Westinghouse

Hematite Decommissioning Project

NUMBER: **HDP-PR-FSS-721**

TITLE: **Final Status Survey Data Evaluation**

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QUALITY-RELATED

Approvals:

Author: Scott G. Zoller — Date: 08/13/15

Owner/Manager: W. Clark Evers — Date: 8/13/15

Project Director: (Deputy Director) Gay M. Fussell — Date: 8/13/15

REVISION LOG	
Revision No. Effect. Date	**Change(s)**
0 01/16/2012	See Revision 0 for information on its changes.
1 02/06/2013	See Revision 1 for information on its changes.
2 02/20/2013	See Revision 2 for information on its changes.
3 11/26/2014	See Revision 3 for information on its changes.
4 01/06/2015	See Revision 4 for information on its changes.
5 02/09/2015	See Revision 5 for information on its changes.
6 03/25/2015	See Revision 6 for information on its changes.
7 04/15/2015	See Revision 7 for information on its changes.
8 06/15/2015	See Revision 8 for information on its changes.
9 See Cover Page	This procedure supersedes HDP-PR-FSS-721, Revision 8. This revision implements clarification on the determination of dose for survey units. The changes are based upon an agreement between the U.S. NRC and Westinghouse in regards to calculating dose. The technical changes were agreed upon during the NRC-Westinghouse teleconference held on August 12, 2015. The agreement between NRC-Westinghouse will be documented in the meeting summary which is available on ADAMS. The revisions are marked by sidebars.

Are Quality Records generated? **YES**. If yes, list quality records below and ensure that these completed records are retained in accordance with HDP-PR-QA-009 (Reference 5.6).

Appendix G-1, *Final Status Survey Data Quality Objectives Review Checklist*
Appendix G-2, *Final Status Survey Investigations for Soil Survey Units*
Appendix G-3, *Final Status Survey Investigations for Structural Survey Units*
Appendix G-4, *Corrective Actions for Final Status Survey Failure*

1.0 PURPOSE

The purpose of this procedure is to provide guidance to interpret survey results using the Data Quality Assessment (DQA) process during the assessment phase of Final Status Survey (FSS) activities in support of the Hematite Decommissioning Project (HDP).

This procedure implements the requirements of the "*Hematite Decommissioning Plan*" (DP) (Reference 5.1) and applicable U.S. Nuclear Regulatory Commission (NRC) regulations and guidance documents; specifically, NUREG-1757, Volume 2, "*Consolidated Decommissioning Guidance – Characterization, Survey, and Determination of Radiological Criteria*" (Reference 5.2), and NUREG-1575, "*Multi-Agency Radiation Survey and Site Investigation Manual*" (MARSSIM, Reference 5.3).

2.0 POLICY

In accordance with HDP-PO-FSS-700, "*Final Status Survey Program*" (Reference 5.4), the DQA process will include a review of the Data Quality Objectives (DQOs) and sample plan design, will include a review of preliminary data, will use appropriate statistical testing when applicable, will verify the assumptions of the statistical test, and will draw conclusions from the data. The DQA process is the primary evaluation tool to determine that data are of the right type, quality and quantity to demonstrate that the dose from residual radioactivity in each survey unit is less than the annual dose criterion for license termination specified in Code of Federal Regulations (CFR), Title 10, Part 20.1402, "*Radiological Criteria for Unrestricted Use*" (Reference 5.5).

3.0 APPLICABILITY

This procedure applies to all personnel evaluating and interpreting survey results in support of FSS.

4.0 DEFINITIONS/ACRONYMS

4.1 Definitions

Note: HDP-PO-FSS-700, "*Final Status Survey Program*" (Reference 5.4) provides a listing of common definitions associated with the FSS program.

4.1.1 Survey Package – Survey packages are prepared for each survey area independently. A survey package is, in essence, a file that will contain all quality records and other documents relevant to the FSS of the survey area.

4.2 Acronyms

AF	Area factor
CAD	Computer Aided Design
CFR	Code of Federal Regulations
CoC	Chain-of-Custody
CSM	Conceptual Site Model
DCGL	Derived concentration guideline level
DP	Decommissioning plan
DQA	Data quality assessment

DQO	Data quality objective
GIS	Geographic Information Specialist
EMC	Elevated Measurement Comparison
FSS	Final Status Survey
FSSP	Final Status Survey Plan
HDP	Hematite Decommissioning Project
HP	Health Physics
m^2	Square meters
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum detectable concentration
NRC	U.S. Nuclear Regulatory Commission
QA	Quality assurance
QC	Quality control
ROC	Radionuclides of Concern
RSO	Radiation Safety Officer
SOF	Sum-of-Fractions
WRS	Wilcoxon Rank Sum

5.0 REFERENCES

5.1 DO-08-004, *Hematite Decommissioning Plan*

5.2 NUREG-1757, *Volume 2, Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria*

5.3 NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual*

5.4 HDP-PO-FSS-700, *Final Status Survey Program*

5.5 Code of Federal Regulations, Title 10, Part 20.1402, *Radiological Criteria for Unrestricted Use*

5.6 HDP-PR-QA-009, *Records Management*

5.7 HDP-PR-FSS-720, *Final Status Survey Data Integrity and Database Management*

5.8 HDP-PR-FSS-722, *Final Status Survey Reporting*

5.9 HDP-PR-FSS-701, *Final Status Survey Plan Development*

5.10 HDP-PR-FSS-703, *Final Status Survey Quality Control*

6.0 RESPONSIBILITIES

6.1 The Radiation Safety Officer (RSO) is responsible for:

6.1.1 The review and approval of the conclusions reached for the survey unit from the assessment of the survey data.

6.1.2 The review and approval of methods for processing and evaluating data.

6.2 The Health Physics (HP) Staff is responsible for:

6.2.1 Providing overall technical support for the review, validation and interpretation of FSS results and analysis.

6.2.2 Ensuring that all required surveys have been performed and documented in accordance with the Final Status Survey Plan (FSSP) and FSS Sample Instructions for the survey unit.

6.2.3 Evaluation of FSS data and results using the DQA process.

6.2.4 Ensuring that the survey data taken for FSS is authentic and of sufficient quality.

6.2.5 Ensuring that the conclusions from FSS are appropriately documented and technically defensible.

6.3 The Geographic Information Specialist (GIS)/Computer Aided Design (CAD) Specialist is responsible for:

6.3.1 Preparation of survey maps, layout of random and systematic samples, and other graphics as necessary to support FSS report development.

7.0 GENERAL

7.1 Documents containing FSS data and survey records are quality assurance (QA) records. Control and storage of these records shall be maintained in accordance with HDP-PR-QA-009, *Records Management* (Reference 5.6).

7.2 Databases and spreadsheets containing FSS data shall be controlled in accordance with HDP-PR-FSS-720, *Final Status Survey Data Integrity and Database Management* (Reference 5.7).

7.3 Personnel removing documents from FSS files, or working within FSS databases, shall have approved access by the RSO in accordance with the requirements of HDP-PO-FSS-700, *Final Status Survey Program* (Reference 5.4).

7.4 Data accepted as the FSS of record shall be reviewed to verify all are complete, accurate, and technically defensible. This review is detailed in Section 8.1.

7.5 Survey data may be accepted as FSS data provided the following requirements are met:

7.5.1 Data was obtained using approved measurement methods, and instrumentation was calibrated and verified operable in accordance with approved procedures.

7.5.2 Quality control measurements required for the FSS have been made and the results accepted.

7.5.3 No further remediation will be performed in the survey unit or, if remediation is performed, then the remediation that occurs will be localized in nature, all resultant contamination material will be controlled, and the area impacted by the remediation activity will be re-scanned.

7.5.4 Adequate isolation and control measures have been applied and maintained. Contact HP Supervision for resolution if isolation controls appear to have been breached. HP Supervision will consult with the RSO and determine if a breach has occurred that could result in cross contamination of the unit. In the event that isolation and control measures established for a given survey unit are compromised, evaluations will be performed and documented to confirm that no radioactive material was introduced into the area that would affect the results of the FSS. This investigation survey will involve judgment sampling of the suspect areas. If the results of the investigation survey indicate that contamination is statistically different than the initial FSS results (>2 standard deviations from the mean), then the investigation survey will be increased to include a larger physical area than the initial investigation survey. If the final results of the investigation survey are statistically different than the FSS survey results, then a full FSS survey of the affected areas will be performed. Any additional surveys or sampling performed due to isolation control breaches should be documented and retained for inclusion into the Survey Area Release Record and/or the Final Report.

7.6 Selection of Derived Concentration Guideline Levels (DCGL)

7.6.1 DCGL applicable to a particular measurement location and radionuclide are selected based on the Conceptual Site Model (CSM) stratum in which the sample is located, with the exception of the deep CSM, in which case the excavation DCGL will be used.

7.7 Considerations for Soil Reused as Backfill

7.7.1 The contribution to the final sum-of-fraction (SOF) from the reuse material will be included in the overall SOF for the survey unit.

7.8 Selection and Performance of Statistical Tests

7.8.1 The statistical test which will be used during data evaluation shall be consistent with the test that was used during the survey design in accordance with HDP-PR-FSS-701 (Reference 5.9).

7.8.2 When the sign test is used for the sample design, it is not necessary to perform a statistical evaluation if all individual measurements subject to this test are less than or equal to one.

7.8.3 When the Wilcoxon Rank Sum (WRS) test is used for the sample design, it is not necessary to perform a statistical evaluation if the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one.

7.9 Remediation, Reclassification and Resurvey

7.9.1 Re-classification of a survey unit from a less restrictive classification to a more restrictive classification may be done without prior NRC approval. However, reclassification to a less restrictive classification requires prior NRC approval.

7.9.2 The decision to separate only a portion of a survey unit and reclassify that portion as a new survey unit having a more restrictive classification due to the presence of elevated residual radioactivity shall be documented, and should consider the following:

- The assumptions made as to how the original survey unit was classified.
- The postulated cause of the elevated residual radioactivity.
- The possibility for other similar areas within the original survey unit having gone undetected.
- The extent of the elevated residual radioactivity (and corresponding remediation) relative to the total area of the original survey unit.

8.0 PROCEDURE

8.1 Data Validation

Responsibility	Step	Action
HP Staff	8.1.1	Perform a review of the survey data to ensure that the data set is complete through an assessment of the following:

a. Verification that the unique sample identification number for each sample or measurement is consistent between the sample analysis report, the Chain-of-Custody (CoC) form, the FSSP and the FSS Sample Instructions.

b. Verification that the data is complete and that there are no missing results or supporting data, including but not limited to Minimum Detectable Concentration (MDC), uncertainty, background or methods of analysis.

c. Verification that the MDC of the instrument used for analysis was adequate to detect all Radionuclides-of-Concern (ROC) or gross activity at the investigation levels specified in the FSSP for that survey unit. When evaluating the MDC for soil samples, consideration should be given to the necessity to achieve a SOF of less than one for the entire radionuclide mixture and as such the SOF using the MDC values for each sample should be evaluated. If U-234 was not directly measured, then infer U-234 MDC by multiplying U-235 MDC by the ratio of U-234:U-235 at the enrichment determined for the sample. The calculated SOF

Responsibility	Step	Action
		must be less than or equal to one, with a preferred value between 0.1 and 0.5.
HP Staff		d. Verification of the absence of anomalies in the sample or measurement results, or in the supporting data, including but not limited to MDC, uncertainty, deviation from established procedure or analysis flags.
	8.1.2	Present survey data results in units appropriate for comparison to the DCGL. As applicable, convert the units for the reported data to the DCGL units by correcting for survey instrument background, efficiency, geometry, detector area, and/or measurement size.
	8.1.3	Once analysis or measurement results have been validated, they can be used for FSS data evaluation. Proceed to Section 8.2 to document the review on the DQO checklist.
	8.1.4	If an analysis result, measurement or set of data cannot be validated, then notify the RSO and do not proceed until the issue has been resolved.
RSO	8.1.5	Perform the following:
		a. Assess the valid data for the survey unit in order to make a determination if the remaining data are sufficient to meet the DQOs for that survey unit.
		b. If the remaining data are insufficient to continue FSS, then direct the acquisition of additional measurements or samples as necessary.

8.2 DQO Checklist

Responsibility	Step	Action
HP Staff	8.2.1	Upon receiving notification that all samples and measurements required by the FSSP and FSS Sample Instructions have been taken or acquired, initiate form Appendix G-1, *Final Status Survey Data Quality Objectives Review Checklist.*
	8.2.2	Using the checklist, review the FSSP, the FSS Sample Instructions, the Field Notes, survey records and/or data analyses reports to ensure that the DQOs used for the survey design have been met.
	8.2.3	If the review identified discrepancies, then document any corrective actions that were taken to resolve the discrepancy.

Responsibility	Step	Action
HP Staff	8.2.4	If discrepancies remain that are unresolved, then forward the form to the RSO for completion.
RSO	8.2.5	Perform the following: a. Assess the data that has been impacted by the discrepancy to determine if the data remains valid. b. Assess the remaining data that has not been impacted by the discrepancy to make a determination if the remaining data are sufficient to meet the DQOs for that survey unit. c. If the remaining data are insufficient to continue FSS, then direct the acquisition of additional measurements or samples as necessary.

8.3 Preliminary Data Review

Responsibility	Step	Action
HP Staff	8.3.1	Compile the Survey Data that will be used for FSS for this survey unit, including scan survey results, any biased samples that were taken and any investigation measurements or samples that were taken as a result of elevated scan measurements.
	8.3.2	Record all valid measured numerical values, including values below the MDC and values that are negative.
	8.3.3	Derive and list the Basic Statistical Data for each analyzed radionuclide or direct measurement in the systematic sample population that will be used to demonstrate compliance for the survey unit. Use net values (gross results minus background, i.e., 1.0 pCi/g for Th-232 and 0.9 pCi/g with unknown ingrowth or 1.07 pCi/g with known ingrowth for Ra-226) for Ra-226 and Th-232, and correct all negative values to zero. At a minimum, the statistics will include: a. Mean value of the data set b. Median value of the data set c. Standard deviation
	8.3.4	If a reported survey result is an isotopic analysis of a volumetric sample (e.g. soil, sediment, liquid), then assess if the sample report provides an analytical result for U-234. If an analytical result for U-

Responsibility	Step	Action
		234 is not reported, then infer U-234 activity in the sample as follows:
HP Staff		a. When U-235 is reported as negative or zero and U-238 is reported as positive, then natural Uranium is assumed and the U-234 concentration will be set equal to the U-238 concentration. b. When U-235 is reported as positive and U-238 is reported as negative or zero, then highly enriched Uranium is assumed and the U-234 concentration will be determined by multiplying the U-235 concentration by 32.50, which is the U-234:U-235 ratio based on the maximum enrichment (100 percent) from Appendix A. c. When both U-235 and U-238 data are reported as positive, but the U-238:U-235 ratio for the data is less than 0.0001 (again, indicating highly enriched Uranium), then the U-234 concentration is determined by multiplying the U-235 concentration by 32.50. d. When both U-235 and U-238 data are reported as positive, but the U-238:U-235 ratio for the data is greater than 155.37 (indicating depleted Uranium), then the U-234 concentration is determined by multiplying the U-235 concentration by the minimum U-234:U-235 ratio of 46.31 from Appendix A. e. When both U-235 and U-238 data are reported as positive, the U-238:U-235 ratio for the data is used to determine the associated U-234:U-235 ratio from Appendix A. The U-234 concentration is determined by multiplying the U-235 concentration by the U-234:U-235 ratio. f. If both U-235 and U-238 are reported as negative or zero, set the U-234 concentration to zero.
GIS/CAD Specialist	8.3.5	Prepare a map(s) for the survey unit that includes the following information: a. The survey unit boundaries. b. The locations corresponding to the coordinates for each systematic measurement or sample. c. The locations corresponding to the coordinates where any elevated scan measurements were detected. d. The locations corresponding to the coordinates for each biased or investigation measurement or sample.

Responsibility	Step	Action
HP Staff	8.3.6	Assess the scan survey results for the survey unit.

a. Review gamma walkover survey and biased sample results and compare to investigation levels that are presented in Appendix B.

b. Evaluate if elevated areas have been adequately sampled. If determined to be necessary, prepare a new FSS sample instruction per Appendix P-3 of HDP-PR-FSS-701 (Reference 5.9) indicating the location of additional biased samples.

8.4 Calculation of the Sum-of-Fractions (SOF)

Responsibility	Step	Action
HP Staff	8.4.1	Select the appropriate DCGL(s) for the survey unit.

a. If the reported survey result is an isotopic analysis of a volumetric sample, then select the appropriate DCGL value for each ROC from Appendix C that is applicable to the CSM strata for the sample locations.

Note: Excavation DCGLs shall be used in the deep CSM stratum.

Note: The DCGLs used to develop the FSS Survey Plans shall be used to calculate the SOF unless otherwise directed by the RSO.

Note: Values of U-235 DCGLs adjusted for Tc-99 are prohibited from use to demonstrate compliance with the final status survey dose criteria.

b. If the reported survey result is a direct measurement of a structural surface, then use the Adjusted Gross DCGL for structural surfaces of 18,925 dpm/100cm^2 from Appendix D.

8.4.2 Subtract the Th-232 or Ra-226 average background (1.0 pCi/g for Th-232 and 0.9 pCi/g with unknown ingrowth or 1.07 pCi/g with known ingrowth for Ra-226) from each Th-232 or Ra-226 result which will be used in the SOF calculation, and any subsequent investigations, if necessary. Note, treat negative values as zero in all subsequent calculations.

Responsibility	Step	Action

HP Staff

8.4.3 Calculate a net Sum of Fractions (SOF_N) for each sample or measurement using the following equation(s).

a. If the reported survey result is an isotopic analysis of a volumetric sample (e.g. soil, sediment, liquid), then;

$$SOF = \frac{Conc_{U\text{-}234}}{DCGL_{w,U\text{-}234}} + \frac{Conc_{U\text{-}235}}{DCGL_{w,U\text{-}235}} + \frac{Conc_{U\text{-}238}}{DCGL_{w,U\text{-}238}} + \frac{Conc_{Tc-99}}{DCGL_{w,Tc-99}} \frac{Conc_{Th-232}}{DCGL_{w,Th-232}} + \frac{Conc_{Ra-226}}{DCGL_{w,Ra-226}}$$

b. If the reported survey result is a direct measurement of a structural surface, then;

$$SOF = \frac{Gross\ Activty\ (dpm/100cm^2)}{Adjusted\ Gross\ DCGL_w}$$

$$SOF = \frac{Gross\ Activty}{Adjusted\ Gross\ DCGL_w}\ in\ dpm/100cm^2$$

Note: Gross Activity value will include subtraction for ambient gamma background. No background correction for the contribution from naturally-occurring radioactivity in the surface being measured will be applied.

8.4.4 If the survey unit is a soil survey unit, then perform the following assessments. If the survey unit is a structural survey unit, then proceed to Step 8.4.5.

a. If the sample location has not been excavated (e.g., a Class 2 or Class 3 survey unit) or has been excavated but not backfilled, then evaluate the soil samples taken in the surface and root strata CSM.

1. If the root stratum SOF_N is greater than 0.5, then;

a) Notify the RSO.

b) Prepare a new FSS sample instruction per Appendix P-3 of HDP-PR-FSS-701 (Reference 5.9) to facilitate the acquisition of additional soil samples from the top 15 cm (or other depth designated by the RSO) of the Deep stratum CSM at each systematic location where the SOF is greater than 0.5 in the root stratum if a sample has not already been collected.

Responsibility	Step	Action
HP Staff	8.4.5	Calculate an average SOF_N for the survey unit.

a. For structural survey units, the average SOF is calculated using the following equation:

$$SOF_{avg} = \frac{\overline{C}}{D}$$

where:

$\overline{C}$ = Average concentration in survey unit (gross surface activity)

D = Gross surface activity DCGL

b. For soil survey units, a weighted average SOF for the survey unit is calculated using the following equation:

$$SOF_{avg} = f_{SS}\sum_{i=1}^{n}\left(\frac{\overline{C}_{i,SS}}{D_{i,SS}}\right) + f_{RS}\sum_{i=1}^{n}\left(\frac{\overline{C}_{i,RS}}{D_{i,RS}}\right) + f_{DS}\sum_{i=1}^{n}\left(\frac{\overline{C}_{i,DS}}{D_{i,DS}}\right)$$

where:

n = Number of measured ROCs;

f_{SS} = Fraction of the survey unit area at the surface stratum depth ;

f_{RS} = Fraction of survey unit area at the root stratum depth;

f_{DS} = Fraction of survey unit area at the deep stratum depth;

$\overline{C}_{i,SS}$ = Average concentration for the i^{th} ROC in the surface stratum;

$\overline{C}_{i,RS}$ = Average concentration for the i^{th} ROC in the root stratum;

$\overline{C}_{i,DS}$ = Average concentration for the i^{th} ROC in the deep stratum.

$D_{i,SS}$ = DCGL for the i^{th} ROC in the surface stratum

$D_{i,RS}$ = DCGL for the i^{th} ROC in the root stratum

$D_{i,DS}$ = DCGL for the i^{th} ROC in the deep stratum

Responsibility	Step	Action
HP Staff		Note: When the Uniform $DCGL_w$ is utilized only one layer exists within the survey unit and the equation above reduces to the following: $$SOF_{avg} = \sum_{i=1}^{n} \left(\frac{\overline{C}_{i,Uniform}}{D_{i,Uniform}} \right)$$
		Note: The DCGLs used to develop the FSS Survey Plans shall be used to calculate the SOF unless otherwise directed by the RSO.
		Note: For unexcavated survey units utilizing the "Three Stratum" $DCGL_w$'s, the values f_{SS}, f_{RS}, and f_{DS} are all 1 and the equation above reduces to the following: $$SOF_{avg} = \sum_{i=1}^{n} \left(\frac{\overline{C}_{i,SS}}{D_{i,SS}} \right) + \sum_{i=1}^{n} \left(\frac{\overline{C}_{i,RS}}{D_{i,RS}} \right) + \sum_{i=1}^{n} \left(\frac{\overline{C}_{i,DS}}{D_{i,DS}} \right)$$
		c. If the soil survey unit will be backfilled using reuse backfill material, then calculate an average SOF for the backfill material using the appropriate DCGL and add the $SOF_{backfill}$ to the average SOF for the survey unit.
		Note: In soil survey units that were evaluated against the Uniform $DCGL_w$, only offsite borrow or reuse backfill also evaluated against the Uniform $DCGL_w$ is allowed to be used. In soil survey units that were evaluated against the "Three Stratum" $DCGL_w$'s, only offsite borrow or reuse backfill also evaluated against the "Three Stratum" $DCGL_w$'s is allowed to be used.
		d. For structure survey units, determine the ventilation system contribution to the survey unit SOF by dividing the predetermined ventilation system dose value by 25 mrem.
		e. Determine the groundwater contribution to the soil survey unit SOF by dividing the predetermined groundwater dose value (based on the highest measured groundwater concentration) by 25 mrem.
		Note: If the method used for determining groundwater dose value is determined to be unduly conservative, additional hydrogeological investigations may be performed.
		f. For piping that has been grouted and the piping DCGLs were used, determine the contribution to the soil or structure survey unit SOF by dividing the predetermined piping dose value by 25 mrem.

Responsibility	Step	Action

g. If the average SOF for a structural survey unit (including the contribution from building ventilation or underground piping systems), or the average SOF for a soil survey unit (including contribution from groundwater, underground piping systems and backfill if applicable) is less than or equal to unity (1), then proceed to Step 8.4.6. If an average SOF is greater than unity (1), the survey unit fails and requires additional remediation. Stop data assessment and notify the RSO.

8.4.6 Determine the dose contribution for the survey unit by multiplying the survey unit average SOF by 25 mrem.

8.5 Performance of Statistical Tests

Responsibility	Step	Action

HP Staff

Note: Statistical tests will only be applied to the systematic sampling and measurement populations.

Note: For soil survey units that have been subjected to remediation, the statistical test will be performed only on the systematic sample population that represents the exposed soil surface, regardless of the strata (i.e., the "topmost" sample in each systematic sampling location.

8.5.1 If every measurement in the systematic sample population is:

- less than or equal to the $DCGL_w$ (structures), or
- where a background reference area is used (soil), the difference between the maximum survey data set gross SOF and the minimum background adjusted SOF is less than or equal to the $DCGL_w$, then a statistical test is not required, proceed to Step 8.6.1.

8.5.2 If the FSS Plan for the survey unit specifies that the Wilcoxon Rank Sum test will be used proceed to Step 8.5.3, otherwise proceed to Step 8.5.4

8.5.3 Perform the WRS test as follows:

a. Calculate a gross -SOF for each systematic sample (using gross results, not net results for Ra-226 and Th-232 and correcting negative values to zero) and background reference sample by taking the sum of the individual DCGL fractions.

Responsibility	Step	Action
HP Staff		b. Adjust the background reference area measurements by adding one to each background reference area SOF.
		c. Sum the number of adjusted background reference area measurements, *m*, and the number of survey unit measurements, *n*, to obtain *N* ($N = m + n$).
		d. Pool and rank all SOF (systematic and adjusted reference) in order of increasing size from 1 to *N*. If several measurements have the same value, they are all assigned the average rank of that group of measurements.
		e. Sum the ranks of the adjusted background reference area measurements to obtain the test statistic, W_r.
		f. Calculate the WRS critical value in accordance with guidance provided in MARSSIM Appendix I.4 (Reference 5.3).
		g. Compare the test statistic, W_r, to the critical value for the Type 1 Error (α) (for HDP, (α) = 0.05). If W_r is greater than the calculated critical value, the null hypothesis can be rejected and the survey data set passes the WRS test. If W_r is less than or equal to the calculated critical value, the survey data set fails the WRS test.
		h. Proceed to Step 8.5.5.
	8.5.4	Perform the Sign test as follows:
		a. List the survey unit measurements, 1, 2, 3…, *n*; where *n* = the number of measurements.
		b. Divide the gross direct measurement by the Adjusted Gross DCGL.
		c. The fraction of the adjusted gross DCGL is the weighted sum for the measurement.
		d. Subtract the weighted sum (W_s) from unity (one) to obtain the difference.
		e. Discard differences where the value is exactly zero and reduce *n* by the number of such zero measurements.
		f. Count the number of positive differences. The result is the test statistic S^+.

Responsibility	Step	Action
HP Staff		g. Compare the value of S^+ to the critical values in Table I.3 of MARSSIM (Reference 5.3). If n is greater than 50, calculate the critical value in accordance with guidance provided in MARSSIM Appendix I.3 (Reference 5.3). If S^+ is greater than or equal to the critical value for the Type 1 Error (α) (for HDP, this value is 0.05), the null hypothesis can be rejected and the survey data set passes the Sign test. If S^+ is less than the critical value, the survey data set fails the Sign test.
		h. Proceed to Step 8.5.5.
	8.5.5	If the survey unit passes the statistical test, then proceed to Section 8.6. If the survey unit fails the statistical test, then inform the RSO and further analyze the data to determine why the statistical test failed.
		a. If it appears that the failure is caused by the presence of radioactivity concentrations that will require further remediation, then proceed to Section 8.7.
		b. If it appears that the failure is due to statistical fluctuations, the survey unit may be resurveyed and another set of discrete measurements or samples collected for statistical analysis. A larger number of measurements may increase the probability of passing the statistical test if the survey unit actually meets the site release criterion.
		c. If it appears the power of the test is insufficient due to the number of measurements, then a retrospective power analysis for the test may be performed as described in Appendices I.9 and I.10 of MARSSIM (Reference 5.3) or additional data may be collected and included in the data set.

8.6 Investigations

Responsibility	Step	Action
HP Staff	8.6.1	If any location exceeds the investigation levels as presented in Appendix B that are applicable to the survey unit, then proceed to the next step. If the survey unit does not have any measurements in excess of the investigation levels as presented in Appendix B, then commence the generation of the Release Record for this survey unit in accordance with HDP-PR-FSS-722, *"Final Status Survey Reporting"* (Reference 5.8).

Responsibility	Step	Action
HP Staff		Note: Appendix G-2, *"Final Status Survey Investigation for Soil Survey Units"*, Appendix G-3, *"Final Status Survey Investigation for Structural Survey Units"* or an equivalent form can be used to document the investigation. Data can also be processed using one or more of the following methods: the use of pre-programmed computer databases, computer spreadsheets, electronic calculators and hand calculations.
	8.6.2	If the survey unit to be investigated is a soil survey unit, then initiate Appendix G-2, *"Final Status Survey Investigation for Soil Survey Units"*. If the survey unit to be investigated is a structural survey unit, then initiate Appendix G-3, *"Final Status Survey Investigation for Structural Survey Units"*.
	8.6.3	Document the reason for the investigation.
	8.6.4	List the locations and sample or measurement results that exceed the investigation levels as presented in Appendix B.
	8.6.5	Using the gamma walkover survey or sample or measurement coordinates, assess if the elevated area has been adequately bounded. If the elevated area has not been adequately bounded, then take additional samples or measurements as necessary to establish the boundaries of the elevated area.
	8.6.6	List the bounding samples or measurements for each elevated area.
	8.6.7	If the survey unit is classified as Class 2 or 3, then proceed to Step 8.6.8. If the survey unit is classified as Class 1, then perform an Elevated Measurement Comparison (EMC) as follows:
		a. In each elevated area, denote the $DCGL_w$ pertinent to the CSM strata where the elevated sample is located or the Adjusted Gross DCGL for structures.
		Note: The DCGLs used to develop the FSS Survey Plans shall be used to calculate the SOF unless otherwise directed by the RSO.
		b. Determine an area in square meters for the identified elevated area(s) and select the appropriate Area Factor (AF) from Appendix E that corresponds to the area and to the radionuclide with the elevated activity for soil survey units or from Appendix F for structure survey units.

Responsibility	Step	Action
HP Staff		c. Calculate a $DCGL_{EMC}$ for each applicable radionuclide (soils) or for gross activity (structures) by multiplying the $DCGL_w$ for the elevated measurement(s) or sample(s) by the AF.
		d. For structural survey units, the average Gross Activity (δj) is calculated as the average of the measurements in the survey unit using only measurements from the systematic sample population that are located outside of any identified elevated area.
		e. For soil survey units, the average radionuclide activity (δ_j) is calculated (for each radionuclide) as the average of the radionuclide measurements in the survey unit using only sample results from the systematic sample population that are located outside of any identified elevated area.
		f. Calculate an Elevated Radioactivity Fraction (f_{EMC}) for each identified elevated area as follows:
		1) Determine the average concentration (τ_j) for gross activity for structural survey units or for each radionuclide for soil survey units in each identified elevated area.
		2) For structural survey units, subtract the Average Gross Activity (δ_j) from the Average Gross Activity Concentration (τ_j) in the elevated area and divide this value by the $DCGL_{EMC}$ to derive an Elevated Radioactivity Fraction (f_{EMC}) for the elevated area. For soil survey units, subtract the Average Radionuclide Concentration (δ_j) for each radionuclide from the average radionuclide concentration (τ_j) in the elevated area and divide this value by the $DCGL_{EMC}$ to derive a Fraction of $DCGL_{EMC}$ (f_{elev}) for each radionuclide.
		3) Sum the Fraction of $DCGL_{EMC}$ (f_{elev}) for each radionuclide to determine the Elevated Radioactivity Fractions (f_{EMC}) for each elevated area.
		g. Sum the Elevated Radioactivity Fraction for each elevated area within the survey unit to determine the Summed Elevated Radioactivity Fraction (f_{EMC}) for the survey unit.
		h. Add the SOF fraction as determined in Step 8.4.5 to the summed Elevated Radioactivity Fraction (f_{EMC}). This value represents the EMC SOF for this survey unit.

Responsibility	Step	Action
HP Staff		i. If the SOF is less than or equal to unity (1), then the survey unit will pass the EMC. If the SOF is greater than unity (1), then proceed to Step 8.6.9.
	8.6.8	If a sample or measurement exceeds the $DCGL_w$ in a Class 2 Survey Unit or 50% of the $DCGL_w$ in a Class 3 Survey Unit, then proceed to Section 8.7. Otherwise, the investigation is complete. Commence the generation of the Release Record for this survey unit in accordance with HDP-PR-FSS-722, *"Final Status Survey Reporting"* (Reference 5.8).
	8.6.9	If a sample or measurement exceeds the $DCGL_w$ in a Class 1 Survey Unit and, the EMC SOF for the survey unit is greater than unity (1), then proceed to Section 8.7. If unity has not been exceeded, then the investigation is complete. Commence the generation of the Release Record for this survey unit in accordance with HDP-PR-FSS-722, *"Final Status Survey Reporting"* (Reference 5.8).

8.7 Corrective Actions for Final Status Survey Failure

Responsibility	Step	Action
HP Staff	8.7.1	Initiate Appendix G-4, *"Corrective Actions for Final Status Survey Failure"*. Depending on the results of the investigation performed in Section 8.6, the survey unit may be acceptable, or may require remediation, reclassification, and/or resurvey. Note: Appendix G-4, *"Corrective Actions for Final Status Survey Failure"* or an equivalent form can be used to document the corrective actions.
	8.7.2	Submit completed form to the RSO for approval.
	8.7.3	When the RSO has approved the corrective action, then prepare a new FSS sample instruction in accordance with HDP-PR-FSS-701, *"Final Status Survey Plan Development"* (Appendix P-3) (Reference 5.9). If any new survey units were created from existing survey units, or the entire FSS will be repeated, then prepare a new survey design in accordance with HDP-PR-FSS-701 (Reference 5.9).

9.0 FORMS

None

10.0 APPENDICES

Appendix A, *Radioactivity and Isotopic Ratios Relative to Enrichment*

Appendix B, *Investigation Levels*

Appendix C, *Adjusted Site-Specific Soil DCGLs*

Appendix D, *Building and Structural Surfaces Gross Radioactivity $DCGL_w$ for Small Office*

Appendix E, *Area Factors for Soil Contamination*

Appendix F, *Area Factors for Building Surfaces (Building Occupancy)*

Appendix G-1, *Final Status Survey Data Quality Objectives Review Checklist*

Appendix G-2, *Final Status Survey Investigations for Soil Survey Units*

Appendix G-3, *Final Status Survey Investigations for Structural Survey Units*

Appendix G-4, *Corrective Actions for Final Status Survey Failure*

APPENDIX A
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction [a]	U-235 Activity Fraction [a]	U-238 Activity Fraction [a]	U-238:U-235 Ratio [a]	U-234:U-235 Ratio [a]
0.1	0.2285	0.0049	0.7666	155.37	46.31
0.2	0.2864	0.0091	0.7045	77.61	31.55
0.3	0.3358	0.0126	0.6516	51.69	26.64
0.4	0.3785	0.0156	0.6059	38.73	24.19
0.5	0.4157	0.0183	0.5660	30.95	22.73
0.6	0.4484	0.0206	0.5310	25.77	21.76
0.7	0.4775	0.0227	0.4999	22.06	21.07
0.72	0.4829	0.0230	0.4941	21.44	20.96
0.8	0.5034	0.0245	0.4721	19.28	20.56
0.9	0.5267	0.0261	0.4472	17.12	20.17
1.0	0.5477	0.0276	0.4247	15.40	19.85
1.1	0.5668	0.0289	0.4043	13.98	19.60
1.2	0.5842	0.0301	0.3857	12.80	19.39
1.3	0.6001	0.0312	0.3687	11.81	19.22
1.4	0.6147	0.0322	0.3530	10.95	19.07
1.5	0.6282	0.0332	0.3386	10.21	18.95
1.6	0.6407	0.0340	0.3253	9.56	18.84
1.7	0.6523	0.0348	0.3129	8.99	18.75
1.8	0.6631	0.0355	0.3014	8.48	18.67
1.9	0.6731	0.0362	0.2907	8.03	18.59
2.0	0.6825	0.0368	0.2806	7.62	18.53
2.1	0.6913	0.0374	0.2712	7.25	18.48
2.2	0.6996	0.0380	0.2624	6.91	18.43
2.3	0.7074	0.0385	0.2541	6.61	18.39
2.4	0.7147	0.0390	0.2463	6.32	18.35
2.5	0.7216	0.0394	0.2390	6.06	18.32
2.6	0.7282	0.0398	0.2320	5.83	18.29
2.7	0.7344	0.0402	0.2254	5.60	18.26
2.8	0.7403	0.0406	0.2191	5.40	18.24
2.9	0.7459	0.0409	0.2132	5.21	18.22
3.0	0.7512	0.0413	0.2075	5.03	18.20
3.1	0.7562	0.0416	0.2022	4.86	18.18
3.2	0.7611	0.0419	0.1971	4.70	18.17
3.3	0.7657	0.0422	0.1922	4.56	18.15

APPENDIX A (continued)
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction	U-235 Activity Fraction	U-238 Activity Fraction	U-238:U-235 Ratio	U-234:U-235 Ratio
3.4	0.7701	0.0424	0.1875	4.42	18.14
3.5	0.7743	0.0427	0.1830	4.29	18.14
3.6	0.7783	0.0429	0.1788	4.16	18.13
3.7	0.7822	0.0432	0.1747	4.05	18.12
3.8	0.7859	0.0434	0.1708	3.94	18.12
3.9	0.7894	0.0436	0.1670	3.83	18.11
4.0	0.7928	0.0438	0.1634	3.73	18.11
4.1	0.7961	0.0440	0.1599	3.64	18.11
4.2	0.7993	0.0441	0.1566	3.55	18.10
4.3	0.8023	0.0443	0.1534	3.46	18.10
4.4	0.8053	0.0445	0.1503	3.38	18.10
4.5	0.8081	0.0446	0.1473	3.30	18.10
4.6	0.8108	0.0448	0.1444	3.22	18.11
4.7	0.8135	0.0449	0.1416	3.15	18.11
4.8	0.8160	0.0451	0.1389	3.08	18.11
4.9	0.8185	0.0452	0.1363	3.02	18.11
5.0	0.8209	0.0453	0.1338	2.95	18.12
5.1	0.8232	0.0454	0.1314	2.89	18.12
5.2	0.8254	0.0455	0.1291	2.83	18.13
5.3	0.8276	0.0456	0.1268	2.78	18.13
5.4	0.8297	0.0457	0.1246	2.72	18.14
5.5	0.8317	0.0458	0.1225	2.67	18.14
5.6	0.8337	0.0459	0.1204	2.62	18.15
5.7	0.8356	0.0460	0.1184	2.57	18.16
5.8	0.8375	0.0461	0.1164	2.53	18.16
5.9	0.8393	0.0462	0.1145	2.48	18.17
6.0	0.8410	0.0463	0.1127	2.44	18.18
6.1	0.8427	0.0463	0.1109	2.39	18.18
6.2	0.8444	0.0464	0.1092	2.35	18.19
6.3	0.8460	0.0465	0.1075	2.31	18.20
6.4	0.8476	0.0466	0.1058	2.27	18.21
6.5	0.8492	0.0466	0.1042	2.24	18.22
6.6	0.8506	0.0467	0.1027	2.20	18.23
6.7	0.8521	0.0467	0.1012	2.16	18.24

APPENDIX A (continued)
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction	U-235 Activity Fraction	U-238 Activity Fraction	U-238:U-235 Ratio	U-234:U-235 Ratio
6.8	0.8535	0.0468	0.0997	2.13	18.24
6.9	0.8549	0.0468	0.0982	2.10	18.25
7.0	0.8563	0.0469	0.0968	2.07	18.26
7.1	0.8576	0.0469	0.0955	2.03	18.27
7.2	0.8589	0.0470	0.0941	2.00	18.28
7.3	0.8602	0.0470	0.0928	1.97	18.29
7.4	0.8614	0.0471	0.0915	1.95	18.30
7.5	0.8626	0.0471	0.0903	1.92	18.31
7.6	0.8638	0.0471	0.0891	1.89	18.32
7.7	0.8649	0.0472	0.0879	1.86	18.34
7.8	0.8661	0.0472	0.0867	1.84	18.35
7.9	0.8672	0.0472	0.0856	1.81	18.36
8.0	0.8682	0.0473	0.0845	1.79	18.37
8.1	0.8693	0.0473	0.0834	1.76	18.38
8.2	0.8703	0.0473	0.0824	1.74	18.39
8.3	0.8713	0.0474	0.0813	1.72	18.40
8.4	0.8723	0.0474	0.0803	1.70	18.41
8.5	0.8733	0.0474	0.0793	1.67	18.42
8.6	0.8742	0.0474	0.0783	1.65	18.44
8.7	0.8752	0.0474	0.0774	1.63	18.45
8.8	0.8761	0.0475	0.0764	1.61	18.46
8.9	0.8770	0.0475	0.0755	1.59	18.47
9.0	0.8779	0.0475	0.0746	1.57	18.48
9.1	0.8787	0.0475	0.0738	1.55	18.50
9.2	0.8796	0.0475	0.0729	1.53	18.51
9.3	0.8804	0.0475	0.0721	1.52	18.52
9.4	0.8812	0.0475	0.0712	1.50	18.53
9.5	0.8820	0.0476	0.0704	1.48	18.55
9.6	0.8828	0.0476	0.0696	1.46	18.56
9.7	0.8836	0.0476	0.0688	1.45	18.57
9.8	0.8843	0.0476	0.0681	1.43	18.58
9.9	0.8851	0.0476	0.0673	1.41	18.60
10.0	0.8858	0.0476	0.0666	1.40	18.61
10.5	0.8893	0.0476	0.0631	1.32	18.67

APPENDIX A (continued)
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction	U-235 Activity Fraction	U-238 Activity Fraction	U-238:U-235 Ratio	U-234:U-235 Ratio
11.0	0.8925	0.0476	0.0599	1.26	18.74
11.5	0.8954	0.0476	0.0569	1.20	18.81
12.0	0.8982	0.0476	0.0542	1.14	18.87
12.5	0.9007	0.0475	0.0517	1.09	18.94
13.0	0.9031	0.0475	0.0494	1.04	19.01
13.5	0.9053	0.0474	0.0472	1.00	19.08
14.0	0.9074	0.0474	0.0452	0.95	19.15
14.5	0.9094	0.0473	0.0433	0.92	19.23
15.0	0.9112	0.0472	0.0416	0.88	19.30
15.5	0.9130	0.0471	0.0399	0.85	19.37
16.0	0.9146	0.0470	0.0384	0.82	19.44
16.5	0.9162	0.0469	0.0369	0.79	19.51
17.0	0.9176	0.0468	0.0355	0.76	19.59
17.5	0.9190	0.0467	0.0342	0.73	19.66
18.0	0.9204	0.0466	0.0330	0.71	19.74
18.5	0.9216	0.0465	0.0318	0.68	19.81
19.0	0.9229	0.0464	0.0307	0.66	19.88
19.5	0.9240	0.0463	0.0297	0.64	19.96
20.0	0.9251	0.0462	0.0287	0.62	20.03
20.5	0.9262	0.0461	0.0277	0.60	20.11
21.0	0.9272	0.0459	0.0268	0.58	20.18
21.5	0.9282	0.0458	0.0260	0.57	20.26
22.0	0.9292	0.0457	0.0251	0.55	20.34
22.5	0.9301	0.0456	0.0244	0.53	20.41
23.0	0.9309	0.0454	0.0236	0.52	20.49
23.5	0.9318	0.0453	0.0229	0.51	20.56
24.0	0.9326	0.0452	0.0222	0.49	20.64
24.5	0.9334	0.0451	0.0215	0.48	20.72
25.0	0.9342	0.0449	0.0209	0.47	20.79
25.5	0.9349	0.0448	0.0203	0.45	20.87
26.0	0.9356	0.0447	0.0197	0.44	20.94
26.5	0.9363	0.0445	0.0192	0.43	21.02
27.0	0.9370	0.0444	0.0186	0.42	21.10
27.5	0.9376	0.0443	0.0181	0.41	21.17

APPENDIX A (continued)
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction	U-235 Activity Fraction	U-238 Activity Fraction	U-238:U-235 Ratio	U-234:U-235 Ratio
28.0	0.9382	0.0442	0.0176	0.40	21.25
28.5	0.9389	0.0440	0.0171	0.39	21.33
29.0	0.9394	0.0439	0.0167	0.38	21.40
29.5	0.9400	0.0438	0.0162	0.37	21.48
30.0	0.9406	0.0436	0.0158	0.36	21.56
30.5	0.9411	0.0435	0.0154	0.35	21.64
31.0	0.9417	0.0434	0.0150	0.35	21.71
31.5	0.9422	0.0432	0.0146	0.34	21.79
32.0	0.9427	0.0431	0.0142	0.33	21.87
32.5	0.9432	0.0430	0.0138	0.32	21.94
33.0	0.9437	0.0429	0.0135	0.31	22.02
33.5	0.9441	0.0427	0.0131	0.31	22.10
34.0	0.9446	0.0426	0.0128	0.30	22.18
34.5	0.9450	0.0425	0.0125	0.29	22.25
35.0	0.9455	0.0423	0.0122	0.29	22.33
35.5	0.9459	0.0422	0.0119	0.28	22.41
36.0	0.9463	0.0421	0.0116	0.28	22.49
36.5	0.9467	0.0420	0.0113	0.27	22.56
37.0	0.9471	0.0418	0.0110	0.26	22.64
37.5	0.9475	0.0417	0.0108	0.26	22.72
38.0	0.9479	0.0416	0.0105	0.25	22.80
38.5	0.9483	0.0415	0.0102	0.25	22.87
39.0	0.9487	0.0413	0.0100	0.24	22.95
39.5	0.9490	0.0412	0.0098	0.24	23.03
40.0	0.9494	0.0411	0.0095	0.23	23.11
40.5	0.9497	0.0410	0.0093	0.23	23.18
41.0	0.9501	0.0408	0.0091	0.22	23.26
41.5	0.9504	0.0407	0.0089	0.22	23.34
42.0	0.9507	0.0406	0.0087	0.21	23.42
42.5	0.9511	0.0405	0.0085	0.21	23.50
43.0	0.9514	0.0404	0.0083	0.20	23.57
43.5	0.9517	0.0402	0.0081	0.20	23.65
44.0	0.9520	0.0401	0.0079	0.20	23.73
44.5	0.9523	0.0400	0.0077	0.19	23.81

APPENDIX A (continued)
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction	U-235 Activity Fraction	U-238 Activity Fraction	U-238:U-235 Ratio	U-234:U-235 Ratio
45.0	0.9526	0.0399	0.0075	0.19	23.89
45.5	0.9529	0.0398	0.0074	0.19	23.96
46.0	0.9532	0.0396	0.0072	0.18	24.04
46.5	0.9534	0.0395	0.0070	0.18	24.12
47.0	0.9537	0.0394	0.0069	0.17	24.20
47.5	0.9540	0.0393	0.0067	0.17	24.28
48.0	0.9543	0.0392	0.0066	0.17	24.35
48.5	0.9545	0.0391	0.0064	0.16	24.43
49.0	0.9548	0.0390	0.0063	0.16	24.51
49.5	0.9550	0.0388	0.0061	0.16	24.59
50.0	0.9553	0.0387	0.0060	0.15	24.67
50.5	0.9555	0.0386	0.0058	0.15	24.74
51.0	0.9558	0.0385	0.0057	0.15	24.82
51.5	0.9560	0.0384	0.0056	0.15	24.90
52.0	0.9563	0.0383	0.0054	0.14	24.98
52.5	0.9565	0.0382	0.0053	0.14	25.06
53.0	0.9567	0.0381	0.0052	0.14	25.13
53.5	0.9570	0.0380	0.0051	0.13	25.21
54.0	0.9572	0.0378	0.0050	0.13	25.29
54.5	0.9574	0.0377	0.0048	0.13	25.37
55.0	0.9576	0.0376	0.0047	0.13	25.45
55.5	0.9578	0.0375	0.0046	0.12	25.53
56.0	0.9581	0.0374	0.0045	0.12	25.60
56.5	0.9583	0.0373	0.0044	0.12	25.68
57.0	0.9585	0.0372	0.0043	0.12	25.76
57.5	0.9587	0.0371	0.0042	0.11	25.84
58.0	0.9589	0.0370	0.0041	0.11	25.92
58.5	0.9591	0.0369	0.0040	0.11	25.99
59.0	0.9593	0.0368	0.0039	0.11	26.07
59.5	0.9595	0.0367	0.0038	0.10	26.15
60.0	0.9597	0.0366	0.0037	0.10	26.23
60.5	0.9599	0.0365	0.0037	0.10	26.31
61.0	0.9600	0.0364	0.0036	0.10	26.39
61.5	0.9602	0.0363	0.0035	0.10	26.46

APPENDIX A (continued)
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction	U-235 Activity Fraction	U-238 Activity Fraction	U-238:U-235 Ratio	U-234:U-235 Ratio
62.0	0.9604	0.0362	0.0034	0.09	26.54
62.5	0.9606	0.0361	0.0033	0.09	26.62
63.0	0.9608	0.0360	0.0032	0.09	26.70
63.5	0.9610	0.0359	0.0032	0.09	26.78
64.0	0.9611	0.0358	0.0031	0.09	26.86
64.5	0.9613	0.0357	0.0030	0.08	26.93
65.0	0.9615	0.0356	0.0029	0.08	27.01
65.5	0.9616	0.0355	0.0029	0.08	27.09
66.0	0.9618	0.0354	0.0028	0.08	27.17
66.5	0.9620	0.0353	0.0027	0.08	27.25
67.0	0.9621	0.0352	0.0026	0.08	27.33
67.5	0.9623	0.0351	0.0026	0.07	27.40
68.0	0.9625	0.0350	0.0025	0.07	27.48
68.5	0.9626	0.0349	0.0024	0.07	27.56
69.0	0.9628	0.0348	0.0024	0.07	27.64
69.5	0.9629	0.0347	0.0023	0.07	27.72
70.0	0.9631	0.0346	0.0023	0.07	27.80
70.5	0.9632	0.0346	0.0022	0.06	27.87
71.0	0.9634	0.0345	0.0021	0.06	27.95
71.5	0.9635	0.0344	0.0021	0.06	28.03
72.0	0.9637	0.0343	0.0020	0.06	28.11
72.5	0.9638	0.0342	0.0020	0.06	28.19
73.0	0.9640	0.0341	0.0019	0.06	28.27
73.5	0.9641	0.0340	0.0019	0.05	28.34
74.0	0.9643	0.0339	0.0018	0.05	28.42
74.5	0.9644	0.0338	0.0017	0.05	28.50
75.0	0.9646	0.0338	0.0017	0.05	28.58
75.5	0.9647	0.0337	0.0016	0.05	28.66
76.0	0.9648	0.0336	0.0016	0.05	28.74
76.5	0.9650	0.0335	0.0015	0.05	28.81
77.0	0.9651	0.0334	0.0015	0.04	28.89
77.5	0.9652	0.0333	0.0015	0.04	28.97
78.0	0.9654	0.0332	0.0014	0.04	29.05
78.5	0.9655	0.0331	0.0014	0.04	29.13

APPENDIX A (continued)
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction	U-235 Activity Fraction	U-238 Activity Fraction	U-238:U-235 Ratio	U-234:U-235 Ratio
79.0	0.9656	0.0331	0.0013	0.04	29.21
79.5	0.9658	0.0330	0.0013	0.04	29.29
80.0	0.9659	0.0329	0.0012	0.04	29.36
80.5	0.9660	0.0328	0.0012	0.04	29.44
81.0	0.9661	0.0327	0.0011	0.03	29.52
81.5	0.9663	0.0326	0.0011	0.03	29.60
82.0	0.9664	0.0326	0.0011	0.03	29.68
82.5	0.9665	0.0325	0.0010	0.03	29.76
83.0	0.9666	0.0324	0.0010	0.03	29.83
83.5	0.9667	0.0323	0.0009	0.03	29.91
84.0	0.9669	0.0322	0.0009	0.03	29.99
84.5	0.9670	0.0322	0.0009	0.03	30.07
85.0	0.9671	0.0321	0.0008	0.03	30.15
85.5	0.9672	0.0320	0.0008	0.02	30.23
86.0	0.9673	0.0319	0.0008	0.02	30.30
86.5	0.9674	0.0318	0.0007	0.02	30.38
87.0	0.9676	0.0318	0.0007	0.02	30.46
87.5	0.9677	0.0317	0.0007	0.02	30.54
88.0	0.9678	0.0316	0.0006	0.02	30.62
88.5	0.9679	0.0315	0.0006	0.02	30.70
89.0	0.9680	0.0315	0.0006	0.02	30.78
89.5	0.9681	0.0314	0.0005	0.02	30.85
90.0	0.9682	0.0313	0.0005	0.02	30.93
90.5	0.9683	0.0312	0.0005	0.01	31.01
91.0	0.9684	0.0311	0.0004	0.01	31.09
91.5	0.9685	0.0311	0.0004	0.01	31.17
92.0	0.9686	0.0310	0.0004	0.01	31.25
92.5	0.9687	0.0309	0.0003	0.01	31.33
93.0	0.9688	0.0309	0.0003	0.01	31.40
93.5	0.9689	0.0308	0.0003	0.01	31.48
94.0	0.9690	0.0307	0.0003	0.01	31.56
94.5	0.9691	0.0306	0.0002	0.01	31.64
95.0	0.9692	0.0306	0.0002	0.01	31.72
95.5	0.9693	0.0305	0.0002	0.01	31.80

APPENDIX A (continued)
RADIOACTIVITY AND ISOTOPIC RATIOS RELATIVE TO ENRICHMENT

Enrichment (%)	U-234 Activity Fraction	U-235 Activity Fraction	U-238 Activity Fraction	U-238:U-235 Ratio	U-234:U-235 Ratio
96.0	0.9694	0.0304	0.0001	0.00	31.87
96.5	0.9695	0.0303	0.0001	0.00	31.95
97.0	0.9696	0.0303	0.0001	0.00	32.03
97.5	0.9697	0.0302	0.0001	0.00	32.11
98.0	0.9698	0.0301	0.0000	0.00	32.19
98.5	0.9699	0.0301	0.0000	0.00	32.27
100.0	0.9702	0.0298	0.0000	0.00	32.50

[a] Though calculations were performed for "enrichments" less than 0.7 percent, those calculated values are subject to significant error due to limitations of the original empirically-derived formulas. Additional calculations should be performed if the weight percent of U-235 is less than 0.7 percent.

APPENDIX B
INVESTIGATION LEVELS

Survey Unit Classification	Flag Scanning Measurement Result When:	Flag Direct Measurement Or Sample Result When:
Class 1	> Investigative Action Level approved by RSO ($DCGL_{EMC}$ or $DCGL_W$ or fraction thereof)	> $DCGL_{EMC}$ or > $DCGL_W$ and > a statistical parameter-based value
Class 2	> $DCGL_W$ or > scan MDC	> $DCGL_w$
Class 3	> $DCGL_W$ or > scan MDC	> 50 percent of $DCGL_w$

APPENDIX C
Adjusted Site-Specific Soil DCGLs

Radionuclide	$DCGL_W$ (pCi/g) [a] By Conceptual Site Model				
	Shallow Stratum	**Root Stratum**	**Deep Stratum**	**Uniform Stratum**	**Excavation Scenario**
U-234	**508.5**	**235.6**	**2890**	**195.4**	**872.4**
U-235 + D [b]	**102.3**	**64.1**	**3034**	**51.6**	**208.1**
U-238 + D [b]	**297.6**	**183.3**	**3028**	**168.8**	**551.1**
Tc-99	**151.0**	**30.1**	**98649**	**25.1**	**74.0**
Th-232 + C [c]	**4.7**	**2.0**	**9279**	**2.0**	**5.2**
Ra-226 + C [c]	**5.0**	**2.1**	**13029**	**1.9**	**5.4**

[a] The reported soil limits are the activities for the parent radionuclide as specified and were calculated using DP Equation 14-1 to account for the dose contribution from insignificant radionuclides (see DP Section 14.1.3.2).
[b] "+ D" = plus short-lived decay products. Values of U-235 DCGLs adjusted for Tc-99 are prohibited from use to demonstrate compliance with the final status survey dose criteria.
[c] "+ C" = plus the entire decay chain (progeny) in secular equilibrium.

APPENDIX D

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 $DCGL_w$ (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.

APPENDIX E
AREA FACTORS FOR SOIL CONTAMINATION

Radionuclide	Elevated Measurement Area (m^2)									
	153,375	10,000	3,000	1,000	300	100	30	10	3	1
Surface Soil										
U-234	1.0	1.5	2.2	2.6	7.8	19.3	41.7	67.3	96.0	119.5
U-235 + D	1.0	1.1	1.2	1.2	1.3	1.5	1.8	2.6	5.4	12.1
U-238 + D	1.0	1.2	1.5	1.6	2.2	2.6	3.4	4.9	10.2	22.3
Tc-99	1.0	1.0	1.0	1.0	3.4	10.3	34.2	102.2	338.5	1,009
Th-232 + C	1.0	1.0	1.1	1.1	1.4	1.7	2.3	3.5	7.3	16.9
Ra-226 + C	1.0	1.1	1.2	1.2	1.8	2.2	3.0	4.5	9.6	22.4
Np-237 + D	1.0	1.1	1.1	1.1	2.6	4.5	7.1	11.0	23.4	52.4
Pu-239/240	1.0	1.1	1.1	1.1	3.6	9.5	23.5	43.0	65.5	83.4
Am-241	1.0	1.0	1.1	1.1	2.9	5.6	9.4	13.9	25.4	42.4
Root Soil										
U-234	1.0	1.2	1.3	1.4	4.1	9.4	19.2	33.0	67.9	130.4
U-235 + D	1.0	1.0	1.1	1.1	1.9	2.3	2.9	4.1	8.3	17.9
U-238 + D	1.0	1.1	1.3	1.3	2.5	3.6	5.0	7.2	14.8	31.5
Tc-99	1.0	1.0	1.0	1.0	3.4	10.3	34.3	103.0	343.3	1,029
Th-232 + C	1.0	1.0	1.0	1.0	2.1	3.0	4.2	6.0	12.8	28.4
Ra-226 + C	1.0	1.0	1.1	1.1	2.4	3.9	5.8	8.7	18.5	41.6
Np-237 + D	1.0	1.0	1.0	1.0	3.4	9.9	30.7	57.2	132.0	298.4
Pu-239/240	1.0	1.0	1.0	1.0	3.4	9.8	29.1	68.4	137.7	207.4
Am-241	1.0	1.0	1.0	1.0	3.1	7.8	17.4	31.0	62.2	109.8

APPENDIX E (continued)
AREA FACTORS FOR SOIL CONTAMINATION

Radionuclide	Elevated Measurement Area (m^2)									
	153,375	10,000	3,000	1,000	300	100	30	10	3	1
Uniform Soil										
U-234	1.0	1.2	1.3	1.3	4.0	9.3	19.6	34.3	70.5	132.8
U-235 + D	1.0	1.1	1.1	1.1	1.9	2.5	3.3	4.7	9.6	20.5
U-238 + D	1.0	1.1	1.3	1.3	2.5	3.6	5.0	7.2	14.9	31.6
Tc-99	1.0	1.0	1.0	1.0	3.4	10.3	34.3	102.9	342.7	1,027
Th-232 + C	1.0	1.0	1.0	1.0	2.1	3.0	4.2	6.1	12.9	28.9
Ra-226 + C	1.0	1.1	1.1	1.1	2.5	4.1	6.1	9.1	19.3	43.4
Np-237 + D	1.0	1.7	4.7	9.7	31.0	84.0	221.3	425.7	981.7	2,218
Pu-239/240	1.0	1.0	1.0	1.0	3.4	9.8	29.1	68.4	137.7	207.3
Am-241	1.0	1.0	1.0	1.0	3.1	7.8	17.4	31.0	62.1	109.7

Effective Area Factor For Use With Excavation DCGLs

Radionuclide	Size of Elevated Area Shown in m^2					
	148	100	30	10	3	1
U-234	1.0	2.0	6.7	19	35	65
U-235 + D	1.0	1.3	2	2	4	7
U-238 + D	1.0	1.9	3	4	7	13
Tc-99	1.0	2.0	6.7	20	67	200
Th-232 + C	1.0	1.9	3	4	7	14
Ra-226 + C	1.0	2.0	4	5	10	20
Np-237 + D	1.0	2.0	6.7	17	37	79
Pu-239/240	1.0	2.0	6.7	20	67	117
Am-241	1.0	2.0	6.7	17	32	58

Underlined values were constrained based on uniform mixing after excavation (200/area)

APPENDIX F

AREA FACTORS FOR BUILDING SURFACES (BUILDING OCCUPANCY)

Radionuclide	Elevated Measurement Area (m^2)		
	6.5	4	1
U-234	1.0	1.6	6.5
U-235 + D	1.0	1.6	6.4
U-238 + D	1.0	1.6	6.5
Tc-99	1.0	1.6	6.4
Th-232 + C	1.0	1.6	6.4
Np-237 + D	1.0	1.6	6.5
Pu-239/ Pu-240	1.0	1.6	6.5
Am-241	1.0	1.6	6.5

+ D = plus short-lived decay products.

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

Survey Area: _____ **Description:** _____
Survey Unit: _____ **Description:** _____

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 ☐	
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☐	No ☐	

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:

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

Survey Area: No. _____ **Description:** _____
Survey Unit: No. _____ **Description:** _____

Discrepancy: _____

Corrective Actions Taken: _____

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): _____ (Print Name) _____ (Signature) _____ (Date)

Approved by (RSO): _____ (Print Name) _____ (Signature) _____ (Date)

APPENDIX G-2
FINAL STATUS INVESTIGATIONS FOR SOIL SURVEY UNITS

Survey Area: No. _____ **Description:** _____ **Classification:** _____

Survey Unit: No. _____ **Description:** _____

1. Reason for Investigation

☐ Sample(s) with Result(s) > Investigation Levels ☐ Scan Measurement(s) > Investigation Levels

☐ Other

2. Identified Elevated Sample(s)

Elevated Area Designation #	Sample ID	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Tc-99 (pCi/g)	Th-232 (pCi/g)	Ra-226 (pCi/g)	SOF_N

Note: Use net values for Th-232 and Ra-226 and correct negative values for all radionuclides to zero throughout this appendix.

3. Bounding of Identified Elevated Area(s)

a. Is the elevated area(s) adequately verified and bounded by the walkover survey data or the existing samples? Yes ☐ No ☐

1) If "Yes", then proceed to Step 4.

2) If "No", then prepare a new FSS sample instruction (Appendix P-3 of HDP-PR-FSS-701) for this survey unit to take additional samples as necessary to adequately verify and bound the identified area(s) of suspected elevated activity.

APPENDIX G-2
FINAL STATUS INVESTIGATIONS FOR SOIL SURVEY UNITS

b. Bounding Sample(s)

Elevated Area Designation #	Sample ID	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Tc-99 (pCi/g)	Th-232 (pCi/g)	Ra-226 (pCi/g)	SOF_N

4. Elevated Measurement Comparison

a. If the survey unit is classified as Class 2 or Class 3, then proceed to Step 5.

b. In each elevated area, denote the $DCGL_w$ pertinent to the CSM stratum where the elevated sample is located. The DCGLs used to develop the FSS Plans shall be used unless otherwise directed by the RSO.

c. Calculate an area in square meters for the identified elevated area(s) and select the appropriate Area Factor from Appendix E that corresponds to the stratum, area and to the radionuclide with the elevated activity.

Elevated Area Designation #	Area (m^2)	CSM	U-234		U-235		U-238		Tc-99		Th-232		Ra-226	
			$DCGL_w$	AF	$DCGL_w$	AF	$DCGL_w$	AF	$DCGL_w$	AF	$DCGL_w$	AF	$DCGL_w$	AF

APPENDIX G-2
FINAL STATUS INVESTIGATIONS FOR SOIL SURVEY UNITS

d. Calculate a $DCGL_{EMC}$ for each applicable radionuclide by multiplying the $DCGL_w$ for the elevated measurement(s) or sample(s) by the Area Factor.

Elevated Area Designation #	U-234 $DCGL_{EMC}$	U-235 $DCGL_{EMC}$	U-238 $DCGL_{EMC}$	Tc-99 $DCGL_{EMC}$	Th-232 $DCGL_{EMC}$	Ra-226 $DCGL_{EMC}$

e. Calculate the Average Radionuclide Activity (δ_j) for the survey unit.

Note: The Average Radionuclide Activity is calculated using only sample results from the systematic sample population that are located outside of any identified elevated area.

Sample ID	U-234 Conc (pCi/g)	U-235 Conc (pCi/g)	U-238 Conc (pCi/g)	Tc-99 Conc (pCi/g)	Th-232 Conc (pCi/g)	Ra-226 Conc (pCi/g)
Average (δ_j)						

f. Calculate an Elevated Radioactivity Fraction (f_{EMC}) for each identified elevated area as follows:

APPENDIX G-2
FINAL STATUS INVESTIGATIONS FOR SOIL SURVEY UNITS

1) Determine the average concentration (τ_j) for each radionuclide in each identified elevated area.

Elevated Area Designation	U-234 - τ_j (pCi/g)	U-235 - τ_j (pCi/g)	U-238 - τ_j (pCi/g)	Tc-99 - τ_j (pCi/g)	Th-232 - τ_j (pCi/g)	Ra-226 - τ_j (pCi/g)

2) Subtract the Average Concentration of Radionuclide (δ_j) for each radionuclide from Step 4e from the average radionuclide concentration (τ_j) in the elevated area and divide this value by the $DCGL_{EMC}$ from Step 4d to derive a Fraction of $DCGL_{EMC}$ (f_{elev}) for each radionuclide.

3) Sum the Fraction of $DCGL_{EMC}$ (f_{elev}) values for each pertinent radionuclide to derive the Elevated Radioactivity Fraction (f_{EMC}) for the elevated area.

Elevated Area Designation #	U-234		U-235		U-238		Tc-99		Th-232		Ra-226		f_{EMC}
	$(\tau_j - \delta_j)$	f_{elev}	$(\tau_j - \delta_j)$	f_{elev}	$(\tau_j - \delta_j)$	f_{elev}	$(\tau_j - \delta_j)$	f_{elev}	$(\tau_j - \delta_j)$	f_{elev}	$(\tau_j - \delta_j)$	f_{elev}	

g. Sum the Elevated Radioactivity Fractions (f_{EMC}) and for each elevated area.

Elevated Area Designation #	f_{EMC}
Sum of f_{EMC}	

Quality Record

APPENDIX G-2
FINAL STATUS INVESTIGATIONS FOR SOIL SURVEY UNITS

h. Add the SOF value from HDP-PR-FSS-721 Step 8.4.5g to the summed Elevated Radioactivity Fractions (f_{EMC}). This value represents the EMC SOF for this survey unit.

f_{EMC}	*SOF*	*EMC SOF*

i. If the SOF is less than or equal to unity (1), then the survey unit will pass the EMC. If the SOF is greater than unity (1), then proceed to Step 5.

5. Investigation Conclusions

a. Class 2 or 3 Survey Unit

1) Is the concentration for any radionuclide reported in any systematic, biased or investigative sample taken in the survey unit equal to or greater than 50% of its respective $DCGL_w$ for a class 3 survey unit or great than the DCGLw for a class 2 survey unit?

Yes ☐ No ☐ NA ☐

(If "Yes", then initiate Appendix G-4, *"Corrective Actions for FSS Failure"*. If "No", then the investigation is complete and no further action is required.)

b. Class 1 Survey Unit

1) Is the concentration for any radionuclide reported in any systematic, biased or investigative sample taken in the survey unit equal to or greater than its respective $DCGL_w$?

Yes ☐ No ☐ NA ☐

(If "Yes", then proceed to next step. If "No", then the investigation is complete and no further action is required.)

2) Is the EMC SOF for this survey unit greater than unity (1)?

Yes ☐ No ☐ NA ☐

(If "Yes", then initiate Appendix G-4, *"Corrective Actions for FSS Failure"*. If "No", then the investigation is complete and no further action is required.)

APPENDIX G-2
FINAL STATUS INVESTIGATIONS FOR SOIL SURVEY UNITS

6. Comments:

7. Approval

Prepared by (HP Staff): _____ (Print Name) _____ (Signature) _____ (Date)

Peer Reviewed by (HP Staff): _____ (Print Name) _____ (Signature) _____ (Date)

Approved by (RSO): _____ (Print Name) _____ (Signature) _____ (Date)

Quality Record

APPENDIX G-3
FINAL STATUS SURVEY INVESTIGATIONS FOR STRUCTURAL SURVEY UNITS

Survey Area: No. _____ **Description:** _____

Survey Unit: No. _____ **Description:** _____

Classification: _____ _____

1. Reason for Investigation

☐ Measurement(s) with Result(s) > Investigation Levels

☐ Scan Measurement(s) > Investigation Levels

☐ Other:

2. Identified Elevated Measurement(s)

Sample ID	Elevated Area Designation #	Coordinates X	Coordinates Y	Direct Measurement dpm/100cm^2	Direct Measurement Fraction of DCGL

3. Bounding of Identified Elevated Area(s)

a. Is the elevated area(s) adequately verified and bounded by the existing measurements?

Yes ☐ No ☐

1) If "Yes", then proceed to Step 4.

APPENDIX G-3
FINAL STATUS SURVEY INVESTIGATIONS FOR STRUCTURAL SURVEY UNITS

2) If "No", then prepare a new FSS sample instruction (Appendix P-3 in HDP-PR-FSS-701) for this survey unit to take additional measurements as necessary to adequately verify and bound the identified area(s) of suspected elevated activity.

b. Bounding Samples

Elevated Area Designation #	Sample ID	Coordinates		Direct Measurement	
		X	Y	dpm/100cm^2	Fraction of DCGL

4. Elevated Measurement Comparison

a. If the survey unit is classified as Class 2 or Class 3, then proceed to Step 5.

Quality Record

APPENDIX G-3
FINAL STATUS SURVEY INVESTIGATIONS FOR STRUCTURAL SURVEY UNITS

b. Calculate an area in square meters for the identified elevated area(s), select the appropriate area factor from Appendix F that corresponds to the area, and calculate the corresponding $DCGL_{EMC}$ by multiplying the Adjusted Gross DCGL (18,925 dpm/100cm^2) by the Area Factor.

Elevated Area Designation #	Area Size (m^2)	$DCGL_{EMC}$

c. Calculate the Average Gross Activity (δ_j) for the survey unit.

Note: The Average Gross Activity is calculated using only measurement results from the systematic sample population that are located outside of any identified elevated area.

	Gross Activity (dpm/100cm^2)
Average for Survey Unit (δ_j)	

d. Calculate an Elevated Radioactivity Fraction (f_{EMC}) for each identified elevated area as follows.

1) Determine the Average Gross Activity Concentration (τ_j) for each identified elevated area.
2) Subtract the Average Gross Activity (δ_j) from the Average Gross Activity Concentration (τ_j) in the elevated area and divide this value by the $DCGL_{EMC}$ from Step 4b to derive an Elevated Radioactivity Fraction (f_{EMC}) for the elevated area.

Elevated Area Designation #	Avg. for Elevated Area (τ_j) (dpm/100cm^2)	Avg. for Survey Unit (δ_j) (dpm/100cm^2)	(τ_j - δ_j) (dpm/100cm^2)	$DCGL_{EMC}$ (dpm/100cm^2)	Elevated Area Fraction (f_{EMC})

e. Sum the Elevated Radioactivity Fractions (f_{EMC}) for each elevated area.

f. Add the survey unit SOF from HDP-PR-FSS-721 Step 8.4.5 g to the summed Elevated Radioactivity Fractions (f_{EMC}). This value represents the EMC SOF for this survey unit.

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g. If the EMC SOF is less than or equal to unity (1), then the survey unit will pass the EMC. If the EMC SOF is greater than unity (1), then proceed to Step 5.

5. Investigation Conclusions

a. Class 3 Survey Unit

Is the measured gross activity reported for any systematic, biased or investigative sample taken in the survey unit equal to or greater than 50% of the respective $DCGL_w$? Yes ☐ No ☐ NA ☐

(If "Yes", then either prepare a new FSS sample instruction (Appendix P-3 in HDP-PR-FSS-701) indicating the location of additional biased samples to evaluate the extent of the elevated measurement and determine if reclassification is appropriate or initiate Appendix G-4, *"Corrective Actions for FSS Failure"*. If "No", then the investigation is complete and no further action is required.)

b. Class 2 Survey Unit

Is the measured gross activity reported for any systematic, biased or investigative sample taken in the survey unit equal to or greater to the respective $DCGL_w$? Yes ☐ No ☐ NA ☐

(If "Yes", then either prepare a new FSS sample instruction (Appendix P-3 in HDP-PR-FSS-701) indicating the location of additional biased samples to evaluate the extent of the elevated measurement and determine if reclassification is appropriate. or initiate Appendix G-4, *"Corrective Actions for FSS Failure"*. If "No", then the investigation is complete and no further action is required.)

c. Class 1 Survey Unit

1) Is the measured gross activity reported for any systematic, biased or investigative sample taken in the survey unit equal to or greater than its respective $DCGL_w$? Yes ☐ No ☐ NA ☐

(If "Yes", then proceed to the next step. If "No", then the investigation is complete and no further action is required.)

2) Is the EMC SOF for this survey unit greater than unity (1)? Yes ☐ No ☐

(If "Yes", then initiate Appendix G-4, *"Corrective Actions for FSS Failure"*. If "No", then the investigation is complete and no further action is required.)

6. Comments:

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7. Approval

	(Print Name)	(Signature)	(Date)
Prepared by (HP Staff):			
Peer Reviewed by (HP Staff):			
Approved by (RSO):			

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APPENDIX G-4
CORRECTIVE ACTIONS FOR FINAL STATUS SURVEY FAILURE

Survey Area: No. _____ **Description:** _____

Survey Unit: No. _____ **Description:** _____

Classification: _____ _____

Performed by: _____ **Date:** _____ **Time:** _____

Resurvey, Reclassification or Remediation

Based upon the failure of the statistical test or the results of an investigation, the following action(s) are required.

☐ Resurvey Action(s) Required _____

☐ Reclassify Action(s) Required _____

☐ Remediate Action(s) Required _____

Approval

Prepared by (HP Staff): _____ (Print Name) _____ (Signature) _____ (Date)

Approved by (RSO): _____ (Print Name) _____ (Signature) _____ (Date)

Quality Record