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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

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)

NMSS20

cc: V. J. Kelmeckis, Westinghouse
S. S. Koenick, NRC/DUWP/MDB
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

Westinghouse

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: **0**

EFFECTIVE DATE: OCT 0 3 2017

Approvals:

Author: _____ 10-03-2017
Kenneth E. Pallagi Date

Owner/Manager: _____ 10/3/17
W. Clark Evers Date

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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
$DCGL_w$	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)
m^2	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
U	Uranium

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.

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.

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

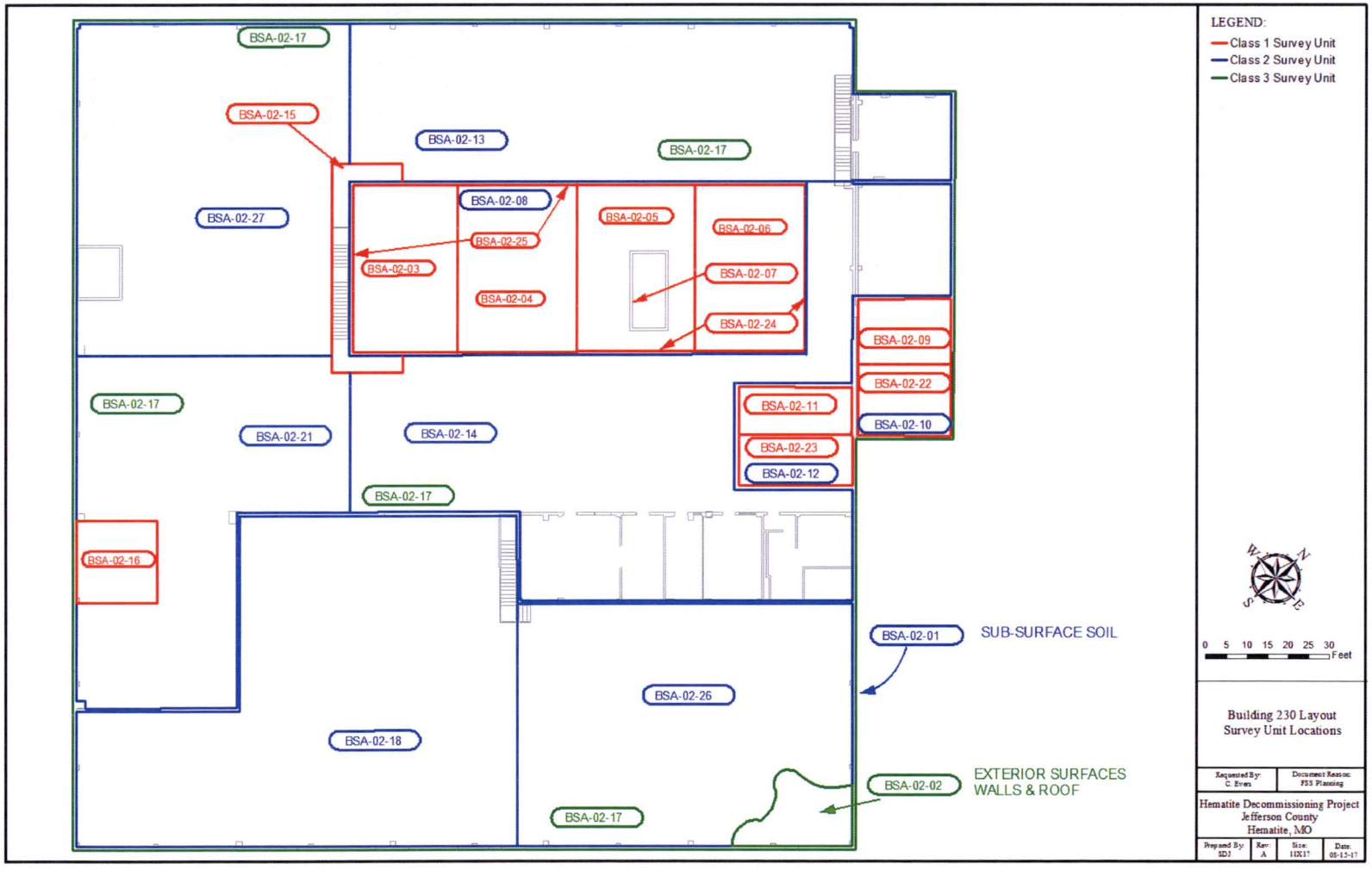
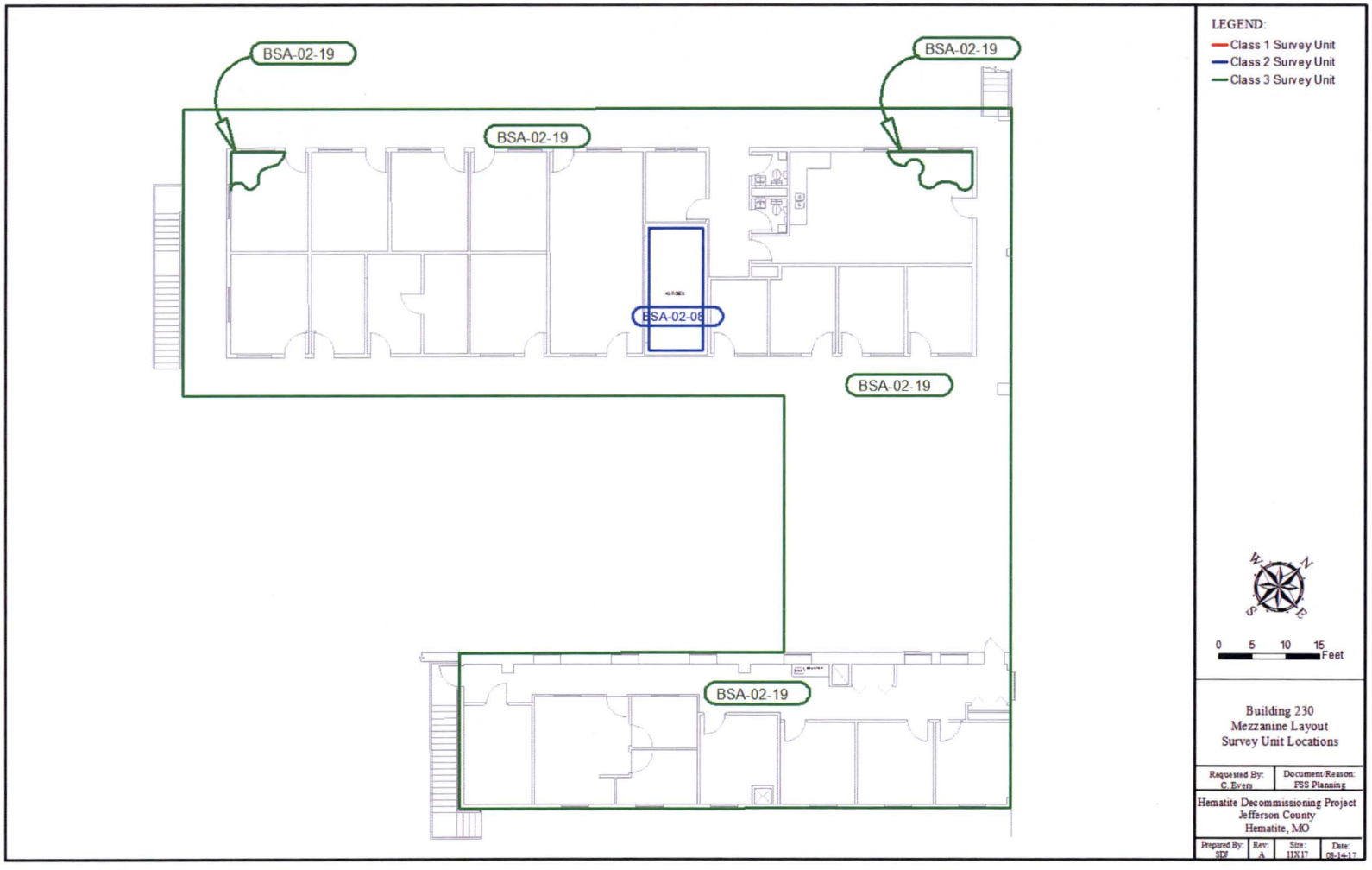


Figure 2-2
Final Configuration of Building Survey Area 02 and Survey Units (Mezzanine Level)



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 m^2 in planar (2-dimensional) extent.

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

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 m^2 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 m^2 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 cm^2 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 m^2 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 m^2 in planar (2-dimensional) extent.

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 m^2 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 m^2 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 m^2 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 m^2 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 m^2 in planar (2-dimensional) extent.

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.

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.

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.

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	Direct (TSC) Measurements (Net Alpha + Beta-Gamma)		Max Removable Activity		DCGL Fraction
	Average	Max	Alpha	Beta	
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 cm^2)
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 cm^2).

All results of the RASS were a fraction of the $DCGL_{SO}$ (18,925 dpm/100 cm^2) 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.

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.

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.

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 cm^2 (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:

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

Equation 5-3

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

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	ß HDP 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 = ε_i * ε_s * Yield * Activity Fraction

ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern

ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-93

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:

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

Equation 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 cm^2 (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:

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

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 cm^2).

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 of Measurements	Comments
Building 230: U-Shaped Area – Section 6 (floor, lower walls, and stairs)	11	A total of **13** TSC measurements locations have been systematically designed from a 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 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, or penetrations, and at floor/wall interfaces. Consult FSS supervision for guidance on the amount and specific locations of biased measurements. At locations where measurements exceed the instrument static 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 lower walls, stairs 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.	

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).

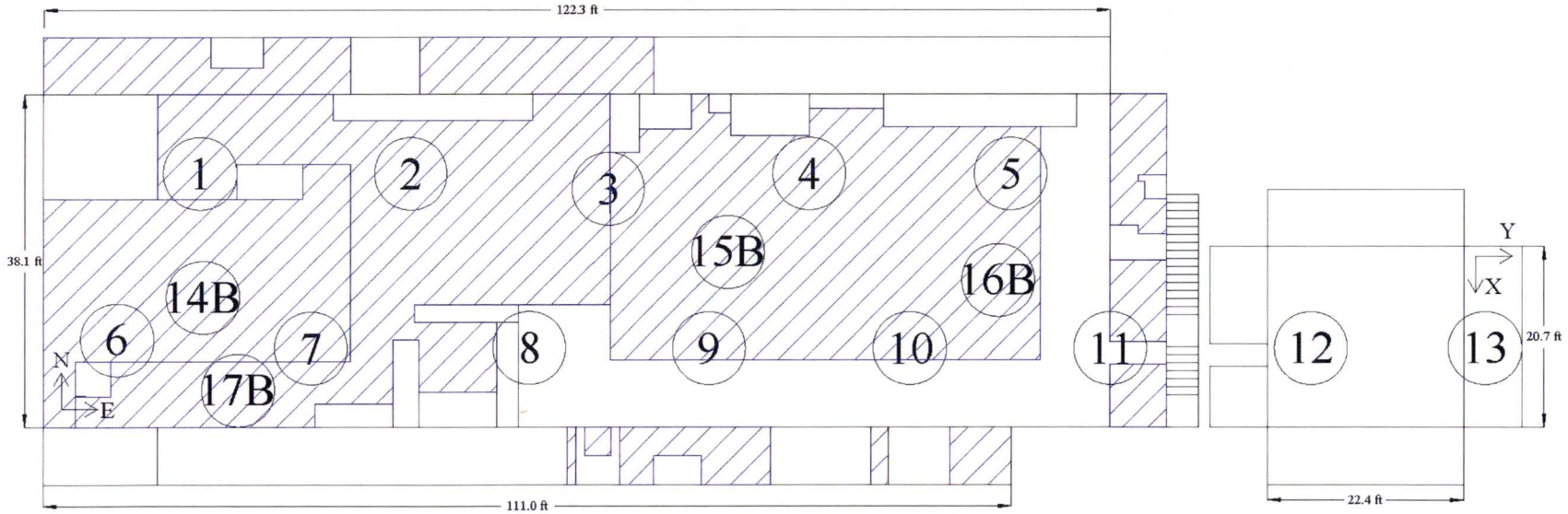
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

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

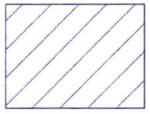
No systematic location exceeded the $DCGL_{SO}$. The highest observed systematic TSC measurement was 1,306 dpm/100 cm^2 (7% of the $DCGL_{SO}$). No removable contamination measurement exceeded the Minimum Detectable Activity (MDA). The FSS documentation for BSA 02-13 is provided in Appendix U.

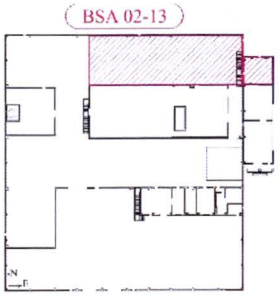
Figure 6-1
BSA 02-13 Systematic Measurement Locations

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



Scanned Area
54% Coverage





Sample Location	Surface	X Coordinates (feet)	Y Coordinates (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

Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
10	Floor	99.4	9.0
11	Floor	122.3	9.0
12	Floor	145.3	9.0
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

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4, Page 1 of 1

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 13 **Description:** U-Shaped Area (Northeast) – Lower Walls, Floor and Stairs

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	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	B	NA	NA	14.0	20.0	Floor Penetration
B02-13-15-S-F-B-00	F	B	NA	NA	24.0	82.4	Floor Diamond Plate
B02-13-16-S-F-B-00	F	B	NA	NA	15.0	108.0	Floor Penetration
B02-13-17-S-F-B-00	F	B	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

Quality Record

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 cm^2 (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.

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%

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

Min	218	**4%**
Max	1306	
Mean	836	**DCGL$_{SO}$**
Median	850	**1.00**
Stdev	265.4	
		mrem/year

8.0 ALARA EVALUATION BSA 02-13

All measurements collected within BSA 02-13 were evaluated against the $DCGL_{SO}$. For BSA 02-13 no measurement result exceeded the $DCGL_{SO}$. The average result, based on all systematically collected measurements was 4% of $DCGL_{SO}$ 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 $DCGL_{SO}$.

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.

- 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.

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	$\alpha = 0.05$
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 Differences (S+)	13	
				Sign Test Critical Value (MARSSIM Table I-3)	9	

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

TEST: PASS

MARSSIM Table I-3 Critical Values for the Sign Test 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		

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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: 13 **Description:** U-Shaped Area (Northeast)-Lower Walls, Floor and Stairs

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation	
	Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 02 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 13 **Description:** U-Shaped Area (Northeast)-Lower Walls, Floor and Stairs

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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)	5-21-17 (Date)
Approved by (RSO):	Clark Evers (Print Name)	(Signature)	5/24/17 (Date)

Quality Record

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 RADIOACTIVITY	
$DCGL_{SO}$	**4%**
Dose	**1.0 mrem/year**

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 cm^2 (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:

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

Equation 12-3

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

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 HDP 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 = ε_i * ε_s * Yield * Activity Fraction

ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern

ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-93

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:

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

Equation 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 cm^2 (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:

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

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 cm^2).

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	Minimum 10% of BSA 02-14 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):	2,250 dpm / 100 cm2 (Ludlum 43-93) 1,072 dpm / 100 cm2 (Ludlum 43-37)	
Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of Measurements	Comments
Building 230: U-Shaped Area – Section 7 (floor, lower walls)	11	A total of **14** TSC measurements locations have been systematically designed from a 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 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, or penetrations, and at floor/wall interfaces. Consult FSS supervision for guidance on the amount and specific locations of biased measurements. At locations where measurements exceed the instrument static 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 lower walls, stairs 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.	

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 cm^2 (5% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-14 is provided in Appendix V.

Figure 13-1
BSA 02-14 Systematic Measurement Locations

BSA 02-14
Floor Area U-Shaped / Southeast Area

Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
1	Instrument Lab North Wall	16.3	6.1
2	Instrument Lab West Wall	4.3	2.1
3	Floor	14.2	48.3
4	Floor	48.7	48.3
5	Floor	83.1	48.3
6	Gad Room North Wall	11.7	4.7
7	U-Shaped Area South Wall	90.4	3.5

Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
8	Floor	65.9	18.4
9	Floor	100.3	18.4
10	HP Office Area North Wall	7.5	4.1
11	HP Office Area North Wall	42.0	4.1
12	HP Office Area North Wall	76.6	4.1
13	HP Office Area South Wall	55.8	4.3
14	HP Office Area South Wall	21.3	4.3

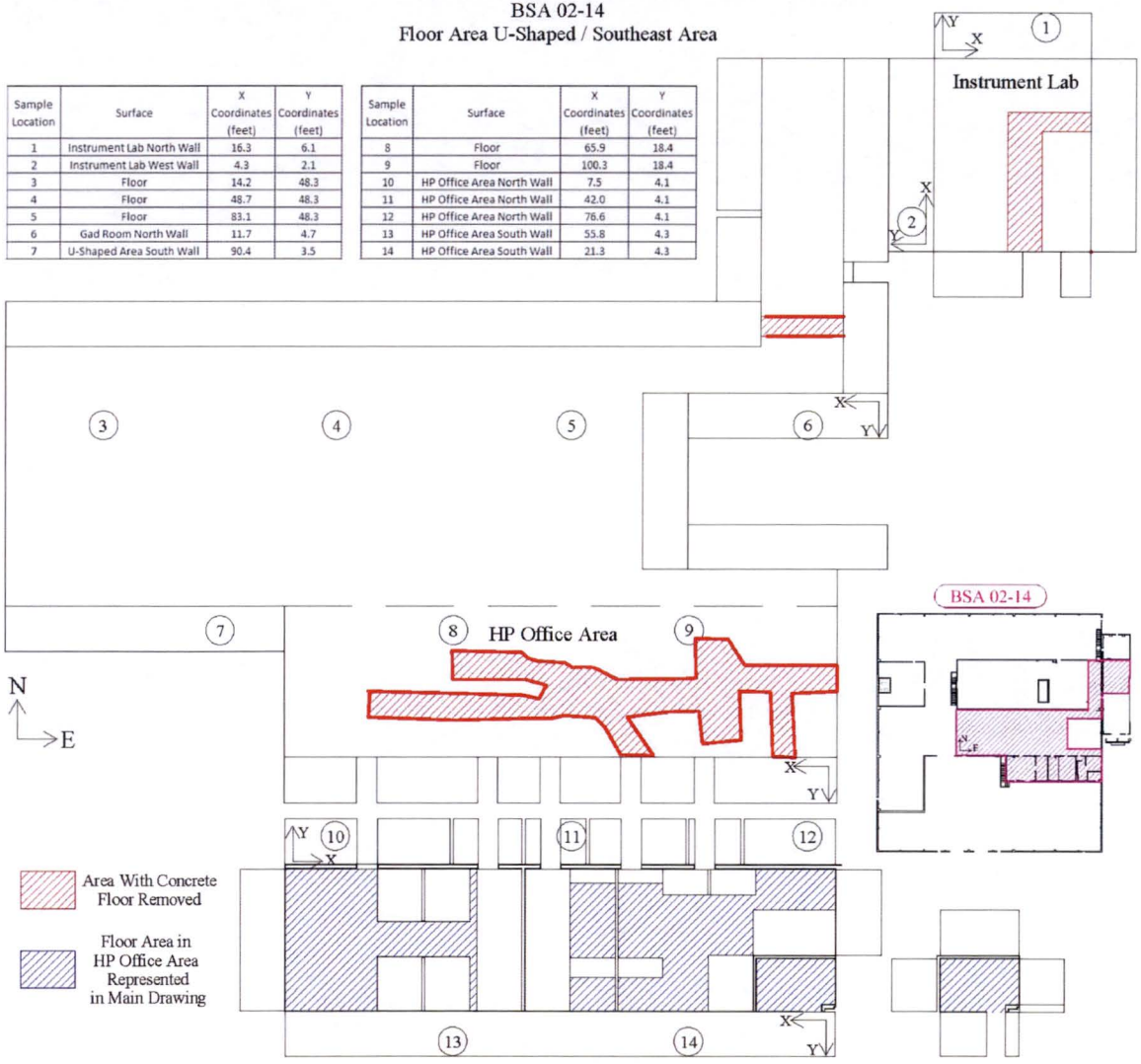


Table 13-1
FSS Measurement Locations for BSA 02-14

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 14 **Description:** U-Shaped Area (Southeast) – Lower Walls, Floor and Stairs

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	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

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 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 1,286 dpm/100 cm^2 (biased location, 7% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 321 dpm/100 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.

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	
Mean	321	$DCGL_{SO}$
Median	104	0.50
Stdev	384.2	
		mrem/year

15.0 ALARA EVALUATION BSA 02-14

All measurements collected within BSA 02-14 were evaluated against the $DCGL_{SO}$. For BSA 02-14 no measurement result exceeded the $DCGL_{SO}$. The average result, based on all systematically collected measurements was 2% of $DCGL_{SO}$ 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 $DCGL_{SO}$.

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

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.

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	$\alpha = 0.05$
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 Differences (S+)	14	
				Sign Test Critical Value (MARSSIM Table I-3)	10	

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

TEST: PASS

MARSSIM Table I-3 Critical Values for the Sign Test 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		

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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: 14 **Description:** U-Shaped Area (Southeast)-Lower Walls, Floor and Stairs

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 02 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 14 **Description:** U-Shaped Area (Southeast)-Lower Walls, Floor and Stairs

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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] (Signature) 5-21-17 (Date)

Approved by (RSO): Clark Evers (Print Name) [signature] (Signature) 8/24/17 (Date)

Quality Record

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.

Table 18-1
BSA 02-14 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**2%**
Dose	**0.5 mrem/year**

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 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 cm^2 (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:

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

Equation 19-3

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

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 HDP 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 = ε_i * ε_s * Yield * Activity Fraction

ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern

ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-93

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:

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

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 (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 cm^2 (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:

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

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.

19.1.6 Investigation Action Level

The Investigation Action Level was established at 50% of the $DCGL_{SO}$ (9,463 dpm/100 cm^2).

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	2,250 dpm / 100 cm^2	
Investigation Action Level (IAL)	9,463 dpm / 100 cm^2 (50% of the DCGL)	
Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of Measurements	Comments
Building 230: U-Shaped Area, Section 8 Trench	14	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:		
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.		
Instrumentation		
Ludlum 2360 with 43-93 scintillation detector.	Used for scanning and to obtain static (TSC) measurements.	
Ludlum 2929 with 43-10-1 scintillation detector.	Used for counting of swipe (smear) samples.	

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).

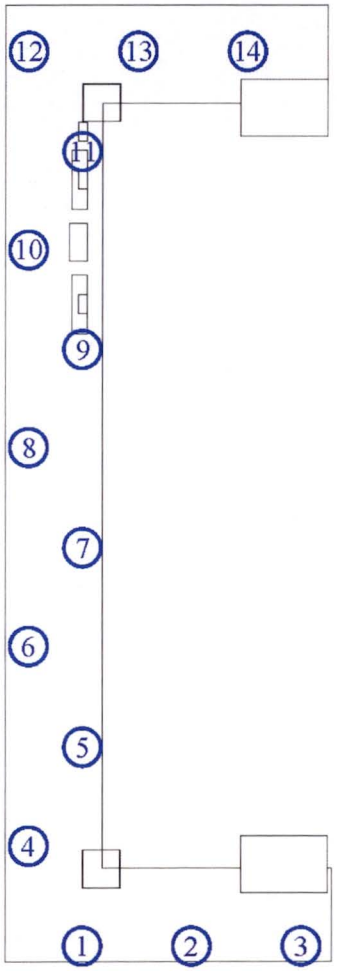
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

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 cm^2 (2% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-15 is provided in Appendix W.

Figure 20-1
BSA 02-15 Systematic Measurement Locations

BSA 02-15 Sample Locations



Sample Location	X Coordinates (feet)	Y Coordinates (feet)
1	65.8	114.1
2	71.8	114.1
3	77.7	114.1
4	62.9	120.2
5	65.8	125.4
6	62.9	130.7
7	65.8	135.9
8	62.9	141.2
9	65.8	146.4
10	62.9	151.7
11	65.8	156.9
12	62.9	162.2
13	68.8	162.2
14	74.8	162.2
2 (QC)	71.8	114.1

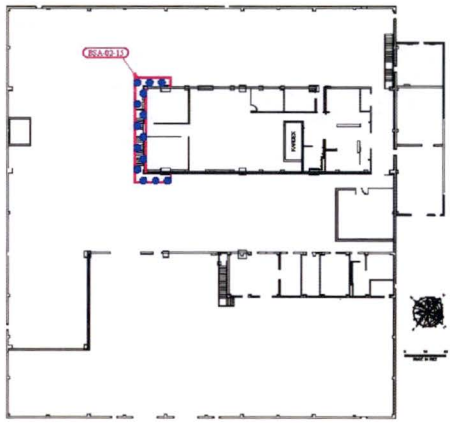


Table 20-1
FSS Measurement Locations for BSA 02-15

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 15 **Description:** U-Shaped Area - Section 8 Trench

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	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
B02-15-12-S-F-S-00	F	S	NA	NA	48.5	1.5	Trench Floor
B02-15-13-S-F-S-00	F	S	NA	NA	48.5	7.4	Trench Floor
B02-15-14-S-F-S-00	F	S	NA	NA	48.5	13.4	Trench Floor
B02-15-15-S-F-B-00	F	B	NA	NA	21.2	4.9	Trench 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

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 $DCGL_{SO}$, the highest identified result was 4,025 dpm/100 cm^2 (21% of the $DCGL_{SO}$).

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 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 4,025 dpm/100 cm^2 (biased location, 21% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 83 dpm/100 cm^2 (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.

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

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
B02-15-01-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	**$DCGL_{SO}$**
Median	6	**0.10**
Stdev	117.4	
		mrem/year

22.0 ALARA EVALUATION BSA 02-15

All measurements collected within BSA 02-15 were evaluated against the $DCGL_{SO}$. For BSA 02-15 no measurement result exceeded the $DCGL_{SO}$. The average result, based on all systematically collected measurements was 0.4% of $DCGL_{SO}$ for BSA 02-15. 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 $DCGL_{SO}$.

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

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 $DCGL_{SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 0.4% of the $DCGL_{SO}$, 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.

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	$\alpha = 0.05$
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	
				Number of Positive Differences (S+)	14	
				Sign Test Critical Value (MARSSIM Table I-3)	10	

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

TEST: PASS

MARSSIM Table I-3 Critical Values for the Sign Test 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		

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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: 15 **Description:** U-Shaped Area – Section 8 Trench

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 04 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 15 **Description:** U-Shaped Area – Section 8 Trench

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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)	8-24-17 (Date)
Approved by (RSO):	Clark Evers (Print Name)	(Signature)	8/24/17 (Date)

Quality Record

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.

Table 25-1
BSA 02-15 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**0.4%**
Dose	**0.1 mrem/year**

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 cm^2 (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:

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

Equation 26-3

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

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	ß Cal. Efficiency
268477	289424	125 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 = ε_i * ε_s * Yield * Activity Fraction
ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern
ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-93

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:

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

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 (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 cm^2 (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:

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

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 cm^2).

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): general area	9,463 dpm / 100 cm^2 (50% of the DCGL)
Scan IAL: (expansion joints, stress cracks, floor/wall interface, small holes and penetrations into floors)	2,351 dpm / 100 cm2 (Ludlum 43-93) 1,193 dpm / 100 cm2 (Ludlum 43-37)

Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of Measurements	Comments
Building 230: U-Shaped Area – Section 9 (floor and lower wall)	11	A total of **11** TSC measurements locations have been systematically designed from a 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 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.

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).

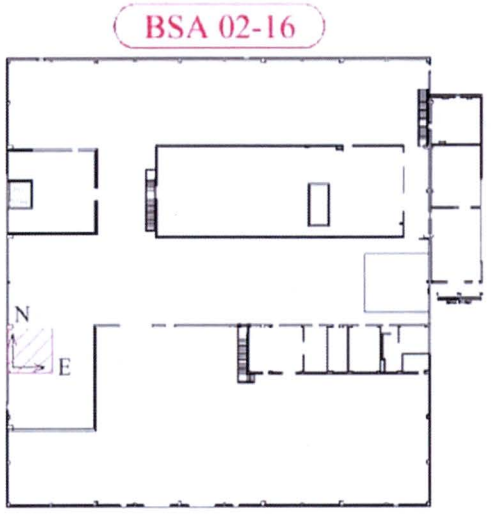
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

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 cm^2 (3% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-16 is provided in Appendix X.

Figure 27-1
BSA 02-16 Systematic Measurement Locations

BSA 02-16 Building 230 Spill Area



Sample Location	X Coordinates (feet)	Y Coordinates (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

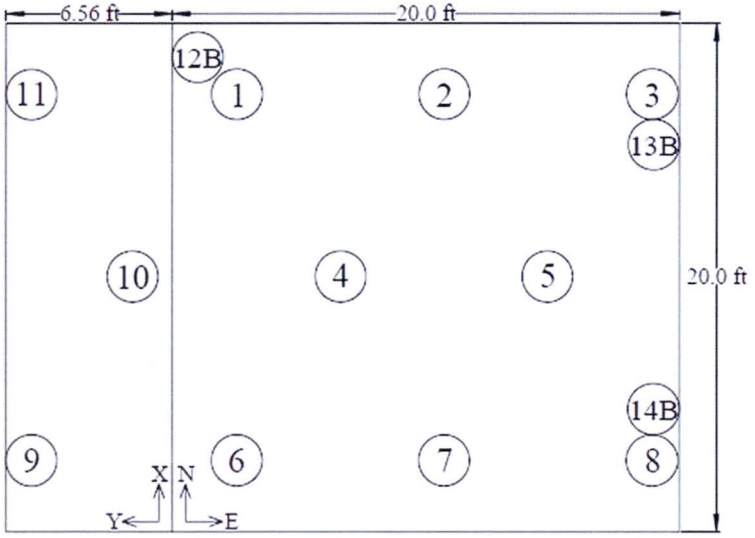


Table 27-1
FSS Measurement Locations for BSA 02-16

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4, Page 1 of 1

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 16 **Description:** U-Shaped Area - Section 9 Floor/Lower Wall

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	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	B	NA	NA	19.5	0.3	Floor
B02-16-13-S-F-B-00	F	B	NA	NA	19.8	19.8	Floor
B02-16-14-S-F-B-00	F	B	NA	NA	0.2	19.8	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

Quality Record

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 l, 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 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 1,047 dpm/100 cm^2 (biased location, 6% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 302 dpm/100 cm^2 (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.

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

Min	0	2%
Max	595	
Mean	302	$DCGL_{SO}$
Median	294	0.50
Stdev	224.8	
		mrem/year

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

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 $DCGL_{SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 3% of the $DCGL_{SO}$, 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.

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	$\alpha = 0.05$
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 Differences (S+)	11	
				Sign Test Critical Value (MARSSIM Table I-3)	8	

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

TEST: **PASS**

MARSSIM Table I-3 Critical Values for the Sign Test 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		

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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: 16 **Description:** U-Shaped Area – Section 9 Floor/Lower Wall

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 02 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 16 **Description:** U-Shaped Area – Section 9 Floor/Lower Wall

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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] (Signature) 8-21-17 (Date)

Approved by (RSO): Clark Evers (Print Name) [signature] (Signature) 8/24/17 (Date)

Quality Record

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.

Table 32-1
BSA 02-16 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**2%**
Dose	**0.5 mrem/year**

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 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 cm^2 (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:

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

Equation 33-3

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

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	ß Cal. Efficiency
268477	289424	125 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 = ε_i * ε_s * Yield * Activity Fraction
ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern
ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-93

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:

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

Equation 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 cm^2 (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:

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

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 cm^2).

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	2,351 dpm / 100 cm^2 (Ludlum 43-93)	
Investigation Action Level (IAL)	2,351 dpm / 100 cm^2 (Ludlum 43-93)	
Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of 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 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:		
Biased measurements may be collected at the discretion of the HP Technician performing the FSS. Based on the RASS data, there are no indications that certain surface features such as cracks, small holes, conduit penetrations, etc., are more elevated than adjacent surfaces.		
Instrumentation:		
Ludlum 2360 with 43-93 scintillation detector.	Used for scanning upper walls and ceilings and to obtain static (TSC) measurements; used to investigate elevated areas.	
Ludlum 2929 with 43-10-1 scintillation detector.	Used for counting of swipe (smear) samples.	

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).

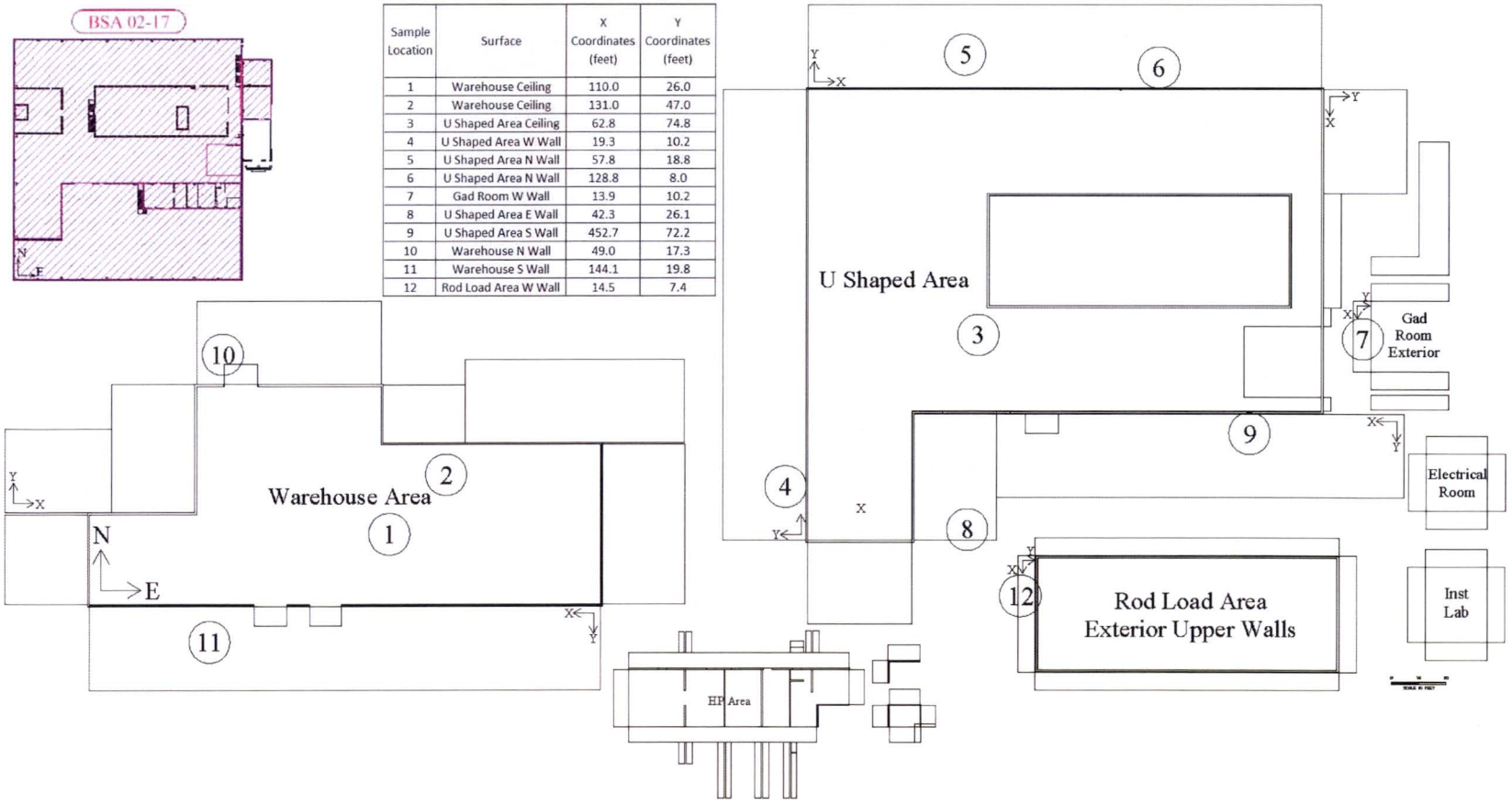
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

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

Figure 34-1
BSA 02-17 Systematic Measurement Locations

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



Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
1	Warehouse Ceiling	110.0	26.0
2	Warehouse Ceiling	131.0	47.0
3	U Shaped Area Ceiling	62.8	74.8
4	U Shaped Area W Wall	19.3	10.2
5	U Shaped Area N Wall	57.8	18.8
6	U Shaped Area N Wall	128.8	8.0
7	Gad Room W Wall	13.9	10.2
8	U Shaped Area E Wall	42.3	26.1
9	U Shaped Area S Wall	452.7	72.2
10	Warehouse N Wall	49.0	17.3
11	Warehouse S Wall	144.1	19.8
12	Rod Load Area W Wall	14.5	7.4

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4, Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 17 **Description:** All Sections and Warehouse, Upper Walls, Ceiling and Duct Exteriors

Survey Type: FSS **Classification:** Class 3

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (feet) (Y Axis) *	Easting (feet) (X Axis) *	Remarks / Notes
B02-17-01-S-C-S-00	C	S	NA	NA	26.0	110.0	Warehouse Ceiling
B02-17-02-S-C-S-00	C	S	NA	NA	47.0	131.0	Warehouse Ceiling
B02-17-03-S-C-S-00	C	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

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

Quality Record

34.3 Biased Measurements

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

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 dpm/100 cm^2 were identified for biased measurement. No static measurement exceeded the $DCGL_{SO}$ of 18,925 dpm/100 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 dpm/100 cm^2 (systematic location, 2% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 82 dpm/100 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.

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 cm^2 (α+β)	Corrected Net dpm/100cm^2	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	
Mean	82	DCGLso
Median	6	0.10
Stdev	114.3	mrem/year

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

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 $DCGL_{SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 0.4% of the $DCGL_{SO}$, 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.

Table 38-1
Sign Test for BSA 02-17

Sign Test							MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+		MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+	
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W_s)	Difference (1-W_s)	Corrected Difference		N	Alpha = 0.05	N	Alpha = 0.05
B02-17-01-S-C-S-00	Warehouse Ceiling	253	0.013	0.987	0.987	$\alpha = 0.05$	4	4	28	18
B02-17-02-S-C-S-00	Warehouse Ceiling	230	0.012	0.988	0.988		5	4	29	19
B02-17-03-S-C-S-00	U-Shaped Area Ceiling	11	0.001	0.999	0.999		6	5	30	19
B02-17-04-S-W-S-00	U-Shaped Area West Wall	287	0.015	0.985	0.985		7	6	31	20
B02-17-05-S-W-S-00	U-Shaped Area North Wall	57	0.003	0.997	0.997		8	6	32	21
B02-17-06-S-W-S-00	U-Shaped Area North Wall	149	0.008	0.992	0.992		9	7	33	21
B02-17-07-S-W-S-00	Gad Room West Ext. Wall	0	0.000	1.000	1.000		10	8	34	22
B02-17-08-S-W-S-00	U-Shaped Area East Wall	0	0.000	1.000	1.000		11	8	35	22
B02-17-09-S-W-S-00	U-Shaped Area South Wall	0	0.000	1.000	1.000		12	9	36	23
B02-17-10-S-W-S-00	Warehouse North Wall	0	0.000	1.000	1.000		13	9	37	23
B02-17-11-S-W-S-00	Warehouse South Wall	0	0.000	1.000	1.000		14	10	38	24
B02-17-12-S-W-S-00	Rod Load West Ext. Wall	0	0.000	1.000	1.000		15	11	39	25
				Number of Positive Differences (S+)	12		16	11	40	25
				Sign Test Critical Value (MARSSIM Table I-3)	9		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		

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

TEST: PASS

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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: 17 **Description:** All Sections and Warehouse, Upper Walls, Ceiling and Duct Exteriors

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☐	No ☐	NA ☒
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 02 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 17 **Description:** All Sections and Warehouse, Upper Walls, Ceiling and Duct Exteriors

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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) 8-21-17 (Date)

Approved by (RSO): Clark Evers (Print Name) (Signature) 8/24/17 (Date)

Quality Record

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

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**0.4%**
Dose	**0.1 mrem/year**

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 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 cm^2 (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:

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

Equation 40-3

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

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	ß Cal. Efficiency
275770	19206	125 cm^2	30.2%	N/A	18.7%	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	0.3020	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 = ε_i * ε_s * Yield * Activity Fraction
ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern
ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-89

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:

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

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 (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 cm^2 (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:

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

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 cm^2).

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
FSS Design Summary for BSA 02-18

Portable Instrument Scanning:		
Scan Coverage	Minimum 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): general area	1,676 dpm/100cm^2 (Ludlum 43-89) 961 dpm/100cm^2 (Ludlum 43-37)	
Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of Measurements	Comments
BSA 02-18 Surfaces (Lower floor and walls)	11	A total of **11** TSC measurements locations have been systematically designed from a random start point.
Removable Activity Locations:		
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 at each TSC location.		
Biased Measurement Locations:		
Perform static biased measurements at points on the concrete and asphalt surfaces such as cracks, holes, or seams where the Scan MDC was exceeded. Consult Radiological Engineering for guidance on the amount and specific locations of biased measurements. At locations where biased measurements exceed the instrument static MDA, adjustments to instrument efficiency 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.	

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).

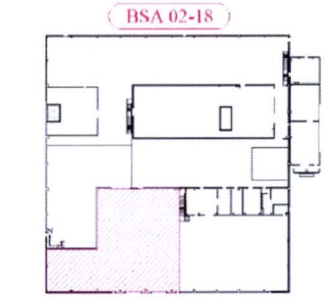
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

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 cm^2 3% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-18 is provided in Appendix Z.

Figure 41-1
BSA 02-18 Systematic Measurement Locations

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



Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
1	Floor	49.2	60.0
2	Floor	75.5	60.0
3	Floor	101.7	60.0
4	Wall	17.1	4.1
5	Wall	37.3	2.4
6	Floor	62.4	37.4
7	Floor	88.6	37.4
8	Floor	23.0	14.7
9	Floor	49.2	14.7
10	Floor	75.5	14.7
11	Floor	101.7	14.7

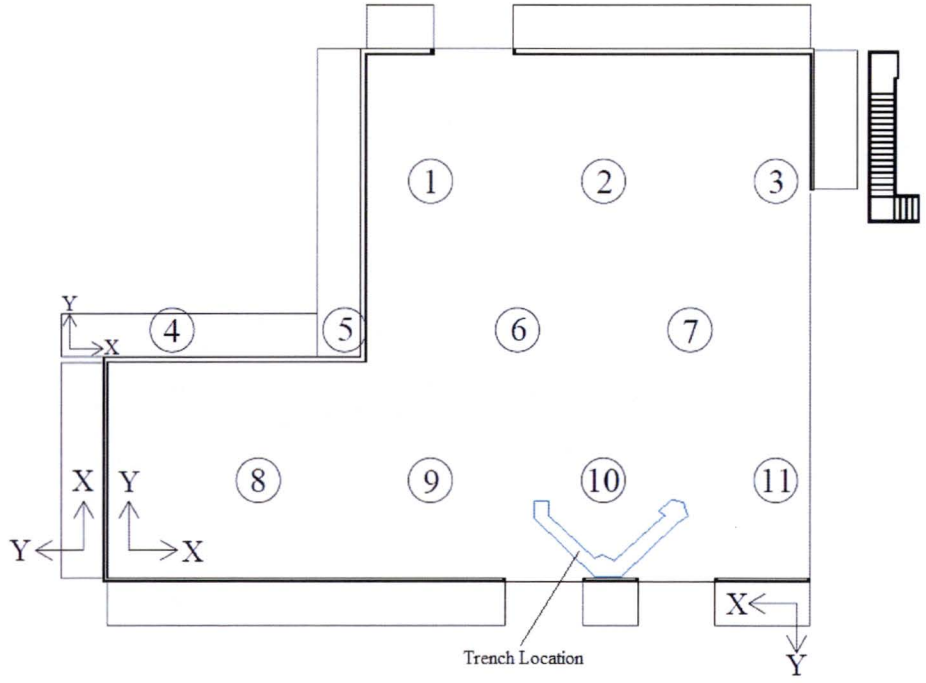


Table 41-1
FSS Measurement Locations for BSA 02-18

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 18 **Description:** Building 230 Bay Warehouse (former WTS area)

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	Start Elevation	End Elevation	Northing (feet) (Y Axis) *	Easting (feet) (X Axis) *	Remarks / Notes
P02-18-01-S-F-S-00	F	S	NA	NA	60.0	49.2	Floor
P02-18-02-S-F-S-00	F	S	NA	NA	60.0	75.5	Floor
P02-18-03-S-F-S-00	F	S	NA	NA	60.0	101.7	Floor
P02-18-04-S-W-S-00	W	S	NA	NA	4.1	17.1	Wall
P02-18-05-S-W-S-00	W	S	NA	NA	2.4	37.3	Wall
P02-18-06-S-F-S-00	F	S	NA	NA	37.4	62.4	Floor
P02-18-07-S-F-S-00	F	S	NA	NA	37.4	88.6	Floor
P02-18-08-S-F-S-00	F	S	NA	NA	14.7	23.0	Floor
P02-18-09-S-F-S-00	F	S	NA	NA	14.7	49.2	Floor
P02-18-10-S-F-S-00	F	S	NA	NA	14.7	75.5	Floor
P02-18-11-S-F-S-00	F	S	NA	NA	14.7	101.7	Floor
B02-18-12-S-F-B-00	F	B	NA	NA	20	20	Floor
B02-18-13-S-F-B-00	F	B	NA	NA	10	30	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

Quality Record

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 dpm/100 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 l, 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.

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 cm^2 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 cm^2. 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 cm^2 (biased location, 4% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 230 dpm/100 cm^2 (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.

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 (α+β)	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

43.0 ALARA EVALUATION BSA 02-18

All measurements collected within BSA 02-18 were evaluated against the $DCGL_{SO}$. For BSA 02-18 no measurement result exceeded the $DCGL_{SO}$. The average result, based on all systematically collected measurements was 1% of $DCGL_{SO}$ 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 $DCGL_{SO}$.

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

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 $DCGL_{SO}$. 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 02-18 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.

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	$\alpha = 0.05$
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 Differences (S+)	11	
				Sign Test Critical Value (MARSSIM Table I-3)	8	

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

TEST: PASS

MARSSIM Table I-3 Critical Values for the Sign Test 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		

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation	
	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: 18 **Description:** Building 230 Bay Warehouse (Former WTS Area)

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 04 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 18 **Description:** Building 230 Bay Warehouse (Former WTS Area)

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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] (Signature) 8-21-17 (Date)

Approved by (RSO): Clark Evers (Print Name) [signature] (Signature) 8/24/17 (Date)

Quality Record

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.

Table 46-1
BSA 02-18 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**1%**
Dose	**0.25 mrem/year**

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 cm^2 (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:

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

Equation 47-3

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

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 HDP Efficiency	ß Cal. Efficiency
278647	311685	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 = ε_i * ε_s * Yield * Activity Fraction
ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern
ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-93

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:

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

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 cm^2 (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:

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

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 cm^2).

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) 1,193 dpm / 100 cm^2 (Ludlum 43-37)
Investigation Action Level (IAL)	2,351 dpm / 100 cm^2 (Ludlum 43-93) 1,193 dpm / 100 cm^2 (Ludlum 43-37)

Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of Measurements	Comments
Building 230: Mezzanine Area - All surfaces (except stairs)	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 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:
Biased measurements may be collected at the discretion of the HP Technician performing the FSS. Based on the RASS data, there are no indications that certain surface features such as cracks, small holes, conduit penetrations, etc., are more elevated than adjacent surfaces.

Instrumentation:	
Ludlum 2360 with 43-93 scintillation detector.	Used for scanning walls, ceilings, roof and to obtain static (TSC) measurements; used to investigate elevated areas.
Ludlum 2360 with 43-37 floor monitor.	Used for scanning floor areas.
Ludlum 2929 with 43-10-1 scintillation detector.	Used for counting of swipe (smear) samples.

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

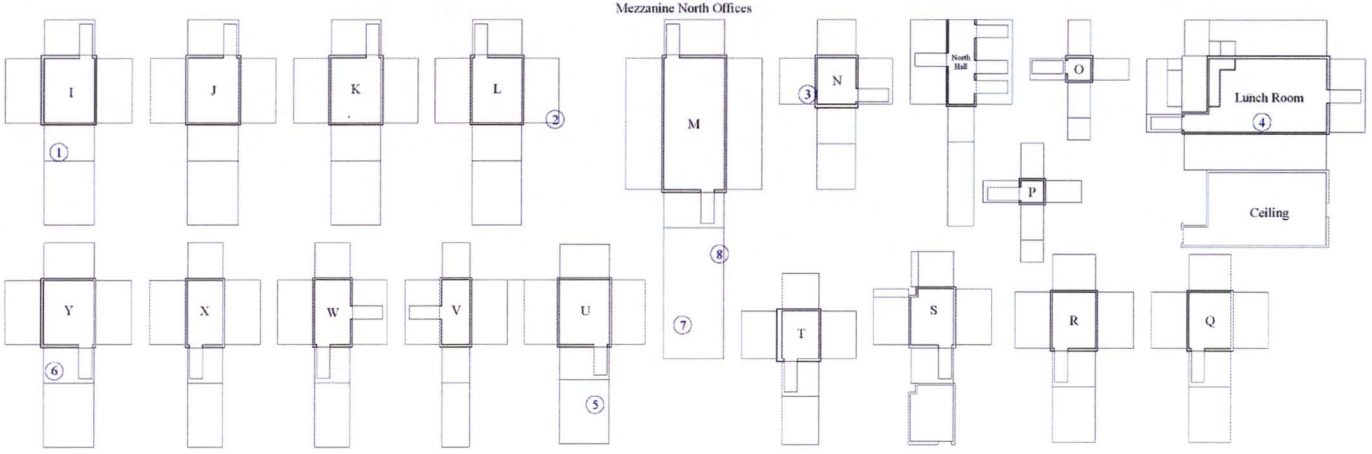
Based on statistical evaluations of the RASS characterization data sets, a minimum of eleven (11) TSC measurements were calculated for BSA 02-19, and a total of twelve (12) measurements were designed by the FSS Plan. These direct, static-count measurement locations were designed in a random pattern (See 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).

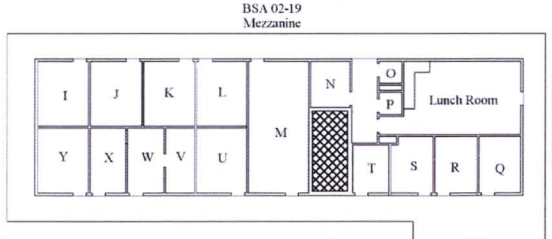
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

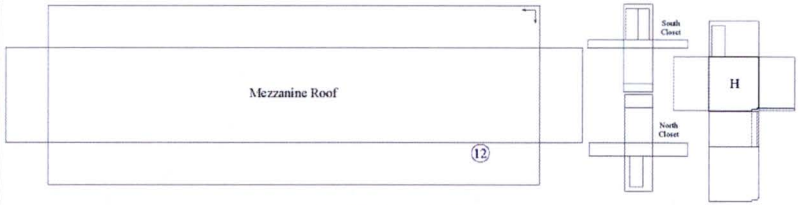
Table 48-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix Q).

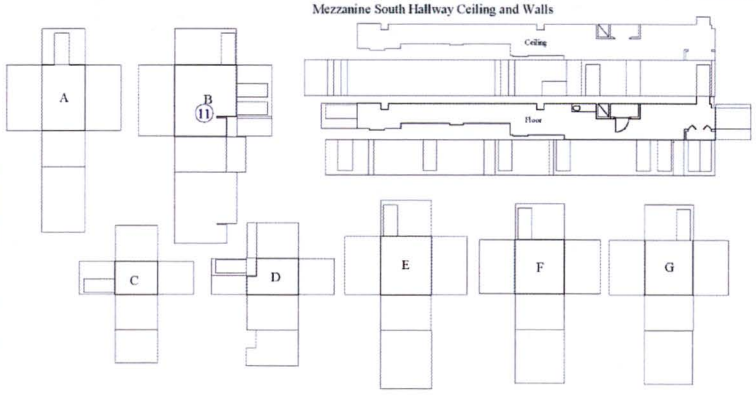
No systematic location exceeded the $DCGL_{SO}$. The highest systematic TSC measurement collected was 254 dpm/100 cm^2 (1% of the DCGLso). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-19 is provided in Appendix AA.

Figure 48-1
BSA 02-19 Systematic Measurement Locations









Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
1	Office I South Wall	8.0	6.1
2	Office L East Wall	13.8	7.2
3	Office N West Wall	2.2	1.8
4	Lunch Room Floor	17.7	2.2
5	Office U Ceiling	8.1	8.9
6	Office Y South Wall	9.0	5.3

Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
7	Conference Room (M) Ceiling	7.0	7.6
8	Conference Room (M) Ceiling	12.7	23.6
9	Mezzanine Floor (open office)	106.4	53.0
10	Open Office Area South Wall	2.6	5.4
11	Office B Floor	6.7	5.1
12	Mezzanine Outer Wall South	97.6	7.1

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

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 18 **Description:** 2nd Floor Mezzanine Floor, Walls, Ceiling and Roof

Survey Type: FSS **Classification:** Class 3

Measurement or Sample ID	Surface or CSM	Type	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	C	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	C	S	NA	NA	7.6	7.0	Conference Room (M) Ceiling
B02-19-08-S-C-S-00	C	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

Quality Record

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 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 254 dpm/100 cm^2 (systematic location, 1% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 58 dpm/100 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.

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 (α+β)	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	
Mean	58	**DCGLso**
Median	0	**0.08**
Stdev	96.8	
		mrem/year

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

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.

Table 52-1
Sign Test for BSA 02-19

Sign Test							MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+		MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+	
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W_s)	Difference ($1-W_s$)	Corrected Difference	$\alpha = 0.05$	N	Alpha = 0.05	N	Alpha = 0.05
B02-19-01-S-W-S-00	Office I South Wall	0	0.000	1.000	1.000		4	4	28	18
B02-19-02-S-W-S-00	Office L East Wall	0	0.000	1.000	1.000		5	4	29	19
B02-19-03-S-W-S-00	Office N West Wall	0	0.000	1.000	1.000		6	5	30	19
B02-19-04-S-F-S-00	Lunch Room Floor	0	0.000	1.000	1.000		7	6	31	20
B02-19-05-S-C-S-00	Office U Ceiling	0	0.000	1.000	1.000		8	6	32	21
B02-19-06-S-W-S-00	Office Y South Wall	0	0.000	1.000	1.000		9	7	33	21
B02-19-07-S-C-S-00	Conference Room (M) Ceiling	0	0.000	1.000	1.000		10	8	34	22
B02-19-08-S-C-S-00	Conference Room (M) Ceiling	95	0.005	0.995	0.995		11	8	35	22
B02-19-09-S-F-S-00	Mezzanine Floor (open office)	243	0.013	0.987	0.987		12	9	36	23
B02-19-10-S-W-S-00	Open Office Area South Wall	254	0.013	0.987	0.987		13	9	37	23
B02-19-11-S-F-S-00	Office B Floor	106	0.006	0.994	0.994		14	10	38	24
B02-19-12-S-W-S-00	Mezzanine Outer Wall South	0	0.000	1.000	1.000		15	11	39	25
				Number of Positive Differences (S+)	12		16	11	40	25
				Sign Test Critical Value (MARSSIM Table I-3)	9		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		

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

TEST: PASS

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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.	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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☐	No ☐	NA ☒
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 04 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 19 **Description:** 2nd Floor Mezzanine Floor, Walls, Ceiling and Roof

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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) Thomas Yardy (Signature) 8-22-17 (Date)

Approved by (RSO): Clark Evers (Print Name) Clark Evers (Signature) 8/24/17 (Date)

Quality Record

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.

Table 53-1
BSA 02-19 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**0.3%**
Dose	**0.08 mrem/year**

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:

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

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 ($\text{eff}_{\text{total}}$) 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 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 cm^2 (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:

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

Equation 54-3

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

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 HDP Efficiency	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 = ε_i * ε_s * Yield * Activity Fraction
ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern
ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-93

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:

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

Equation 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 (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 cm^2 (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:

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

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 cm^2).

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	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 cm^2 (Ludlum 43-93) 1,193 dpm / 100cm^2 (Ludlum 43-37)	
Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of Measurements	Comments
Building 230: U-Shaped Area, Southwest (floor and lower walls)	11	A total of **11** TSC measurements locations have been systematically designed from a random start point.
TSC Investigation 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, or penetrations, and at floor/wall interfaces. Consult FSS supervision for guidance on the amount and specific locations of biased measurements. At locations where measurements exceed the instrument static 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 lower walls 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.	

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).

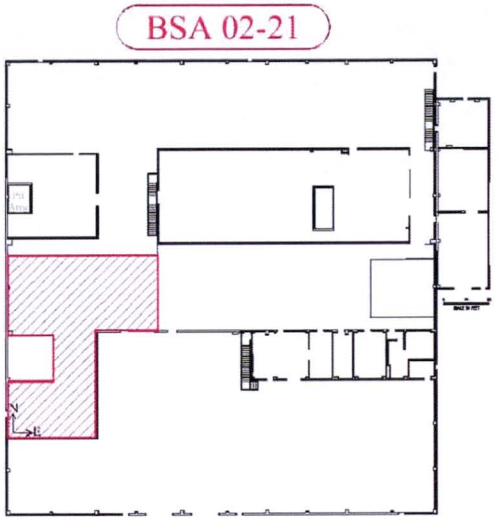
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

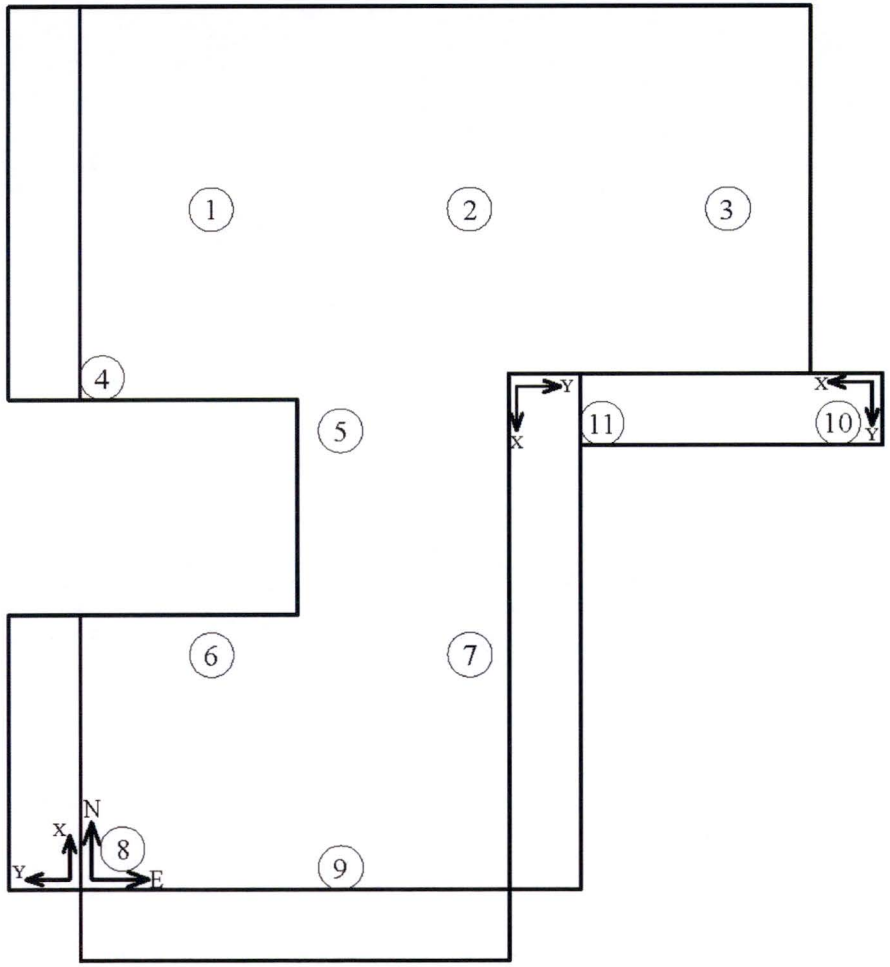
Table 62-1 provides the listing of systematic measurement locations as specified in the FSS Plan (Appendix R).

No systematic location exceeded the $DCGL_{SO}$. The highest systematic TSC location result was 1,389 dpm/100 cm^2 (7% of the $DCGL_{SO}$). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-21 is provided in Appendix BB.

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

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

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 14 **Description:** U-Shaped Area (Southeast) – Lower Walls, Floor and Stairs

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	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	B	NA	NA	42.0	24.0	Floor
B02-21-13-S-F-B-00	F	B	NA	NA	22.0	38.0	Floor
B02-21-14-S-F-B-00	F	B	NA	NA	1.0	4.0	Floor
B02-21-15-S-F-B-00	F	B	NA	NA	62.0	15.0	Floor
B02-21-16-S-F-B-00	F	B	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

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 cm^2 (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 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 1,390 dpm/100 cm^2 (systematic location, 7% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 783 dpm/100 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.

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

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm ($\alpha+\beta$)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm^2 ($\alpha+\beta$)	Corrected Net dpm/100cm^2	Fraction of DCGL
B02-21-01-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	246	161	85	881	881	5%
B02-21-02-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	295	161	134	1389	1389	7%
B02-21-03-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	254	161	93	964	964	5%
B02-21-04-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	248	161	87	902	902	5%
B02-21-05-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	236	161	75	778	778	4%
B02-21-06-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	221	161	60	622	622	3%
B02-21-07-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	249	161	88	912	912	5%
B02-21-08-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	294	161	133	1379	1379	7%
B02-21-09-S-F-S-00	Floor	11/4/2015	alpha + beta TSC	237	161	76	788	788	4%
B02-21-10-S-W-S-00	South Wall	11/4/2015	alpha + beta TSC	150	161	-11	-114	0	0%
B02-21-11-S-W-S-00	South Wall	11/4/2015	alpha + beta TSC	133	161	-28	-290	0	0%
B02-21-12-S-F-B-00	Floor	11/4/2015	alpha + beta TSC	237	161	76	788	788	4%
B02-21-13-S-F-B-00	Floor	11/4/2015	alpha + beta TSC	285	161	124	1286	1286	7%
B02-21-14-S-F-B-00	Floor	11/4/2015	alpha + beta TSC	212	161	51	529	529	3%
B02-21-15-S-F-B-00	Floor	11/4/2015	alpha + beta TSC	258	161	97	1006	1006	5%
B02-21-16-S-F-B-00	Floor	11/4/2015	alpha + beta TSC	230	161	69	715	715	4%

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

Min	0	4%
Max	1389	
Mean	783	$DCGL_{SO}$
Median	881	1.00
Stdev	452.6	
		mrem/year

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

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.

Table 59-1
Sign Test for BSA 02-21

Sign Test							MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+		MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+	
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W_s)	Difference (1-W_s)	Corrected Difference		N	Alpha = 0.05	N	Alpha = 0.05
B02-21-01-S-F-S-00	Floor	881	0.047	0.953	0.953	$\alpha = 0.05$	4	4	28	18
B02-21-02-S-F-S-00	Floor	1389	0.073	0.927	0.927		5	4	29	19
B02-21-03-S-F-S-00	Floor	964	0.051	0.949	0.949		6	5	30	19
B02-21-04-S-F-S-00	Floor	902	0.048	0.952	0.952		7	6	31	20
B02-21-05-S-F-S-00	Floor	778	0.041	0.959	0.959		8	6	32	21
B02-21-06-S-F-S-00	Floor	622	0.033	0.967	0.967		9	7	33	21
B02-21-07-S-F-S-00	Floor	912	0.048	0.952	0.952		10	8	34	22
B02-21-08-S-F-S-00	Floor	1379	0.073	0.927	0.927		11	8	35	22
B02-21-09-S-F-S-00	Floor	788	0.042	0.958	0.958		12	9	36	23
B02-21-10-S-W-S-00	South Wall	0	0.000	1.000	1.000		13	9	37	23
B02-21-11-S-W-S-00	South Wall	0	0.000	1.000	1.000		14	10	38	24
				Number of Positive Differences (S+)	11		15	11	39	25
				Sign Test Critical Value (MARSSIM Table I-3)	8		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		

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

TEST: PASS

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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: 21 **Description:** U-Shaped Area (Southeast)-Lower Walls, Floor

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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] (Signature) 8-30-17 (Date)

Approved by (RSO): Clark Evers (Print Name) [signature] (Signature) 8/30/17 (Date)

Quality Record

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.

Table 60-1
BSA 02-21 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**4%**
Dose	**1.0 mrem/year**

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 cm^2 (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:

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

Equation 61-3

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

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	α Cal. Efficiency	ß HDP Efficiency	ß Cal. Efficiency
275770	19026	125 cm^2	30.2%	N/A	18.7%	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	0.3020	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 = ε_i * ε_s * Yield * Activity Fraction
ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern
ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-89

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:

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

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 cm^2 (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:

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

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 cm^2).

61.1.7 BSA 02-26 FSS Design Summary

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

Portable Instrument Scanning:		
Scan Coverage		Minimum 10% of BSA 02-26 total area
Scan MDC		1,676 dpm/100cm^2 (Ludlum 43-89) 961 dpm/100cm^2 (Ludlum 43-37)
Investigation Action Level (IAL): general area		1,676 dpm/100cm^2 (Ludlum 43-89) 961 dpm/100cm^2 (Ludlum 43-37)
Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of Measurements	Comments
BSA 02-26 Surfaces (Lower floor and walls)	11	A total of **12** TSC measurements locations have been systematically designed from a random start point.
Removable Activity Locations:		
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 at each TSC location.		
Biased Measurement Locations:		
Perform static biased measurements at points on the concrete and asphalt surfaces such as cracks, holes, or seams where the Scan MDC was exceeded. Consult Radiological Engineering for guidance on the amount and specific locations of biased measurements. At locations where biased measurements exceed the instrument static MDA, adjustments to instrument efficiency 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.

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).

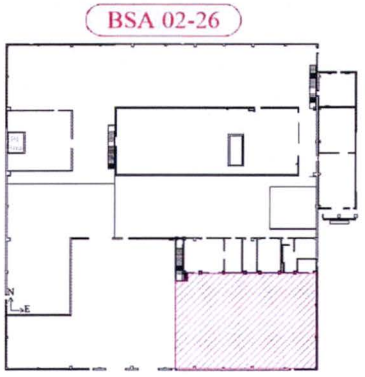
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

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 cm^2 (3% of the $DCGL_{SO}$). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-26 is provided in Appendix CC.

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

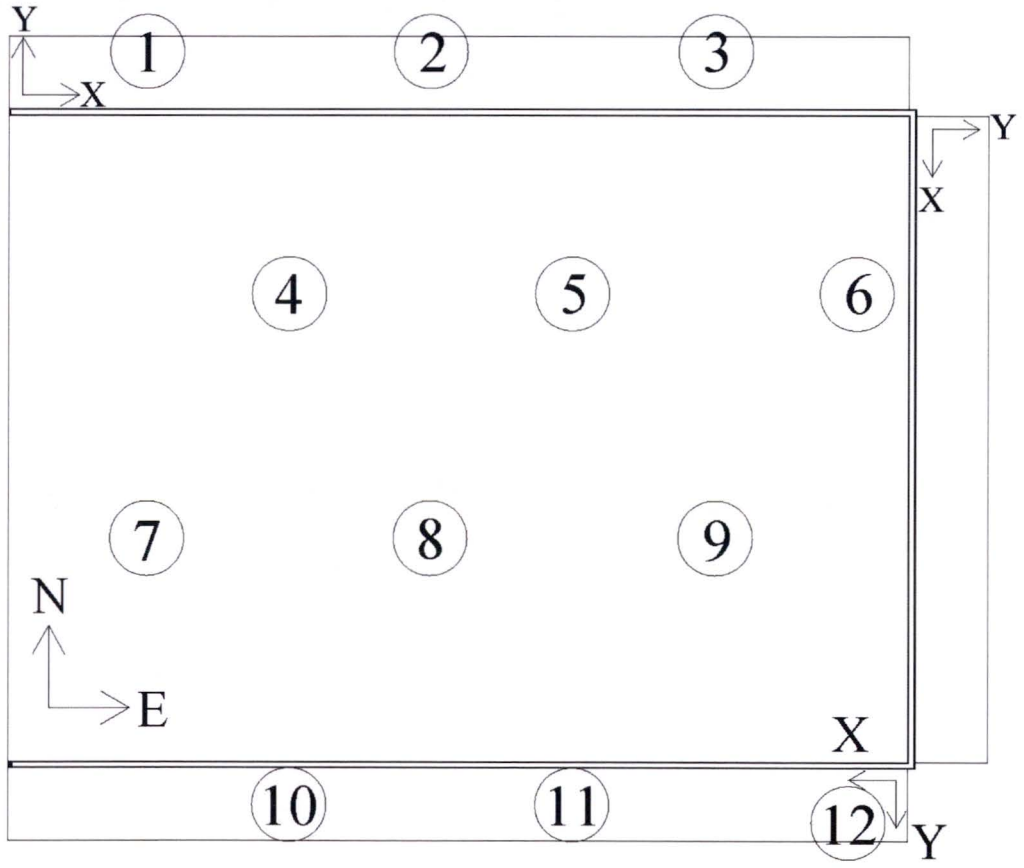


Table 62-1
FSS Measurement Locations for BSA 02-26

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 26 **Description:** Building 230 Bay Warehouse (former WTS area)

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	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
P02-26-10-S-W-S-00	W	S	NA	NA	1.4	65.0	South Wall
P02-26-11-S-W-S-00	W	S	NA	NA	1.4	363.0	South Wall
P02-26-12-S-W-S-00	W	S	NA	NA	1.4	670.0	South 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

Quality Record

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 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 655 dpm/100 cm^2 (systematic location, 3% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 240 dpm/100 cm^2 (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.

Table 63-1

FSS Data Summary for BSA 02-26

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 dpm/100 cm²	Fraction of 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: Differences from documented survey results are due to rounding in Excel

Min	0	**1%**
Max	655	
Mean	240	**DCGLso**
Median	114	**0.25**
Stdev	267.6	
		mrem/year

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

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.

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	α = 0.05
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 Differences (S+)	12	
				Sign Test Critical Value (MARSSIM Table I-3)	9	

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

TEST: PASS

MARSSIM Table I-3 Critical Values for the Sign Test 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		

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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: 26 **Description:** Building 230 Bay Warehouse (former WTS Area)

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☐	No ☐	NA ☒
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

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

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 04 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 26 **Description:** Building 230 Bay Warehouse (former WTS Area)

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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)	6-22-17 (Date)
Approved by (RSO):	Clark Evers (Print Name)	(Signature)	8/28/17 (Date)

Quality Record

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

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**1%**
Dose	**0.25 mrem/year**

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:

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

Equation 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 ($\text{eff}_{\text{total}}$) 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 cm^2 (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:

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

Equation 68-3

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

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	ß Cal. Efficiency
268647	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 = ε_i * ε_s * Yield * Activity Fraction
ε_i = 2 Pi Instrument Efficiency for Nuclide of Concern
ε_s = Surface Efficiency for Nuclide of Concern

Lud 43-93

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:

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

Equation 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 cm^2 (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:

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

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 cm^2).

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 (crane pit scan mandatory)	
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 cm^2 (Ludlum 43-93) 1,193 dpm / 100 cm^2 (Ludlum 43-37)	
Total Surface Contamination (TSC) Measurements:		
Surface	Minimum Number of Measurements	Comments
Building 230: U-Shaped Area – Northwest (floor, lower walls, and interior walls)	11	A total of **11** TSC measurements locations have been systematically designed from a 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 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, or penetrations, and at floor/wall interfaces. Consult FSS supervision for guidance on the amount and specific locations of biased measurements. At locations where measurements exceed the instrument static 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 lower walls, stairs 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.	

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).

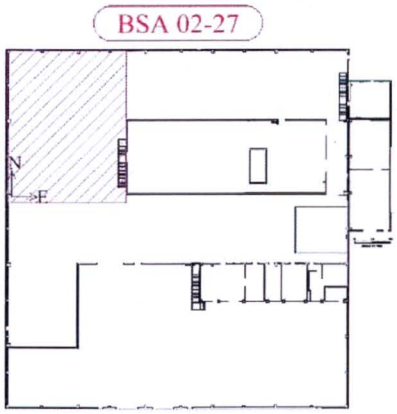
Additionally, a removable smear contamination measurement was collected at each TSC location, after the initial TSC measurement was collected. The smear measurement provides the necessary information to determine how much of the TSC measurement is considered removable contamination.

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 cm^2 (5% of the $DCGL_{SO}$). No removable contamination measurement exceeded the MDA. The FSS documentation for BSA 02-27 is provided in Appendix DD.

Figure 69-1
BSA 02-27 Systematic Measurement Locations

BSA 02-27
Floor and Lower Walls of the NW Section of the U Shaped Area



Sample Location	Surface	X Coordinates (feet)	Y Coordinates (feet)
1	Floor	5.2	65.0
2	Floor	35.0	65.0
3	Floor	20.0	37.4
4	Floor	51.9	37.4
5	Floor	5.2	9.9
6	Floor	35.0	9.9
7	Rod Load W Wall	37.0	2.8
8	FSS Office E Wall (outer)	16.9	1.4
9	Ops Office E Wall (inner)	8.6	1.3
10	Ops Office S Wall (inner)	14.9	3.6
11	Ops Pit N Wall (outer)	11.5	2.1

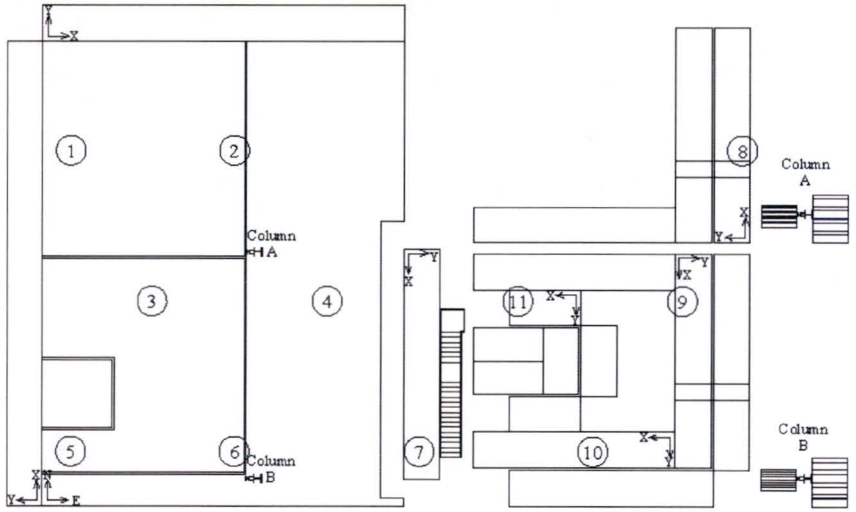


Table 69-1
FSS Measurement Locations for BSA 02-27

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 02 **Description:** Building Survey Area (Building 230)

Survey Unit: 27 **Description:** U-Shaped Area (Northwest) – Lower Walls, Floor, Stairs

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	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 Inner
B02-27-10-S-F-S-00	W	S	NA	NA	3.6	14.9	Ops Offices S Wall Inner
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	B	NA	NA	70.0	20.0	Floor
B02-27-13-S-F-B-00	F	B	NA	NA	65.0	45.0	Floor
B02-27-14-S-F-B-00	F	B	NA	NA	30.0	50.0	Floor
B02-27-15-S-F-B-00	F	B	NA	NA	30.0	22.0	Floor
B02-27-16-S-F-B-00	F	B	NA	NA	15.0	5.0	Floor
B02-27-17-S-F-B-00	F	B	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

Quality Record

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 cm^2 (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 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 947 dpm/100 cm^2 (systematic location, 5% of the $DCGL_{SO}$), and the average residual radioactivity based on all systematically collected measurements is 380 dpm/100 cm^2 (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.

Table 70-1

FSS Data Summary for BSA 02-27

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 dpm/100cm²	Fraction of 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 documented survey results are due to rounding in Excel

Min	0	**2%**
Max	947	**$DCGL_{SO}$**
Mean	380	**0.50**
Median	495	**mrem/year**
Stdev	333.6	

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

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.

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		MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+		MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+	
B02-27-01-S-F-S-00	Floor	495	0.026	0.974	0.974	α = 0.05	N	Alpha = 0.05	N	Alpha = 0.05
B02-27-02-S-F-S-00	Floor	344	0.018	0.982	0.982		4	4	28	18
B02-27-03-S-F-S-00	Floor	947	0.050	0.950	0.950		5	4	29	19
B02-27-04-S-F-S-00	Floor	535	0.028	0.972	0.972		6	5	30	19
B02-27-05-S-F-S-00	Floor	656	0.035	0.965	0.965		7	6	31	20
B02-27-06-S-F-S-00	Floor	636	0.034	0.966	0.966		8	6	32	21
B02-27-07-S-F-S-00	Rod Load West Wall	565	0.030	0.970	0.970		9	7	33	21
B02-27-08-S-F-S-00	FSS Office E Wall Outer	0	0.000	1.000	1.000		10	8	34	22
B02-27-09-S-F-S-00	Ops Offices E Wall Inner	0	0.000	1.000	1.000		11	8	35	22
B02-27-10-S-F-S-00	Ops Offices S Wall Inner	0	0.000	1.000	1.000		12	9	36	23
B02-27-11-S-W-S-00	Ops Pit North Wall	0	0.000	1.000	1.000		13	9	37	23
				Number of Positive Differences (S+)	11		14	10	38	24
				Sign Test Critical Value (MARSSIM Table I-3)	8		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		

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

TEST: PASS

Figure 73-1
Data Evaluation Checklists prepared for BSA 02-27 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		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: 27 **Description:** U-Shaped Area (Northwest)-Lower Walls, Floor, Stairs

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?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☐	No ☐	NA ☒
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☐	No ☐	NA ☒
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☐	No ☐	NA ☒
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.

Comments: N/A

Quality Record

Figure 73-1
Data Evaluation Checklists prepared for BSA 02-27 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. BSA 04 **Description:** Building Survey Area (Building 230)
Survey Unit: No. 27 **Description:** U-Shaped Area (Northwest)-Lower Walls, Floor, Stairs

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? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    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] (Signature) 8-30-17 (Date)

Approved by (RSO): Clark Evers (Print Name) [signature] (Signature) 8/30/17 (Date)

Quality Record

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.

Table 74-1
BSA 02-27 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**2%**
Dose	**0.5 mrem/year**

75.0 REFERENCES

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
APPENDIX B: Analytical Data Evaluation Spreadsheets for BSA 02-14
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