to residual activity contribution from the SU area of 1.0 mrem/year for BSA 02-21. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the DCGL $_{SO}$.

As the estimated TEDE for BSA 02-21 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-21 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-21.

58.0 FSS PLAN DEVIATIONS BSA 02-21

There were no deviations from the FSS Plan as written.

58.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-21.

59.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

59.1 Data Quality Assessment for BSA 02-21

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-21 (see Figure 59-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (Operation of the Ludlum 2360 for Final Status Survey), and HDP-PR-HP-411 (Radiological Instrumentation).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected (on a random pattern) and the scan surveys that were conducted were performed in accordance with

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procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- Quality Control sample results were not necessary for BSA 02-21. However a
 Quality Control Replicate Survey was performed for BSA 02-16 and BSA 02-18,
 and the results were found to be acceptable, satisfying the requirement that a
 minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-21 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Eleven (11) systematic measurements were collected in BSA 02-21. None of the 11 measurements exceeded the $DCGL_{SO}$ resulting in a systematic average result of 4% of the $DCGL_{SO}$. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 59-1. The Sign Test was successful as the total number of systematic measurements (11), exceeded the minimum requirement of 8 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-21 was 7% of the DCGL $_{SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 4% of the DCGL $_{SO}$, resulting in a residual dose contribution of 1.0 mrem/year.
- No FSS measurement result in BSA 02-21 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-21 was completed prior to and after the performance of the FSS. BSA 02-21 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

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 $\alpha = 0.05$

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MARSSIM Table I-3

Table 59-1 Sign Test for BSA 02-21

Sign Test							
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference		
B02-21-01-S-F-S-00	Floor	881	0.047	0.953	0.953		
B02-21-02-S-F-S-00	Floor	1389	0.073	0.927	0.927		
B02-21-03-S-F-S-00	Floor	964	0.051	0.949	0.949		
B02-21-04-S-F-S-00	Floor	902	0.048	0.952	0.952		
B02-21-05-S-F-S-00	Floor	778	0.041	0.959	0.959		
B02-21-06-S-F-S-00	Floor	622	0.033	0.967	0.967		
B02-21-07-S-F-S-00	Floor	912	0.048	0.952	0.952		
B02-21-08-S-F-S-00	Floor	1379	0.073	0.927	0.927		
B02-21-09-S-F-S-00	Floor	788	0.042	0.958	0.958		
B02-21-10-S-W-S-00	South Wall	0	0.000	1.000	1.000		
B02-21-11-S-W-S-00	South Wall	0	0.000	1.000	1.000		
			Number of Positive D	ifferences (S+)	11		
		Sign To	est Critical Value (MAR	SSIM Table I-3)	8		

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST:

PASS

Critical V	IM Table I-3 alues for the t Statistic S+	Critical V	I Table I-3 /alues for yn Test tic S+
N	Alpha = 0.05	N	Alpha = 0.05
4	4	28	18
5	4	29	19
6	5	30	19
7	6	31	20
8	6	32	21
9	7	33	21
10	8	34	22
11	8	35	22
12	9	36	23
13	9	37	23
14	10	38	24
15	11	39	25
16	11	40	25
17	12	41	26
18	12	42	26
19	13	43	27
20	14	44	27
21	14	45	28
22	15	46	29
23	15	47	29
24	16	48	30
25	17	49	30
26	17	50	31
27	18		

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 59-1 Data Evaluation Checklists prepared for BSA 02-21 (page 1 of 2)

Hematite	Procedure: HDP-PR-FSS-721, Final Status Survey Data Eval	uation	
Decommissioning Project		Revision: 10	Appendix G-1, Page 1 of 2
FINAL	APPENDIX G-1 STATUS SURVEY DATA QUALITY OBJECTIVES REV	TEW CHEC	KLIST
		/D '11'	220)
Survey Area: Survey Unit:	BSA 02 Description: Building Survey A 21 Description: U-Shaped Area (So		
to data an	neasurements and/or analysis results that will be subjected alysis for FSS been individually reviewed and validated in e with Section 8.1 of this procedure?	Yes 🖂 N	No 🗌
Have all acquired a Instruction	systematic measurements and/or samples been taken or at the locations specified in the FSSP and the FSS Sample as?	Yes 🛛 N	No 🗌
 Have all required in 	scans surveys been performed of the areas specified as n the FSSP and the FSS Sample Instructions?	Yes 🛛 N	No 🗌
4. Have all bat the loca	piased measurements and/or samples been taken or acquired ations specified in the FSSP & the FSS Sample Instructions?	Yes 🛛 N	No NA NA
 Have dup acquired a 	licate and/or split samples or measurements been taken or at each location designated as a QC sample?	Yes 🗌 🗈	No 🗌 NA 🖂
capable o	instruments used to measure or analyze the survey data f detecting the ROCs or gross activity at a MDC less than priate investigation level?	Yes 🛛 🗅	No 🗌
analyze d	calibration of all instruments that were used to measure or lata, current at the time of use and were those calibrations d using a NIST traceable source?	Yes 🖂 🚶	No 🗌
	instruments successfully response-checked before use and, juired, after use on the day the data was measured?	Yes 🖂	No 🗌
9. Do the sa	mples match those identified on the chain of custody?	Yes 🗌	No 🗌 NA 🛛
10. Do the Q HDP-PR-	C Sample Results meet the acceptance criteria as specified in FSS-703, Final Status Survey Quality Control?	Yes 🗌	No 🗌 NA 🖂
11. Are all La	aboratory QC parameters within acceptable limits?	Yes [No 🗌 NA 🛛
If "No" was to corrective acti	the response to any of the questions above, then document to ons that were taken to resolve the discrepancy.	the discrepand	cy as well as any
Comments: N	A		
Quality Record			

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Figure 59-1 Data Evaluation Checklists prepared for BSA 02-21 (page 2 of 2)

Project Project Project Revision: 10 Appendix G-Page 2 of 2			D DOG 701 Ft 10	0 0 0	Land to a	
APPENDIX G-1 FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST Survey Area: No. BSA 02		Procedure: HDP-P	R-FSS-721, Final Status	Survey Data Eval	luation	
Survey Area: No. BSA 02 Description: Building Survey Area (Building 230) Survey Unit: No. 21 Description: U-Shaped Area (Southeast)-Lower Walls, Floor Discrepancy: None Corrective Actions Taken: None 11. Have the corrective actions resolved the discrepancy with the data? Yes No NA a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy Signyaure) Signyaure (Date) Clark Evers W. Markey Area (Building 230) U-Shaped Area (Southeast)-Lower Walls, Floor Building Survey Area (Building 230) U-Shaped Area (Southeast)-Lower Walls, Floor In Shaped Area (Southeast)-Lower Walls, Floor					Revision: 10	Appendix G-1 Page 2 of 2
Discrepancy: None Corrective Actions Taken: None 11. Have the corrective actions resolved the discrepancy with the data? Yes No NA a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy (Print Name) (Sugnyture) (Date) Approved by (RSO): Clark Evers	FINAL S	STATUS SURVEY	APPENDIX G Y DATA QUALITY OF	-1 BJECTIVES REV	VIEW CHECK	LIST
Corrective Actions Taken: None 11. Have the corrective actions resolved the discrepancy with the data? Yes \ No \ NA \ a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy (Print Name) (Staggarder) (Date) Approved by (RSO): Clark Evers						
Corrective Actions Taken: None 11. Have the corrective actions resolved the discrepancy with the data? Yes \ No \ NA \ a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy	Survey Carrie					
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11. Have the corrective actions resolved the discrepancy with the data? Yes No NA a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy Syndy Certain Name) Syndyles						
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11. Have the corrective actions resolved the discrepancy with the data? Yes No NA a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy Syndy Certain Name) Syndyles						
11. Have the corrective actions resolved the discrepancy with the data? Yes No NA a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy Syndy Certain Name) Syndyles						
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11. Have the corrective actions resolved the discrepancy with the data? Yes No NA a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy Signature (Joate) (Joa	Corrective Action	ons Taken: None				
a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy Signature (Signature) (Signature) (Date) Approved by (RSO): Clark Evers						
a. If "No", then forward this form to the RSO. 12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy Signature (Signature) (Signature) (Date) Approved by (RSO): Clark Evers						
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12. The following questions will be answered by the RSO. a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy (Print Name) (Signature) (Date) Approved by (RSO): Clark Evers				with the data?	Yes N	o 🗌 NA 🖂
a. If the answer to question 11 was "No", then is the affected data still valid? b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy (Print Name) (Signuture) (Date) Approved by (RSO): Clark Evers						
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sufficient to demonstrate compliance for the survey unit? c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy (Print Name) (Signature) (Date) (Date)			11 was "No", then is the	affected data	Yes N	o 🗌 NA 🖂
demonstrate compliance for the survey unit. Prepared by (HP Staff): Thomas Yardy (Print Name) (Signature) (Date) Approved by (RSO): Clark Evers	b. If "No" sufficie	then are the exist and to demonstrate of	ing valid measurements compliance for the surve	or samples y unit?	Yes N	lo 🗌 NA 🖂
Approved by (RSO): Clark Evers (Signature) (Date)	c. If "No" demons	then direct the ac strate compliance f	quisition of additional morthe survey unit.	easurements or sa	mples as necess	ary to
Approved by (RSO): Clark Evers (1) (1) 8/30/17	Prepared by	(HP Staff):		The Si	ture)	8-30-17 (Date)
	Approved b	y (RSO):	Clark Evers	(Signa	410 ture)	8/30/17 (Date)

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60.0 CONCLUSION BSA 02-21

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-21 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

 $\begin{tabular}{ll} Table~60-1\\ BSA~02-21~DCGL_{SO}~and~Dose~Summation \end{tabular}$

AVE. SU	RESIDUAL		
RADIO	ACTIVITY		
DCGL _{so}	4%		
Dose 1.0 mrem/year			

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61.0 FINAL STATUS SURVEY DESIGN BSA 02-26

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-26 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_{SO}$, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-26 and the detection sensitivities are also discussed.

61.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-26 were driven by the type (Structure) and Class (Class 2) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

61.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-26. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the DCGL_{SO}.

61.1.2 Scan Coverage

As a Class 2 structure SU, the scan survey requirement is a minimum of 10% of the exposed surfaces of the structure.

61.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-89 detector, paired with a Ludlum Model 2360 data logging meter.

61.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 176 cpm (based on observed operational instrument background) for the Ludlum Model 43-89 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe\ Area}{100}\right)}$$

Equation 61-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_i * \varepsilon_s * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes:

 ϵ_i = 2 pi (π) instrument efficiency for nuclide of concern ϵ_s = surface efficiency for nuclide of concern Yield = 100% for all nuclides of concern Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 61-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 125 cm² (e.g., Ludlum Model 43-89), a nominal background rate of 176 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.58% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{176}{60} \times \frac{60}{1}}}{0.707 \times 0.0958 \times (\frac{125}{100})} = 1,676 \text{ dpm/}100 \text{ cm}^2$$

Equation 61-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-89 is given in Table 61-1.

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 61-1
Total Weighted Efficiency Calculation (Ludlum Model 43-89) for BSA 02-26

Ludlum 2360	Ludlum Model 43-89	Active Probe Area	α HDP Efficiency	Efficiency α Cal. Efficiency β HDP Efficiency		ß Cal. Efficiency	
275770	19026	125 cm ²	30.2%	N/A	18.7%		N/A
		TOTAL WEIG	HTED INSTRUMENT EFF	CICIENCY CALCULATIO	N		
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ɛ _s)	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.3020	0.25	1.00	2.682E-03	2.02E-04
Np-237	Alpha	5.0	0.3020	0.25	1.00	5.573E-05	4.21E-06
Pu-239	Alpha	5.2	0.3020 0.25 1.00 2.027		2.027E-06	1.53E-07	
Tc-99	Beta	0.294	0.1870	0.25 1.00 2.829E-03		1.32E-04	
Th-232	Alpha	4.1	0.3020	0.25	1.00 3.214E-03 2.		2.43E-04
Ra-228	Beta	0.046	0.1870	0 0.00 1.00 3.214E-03		3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.1870	0.50 1.00 3.214E-03		3.01E-04	
Th-228	Alpha	5.5	0.3020	0.25	0.25 1.00 3.214E-03		2.43E-04
Ra-224	Alpha	5.8	0.3020	020 0.25 1.00 3.214E-		3.214E-03	2.43E-04
U-234	Alpha	4.9	0.3020	0.25	1.00	8.270E-01	6.24E-02
U-235	Alpha	4.7	0.3020	0.25	1.00	3.720E-02	2.81E-03
Th-231	Beta	0.390	0.1870 0.25 1.00 3.7		3.720E-02	1.74E-03	
U-238	Alpha	4.3	0.3020 0.25 1.00 1		1.270E-01	9.59E-03	
Th-234	Beta	0.270	0.1870	0.1870 0.25 1.00 1.270E-01		5.94E-03	
Pa-234m	Beta	2.20	0.1870	0.50	1.00	1.270E-01	1.19E-02
						Σ=	9.58%

Total Weighted Instrument Efficiency = Σ Weighted Instrument Efficiency for all Nuclides of Concern Weighted Instrument Efficiency = $\epsilon_i * \epsilon_s * \text{Yield} * \text{Activity Fraction}$

 $\varepsilon_i = 2$ Pi Instrument Efficiency for Nuclide of Concern

ε_s = Surface Efficiency for Nuclide of Concern

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61.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_B t_s \left(1+\frac{t_s}{t_b}\right)}}{(\varepsilon_t)(t_s)\left(\frac{A}{100 \ cm^2}\right)}$$

Equation 61-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

t_b = Background count time (minutes);

 ε_t = Total weighted efficiency (2π) ; and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 125 cm² (e.g., Ludlum Model 43-89), a nominal background rate of 176 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.58% is calculated to be:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{176 \times 1\left(1+\frac{1}{1}\right)}}{(0.0958)(1)\left(\frac{125}{100}\right)} = 690 \text{ dpm/}100 \text{ cm}^2$$

Equation 61-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-89 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-26. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

61.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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61.1.7 BSA 02-26 FSS Design Summary

Ludlum 2360 with 43-37 gas proportional detector.

Tennelec or Ludlum 3030 with 43-10-1 scintillation

detector.

The complete FSS Plan for BSA 02-26 is provided in Appendix S. A summary table of the requirements in the FSS Plan for BSA 02-26 is presented in Table 61-2 below.

Table 61-2 FSS Design Summary for BSA 02-26

	Design Summary 10		
Portable Instrument Scanning: Scan Coverage		Mi	nimum 10% of BSA 02-26 total area
Scan MDC		1,6	776 dpm/100cm ² (Ludlum 43-89) 1 dpm/100cm ² (Ludlum 43-37)
Investigation Action Level (IAL): g	eneral area	1,6	76 dpm/100cm ² (Ludlum 43-89) 1 dpm/100cm ² (Ludlum 43-37)
Total Surface Contamination (TS	C) Measurements:		
Surface	Minimum Number Measurements	of	Comments
BSA 02-26 Surfaces (Lower floor and walls)	locations have been systema		A total of 12 TSC measurements locations have been systematically designed from a random start point.
Removable Activity Locations:			
Using moderate pressure swipe a clean S-shaped pattern within an appro			(e.g. exterior wall, roof, window, etc.) in each TSC location.
Biased Measurement Locations:			
or seams where the Scan MDC wa amount and specific locations of bia	as exceeded. Consult ased measurements. A streets to instrument	Radi t loc effi	and asphalt surfaces such as cracks, holes, ological Engineering for guidance on the ations where biased measurements exceed ciency or volumetric sampling may be
Instrumentation			
Ludlum 2360 with 43-89 scintillation detector.		Used for scanning and to obtain static (T measurements.	

Used for scanning floors.

Used for counting of swipe (smear) samples.

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62.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-26

FSS was performed in accordance with procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems, and Components.

62.1 Scan Survey Performance

As a Class 2 SU the FSS plan required that a minimum of 10% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover at least 10% of the structural surfaces (provided in Appendix CC).

62.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated for BSA 02-26, and a total of twelve (12) measurements were designed by the FSS Plan. These direct, static-count measurement locations were designed in a random start, systematic pattern (See Figure 62-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 62-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix S).

No systematic location exceeded the $DCGL_{SO}$. The highest systematic TSC location result was 655 dpm/100 cm² (3% of the $DCGL_{SO}$). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-26 is provided in Appendix CC.

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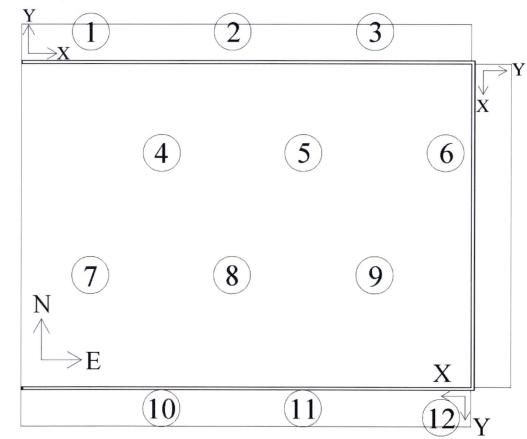
Figure 62-1 BSA 02-26 Systematic Measurement Locations

BSA 02-26

Lower Walls and Floor of East Warehouse in B230



Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)	
1	North Wall	119.6	5.2	
2	North Wall	145.2	5.2	
3	North Wall	170.8	5.2	
4	Floor	132.4	42.0	
5	Floor	158.0	42.0	
6	Floor	183.6	42.0	
7	Floor	119.6	20.0	
8	Floor	145.2	20.0	
9	Floor	170.8	20.0	
10	South Wall	65.0	1.4	
11	South Wall	363.0	1.4	
12	South Wall	670.0	1.4	



FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

1.4

1.4

1.4

65.0

363.0

670.0

South Wall

South Wall

South Wall

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Table 62-1 FSS Measurement Locations for BSA 02-26

Homotito		Procedure:	HDP-PR-FSS-701, Fina	al Status Survey Plan De	evelopment			
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		P00.0		PPENDIX P-4	4.600000			
		FSS SA	AMPLE & MEASURE	MENT LOCATIONS	& COORDI	NATES		
Survey Area:	BSA 02		_	Description:	Build	ling Survey Area (Bu	uilding 230)	
Survey Unit:	26		_	Description:	Build	ling 230 Bay Wareho	ouse (former WTS area)	
Survey Type:	FSS		Classification: Class 2					
Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes	
P02-26-01-S-W-S-00	W	S	NA	NA	5.2	119.6	North Wall	
P02-26-02-S-W-S-00	W	S	NA	NA	5.2	145.2	North Wall	
P02-126-03-S-W-S-00	W	S	. NA	NA	5.2	170.8	North Wall	
P02-26-04-S-W-S-00	F	S	NA	NA	42.0	132.4	Floor	
P02-26-05-S-W-S-00	F	S	NA	NA	42.0	158.0	Floor	
P02-26-06-S-F-S-00	F	S	NA	NA	42.0	183.6	Floor	
P02-26-07-S-F-S-00	F	S	NA	NA	20.0	119.6	Floor	
P02-26-08-S-F-S-00	F	S	NA	NA	20.0	145.2	Floor	
P02-26-09-S-F-S-00	F	S	NA	NA	20.0	170.8	Floor	

NA

NA

NA

*X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area)

NA

NA

NA

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

P02-26-10-S-W-S-00

P02-26-11-S-W-S-00

P02-26-12-S-W-S-00

CSM: Three-Layer (Surface-Root-Deep) or Uniform

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

W

W

W

S

S

S

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62.3 Biased Measurements

During the scanning of BSA 02-26, no elevated areas of interest were identified, and therefore no biased measurement locations were determined to be necessary.

62.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, no QC measurements were necessary for BSA 02-26.

63.0 FINAL STATUS SURVEY RESULTS BSA 02-26

During the performance of FSS in BSA 02-26, all scan measurements exceeding the Scan MDC of 2,187 dpm/100 cm² were identified for biased measurement. No static measurement exceeded the DCGL_{SO} of 18,925 dpm/100 cm². No removable contamination measurement exceeded the MDA, therefore no removable contamination measurement exceeded 10% of the DCGL_{SO}. The highest observed TSC measurement was 655 dpm/100 cm² (systematic location, 3% of the DCGL_{SO}), and the average residual radioactivity based on all systematically collected measurements is 240 dpm/100 cm² (1% of the DCGL_{SO}).

The analytical data sheets used to evaluate the BSA 02-26 FSS data are provided in Appendix I. A summary table of the FSS results is presented below in Table 63-1.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 63-1 FSS Data Summary for BSA 02-26

	MEASUREMENT			GROSS cpm	BKG cpm	Net cpm	Combined Net dpm/100	Corrected Net	Fraction of
MEASUREMENT ID	LOCATION	DATE MEAS	MEASUREMENT	(α+β)	(a+b)	$(\alpha + \beta)$	$cm^2(\alpha+\beta)$	dpm/100 cm ²	DCGL
P02-26-01-S-W-S-00	North Wall	6/16/2016	alpha + beta TSC	140	182	-42	-348	0	0%
P02-26-02-S-W-S-00	North Wall	6/16/2016	alpha + beta TSC	143	182	-39	-323	0	0%
P02-126-03-S-W-S-00	North Wall	6/16/2016	alpha + beta TSC	139	182	-43	-357	0	0%
P02-26-04-S-W-S-00	Floor	6/16/2016	alpha + beta TSC	237	182	55	463	463	2%
P02-26-05-S-W-S-00	Floor	6/16/2016	alpha + beta TSC	209	182	27	228	228	1%
P02-26-06-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	241	182	59	496	496	3%
P02-26-07-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	240	182	58	488	488	3%
P02-26-08-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	260	182	78	655	655	3%
P02-26-09-S-F-S-00	Floor	6/16/2016	alpha + beta TSC	247	182	65	546	546	3%
P02-26-10-S-W-S-00	South Wall	6/16/2016	alpha + beta TSC	166	182	-16	-131	0	0%
P02-26-11-S-W-S-00	South Wall	6/16/2016	alpha + beta TSC	158	182	-24	-198	0	0%
P02-26-12-S-W-S-00	South Wall	6/16/2016	alpha + beta TSC	150	182	-32	-265	0	0%
	*NOTE: Difference	es from documer	nted survey results are	e due to ro	unding in	Excel	Min Max	0 655	1%

Min 0 1%

Max 655

Mean 240 DCGLso

Median 114
Stdev 267.6

mrem/year

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64.0 ALARA EVALUATION BSA 02-26

All measurements collected within BSA 02-26 were evaluated against the $DCGL_{SO}$. For BSA 02-26 no measurement result exceeded the $DCGL_{SO}$. The average result, based on all systematically collected measurements was 1% of $DCGL_{SO}$ for BSA 02-26. The average of all measurements equates to residual activity contribution from the SU area of 0.25 mrem/year for BSA 02-26. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the $DCGL_{SO}$.

As the estimated TEDE for BSA 02-26 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-26 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-26.

65.0 FSS PLAN DEVIATIONS BSA 02-26

There were no deviations from the FSS Plan as written.

65.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-26.

66.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

66.1 Data Quality Assessment for BSA 02-26

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-26 (see Figure 66-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (*Operation of the Ludlum 2360 for Final Status Survey*), and HDP-PR-HP-411 (*Radiological Instrumentation*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected (on a random pattern) and the scan surveys that were conducted were performed in accordance with

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procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- Quality Control sample results were not necessary for BSA 02-26. However a Quality Control Replicate Survey was performed for BSA 02-16 and BSA 02-18, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-26 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Twelve (12) systematic measurements were collected in BSA 02-26. None of the 12 measurements exceeded the $DCGL_{SO}$ resulting in a systematic average result of 0% of the $DCGL_{SO}$. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 66-1. The Sign Test was successful as the total number of systematic measurements (12), exceeded the minimum requirement of 9 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-26 was 3% of the DCGL $_{SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 1% of the DCGL $_{SO}$, resulting in a residual dose contribution of 0.25 mrem/year.
- No FSS measurement result in BSA 02-26 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-26 was completed prior to and after the performance of the FSS. BSA 02-26 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

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 $\alpha = 0.05$

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Table 66-1 Sign Test for BSA 02-26

		Sign Test			
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference
P02-26-01-S-W-S-00	North Wall	0	0.000	1.000	1.000
P02-26-02-S-W-S-00	North Wall	0	0.000	1.000	1.000
P02-126-03-S-W-S-00	North Wall	0	0.000	1.000	1.000
P02-26-04-S-W-S-00	Floor	463	0.024	0.976	0.976
P02-26-05-S-W-S-00	Floor	228	0.012	0.988	0.988
P02-26-06-S-F-S-00	Floor	496	0.026	0.974	0.974
P02-26-07-S-F-S-00	Floor	488	0.026	0.974	0.974
P02-26-08-S-F-S-00	Floor	655	0.035	0.965	0.965
P02-26-09-S-F-S-00	Floor	546	0.029	0.971	0.971
P02-26-10-S-W-S-00	South Wall	0	0.000	1.000	1.000
P02-26-11-S-W-S-00	South Wall	0	0.000	1.000	1.000
P02-26-12-S-W-S-00	South Wall	0	0.000	1.000	1.000
			Number of Positive D	ifferences (S+)	12
		Sign Te	st Critical Value (MAR	SSIM Table I-3)	9

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST:

PASS

Critical V	IM Table I-3 /alues for the t Statistic S+	MARSSIM Table I- 3 Critical Values for the Sign Test Statistic S+		
N	Alpha = 0.05	N	Alpha = 0.05	
4	4	28	18	
5	4	29	19	
6	5	30	19	
7	6	31	20	
8	6	32	21	
9	7	33	21	
10	8	34	22	
11	8	35	22	
12	9	36	23	
13	9	37	23	
14	10	38	24	
15	11	39	25	
16	11	40	25	
17	12	41	26	
18	12	42	26	
19	13	43	27	
20	14	44	27	
21	14	45	28	
22	15	46	29	
23	15	47	29	
24	16	48	30	
25	17	49	30	
26	17	50	31	
27	18			

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 66-1 Data Evaluation Checklists prepared for BSA 02-26 (page 1 of 2)

Hema	atite	Procedure: HDP-PF	R-FSS-721, Final Statu	s Survey Data Eval	luation		
Decommi	ecommissioning Project		Revision: 1	Appendix G-1, Page 1 of 2			
APPENDIX G-1 FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST						KLIST	
	ey Area:	BSA 02 26	Description:	Building Survey A			
1. H	Have all n	neasurements and/or alysis for FSS been	analysis results that vindividually reviewed	vill be subjected		No 🗌	
2. I	Have all	t the locations speci	this procedure? ments and/or samples fied in the FSSP and		Yes 🖂 🚶	No 🗌	
			performed of the are SS Sample Instructions		Yes 🖂 🚶	No 🗌	
		is iased measurements and/or samples been taken or acquired tions specified in the FSSP & the FSS Sample Instructions?					
		icate and/or split samples or measurements been taken or each location designated as a QC sample?					
C	capable of	e instruments used to measure or analyze the survey data of detecting the ROCs or gross activity at a MDC less than Yes No populate investigation level?					
a	analyze da	as the calibration of all instruments that were used to measure or alyze data, current at the time of use and were those calibrations Yes No rformed using a NIST traceable source?					
		the instruments successfully response-checked before use and, required, after use on the day the data was measured?				No 🗌	
9. I	Do the san	nples match those ide	entified on the chain of	f custody?	Yes 🗌	No 🗌 NA 🖂	
		he QC Sample Results meet the acceptance criteria as specified in P-PR-FSS-703, Final Status Survey Quality Control?				No 🗌 NA 🖂	
11.	Are all La	re all Laboratory QC parameters within acceptable limits?					
If "N	o" was the	ne response to any cons that were taken to	of the questions above resolve the discrepand	e, then document to	he discrepand	ey as well as any	
Comr	ments: N/	A					
Quality	Record						

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)*

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Figure 66-1
Data Evaluation Checklists prepared for BSA 02-26 (page 2 of 2)

Hamatita	Procedure: HDP-F	PR-FSS-721, Final Status	Survey Data Eval	uation	
Hematite Decommissioning Project				Revision: 10	Appendix G-1, Page 2 of 2
FINAL	STATUS SURVE	APPENDIX G Y DATA QUALITY OF		IEW CHECK	LIST
Survey Area: Survey Unit:			Building Survey Building 230 Bay		
Discrepancy:	None				
Corrective Acti	ions Taken: None				
	corrective actions re	esolved the discrepancy v	vith the data?	Yes No	o 🗌 NA 🖂
12. The follow	wing questions will	be answered by the RSO			
	answer to question 1	1 was "No", then is the a		Yes N	o 🗌 NA 🖂
		ing valid measurements compliance for the survey		Yes N	o 🗌 NA 🖂
	", then direct the ac astrate compliance for	quisition of additional moor the survey unit.	easurements or san	nples as necessa	ary to
Prepared by	y (HP Staff):	Thomas Yardy (Print Name)	Signatu	re) 5	(Date)
Approved I	by (RSO):	Clark Evers (Print Name)	W. LOG (Signatu	ire)	(Date)
Quality Record					

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67.0 CONCLUSION BSA 02-26

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-26 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 67-1
BSA 02-26 DCGL_{SO} and Dose Summation

	RESIDUAL CTIVITY
DCGL _{so}	1%
Dogg	0.25
Dose	mrem/year

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68.0 FINAL STATUS SURVEY DESIGN BSA 02-27

This section of the report describes the method for determining the number of measurements required for the FSS of BSA 02-27 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_{SO}$, scan survey coverage and IAL. The radiological instrumentation used in the FSS of BSA 02-27 and the detection sensitivities are also discussed.

68.1 FSS Plan Design Requirements

FSS Plan requirements for BSA 02-27 were driven by the type (Structure) and Class (Class 2) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 2015.

68.1.1 DCGL_{SO}

During the FSS design process a review was performed of the RASS radiological survey data for BSA 02-27. The RASS radiological survey data provided an expectation that the structure would meet the release criteria of the $DCGL_{SO}$.

68.1.2 Scan Coverage

As a Class 2 structure SU, the scan survey requirement is a minimum of 10% of the exposed surfaces of the structure.

68.1.3 Instrumentation

The selected instrumentation was a Ludlum Model 43-93 detector, paired with a Ludlum Model 2360 data logging meter.

68.1.4 Scan Minimum Detectable Concentration

Instrument detection sensitivities depend upon the measurement geometry, instrument efficiencies, count times and scan speeds. Both scan and static measurement sensitivities for the various detectors are determined using the guidance in Chapter 14 of the DP.

The calculations for detection sensitivity assume a nominal background rate of 200 cpm (based on observed operational instrument background) for the Ludlum Model 43-93 probe. The Scan MDC calculation for SSC SUs given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.3.5.b, was applied:

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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$$Scan \ MDC = \frac{1.38 \times \sqrt{\frac{bkgd}{60}} \times \frac{60}{1}}{0.707 \times eff_{total} \times \left(\frac{Probe \ Area}{100}\right)}$$

Equation 68-1

This equation assumes the following parameters:

- An index of sensitivity (1.38) corresponding to the Type I and Type II error rates of 0.05 and 0.10, respectively.
- A background count performed for 60 seconds
- A surveyor efficiency of 0.5.

In order to calculate the Scan MDC using the above equation, the total weighted efficiency (eff_{total}) must be calculated for each probe used during FSS. The method for calculating the weighted and total weighted efficiency from Appendix A of HDP-PR-HP-415 (Equation 1) is:

Weighted Instrument Efficiency = $\varepsilon_i * \varepsilon_s * Yield * Activity Fraction$

Total Weighted Instrument Efficiency = \sum Weighted Instrument Efficiency (for all nuclides of concern)

Notes:

 ϵ_i = 2 pi (π) instrument efficiency for nuclide of concern ϵ_s = surface efficiency for nuclide of concern Yield = 100% for all nuclides of concern Activity Fraction = value listed on Form HDP-PR-HP-415-2 for nuclide of concern

Equation 68-2

The Scan MDC calculation using the inputs of the instrumentation used for FSS are given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.07% is calculated to be:

Scan MDC =
$$\frac{1.38 \times \sqrt{\frac{200}{60} \times \frac{60}{1}}}{0.707 \times 0.0907 \times (\frac{100}{100})} = 2,351 \text{ dpm}/100 \text{ cm}^2$$

Equation 68-3

The total weighted efficiency calculation worksheet for the Ludlum Model 43-93 is given in Table 68-1.

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 68-1
Total Weighted Efficiency Calculation (Ludlum Model 43-93) for BSA 02-27

Ludlum 2360	Ludlum Model 43-93	Active Probe Area	α HDP Efficiency	α Cal. Efficiency	ß HDP Efficiency 25.5%		B Cal. Efficiency
268647	289424	100 cm ²	25.3%	N/A			N/A
		TOTAL WEIG	GHTED INSTRUMENT EFF	CICIENCY CALCULATIO	N		
Radionuclide	Radiation	Maximum Energy (MeV)	Instrument Efficiency (ε _i)	Surface Efficiency (ɛ _s)	Yield 100%	Activity Fraction	Weighted Efficiency
Am-241	Alpha	5.6	0.2530	0.25	1.00	2.682E-03	1.70E-04
Np-237	Alpha	5.0	0.2530	0.25	1.00	5.573E-05	3.52E-06
Pu-239	Alpha	5.2	0.2530	0.25	1.00	2.027E-06	1.28E-07
Tc-99	Beta	0.294	0.2550	0.25	1.00	2.829E-03	1.80E-04
Th-232	Alpha	4.1	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-228	Beta	0.046	0.2550	0.00	1.00	3.214E-03	0.00E+00
Ac-228	Beta	2.13	0.2550	0.50	1.00	3.214E-03	4.10E-04
Th-228	Alpha	5.5	0.2530	0.25	1.00	3.214E-03	2.03E-04
Ra-224	Alpha	5.8	0.2530	0.25	1.00	3.214E-03	2.03E-04
U-234	Alpha	4.9	0.2530	0.25	1.00	8.270E-01	5.23E-02
U-235	Alpha	4.7	0.2530	0.25	1.00	3.720E-02	2.35E-03
Th-231	Beta	0.390	0.2550	0.25	1.00	3.720E-02	2.37E-03
U-238	Alpha	4.3	0.2530	0.25	1.00	1.270E-01	8.03E-03
Th-234	Beta	0.270	0.2550	0.25	1.00	1.270E-01	8.10E-03
Pa-234m	Beta	2.20	0.2550	0.50	1.00	1.270E-01	1.62E-02
						Σ=	9.07%

 $Total\ Weighted\ Instrument\ Efficiency = \Sigma\ Weighted\ Instrument\ Efficiency\ for\ all\ Nuclides\ of\ Concern\ Weighted\ Instrument\ Efficiency = \epsilon_i * \epsilon_s * Yield * Activity\ Fraction$

 $\varepsilon_i = 2$ Pi Instrument Efficiency for Nuclide of Concern

 ε_s = Surface Efficiency for Nuclide of Concern

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68.1.5 Static Minimum Detectable Concentration

The Static MDC for Piping and Structural Surfaces (using Equation 14-29, Section 14.4.4.2.5 of Chapter 14 of the DP) is calculated as follows:

Static MDC (dpm/100 cm²) =
$$\frac{3+3.29\sqrt{R_Bt_S\left(1+\frac{t_S}{t_b}\right)}}{(\varepsilon_t)(t_S)\left(\frac{A}{100\ cm^2}\right)}$$

Equation 68-4

where:

 $R_B = Background count rate (cpm);$

t_S = Sample or measurement count time (minutes);

t_b = Background count time (minutes);

 ε_t = Total weighted efficiency (2π) ; and;

 $A = Probe area (cm^2).$

The Static MDC calculation using inputs of the instrumentation used for FSS is given below. The Static MDC for a detector having an area of 100 cm² (e.g., Ludlum Model 43-93), a nominal background rate of 200 cpm (based on observed operational instrument background), and a total weighted efficiency of 9.97% is calculated to be:

Static MDC
$$(dpm/100 \text{ cm}^2) = \frac{3+3.29\sqrt{200 \times 1\left(1+\frac{1}{1}\right)}}{(0.0997)(1)\left(\frac{100}{100}\right)} = 690 \text{ dpm}/100 \text{ cm}^2$$

Equation 68-5

The average background count rate (in cpm) is subtracted from each gross TSC measurement prior to calculation of a dpm value, which is in turn compared to the IAL or $DCGL_{SO}$. The typical background values for the Ludlum Model 43-93 detectors for FSS for the SUs were between 100 and 300 cpm for BSA 02-27. Negative values are treated as zero for calculating the DCGL Fraction.

Note that the instrument sensitives presented above are the prospective values used during the development of the FSS Plan. The actual instrument sensitivities will vary slightly based on the background and efficiency of the scanning instrumentation that was used to perform the FSS survey.

68.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the DCGL_{SO} (9,463 dpm/100 cm²).

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68.1.7 BSA 02-27 FSS Design Summary

The complete FSS Plan for BSA 02-27 is provided in Appendix T. A summary table of the requirements in the FSS Plan for BSA 02-27 is presented in Table 68-2 below.

Table 68-2 FSS Design Summary for BSA 02-27

Portable Instrument Scanning:				
Scan Coverage		Minimum 10% of BSA 02-27 total area		
		ne pit scan mandatory)		
Scan MDC		51 dpm / 100 cm ² (Ludlum 43-93) 93 dpm / 100 cm ² (Ludlum 43-37)		
Investigation Action Level (IAL)		51 dpm / 100 cm ² (Ludlum 43-93)		
investigation Action Level (IAL)		23 dpm / 100 cm ² (Ludlum 43-37)		
Total Surface Contamination (TSC)	Measurements:			
Surface	Minimum Number of	Comments		
	Measurements			
Building 230: U-Shaped Area -		A total of 11 TSC measurements locations		
Northwest (floor, lower walls, and	11	have been systematically designed from a		
interior walls)		random start point.		
TSC Investigation Action Level	/ 100 cm ² (Adjusted Gross DCGL)			
Removable Activity Locations:				
After each TSC measurement, at the sa				
After each TSC measurement, at the sa smear over the surface (e.g. exterior wa				
After each TSC measurement, at the sa smear over the surface (e.g. exterior wa 4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amount of the supervision for guidance on	r seams, cracks, or penetration and specific locations atic MDA, adjustments to in	ons, and at floor/wall interfaces. Consult FS of biased measurements. At locations wherestrument efficiency or volumetric sampling ma		
After each TSC measurement, at the sa smear over the surface (e.g. exterior wa 4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amor measurements exceed the instrument sta	r seams, cracks, or penetration and specific locations atic MDA, adjustments to in	ons, and at floor/wall interfaces. Consult FS of biased measurements. At locations wher		
After each TSC measurement, at the sa smear over the surface (e.g. exterior wa 4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amor measurements exceed the instrument stable necessary – consult FSS supervision	seams, cracks, or penetration and specific locations atic MDA, adjustments to in for guidance. Used for static (S-shaped pattern within an approximately 4" booms, and at floor/wall interfaces. Consult FS of biased measurements. At locations when		
After each TSC measurement, at the samear over the surface (e.g. exterior wa 4" box. Biased Measurement Locations: Perform biased measurements on floor supervision for guidance on the amor measurements exceed the instrument stable necessary – consult FSS supervision Instrumentation:	r seams, cracks, or penetration and specific locations atic MDA, adjustments to in for guidance. Used for static (elevate	ons, and at floor/wall interfaces. Consult FS of biased measurements. At locations wher strument efficiency or volumetric sampling material or scanning lower walls, stairs and to obtain TSC) measurements; used to investigate		

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69.0 FINAL STATUS SURVEY IMPLEMENTATION BSA 02-27

FSS was performed in accordance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems, and Components*.

69.1 Scan Survey Performance

As a Class 2 SU the FSS plan required that a minimum of 10% of the exposed structural surfaces be subject to scanning. Review of the FSS Documentation, and observations performed of personnel performing the surveys confirmed that the actual FSS scan performed did in fact cover greater than 10% of the structural surfaces (provided in Appendix DD).

69.2 Systematic Measurements

Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated and designed for BSA 02-27 by the FSS Plan. These direct, static-count measurement locations were designed in a random start, systematic pattern (See Figure 69-1). Determination of the required number of TSC measurements for the SU was performed according to the requirements in Step 8.3.4 of HDP-PR-FSS-701 (and is documented in the FSS Plan in Step 7 of Appendix P-2).

Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

Table 69-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix T).

No systematic location exceeded the $DCGL_{SO}$. The highest systematic TSC location had a result of 947 dpm/100 cm² (5% of the $DCGL_{SO}$). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-27 is provided in Appendix DD.

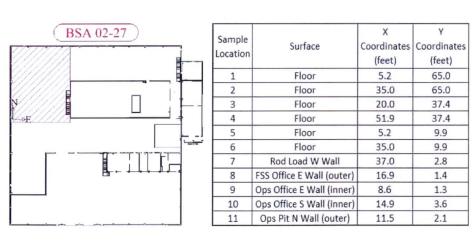
FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

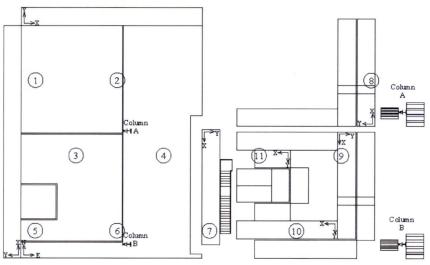
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Figure 69-1 BSA 02-27 Systematic Measurement Locations

 ${\rm BSA~02\text{-}27}$ Floor and Lower Walls of the NW Section of the U Shaped Area





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Table 69-1 FSS Measurement Locations for BSA 02-27

Hematite	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
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	APPENDIX P-4		

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: **BSA 02** **Description:**

Building Survey Area (Building 230)

Class 2

Survey Unit:

27

Description:

U-Shaped Area (Northwest) - Lower Walls, Floor, Stairs

Survey Type: **FSS** Classification:

Measurement or Sample ID	Surface or CSM	Туре	Start Elevation	End Elevation	Northing (feet) (Y Axis)	Easting (feet) (X Axis) *	Remarks / Notes	
B02-27-01-S-F-S-00	F	S	NA	NA	65.0	5.2	Floor	
B02-27-02-S-F-S-00	F	S	NA	NA	65.0	35.0	Floor	
B02-27-03-S-F-S-00	F	S	NA	NA	37.4	20.0	Floor	
B02-27-04-S-F-S-00	F	S	NA	NA	37.4	51.9	Floor	
B02-27-05-S-F-S-00	F	S	NA	NA	9.9	5.2	Floor	
B02-27-06-S-F-S-00	F	S	NA	NA	9.9	35.0	Floor	
B02-27-07-S-F-S-00	W	S	NA	NA	2.8	37.0	Rod Load West Wall	
B02-27-08-S-F-S-00	W	S	NA	NA	1.4	16.9	FSS Office E Wall Outer	
B02-27-09-S-F-S-00	W	S	NA	NA	1.3	8.6	Ops Offices E Wall Inne	
B02-27-10-S-F-S-00	W	S	NA	NA	3.6	14.9	Ops Offices S Wall Inne	
B02-27-11-S-W-S-00	W	S	NA	NA	2.1	11.5	Ops Pit North Wall	
B02-27-12-S-F-B-00	F	В	NA	NA	70.0	20.0	Floor	
B02-27-13-S-F-B-00	F	В	NA	NA	65.0	45.0	Floor	
B02-27-14-S-F-B-00	F	В	NA	NA	30.0	50.0	Floor	
B02-27-15-S-F-B-00	F	В	NA	NA	30.0	22.0	Floor	
B02-27-16-S-F-B-00	F	В	NA	NA	15.0	5.0	Floor	
B02-27-17-S-F-B-00	F	В	NA	NA	50.0	4.0	Floor	

^{*}X and Y coordinates are provided using Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area)

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R CSM: Three-Layer (Surface-Root-Deep) or Uniform Type: Systematic = S, Biased = B; QC =Q; Investigation = I

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69.3 Biased Measurements

In total, six (6) areas were identified for biased measurement. These areas were identified by scan measurements that approached or exceeded the Scan IAL. No biased measurement was identified to exceed the DCGL_{SO}, the highest identified result was 696 dpm/100 cm² (4% of the DCGLso).

69.4 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergoes a complete replicate survey by a different HP Technician from that which was used in the original FSS of the selected structural SU. As there are 36 structural SUs in total identified for FSS (comprising Building 110, Building 230 and Building 231), two QC replicate survey will be performed (5.6%). BSA 02-16 and BSA 02-18 were randomly selected as the BSA SU to undergo a QC replicate survey, and as such, no QC measurements were necessary for BSA 02-27.

70.0 FINAL STATUS SURVEY RESULTS BSA 02-27

During the performance of FSS in BSA 02-27, all scan measurements exceeding the Scan MDC of 2,187 dpm/100 cm² were identified for biased measurement. No static measurement exceeded the DCGL_{SO} of 18,925 dpm/100 cm². No removable contamination measurement exceeded the MDA, therefore no removable contamination measurement exceeded 10% of the DCGL_{SO}. The highest observed TSC measurement was 947 dpm/100 cm² (systematic location, 5% of the DCGL_{SO}), and the average residual radioactivity based on all systematically collected measurements is 380 dpm/100 cm² (2% of the DCGL_{SO}),

The analytical data sheets used to evaluate the BSA 02-27 FSS data are provided in Appendix J. A summary table of the FSS results is presented below in Table 70-1.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Table 70-1 FSS Data Summary for BSA 02-27

				GROSS	вкс	Net cpm	Combine d Net	Corrected Net	
	MEASUREMENT	DATEMENS	BAE A CUIDEBAENT	cpm	cpm	(α +	dpm/100	dpm/100c	Fraction of
MEASUREMENT ID	LOCATION	DATE MEAS	MEASUREMENT	(α+β)	(a+b)	β)	$cm^2(\alpha+\beta)$	m ²	DCGL
B02-27-01-S-F-S-00	Floor	9/11/2015	alpha + beta TSC	193	144	49	495	495	3%
B02-27-02-S-F-S-00	Floor	9/11/2015	alpha + beta TSC	178	144	34	344	344	2%
B02-27-03-S-F-S-00	Floor	9/11/2015	alpha + beta TSC	238	144	94	947	947	5%
B02-27-04-S-F-S-00	Floor	9/11/2015	alpha + beta TSC	197	144	53	535	535	3%
B02-27-05-S-F-S-00	Floor	9/11/2015	alpha + beta TSC	209	144	65	656	656	3%
B02-27-06-S-F-S-00	Floor	9/11/2015	alpha + beta TSC	207	144	63	636	636	3%
B02-27-07-S-F-S-00	Rod Load West Wall	9/11/2015	alpha + beta TSC	200	144	56	565	565	3%
B02-27-08-S-F-S-00	FSS Office E Wall Outer	9/11/2015	alpha + beta TSC	136	144	-8	-77	0	0%
B02-27-09-S-F-S-00	Ops Offices E Wall Inner	9/11/2015	alpha + beta TSC	109	144	-35	-348	0	0%
B02-27-10-S-F-S-00	Ops Offices S Wall Inner	9/11/2015	alpha + beta TSC	125	144	-19	-188	0	0%
B02-27-11-S-W-S- 00	Ops Pit North Wall	9/11/2015	alpha + beta TSC	114	144	-30	-298	0	0%
B02-27-12-S-F-B-00	Floor	9/11/2015	alpha + beta TSC	171	144	27	274	274	1%
B02-27-13-S-F-B-00	Floor	9/11/2015	alpha + beta TSC	213	144	69	696	696	4%
B02-27-14-S-F-B-00	Floor	9/11/2015	alpha + beta TSC	201	144	57	575	575	3%
B02-27-15-S-F-B-00	Floor	9/11/2015	alpha + beta TSC	168	144	24	244	244	1%
B02-27-16-S-F-B-00	Floor	9/11/2015	alpha + beta TSC	204	144	60	605	605	3%
B02-27-17-S-F-B-00	Floor	9/11/2015	alpha + beta TSC	198	144	54	545	545	3%
	*NOTE: Differences	from documente	d survey results are du	ue to round	ding in Ex	xcel	Min	0	20/

Min	0	2%
Max	947	270
Mean	380	DCGLso
Median	495	0.50
Stdev	333.6	0.50

mrem/year

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71.0 ALARA EVALUATION BSA 02-27

All measurements collected within BSA 02-27 were evaluated against the $DCGL_{SO}$. For BSA 02-27 no measurement result exceeded the $DCGL_{SO}$. The average result, based on all systematically collected measurements was 2% of $DCGL_{SO}$ for BSA 02-27. The average of all measurements equates to residual activity contribution from the SU area of 0.5 mrem/year for BSA 02-27. No removable contamination measurement was identified to exceed the instrument MDA, and therefore no removable contamination measurement exceeded 10% of the $DCGL_{SO}$.

As the estimated TEDE for BSA 02-27 is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of BSA 02-27 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 02-27.

72.0 FSS PLAN DEVIATIONS BSA 02-27

There were no deviations from the FSS Plan as written.

72.1 Remedial Actions During FSS

There were no remedial actions required in BSA 02-27.

73.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

73.1 Data Quality Assessment for BSA 02-27

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 02-27 (see Figure 73-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-415 (Operation of the Ludlum 2360 for Final Status Survey), and HDP-PR-HP-411 (Radiological Instrumentation).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The TSC systematic measurements that were collected (on a random pattern) and the scan surveys that were conducted were performed in accordance with

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procedure HDP-PR-FSS-712, Final Status Surveys of Structures, Systems and Components.

- Quality Control sample results were not necessary for BSA 02-27. However a Quality Control Replicate Survey was performed for BSA 02-16 and BSA 02-18, and the results were found to be acceptable, satisfying the requirement that a minimum of 5% of structure surveys undergo a successful QC Replicate Survey.
- BSA 02-27 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- Eleven (11) systematic measurements were collected in BSA 02-27. None of the 11 measurements exceeded the DCGL_{SO} resulting in a systematic average result of 2% of the DCGL_{SO}. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 73-1. The Sign Test was successful as the total number of systematic measurements (11), exceeded the minimum requirement of 8 measurements.
- Smear samples were collected at each TSC measurement location after the initial TSC measurement was collected. No removable smear sample exceeded MDA, and therefore no removable activity exceeding 10% of the DCGL_{SO} was identified.
- The maximum observed systematic result in BSA 02-27 was 5% of the DCGL_{SO}. The average residual radioactivity concentration fraction based on the systematically collected measurements was 2% of the DCGL_{SO}, resulting in a residual dose contribution of 0.5 mrem/year.
- No FSS measurement result in BSA 02-27 exceeded the DCGL_{SO}, therefore an EMC or hot spot averaging was not required.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for BSA 02-27 was completed prior to and after the performance of the FSS. BSA 02-27 remained isolated after the completion of FSS field activities ensuring SU isolation until the completion of all onsite FSS activities. The radiological status of the SU was confirmed through the ongoing clean area routine survey program.

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

 $\alpha = 0.05$

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MARSSIM Table I-3

Table 73-1 Sign Test for BSA 02-27

Sign Test						
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W _s)	Difference (1-W _s)	Corrected Difference	
B02-27-01-S-F-S-00	Floor	495	0.026	0.974	0.974	
B02-27-02-S-F-S-00	Floor	344	0.018	0.982	0.982	
B02-27-03-S-F-S-00	Floor	947	0.050	0.950	0.950	
B02-27-04-S-F-S-00	Floor	535	0.028	0.972	0.972	
B02-27-05-S-F-S-00	Floor	656	0.035	0.965	0.965	
B02-27-06-S-F-S-00	Floor	636	0.034	0.966	0.966	
B02-27-07-S-F-S-00	Rod Load West Wall	565	0.030	0.970	0.970	
B02-27-08-S-F-S-00	FSS Office E Wall Outer	0	0.000	1.000	1.000	
B02-27-09-S-F-S-00	Ops Offices E Wall Inner	0	0.000	1.000	1.000	
B02-27-10-S-F-S-00	Ops Offices S Wall Inner	0	0.000	1.000	1.000	
B02-27-11-S-W-S-00	Ops Pit North Wall	0	0.000	1.000	1.000	
			Number of Positive D	ifferences (S+)	11	
		Sign T	est Critical Value (MAR	SSIM Table I-3)	8	

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

TEST:

PASS

Critical V	IM Table I-3 alues for the t Statistic S+	Critical Values for the Sign Test Statistic S+		
N	Alpha = 0.05	N	Alpha = 0.05	
4	4	28	18	
5	4	29	19	
6	5	30	19	
7	6	31	20	
8	6	32	21	
9	7	33	21	
10	8	34	22	
11	8	35	22	
12	9	36	23	
13	9	37	23	
14	10	38	24	
15	11	39	25	
16	11	40	25	
17	12	41	26	
18	12	42	26	
19	13	43	27	
20	14	44	27	
21	14	45	28	
22	15	46	29	
23	15	47	29	
24	16	48	30	
25	17	49	30	
26	17	50	31	
27	18			

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (*BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 73-1 Data Evaluation Checklists prepared for BSA 02-27 (page 1 of 2)

Hematite	Procedure: HDP-P	R-FSS-721, Final Statu	s Survey Data Eva	luation				
ecommissioning Project	5			Revision: 10 Appendix C Page 1 of 2				
APPENDIX G-1 FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST								
Survey Area:	BSA 02	Description:	Building Survey	Area (Buildin	ng 230)			
Survey Unit:	27	Description:	U-Shaped Area (Nort	hwest)-Lower	Walls, Floor, Stairs			
to data a		r analysis results that v individually reviewed this procedure?		Yes 🖂	No 🗌			
	at the locations spec	ments and/or samples ified in the FSSP and		Yes 🖂	No 🗌			
		performed of the ar SS Sample Instructions		Yes 🖂	No 🗌			
		and/or samples been t FSSP & the FSS Sam		Yes 🖂	No 🗌 NA 🗌			
		eate and/or split samples or measurements been taken or each location designated as a QC sample?						
capable of	of detecting the ROC	detecting the ROCs or gross activity at a MDC less than Yes No interior investigation level?						
analyze	he calibration of all instruments that were used to measure or ze data, current at the time of use and were those calibrations Yes No med using a NIST traceable source?							
		fully response-checked te day the data was mea		Yes 🖂	No 🗌			
9. Do the sa	amples match those id	lentified on the chain of	f custody?	Yes 🗌	No 🗌 NA 🖂			
	QC Sample Results meet the acceptance criteria as specified in R-FSS-703, Final Status Survey Quality Control?							
11. Are all L	aboratory QC parame	eters within acceptable	limits?	Yes 🗌	No 🗌 NA 🖂			
		of the questions above o resolve the discrepand		he discrepan	cy as well as an			
Comments: N	/A							
Quality Record								

FSSFR Volume 4, Chapter 3: *Survey Area Release Record for Building Survey Area 02*, *Survey Unit 13*, *14*, *15*, *16*, *17*, *18*, *19*, *20*, *21*, *26 and 27* (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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Figure 73-1 Data Evaluation Checklists prepared for BSA 02-27 (page 2 of 2)

Hematite	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation				
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FINAL	STATUS SURVE	APPENDIX O Y DATA QUALITY O		IEW CHECK	LIST
~	No. BSA 04		Building Survey		
Survey Unit:	No. <u>27</u>	Description:	U-Shaped Area (No	rtnwest)-Lower w	alis, Floor, Stairs
Discrepancy:	None		7		

Corrective Acti	ions Taken: None	2			
11. Have the	corrective actions r	resolved the discrepancy	with the data?	Yes N	o 🗌 NA 🖂
	", then forward this				
		be answered by the RS			
a. If the a still va		11 was "No", then is the	affected data	Yes N	o 🗌 NA 🖂
b. If "No sufficient	", then are the exist ent to demonstrate	ting valid measurements compliance for the surve	or samples ey unit?	Yes N	o □ NA ⊠
	", then direct the ac instrate compliance f	equisition of additional r for the survey unit.	neasurements or sai	mples as necess	ary to
Prepared by	y (HP Staff):	Thomas Yardy (Print Name)	- franchista de la constantina della constantina	ure)	8-30-17 (Date)
Approved I	by (RSO):	Clark Evers (Print Name)	\(\lambda \lambda \lambda \lambda \text{(Signat)}	dure)	P/30/17 (Date)
Quality Record					

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74.0 CONCLUSION BSA 02-27

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structure designated as BSA 02-27 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

 $\label{eq:Table 74-1} \textbf{BSA 02-27 DCGL}_{SO} \ \textbf{and Dose Summation}$

AVE. SU	RESIDUAL
RADIO	ACTIVITY
DCGL _{so}	2%
Dose	0.5 mrem/year

FSSFR Volume 4, Chapter 3: Survey Area Release Record for Building Survey Area 02, Survey Unit 13, 14, 15, 16, 17, 18, 19, 20, 21, 26 and 27 (BSA 02-13, BSA 02-14, BSA 02-15, BSA 02-16, BSA 02-17, BSA 02-18, BSA 02-19, BSA 02-21, BSA 02-26 and BSA 02-27)

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75.0 REFERENCES

APPENDIX CC:

APPENDIX DD:

75.1 DO-08-004, Hematite Decommissioning Plan {ML092330123}

76.0 APPENDICES (To Be Provided On A Separate Data Disc)

APPENDIX A: Analytical Data Evaluation Spreadsheets for BSA 02-13 Analytical Data Evaluation Spreadsheets for BSA 02-14 APPENDIX B: Analytical Data Evaluation Spreadsheets for BSA 02-15 APPENDIX C: Analytical Data Evaluation Spreadsheets for BSA 02-16 APPENDIX D: APPENDIX E: Analytical Data Evaluation Spreadsheets for BSA 02-17 Analytical Data Evaluation Spreadsheets for BSA 02-18 APPENDIX F: Analytical Data Evaluation Spreadsheets for BSA 02-19 APPENDIX G: Analytical Data Evaluation Spreadsheets for BSA 02-21 APPENDIX H: APPENDIX I: Analytical Data Evaluation Spreadsheets for BSA 02-26 APPENDIX J: Analytical Data Evaluation Spreadsheets for BSA 02-27 APPENDIX K: FSS Plan Development for BSA 02-13 APPENDIX L: FSS Plan Development for BSA 02-14 APPENDIX M: FSS Plan Development for BSA 02-15 APPENDIX N: FSS Plan Development for BSA 02-16 FSS Plan Development for BSA 02-17 APPENDIX O: APPENDIX P: FSS Plan Development for BSA 02-18 APPENDIX Q: FSS Plan Development for BSA 02-19 APPENDIX R: FSS Plan Development for BSA 02-21 FSS Plan Development for BSA 02-26 APPENDIX S: FSS Plan Development for BSA 02-27 APPENDIX T: FSS Documentation for BSA 02-13 APPENDIX U: APPENDIX V: FSS Documentation for BSA 02-14 APPENDIX W: FSS Documentation for BSA 02-15 FSS Documentation for BSA 02-16 APPENDIX X: APPENDIX Y: FSS Documentation for BSA 02-17 APPENDIX Z: FSS Documentation for BSA 02-18 APPENDIX AA: FSS Documentation for BSA 02-19 APPENDIX BB: FSS Documentation for BSA 02-21

FSS Documentation for BSA 02-26

FSS Documentation for BSA 02-27