ATTACHMENT A

D&D Procedure Cover Page

CHARACTERIZATION/LICENSE TERMINATION PROCEDURE

FINAL RADIATION SURVEY PACKAGE DEVELOPMENT
ZS-LT-300-001-001
Revision No. 2

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Regulatory Required Reviews (per AD-11, "Regulatory Reviews")		
Part 72 ISFSI Impact License: 10 CFR 72.48	☐ YES	☒ NO
Part 50 License: 10 CFR 50.59 and 50.90	☐ YES	☒ NO
Fire Protection: 10 CFR 50.48(f)	☐ YES	☒ NO
Conditions of License: E-Plan: 10 CFR 50.54(q)	☐ YES	☒ NO

QA Review Required? ☐ YES ☒ NO

QA Reviewer: N/A DATE:
Print Name / Signature

Technical Review Required? ☐ YES ☒ NO

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Print Name / Signature

Approval Section

DEPARTMENT MANAGER: [signature] DATE: 1/19/16
RF Yetter / Signature

DECOMMISSIONING PLANT MANAGER*: N/A DATE:
Print Name / Signature

* Required for Technical Reviews only

Effective Date: January 19, 2016

Summary of Changes in this Revision:

Rev. 2 – Added clarification from MARSSIM for areas that do not have sufficient characterization data

1. PURPOSE AND SCOPE

1.1. Purpose

This procedure provides instructions for the development, implementation and review of Final Radiation Survey (FRS) survey packages and sample plans generated to demonstrate compliance with the dose-based unrestricted release criteria at the Zion Station Restoration Project (ZSRP). Because of differences in the conceptual models and required source terms, the FRS includes two different approaches depending on the media; (1) Final Status Survey (FSS) is conducted on soil, buried piping and groundwater to demonstrate that residual radionuclide concentrations are equal to or below site-specific Derived Concentration Guideline Levels (DCGL), and (2) a "Source Term Survey" (STS) is conducted to demonstrate that the inventory of residual radioactivity in building basements, embedded piping and penetrations is below a source term inventory commensurate with the dose criterion in 10 CFR 20.1402.

The term "FRS" is used in this procedure to represent both the FSS and STS surveys. When the discussion applies to only one of the survey methods, either FSS or STS is specifically referenced.

1.2. Scope

This procedure implements the requirements of applicable U.S. Nuclear Regulatory Commission (NRC) regulations and guidance documents; specifically, NUREG-1757, Volume 2, Revision 1 "*Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria"* (Reference 6.1), NUREG-1575, "*Multi-Agency Radiation Survey and Site Investigation Manual"* (MARSSIM, Reference 6.2) and Chapter 5 of the ZSRP License Termination Plan (LTP) (Reference 6.3).

This procedure applies to all personnel performing FRS survey package development and/or implementation.

2. RESPONSIBILITIES

2.1. Characterization/License Termination (C/LT) Manager – is responsible for:

- Providing overall guidance and support for the development and implementation of FRS sample plans and survey packages.
- Reviewing and approving all FRS sample plans.

2.2. Radiological Engineer (RE) – is responsible for:

- Preparing FRS sample plans and survey packages.
- Ensuring FRS surveys are conducted in accordance with approved survey and sampling plans, procedures, and work instructions.
- Providing technical direction and guidance to field survey and sampling activities.

2.3. Characterization/Final Radiation Survey (C/FRS) Supervisor – is responsible for:

- Controlling and implementing sample plan instructions during field activities.
- Survey area/unit preparation, isolation, turnover and prerequisites (e.g., reference grid layout, identification of working constraints and accessibility needs).
- Providing daily supervision and guidance to field survey and sampling crews and performing quality checks of field activities.
- Overseeing the preparation of samples for transfer to on or off site laboratories.
- Ensuring all necessary instrumentation and other equipment is available to support survey activities.

2.4. Graphics/GPS Specialist – is responsible for:

- Preparing survey maps, layout diagrams, composite view drawings and other graphics as necessary to support survey design and reporting.
- Interacting with the RE regarding the preparation of maps, diagrams and other graphics which present survey units and sample or measurement locations.

2.5. Characterization/Final Radiation Survey (C/FRS) Technicians – are responsible for:

- Obtaining and documenting survey measurements in accordance with the survey package instructions.
- Ensuring that all activities, actions, observations and obstructions that are encountered during the performance of characterization are documented in Attachment 14, "Field Log" for that survey unit.

3. DEFINITIONS

3.1. **Area Factor (AF)** – The factor by which an individual measurement within a specific area can exceed the DCGL, while maintaining compliance with the release criterion.

3.2. **Biased Measurements** – Measurements performed at locations selected using professional judgment based on unusual appearance, location relative to known contamination areas, high potential for residual radioactivity, general supplemental information, etc. Biased measurements are not included in the statistical evaluation of the survey unit data because they violate the assumption of randomly selected, independent measurements. Instead, judgment measurements are individually compared to the $DCGL_W$.

3.3. **Data Quality Assessment (DQA)** – The scientific and statistical evaluation of data to determine if the data are of the right type, quantity, and quality for the intended use.

3.4. **Data Quality Objectives (DQO)** – Qualitative and quantitative statements derived from the DQO process that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

3.5. **Derived Concentration Guideline Level (DCGL)** – A derived, radionuclide-specific activity concentration within a survey unit corresponding to the release criterion. The DCGL is based on the spatial distribution of the contaminant and hence is derived differently for the nonparametric statistical test ($DCGL_W$) and the Elevated Measurement Comparison ($DCGL_{EMC}$). DCGLs are derived from activity/dose relationships through various exposure pathway scenarios.

3.6. **Final Radiation Survey (FRS)** – Measurements and sampling to describe the radiological conditions of a site, following completion of decontamination activities (if any) in preparation for release.

3.7. **Final Status Survey (FSS)** – FRS conducted on soil, buried piping and groundwater to demonstrate that residual radionuclide concentrations are equal to or below site-specific DCGLs.

3.8. **Gray Region** – A range of values of the parameter of interest for a survey unit where the consequences of making a decision error are relatively minor. The upper bound of the gray region in MARSSIM is set equal to the $DCGL_W$, and the Lower Bound of the Gray Region (LBGR) is a site-specific variable.

3.9. **Investigation Level** – A derived media-specific, radionuclide-specific concentration or activity level of radioactivity that: 1) is based on the release criterion, and 2) triggers a response, such as further investigation or cleanup, if exceeded.

3.10. **Historical Site Assessment (HSA)** – A compilation of information prepared for use in planning the FRS of a survey unit. It summarizes the operational history, characterization, remedial action, or operational survey data, and other information, such as past burial or spill events, to help establish the final survey unit classification and the bases for the design of the FRS.

3.11. **Measurement** – For the purpose of MARSSIM, it is used interchangeably to mean: 1) the act of using a detector to determine the level or quantity of radioactivity on a surface or in a sample of material removed from a media being evaluated, or 2) the quantity obtained by the act of measuring.

3.12. **Minimum Detectable Concentration (MDC)** – The minimum detectable concentration is the *a priori* activity level that a specific instrument and technique can be expected to detect 95% of the time. When stating the detection capability of an instrument, this value should be used. The MDC is the Detection Limit, L_D, multiplied by an appropriate conversion factor to give units of activity concentration.

3.13. **Nonparametric Statistical Test** – A test based on relatively few assumptions about the exact form of the underlying probability distributions of the measurements. As a consequence, nonparametric statistical tests are generally valid for a fairly broad class of distributions. The Wilcoxon Rank Sum test and the Sign test are examples of nonparametric statistical tests.

3.14. **<u>Reference Area</u>** – Geographical area from which representative reference measurements are performed for comparison with measurements performed in a specific survey unit at remediation site. A site radiological reference area (background area) is defined as an area that has similar physical, chemical, radiological, and biological characteristics as the site area being remediated, but which has not been contaminated by site activities.

3.15. **<u>Sample Plan</u>** – Sample plans are prepared for each survey unit independently and contain, at a minimum, survey instructions, the number and location of survey measurements and samples, survey maps, instrumentation requirements, and safety requirement as necessary.

3.16. **<u>Sign Test</u>** – A nonparametric statistical test used to demonstrate compliance with the site release criterion when the radionuclide of interest is not present in background or constitutes a small fraction of the $DCGL_W$.

3.17. **<u>Source Term Survey (STS)</u>** – FRS conducted to demonstrate that the inventory of residual radioactivity in building basements, embedded piping and penetrations is below a source term inventory commensurate with the dose criterion in 10 CFR 20.1402.

3.18. **<u>Survey Area</u>** – Survey areas are established based on logical physical boundaries and site landmarks for the purpose of documenting and conveying radiological information, and in order to facilitate the scheduling, management and reporting of the FRS. The survey areas may then be sub-divided into one or more survey units to meet the size requirements as specified by MARSSIM.

3.19. **<u>Survey Package</u>** – Survey packages are prepared for each survey unit. A survey package is, in essence, a file that contains all sample plans, results, records and other documents relevant to the FRS of the survey unit.

3.20. **<u>Survey Unit</u>** - The study area consisting of structures or land areas of specified size and shape for which a separate decision will be made to judge whether the remedial action has achieved the site-specific reference-based cleanup standard for the designated pollution parameter. Survey units are generally formed by grouping contiguous site areas with a similar use history and the same classification of contamination potential. Survey units are established to facilitate the survey process and the statistical analysis of survey data. *The survey unit is the fundamental unit of compliance. Each survey unit will meet, or fail to meet, the release criteria independently of all the other survey units. All the survey units must pass if the site is to be released.*

3.21. **<u>Survey Unit Release Record</u>** – A document compiled for each survey unit which demonstrates that it is suitable for unrestricted use. It contains evaluated survey data and supporting information to provide a concise record of the survey results and basis for the conclusion that the release criteria are satisfied.

3.22. **<u>Type I Error (α)</u>** – A decision error that occurs when the null hypothesis is rejected when it is true for the scenario used. This would result in incorrectly releasing an area that does not meet the release criteria.

3.23. **<u>Type II Error (β)</u>** – A decision error that occurs when the null hypothesis is not rejected when it is false for the scenario used. This would result in failing to release an area that meets the release criteria.

3.24. **<u>Unity Rule</u>** – A rule applied when more than one radionuclide is present at a concentration that is distinguishable from background and where a single concentration comparison does not apply. In this case, the combination of measurement results for each singular radionuclide present in the distribution are compared against the release criteria by applying the unity rule. This is accomplished by determining: 1) the ratio between the concentration of each radionuclide in the mixture, and 2) the concentration for that radionuclide that coincides with the release criteria (DCGL). To demonstrate compliance for the survey unit, the sum-of-fractions (SOF) for all radionuclides in the mixture should not exceed 1.

3.25. **<u>Wilcoxon Rank Sum (WRS) Test</u>** – A nonparametric statistical test used to determine compliance with the site release criterion when the radionuclide of concern is present in background

3.26. **<u>Acronyms</u>**

α	Type I Error Probability
β	Type II Error Probability
σ	Standard Deviation (sigma)
AF	Area Factor
CoC	Chain-of-Custody
CFR	Code of Federal Regulations
C/FRS	Characterization/Final Radiation Survey
C/LT	Characterization/License Termination
DCGL	Derived Concentration Guideline Level
DQA	Data Quality Assessment
DQO	Data Quality Objectives
EMC	Elevated Measurement Comparison
ETD	Easy to Detect
FRS	Final Radiation Survey
FOV	Field of View
FSS	Final Status Survey
GPS	Global Positioning System
HSA	Historical Site Assessment
HTD	Hard-to-Detect

ISOCS	*In-Situ* Object Counting System
L	Grid Spacing
LBGR	Lower Bound of the Grey Region
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
NAD	North American Datum
NRC	United States Nuclear Regulatory Commission
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RASS	Remedial Action Support Survey
RE	Radiological Engineer
ROC	Radionuclides of Concern
RWP	Radiation Work Permit
SFP	Spent Fuel Pool
SOF	Sum-of-Fractions
STS	Source Term Survey
TSD	Technical Support Document
VSP	Visual Sample Plan
WRS	Wilcoxon Rank Sum
WWTF	Waste Water Treatment Facility
ZSRP	Zion Station Restoration Project

4. PRECAUTIONS, LIMITATIONS, AND PREREREQUISITES

4.1. Precautions

4.1.1 Documents and databases containing FRS survey data and survey records are Quality Assurance (QA) records when complete. Positive control of these records shall be maintained until they are forwarded to Records Management in accordance with AD-20, *"Records Management Program"* (Reference 6.4).

4.1.2 When documenting survey information, ensure that all QA records are of good quality and legible. Legibility is determined to be readable and reproducible.

4.1.3 For FSS survey design, if background is a significant fraction of the $DCGL_w$, the WRS test shall be used. If the contaminant is not in the background or constitutes a small fraction of the $DCGL_w$, the Sign Test shall be used. The determination of which test to use will be integral to the DQO process implemented during the FSS design.

4.1.4 In Class 1 open land survey units, a subsurface soil sample shall be taken at 10% of the systematic surface soil sample locations in the survey unit with the location(s) selected at random.

4.1.5 For open land survey units, if during the performance of FSS, the analysis of a surface soil sample, or the results of a surface gamma scan indicates the potential presence of residual radioactivity at a concentration of 75% of the subsurface $DCGL_w$, then additional biased subsurface soil sample(s) shall be taken to the appropriate depth within the area of concern as part of the investigation.

4.2. Limitations

4.2.1 All attachments described in this procedure may be generated electronically. If electronic attachments are used, the physical layout of the attachment may be modified provided the intent described in this procedure is not changed.

4.2.2 The output of the design process is the sample plan (instructions). A sample plan is prepared for each survey unit independently. A survey package is prepared for each survey unit and may contain one or more sample plans.

4.2.3 Radiation detection and measurement instrumentation will be selected based on the type and quantity of radiation to be measured. The target MDC for measurements obtained using field instruments will be 50 percent of the applicable $DCGL_w$.

4.2.4 Instruments used for scan measurements in Class 1 areas are required to be capable of detecting radioactive material at the $DCGL_{EMC}$.

4.2.5 The target MDC for measurements obtained using laboratory instruments will be 10 percent of the applicable $DCGL_w$.

4.2.6 Measurement results with associated MDC that exceed the target MDC values may be accepted as valid data after evaluation by C/LT supervision.

4.2.7 The Canberra *In-Situ* Object Counting System (ISOCS) has been selected as the primary instrument that will be used to perform STS. Zion*Solutions* Technical Support Document (TSD) 14-022, "*Use of In-Situ Gamma Spectroscopy for Source Term Survey of End State Structures*" (Reference 6.5) provides the initial justification for selecting a reasonably conservative geometry for efficiency calibrations for the ISOCS based on the physical conditions of the remediated surface and the depth and distribution of activity in the concrete surface. Review post remediation conditions and surveys to determine if the geometry of remaining residual radioactivity has significantly changed from that assumed in TSD 14-022. If the geometry appears to be significantly different from that which was assumed in TSD 14-022, then inform the C/LT Manager.

4.2.8 After completion of the FRS in a specific survey unit, the sample plan is reviewed for completeness and the data validated in accordance with ZS-LT-300-001-004, *"Final Radiation Survey Data Assessment"* (Reference 6.6) before sample plan closure and the reporting of results.

4.2.9 Upon closure of the sample plan, a survey unit release record will be prepared for each survey unit within the survey area in accordance with ZS-LT-300-001-005, *"Final Radiation Survey Reporting"* (Reference 6.7).

4.2.10 For the FRS of Class 3 survey units, if a randomly selected location is found to be either inaccessible or unsuitable, then the location will be adjusted to the closest adjacent suitable location. In these cases, a notation will be made in Attachment 14, "Field Log" and the coordinates of the new location documented.

4.3. Prerequisites

4.3.1 A FRS package will be prepared for each applicable survey unit. A folder designated as the FRS package should be utilized to keep original documents. The folder shall be controlled in accordance with the record quality requirements of ZS-LT-01 *"Quality Assurance Project Plan (QAPP) for Characterization and Final Radiation Survey"* (Reference 6.8).

4.3.2 The impacted structural and open land survey areas at ZSRP have been subdivided into Class 1, Class 2, or Class 3 survey units. The initial classifications and survey unit boundaries are specified in the Commonwealth Edison *"Zion Station Historical Site Assessment"*, (HSA, Reference 6.9). Actual open land survey unit boundaries may vary from the conceptual survey unit boundaries presented in the HSA based on actual conditions at the time of survey design as long as the classification does not change. The survey units designated for structures below 588 foot elevation from the HSA were based on screening values and source term assumptions that are not applicable.

4.3.3 With the exception of the Auxiliary Building, where the walls and floor will be separate survey units, the STS survey units will be comprised of the combined wall and floor surfaces of each remaining building basement (i.e. Unit 1 Containment, Unit 2 Containment, Turbine Building, Crib House/Forebay, Waste Water Treatment Facility (WWTF), remnants of the Spent Fuel Pool (SFP)/Fuel Transfer Canal and the Circulating Water Intake and Circulating Water Discharge Tunnels). The total embedded pipe located within a STS survey area will be treated as a separate STS survey unit. As such, the STS penetration and/or embedded pipe survey unit will be part of the summation of the fraction of the inventory source term calculated for each building basement in which they are located.

4.3.4 Characterization data, radiological surveys performed to support commodity removal, and surveys performed to support structural remediation for open air demolition will be used to verify that the contamination potential within each STS survey unit is reasonably uniform throughout all walls and floor surfaces.

4.3.5 The size of a Class 1 open land survey unit will not exceed 2,200 m^2 and the size of a Class 2 open land survey unit will not exceed 11,000 m^2 without approval of the C/LT Manager.

4.3.6 Final classification of an open land survey unit should be assigned and/or validated in accordance with ZS-LT-300-001-002, *"Survey Unit Classification"* (Reference 6.10).

4.3.7 Prior to issuance of a specific sample plan for performance of the FRS, isolation and control measures shall be established in accordance with ZS-LT-300-001-003, *"Isolation and Control for Final Radiation Survey"* (Reference 6.11).

4.3.8 Survey units should be cleared of all loose equipment and materials to the maximum extent possible.

NOTES

The vegetation in open land survey units should be cut as close to the ground surface as possible.

With the exception of accessibility, the use of an ISOCS for FSS does not require vegetation to be removed.

4.3.9 To eliminate physical obstructions, open land survey units should be cleared of debris and/or vegetation to the extent possible.

4.3.10 All identified physical hazards in the survey unit shall be either removed or marked as appropriate.

4.3.11 Prior to performing FRS, a reference coordinate system or grid will be established. For the FSS of open land survey units, reference coordinates will be acquired using a Global Positioning System (GPS) coupled with the North American Datum (NAD) standard topographical grid coordinate system.

4.3.12 The systematic sampling and measurement locations within each survey unit will be clearly identified and documented for the purposes of reproducibility. Actual measurement locations will be marked and identified by tags, labels, flags, stakes, paint marks, GPS location, photographic record, or equivalent.

4.3.13 Prior to using any survey instrument, the current calibration will be verified. Response checks will be performed daily before instrument use and again at the end of use.

5. MAIN BODY

5.1. FRS Package Numbering

NOTES

The Survey Area Number, Survey Unit Number and current classification are taken from the updated master copy of "Survey Units for Open Land Areas" and "Survey Units for Structures" that are maintained by the C/LT Manager in accordance with procedure ZS-LT-300-001-002, *"Survey Unit Classification"*.

5.1.1 Prepare a FRS Package. FRS Packages will be designated as follows:

1.) The 1st digit indicates the type of Survey Area
   - A. L = Open Land
   - B. B = Structural
   - C. S = System

2.) The 2nd digit indicates the Current Classification
   - A. 1 = Class 1
   - B. 2 = Class 2
   - C. 3 = Class 3
   - D. 4 = Non-Impacted
   - E. 5 = Unassigned

3.) The 3rd, 4th and 5th digits indicates Survey Area Number

4.) The 6th and 7th digits indicates Survey Unit Number

5.) The 8th digit is the alphanumeric sequence where: Sequence A-J allows the survey unit to be divided into 10 smaller survey units. Sequence K-Z allows for up to 16 different survey instructions for a single survey unit.

6.) The 9th digit is the letter "F" to designate FSS or the letter "S" to designate STS.

5.2. FRS Sample Plan Development

5.2.1 Prepare a FRS Sample Plan for each survey unit independently. A FRS Package may contain one or more FRS Sample Plans.

NOTE

The RE tasked with the development and implementation of multiple FRS Sample Plans for a single survey unit must be aware that it is possible that duplicate sample/measurement numbers may be generated when using the guidance for designating a unique sample identification number in accordance with the "Sample & Measurement Unique Identification Designation" presented in Attachment 7. Consequently, the responsible RE must be vigilant to ensure that this does not occur.

5.2.2 Designate each FRS Sample Plan in the FRS Package specific to a survey unit numerically by sequence (e.g., Plan #1, Plan #2, etc…).

5.2.3 A FRS sample plan will usually contain the items listed below.

1.) Attachment 11, "FRS Sample Plan Cover Sheet."

2.) "Area Turnover and Control Checklist" from ZS-LT-300-001-003, *"Isolation and Control for Final Radiation Survey"*.

3.) "Pre-Turnover Walk-Down" from ZS-LT-300-001-003, *"Isolation and Control for Final Radiation Survey."*

4.) "Survey Unit Classification Basis Summary" from ZS-LT-300-001-002, *"Survey Unit Classification."*

5.) "Survey Unit Classification Worksheet" from ZS-LT-300-001-002, *"Survey Unit Classification."*

6.) Attachment 12, "FRS Data Quality Objectives and Survey Design."

7.) Attachment 13, "Survey Instructions."

8.) Attachment 14, "Field Log."

9.) Attachment 15, "Sample/Measurement Identification and Coordinates."

10.) Attachment 16, "Scan Area Identification and Coordinates."

11.) Photographs, maps, and/or drawings of the survey unit.

12.) FRS field measurement and analytical results.

5.2.4 Include any available relevant information for the survey unit, (i.e. as-built floor plans, blue prints, photographs, computer generated or hand drawn survey maps) in the FRS sample plan.

5.2.5 Provide a unique sample identification number for all FRS direct measurements and/or samples in accordance with Attachment 7, "Sample & Measurement Unique Identification Designation."

5.3. FRS Sample Plan Cover Sheet

5.3.1 Initiate Attachment 11, "FRS Sample Plan Cover Sheet" for the survey unit.

5.3.2 Complete the General Section of Attachment 11, by entering the requested information.

5.3.3 Assess the readiness of the survey unit by completing the "Preparation for Final Radiation Survey" section of Attachment 11 using the following guidance:

1.) Ensure that a pre-FRS walk-down of the survey unit has been performed in accordance with ZS-LT-300-001-003, *"Isolation and Control for Final Radiation Survey"* and that all items identified for hazard mitigation and area preparation have been satisfactorily completed.

2.) Ensure that all turnover items that were identified on the "Area Turnover and Control Checklist" from ZS-LT-300-001-003, *"Isolation and Control for Final Radiation Survey"*, have been completed or resolved prior to signifying readiness.

5.3.4 The responsible RE shall signify by signature on Attachment 11 that the survey unit is ready for FRS implementation.

5.4. FRS Data Quality Objectives and Survey Design

5.4.1 Initiate Attachment 12, "FRS Data Quality Objectives and Survey Design" for the survey unit.

> **NOTE**
>
> The problem associated with FRS is to determine whether the survey unit meets a specified radiological release criterion (e.g., 10 CFR 20.1402).

5.4.2 State the Problem - commence survey design through the DQO process by providing a clear description of the problem and a conceptual model of the hazard to be investigated.

1.) Clearly state the problem.

2.) Identify the stakeholders.

3.) Identify the planning team and decision maker(s).

4.) Specify the anticipated schedule for the activity.

5.) Identify the resources and support that will be required to successfully complete the activity.

> **NOTE**
>
> The principal study question for FSS might be, "Does the residual radioactive contamination present in the survey unit exceed the release criteria?". The principal study question for STS might be, "Is the inventory of residual radioactivity in the building basement, including all relevant embedded piping and penetrations, when multiplied by the Basement Dose Factors, below the 25 mrem/yr dose criterion?". Alternative actions may include no action, investigation, re-survey, remediation and/or reclassification. The stated decision may be, "IF any of the measurement data results exceed the release criteria, THEN use the DQA process to evaluate the alternative action or combination of actions".

5.4.3 Identify the Decision – develop objectives for the FRS, or if applicable, several objectives, based on the stated problem.

1.) State the principal study question.

2.) List any alternative actions.

3.) Clearly state the decision.

5.4.4 Identify Inputs to the Decision - Identify the types and quantity of radiological data that will be necessary to address the objectives identified in the previous step.

1.) State the information needed.

A. Identify the sample media (e.g., surface soil, concrete).

B. Identify the types of measurement (e.g., scan, static measurement, surface soil sampling, etc.).

C. Identify sources of information that will be used (e.g., HSA, previous survey data, etc).

2.) Summarize any relevant historical information for the survey unit using the following guidance:

A. Summarize the function of the survey unit during facility operation.

B. Summarize any process events, spills or radiological incidents that have been documented in the HSA and are pertinent to the survey unit.

C. Summarize the current radiological condition of the survey unit using all available past and present radiological surveys [e.g. routine surveys, Radiation Work Permit (RWP) coverage surveys] that are pertinent to the survey unit.

3.) List the Radionuclides-of-Concern (ROC) and the basis for being included in the sampling plan.

NOTE

Attachment 1 presents the Basement Dose Factors from LTP Chapter 5, Table 5-3. Attachment 2 presents the site-specific DCGLs for surface and subsurface soils reproduced from Table 5-4 and Table 5-5 of LTP Chapter 5. Attachment 3 presents the site-specific DCGLs for buried pipe reproduced from Table 5-6 of LTP Chapter 5.

For multiple radionuclides, the unity rule applies.

4.) State the release criteria (DCGL or Basement Dose Factors) for each ROC applicable to the survey.

5.) Summarize the radiological survey data that will be used for FSS design for open land and buried pipe survey units. For STS survey units, summarize the historical radiological conditions applicable to the survey unit and proceed to step 5.4.5.

A. Review the characterization and/or RASS sample data to determine if adequate data is available to perform FSS design. When preliminary data are not obtained, it may be reasonable to assume a coefficient of variation on the order of 30%, based on experience.

B. Derive and list the basic statistical data for each analyzed radionuclide or direct measurement in the survey data that will be used for the FSS design for the survey unit. At a minimum, the statistics will include the minimum, maximum, mean and median value of the data set and the standard deviation.

C. Calculate a mean SOF for the survey data that will be used for the FSS design using the following equation.

$$SOF_{Mean} = \frac{Conc_1}{DCGL_1} + \frac{Conc_2}{DCGL_2} + \cdots\cdots \frac{Conc_n}{DCGL_n}$$

Where $Conc_n$ = mean concentration of radionuclide n and

$DCGL_n$ = DCGL of radionuclide n

D. Calculate a weighted Standard Deviation (σ_{SOF}) for the survey data that will be used for the FSS design for the survey unit.

$$\sigma_{SOF} = \sqrt{\left[\left(\frac{\sigma_1}{DCGL_1}\right)^2 + \left(\frac{\sigma_2}{DCGL_2}\right)^2 + \cdots\cdots \left(\frac{\sigma_n}{DCGL_n}\right)^2\right]}$$

Where σ_n = standard deviation of radionuclide n and

$DCGL_n$ = DCGL of radionuclide n

NOTE

Characterization or RASS data with excessive variability is typically not representative of the radiological condition of the survey unit at the time of the FSS.

E. Assess the variability of the survey data that will be used for survey design.

F. Document on the sample plan that the characterization and/or RASS data that will be used for survey design is satisfactory. If the data is not satisfactory, then provide a technical justification to continue the planning process that includes an assessment of process knowledge and historical information. Document the basis in the sample plan or, stop and perform additional characterization surveys and repeat the planning process.

G. Determine the need to sample and analyze for HTD radionuclides or, if a surrogate relationship will be established between the presence of the HTD radionuclide and a gamma-emitting radionuclide.

i. If a surrogate relationship is to be established, then describe the survey populations used to establish the relationship, the fraction that will be used to mathematically describe the relationship between the HTD radionuclide and gamma-emitting or easy-to-detect (ETD) radionuclide and the basis for its use.

ii. Derive the surrogate DCGL using the following equation;

$$DCGL_{sur} = \frac{1}{\left[\left(\frac{1}{DCGL_1}\right) + \left(\frac{R_2}{DCGL_2}\right) + \left(\frac{R_3}{DCGL_3}\right) + \cdots \left(\frac{R_n}{DCGL_n}\right)\right]}$$

Where $DCGL_{sur}$ = Surrogate DCGL for ETD radionuclide

R_n = Established ratio of radionuclide n with radionuclide to be used as surrogate

$DCGL_n$ = DCGL of radionuclide n

6.) Describe the action levels as well as the actions that will be taken if they are reached. The action level provides the criterion used during the decision process for choosing among alternative actions.

7.) Establish the requisite scan coverage area for the sample plan and the basis for the selection.

A. Survey units will be scanned in accordance with their classification. Scan coverage recommendations for characterization for each class of survey unit is presented in Attachment 4.

B. If less than 100% scan coverage is required, then designate areas to be scanned using the reference coordinate system that equates to the required total area that is to be scanned and document the basis of why that area was selected.

C. Designate scan locations, and location coordinates on Attachment 16, "Scan Area Identification and Coordinates" and on the survey map.

D. If less than 100% scan coverage is required, then a 1-meter radius should be scanned around each probability-based and biased sample location in addition to the area designated for scanning.

8.) Determine and document the type and frequency of Quality Control (QC) measurements using the QAPP as guidance.

9.) Determine the investigation levels using Attachment 5 as guidance and document in the sampling plan.

NOTE

Static and Scan MDC for scanning structures and soil will be determined in accordance with the guidance provided in Attachment 8.

10.) Determine the type of analyses that will be performed on material sample(s).

A. Establish the analytical MDCs and reporting errors necessary to meet objectives of the sampling plan.

B. Designate the radiological instrumentation that will be used to acquire field measurements and document that the static and scan MDC is sufficient for the action levels specified.

C. Establish criteria for sample moisture content, considering the impact on detection sensitivity to low energy photons or particles (requires drying or maximum moisture content).

5.4.5 Define the Study Boundaries

1.) Generate a computerized survey map for the survey unit and include the boundaries of the entire survey unit and major geographic or physical features. (If necessary, drawings may be substituted for computer generated maps). Ensure the graphic representation of the dimensions and boundaries correspond to the established reference coordinate system.

2.) Describe the boundaries, physical conditions, orientation and landmarks of the survey unit using the following guidance:

A. Describe the spatial boundaries of the survey unit, including length and width in meters.

B. Describe the different surfaces and media present in the survey unit (e.g. surface soil, sediment bed, sand beach).

C. Describe any physical landmarks or prominent features present.

D. Describe the orientation of the survey unit in relation to other survey units, prominent or established geographic landmarks and compass direction.

3.) Describe the temporal boundaries, including the anticipated schedule for performing the survey, the expected weather conditions and any time constraints.

4.) Describe any applicable and practical constraints or conditions when survey performance may not be possible, including but not limited to, physical obstacles to access the area of interest and inclement weather.

5.) Identify contingencies when possible to define acceptable solutions or alternatives to these constraints.

5.4.6 Develop a Decision Rule - Using the "If", "Then" format, and create a condition or set of condition(s) where a conclusion or set of conclusions can be made in regard to the objectives of the survey based on comparison of the survey results with the action level(s) and/or an assessment of the data statistics.

5.4.7 Specify Limits on Decision Errors

1.) State the null hypothesis (e.g., "The survey unit exceeds the release criteria.")

> **NOTE**
>
> Section 5.5.2.2 of LTP Chapter 5 presents the logic and reasoning employed to determine adequate areal coverage based upon contamination potential for each STS survey unit. The required number of ISOCS measurements required in each STS survey unit was then calculated as the quotient of the ISOCS Field-of-View (FOV) divided into the surface area required for areal coverage. To ensure that the number of ISOCS measurements based on the necessary areal coverage in a STS survey unit was sufficient to satisfy a statistically based sample design, a simplified calculation was performed to determine sample size using the guidance in MARSSIM. This calculation is summarized in section 5.5.2.2 of LTP Chapter 5 and was applied to the Class 2 and Class 3 STS survey units. Attachment 6 presents the STS survey units and the minimum number of ISOCS measurements that shall be taken in each for STS.

2.) If performing survey design for STS, then proceed to 5.4.8, step 5.

3.) Define both the Type I, or (α value) error and the Type II, or (β value) error as "0.05." The Type I error will always be set at 0.05 unless prior NRC approval is granted for using a less restrictive value. The Type II error may be adjusted with the concurrence of the C/LT Manager, after weighing the resulting change in the number of required sample or measurement locations against the risk of unnecessarily investigating and/or remediating survey units that are truly below the release criterion.

> **NOTE**
>
> If no other information is available regarding the survey unit, the LBGR may be initially set equal to 0.5 times the applicable $DCGL_W$ and may be set as low as the MDC for the specific analytical technique.

4.) Establish the LBGR. The LBGR should be initially set at the mean concentration of residual radioactivity that is estimated to be present in the survey unit or the mean Sum-of-Fractions (SOF_{Mean}) if multiple radionuclides are present.

5.4.8 Optimize the Design.

> **NOTE**
>
> The Sign Test is expected to be the most appropriate test for ZSRP FRS results because background is expected to constitute a small fraction of the DCGL. If a situation is encountered where background is a significant fraction of the DCGL, the WRS Test may be used.

1.) Determine the appropriate statistical test, Sign Test or WRS that will be used to meet the objectives of the sampling plan.

2.) Calculate the relative shift (Δ/σ) using the following equation:

$$\Delta/\sigma = \frac{Action\ Level - LBGR}{\sigma_{SOF}}$$

where; Δ/σ = Relative Shift

LBGR = Lower Bound of the Gray Region

A. If the resulting Relative Shift is between (and including) one (1) and three (3), then go to step 3.). Otherwise, proceed to the next step.

B. If the Relative Shift is greater than three (3), then use a value of three (3) as the adjusted Relative Shift. Adjust the LBGR by subtracting the estimated concentration variability from the DCGL.

C. If the Relative Shift is less than one (1), then stop and return to the DQO process to determine the cause and/or make adjustments to the DQOs.

3.) Determine the number of samples (N) needed in the survey unit for the selected values of Type I error (α), Type II error (β) and Relative or adjusted Relative Shift (Δ/σ) from the appropriate table of the number of samples and record in the space provided.

A. If the Sign Test has been chosen as the statistical test, then use Attachment 9 to determine N.

B. If the WRS Test has been chosen as the statistical test, then use Attachment 10 to determine N/2.

4.) Ensure that the scan MDC of the instrument and detector that will be used for scanning is less than the $DCGL_w$ of the most limiting ROC or surrogate radionuclide. If the scan MDC is greater than the $DCGL_w$ of the most limiting ROC or surrogate radionuclide, then the N value must be adjusted in accordance with MARSSIM, section 5.5.2.4.

NOTE

Software such as Visual Sample Plan (VSP) may be used to determine the location of samples or direct measurements in lieu of the following steps.

5.) Calculate the Grid Spacing

A. If the survey unit is classified as Class 3, then proceed to step 6.

B. If the survey unit is STS and classified as Class 1 (Auxiliary Building 542 foot Floor or the SFP/Transfer Canal), then sufficient ISOCS measurements shall be taken in the survey units to provide 100% areal coverage.

C. If the survey unit is STS and classified as Class 2 or, if the survey units is FSS and classified as Class 1 or Class 2, then calculate the Grid Spacing (L) as follows;

D. $L = \sqrt{\frac{\text{Area}}{.866\left(N\ or\ N/2\right)}}$ for a triangular grid, or $L = \sqrt{\frac{\text{Area}}{\left(N\ or\ N/2\right)}}$ for a square grid

6.) Generate a Survey Map

A. Assign a unique identification number to each sample in the Statistical Sample Population using the guidance and direction provided in Attachment 7.

> **NOTE**
>
> A computer generated survey map shall be generated for each sample plan and should show the boundaries of the entire survey unit, major geographic or physical features and the coordinates of all survey locations.
>
> Software such as VSP may be used to determine the location of samples or direct measurements in lieu of the following steps.

B. Generate a graphic representation of the Survey Unit with dimensions and boundaries corresponding to the established reference coordinate system.

C. If the survey unit is classified as STS Class 1, then establish a sufficient number of measurement locations with an overlapping FOV to provide 100% areal coverage and continue to step H.

D. If the survey unit is classified as STS or FSS Class 3, then establish sample locations on the survey map using a random-number generator and continue to step H.

> **NOTE**
>
> The grid spacing may be rounded down for ease of locating sampling and measurement locations on the reference grid. Depending on the configuration and layout of the survey unit and the starting grid location, the minimum number of sampling and measurement locations may not be identified (as they fall out of the survey unit footprint). In this event, either a new random starting location will be specified or the grid spacing adjusted downward until the appropriate number of locations is reached.

E. If the survey unit is STS and classified as Class 2 or, if the survey units is FSS and classified as Class 1 or Class 2, then establish a Random Starting Point within the Survey Unit.

F. Starting from the randomly-selected location, establish a row of points parallel to one of the survey units axes at intervals of L.

G. Establish additional rows parallel to the first row.

i. For a triangular grid, additional rows will be added at a spacing of 0.866L from the first row, with points on alternate rows spaced mid-way between the points from the previous row.

ii. For a square grid, points and rows will be spaced at intervals of L.

H. Using the reference coordinate system, ascertain coordinates for each sample location.

I. Designate sample locations, and location coordinates on Attachment 15, "Sample/Measurement Identification and Coordinates."

7.) Designate 5% of the systematic measurement and/or sample locations, chosen at random, for replicate measurement and/or split sample analyses in accordance with the QAPP. Designate QC sample locations, and location coordinates on Attachment 15, "Sample/Measurement Identification and Coordinates" and the survey map.

> **NOTE**
>
> Biased samples are not included as part of the Statistical Sample Population. Rather, they are treated as pre-emptive investigation samples.

8.) Designate if any biased samples will be taken at the discretion of the survey designer and the basis for taking them.

A. Using the reference coordinate system, ascertain coordinates for each biased sample location.

B. Designate biased sample locations and location coordinates on Attachment 15, "Sample/Measurement Identification and Coordinates" and the survey map.

5.5. Sample Plan Survey Instructions

> **NOTE**
>
> Survey instructions may be provided without using Attachment 13 provided all the applicable items of the Survey Instruction attachment are included.

5.5.1 Complete the General Instructions section of Attachment 13, "Survey Instructions." The type of instructions that may be specified in the General Instructions include but are not limited to the following:

1.) Area description and dimensions, physical features, water bodies and natural boundaries.

2.) Any temporal boundaries such as:

A. Expected weather conditions

B. Time constraints

C. Schedule for survey (e.g., round-the-clock, daylight hours).

3.) Safety considerations including any required Personal Protective Equipment, safety sampling and/or safety surveillances.

4.) References to relevant procedures for survey performance, sample collection and sample analysis.

5.) A list of all equipment and instrumentation required to perform the survey, as well as applicable procedural references.

6.) Quality control measures such as instrument calibration requirements, instrument control requirements and instrument response check requirements as necessary.

7.) Additional requirements such as GPS use, marking of sample locations, documentation, photographs, etc.

5.5.2 Complete the Specific Instructions section of Attachment 13. The type of instructions that may be specified in the Specific Instructions include, but are not limited, to the following:

1.) Description of potential safety hazards that may be encountered during performance of the survey.

2.) Identified areas, conditions or constraints where sampling or surveying may not be possible and alternative solutions to support survey requirements if these obstacles are encountered.

3.) Specific instructions for performing sampling, scans, static measurements, loose surface contamination measurements or special measurements that may include, but is not limited to:

A. Area (in square meters) and location for surface scans.

B. Specific scanning instructions including scan speed, pattern (e.g., serpentine), alarm set-points, action levels, background check, etc.

C. Scan MDC requirements.

D. Contingency for relocating sample location due to obstacle, obstruction, or for safety reasons.

E. Instructions for background correction if applicable.

F. Count times for static measurements.

G. Desired depth and volume requirements for surface and subsurface soil samples.

H. Directions for collecting and analyzing samples of other media types.

I. Directions for collecting water, sediment or vegetation samples as necessary.

4.) Instructions for performing other radiological surveys.

5.) Instructions for quality control (e.g., techniques to prevent cross-contamination, proper sampling, and labeling techniques).

6.) Investigation actions to be performed in the survey specific instructions if action levels for scanning are exceeded.

7.) Documentation requirements (e.g., survey map, documentation of anomalies, clarity and good legibility).

8.) Chain-of-Custody (CoC) instructions in accordance with procedure ZS-WM-131, *"Chain-Of-Custody"* (Reference 6.12).

9.) Any areas of interface where the progress of the survey will be contingent on interaction or support from another department or group (e.g., security notification, man-lift support, scaffold erection support, excavation or soil loading support, etc.)

5.6. Sample Plan Approval

5.6.1 Once a sample plan is complete, forward it to a separate qualified individual to perform an independent peer review to check for plan completeness, accuracy of calculations and viability of assumptions.

5.6.2 Complete the independent peer review and sign as the reviewer on Attachment 11, "FRS Sample Plan Cover Sheet." **(Peer Reviewer)**

5.6.3 Upon completion of the peer review, forward the sample plan to the C/LT Manager for approval.

NOTE

FRS may not proceed in a survey unit until Attachment 11 has been signed by the C/LT Manager.

5.6.4 Signify approval of the FRS Sample Plan by signing Attachment 11, "FRS Sample Plan Cover Sheet." **(C/LT Manager)**

5.7. Survey Package Implementation

5.7.1 Perform a pre-survey briefing with the C/FRS Technicians to review instructions and safety issues. **(RE)**

5.7.2 Initiate a Field Log (Attachment 14) for the sample plan. **(C/FRS Supervisor)**

5.7.3 Perform surveys in accordance with the survey unit specific survey instructions contained in each FRS Sample Plan. **(C/FRS Technicians)**

1.) If a situation is encountered in which survey instructions cannot be followed as written, then contact the responsible RE for resolution.

A. Make minor changes that do not affect the technical content of the survey package (typographical errors, instrument ID, etc.) using a pen and ink change.

B. Make major changes to survey instructions that would affect the technical content (i.e. number of measurements, instrument MDC, etc.) by revising the sample plan instructions and include a revision number. Document sample plan revisions and reasons and forward the revised sample plan to the C/LT Manager for approval.

6. REFERENCES

6.1. NUREG-1757, “Consolidated NMSS Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria” Volume 2, Revision 1 – September 2002

6.2. NUREG-1575, “Multi-Agency Radiation Survey and Site Investigation Manual” (MARSSIM) – August 2000

6.3. Zion Station Restoration Project License Termination Plan – December 2014

6.4. AD-20, “Records Management Program”

6.5. ZionSolutions Technical Support Document 14-022, “Use of In-Situ Gamma Spectroscopy for Source Term Survey of End State Structures” – May 2015

6.6. ZS-LT-300-001-004, “Final Radiation Survey Data Assessment”

6.7. ZS-LT-300-001-005, “Final Radiation Survey Reporting”

6.8. ZS-LT-01 “Quality Assurance Project Plan (QAPP) for Characterization and FRS”

6.9. Commonwealth Edison “Zion Station Historical Site Assessment”

6.10. ZS-LT-300-001-002, “Survey Unit Classification”

6.11. ZS-LT-300-001-003, “Isolation and Control for Final Radiation Survey”

6.12. ZS-WM-131, “Chain-Of-Custody”

6.13. ISO 7503-1, “Evaluation of surface contamination – Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters”

6.14. Zion*Solutions* Technical Support Document 11-004, *“Ludlum Model 44-10 Detector Sensitivity”* – February 2012

7. RECORDS

7.1. Final Radiation Survey Package

8. ATTACHMENTS

8.1. Attachment 1, Basement Dose Factors

8.2. Attachment 2, Site-Specific DCGLs for Surface and Subsurface Soils

8.3. Attachment 3, Site-Specific DCGLs for Buried Piping

8.4. Attachment 4, Recommended Scan Coverage

8.5. Attachment 5, Investigation Levels

8.6. Attachment 6, Number of ISOCS Measurements per STS Survey Unit based on Areal Coverage

8.7. Attachment 7, Sample & Measurement Unique Identification Designation

8.8. Attachment 8, Calculation of Static and Scan MDC

8.9. Attachment 9, Number of Samples Required for the Sign Test

8.10. Attachment 10, Number of Samples Required for the WRS Test

8.11. Attachment 11, FRS Sample Plan Cover Sheet

8.12. Attachment 12, FRS Data Quality Objectives and Survey Design

8.13. Attachment 13, Survey Instructions

8.14. Attachment 14, Field Log

8.15. Attachment 15, Samples/Measurement Identification & Coordinates

8.16. Attachment 16, Scan Area Identification & Coordinates

9. FORMS

None

Attachment 1
Basement Dose Factors

Nuclide	Auxiliary	Containment	Turbine	SFP	Crib House/Forebay	WWTF
Co-60	1.10E-02	4.13E-02	1.26E-02	1.20E+00	2.05E-02	7.57E-01
Cs-134	1.57E-02	2.16E-01	5.56E-02	7.15E-01	5.31E-02	9.27E+00
Cs-137	3.00E-02	1.65E-01	4.21E-02	3.67E-01	3.83E-02	7.31E+00
Eu-152	5.14E-03	1.77E-02	5.48E-03	5.66E-01	9.18E-03	2.83E-01
Eu-154	5.70E-03	2.04E-02	6.21E-03	6.26E-01	1.01E-02	3.73E-01
H-3	6.28E-03	2.73E-02	6.88E-03	1.10E-08	5.87E-03	1.25E+00
Ni-63	2.89E-04	1.61E-03	4.06E-04	2.85E-06	3.48E-04	7.40E-02
Sr-90	3.33E-01	4.54E+00	1.15E+00	5.83E-04	9.78E-01	2.09E+02

Note In units of mrem/yr per mCi

DCGLs for Surface Soils

Radionuclide	Surface Soil DCGL (pCi/g)
Co-60	4.7
Cs-134	7.5
Cs-137	15.7
Ni-63	3998
Sr-90	14.3

DCGLs for Subsurface Soils

Radionuclide	Subsurface Soil DCGL (pCi/g)
Co-60	3.8
Cs-134	4.9
Cs-137	8.5
Ni-63	847
Sr-90	1.8

Attachment 3
Site Specific DCGLs for Buried Piping

DCGLs for Buried Piping

Radionuclide	Buried Piping DCGL (dpm/100 cm^2)
Co-60	3.60E+04
Cs-134	6.33E+04
Cs-137	1.50E+05
Ni-63	1.31E+08
Sr-90	3.49E+05

Attachment 4
Recommended Scan Coverage

Area Classification	Scan Coverage	Surface Activity Measurements Or Soil Samples
Class 1	100 percent	As determined by statistical tests; additional measurements/samples to account for small areas of elevated activity as necessary
Class 2	10 to 100 percent	As determined by statistical tests
Class 3	1 to 10 percent (Judgmental)	

Attachment 5
Investigation Levels

Survey Unit Classification	Scan Investigation Levels:	Direct Measurement Investigation Levels:
Class 1	> $DCGL_{EMC}$	> $DCGL_{EMC}$
Class 2	> $DCGL_W$ or > MDC_{scan} if MDC_{scan} is greater than $DCGL_W$	> $DCGL_w$
Class 3	> $DCGL_W$ or > MDC_{scan} if MDC_{scan} is greater than $DCGL_W$	> 50 percent of $DCGL_w$

STS Survey Unit	Classification	Required Areal Coverage (m^2)	Minimum # of ISOCS Measurements	Adjusted Areal Coverage (m^2)	Adjusted Areal Coverage (% of Area)
Auxiliary Building 542 foot Floor	Class 1	2,591	93	2,591	100%
Auxiliary Building Basement Walls	Class 2	392	14	392	10%
Unit 1 Containment Basement	Class 2	276	14	392	14%
Unit 2 Containment Basement	Class 2	276	14	392	14%
SFP/Transfer Canal	Class 1	780	28	780	100%
Turbine Building Basement	Class 3	147	14	392	3%
Crib House/Forebay	Class 3	69	14	392	6%
Circulating Water Discharge Tunnels	Class 3	49	14	392	8%
WWTF	Class 3	11	14	392	35%

Note: 1) The minimum number of ISOCS measurements is based on a measurement FOV of 28 m^2.

Attachment 7
Sample & Measurement Unique Identification Designation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)

Classification & Survey Area

1st digit indicates type of Survey Area

L = Open Land Area
B = Structural Survey Area
S = System

2nd digit indicates Classification

1 = Class 1
2 = Class 2
3 = Class 3
4 = Non-impacted
5 = Unassigned

3rd, 4th and 5th digits indicates Survey Area Number

[The Survey Area Number, Survey Unit Number and current classification are taken from the updated master copy of "Survey Units for Open Land Areas" and "Survey Units for Structures" that are maintained by the Characterization/License Termination Manager in accordance with procedure ZS-LT-300-001-002, *"Survey Unit Classification"* (Reference 6.9)]

Survey Unit Number & Sequence Indicator

6th and 7th digits indicates Survey Unit Number

(from Tables 6-1 and 6-2)

The 8th digit indicate alphanumeric sequence

(Sequence A-J) allows the survey unit to be divided into 10 smaller survey units.

(Sequence K-Z) allows for up to 16 different survey instructions for a single survey unit.

Survey and Measurement Type

The 9th digit indicate the type of survey.

A = Assessment
B = Background
S = Scoping
C = Characterization
R = Remedial Action
F = FRS
I = Investigation
V = Verification
Q = QA/QC
A

The 10th digit indicates the type of measurement.

B = Background
R = Random
S = Systematic
J = Biased
I = Investigation
V = Verification
Q = QA/QC

Surface Type

The 11th digit indicates the type of surface where the measurement was taken.

F = Floor
W = Wall
C = Ceiling
S = System
R = Roof
P = Paved Road
G = Ground
L = Water

The 12th digit indicates the material composition of the surface where the measurement was taken.

C = Concrete
M = Metal
W = Wood
B = Cinder Block
K = Brick
A = Asphalt
S = Soil
T = Tar
L = Liquid

Sample or Measurement No.

The 13th, 14th and 15th digits indicate the alphanumeric measurement number

Sequentially, 001 through 999

Media Type

The 16th and 17th digits indicate the type of media that was sampled.

SS = Surface Soil
SB = Subsurface Soil
SM = Sediment
WT = Water
LQ = Other liquids besides water
OL = Oil
CV = Volumetric Concrete
AV = Volumetric Asphalt
MT = Metal
PT = Paint
SW = Smear Sample
BD = Beta Direct
AD = Alpha Direct
GD = Static Gamma measurement
BS = Beta Scan
GS = Gamma Scan
JS = Juncture Scan
JD = Juncture Direct
PS = Penetration Scan
PD = Penetration Direct

MDC is the minimum activity concentration on a surface or within a material volume, that an instrument is expected to detect (e.g., activity expected to be detected with 95% confidence). The MDC is dependent upon the counting time, geometry, sample size, detector efficiency and background count rate. For a portable instrument, MDC is calculated using two different methods depending on the mode of operation, static (MDC_{static}) or scanning (MDC_{scan}).

<u>Total Efficiency</u>

Instrument efficiencies (ε_i) are derived from the surface emission rate of the radioactive source(s) used during the instrument calibration. Total Efficiency (ε_t) is calculated by multiplying the instrument efficiency (ε_i) by the surface efficiency (ε_s) commensurate with the radionuclide's alpha or beta energy using the guidance provided in ISO 7503-1, *"Evaluation of surface contamination – Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters"* (Reference 6.13).

Beta-Gamma Scan Measurement MDC

The formula used to determine the scanning MDC at the 95% confidence level is:

$$MDC_{scan} = \frac{d'(\sqrt{b_i} * \frac{60}{i})}{(\epsilon_t)\sqrt{p}(\frac{A}{100})}$$

Where,	MDC_{scan}	=	Minimum Detectable Concentration in dpm/100 cm^2
	d'	=	index of sensitivity (1.38)
	I	=	observation interval (seconds)
	b_i	=	background counts per observation interval
	ε_t	=	total efficiency
	p	=	surveyor efficiency (0.5)
	A	=	detector area in cm^2 (not to exceed 126 cm^2)

The observation interval (*i*) is considered to be the amount of time required for the detector field of view to pass over the area of concern. This time depends upon the scan speed, the size of the source, and the fraction of the detector's sensitive area that passes over the source. The scan speed is based on one detector window width per second however; other scan speeds may be used. For the Ludlum Model 43-68 gas flow proportional detector, the window width is 8.8 cm resulting in a scan speed of ~3.5 inches per second. The floor monitor detector is the Ludlum Model 43-37 with a window width of 13.35 cm which results in a scan speed of 5.25 inches per second.

Direct Beta-Gamma Measurement MDC

Direct (static) measurements utilize the following formula:

$$MDC_{static} = \frac{\frac{2.71}{t_s}+3.29\sqrt{\frac{R_b}{t_s}+\frac{R_b}{t_b}}}{\varepsilon_t \frac{A}{100\ cm^2}}$$

Where,	MDC_{static}	=	Minimum Detectable Concentration in dpm/100 cm^2
	t_s	=	sample count time
	t_b	=	background count time
	R_b	=	background count rate (cpm)
	ε_t	=	total efficiency
	A	=	detector window area (cm^2)

Gamma Scan MDC

The gamma scan MDC is discussed in detail in TSD 11-004, "Ludlum Model 44-10 Detector Sensitivity" (Reference 6.14). This Technical Support Document (TSD) examines the gamma sensitivity for 5.08 by 5.08 cm (2" x 2") NaI detectors to several radionuclide mixtures of Co-60 and Cs-137 using sand (SiO_2) as the soil base. The TSD derives the MDC for the radionuclide mixtures at various detector distances and scan speeds. The TSD model uses essentially the same geometry configuration as the model used in MARSSIM. TSD 11-004 provides MDC values for the expected ZSRP soil mixture based on detector background condition, scan speed, soil depth (15 cm), soil density (1.6 g/cm^3) and detector distance to the suspect surface.

	$\alpha = 0.05$				
	β				
Δ/σ	**0.01**	**0.025**	**0.05**	**0.10**	**0.25**
0.1	2984	2459	2048	1620	1018
0.2	754	622	518	410	258
0.3	341	281	234	185	117
0.4	197	162	136	107	68
0.5	130	107	89	71	45
0.6	94	77	65	52	33
0.7	72	59	50	40	26
0.8	58	48	40	32	21
0.9	48	40	34	27	17
1.0	41	34	29	23	15
1.1	36	30	26	21	14
1.2	33	27	23	18	12
1.3	30	24	21	17	11
1.4	28	23	20	16	10
1.5	27	22	18	15	10
1.6	24	21	17	14	9
1.7	24	20	17	14	9
1.8	23	20	16	12	9
1.9	22	18	16	12	9
2.0	22	18	15	12	8
2.5	21	17	15	11	8
3.0	20	17	14	11	8

Attachment 10
Number of Samples Required for the WRS Test

	α=0.01					α=0.025					α=0.05					α=0.10					α=0.25				
	β					β					β					β					β				
Δ/σ	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25	0.01	0.025	0.05	0.10	0.25
0.1	5452	4627	3972	3278	2268	4627	3870	3273	2646	1748	3972	3273	2726	2157	1355	3278	2646	2157	1655	964	2268	1748	1355	964	459
0.2	1370	1163	998	824	570	1163	973	823	665	440	998	823	685	542	341	824	665	542	416	243	570	440	341	243	116
0.3	614	521	448	370	256	521	436	369	298	197	448	369	307	243	153	370	298	243	187	109	256	197	153	109	52
0.4	350	297	255	211	146	297	248	210	170	112	255	210	175	139	87	211	170	139	106	62	146	112	87	62	30
0.5	227	193	166	137	95	193	162	137	111	73	166	137	114	90	57	137	111	90	69	41	95	73	57	41	20
0.6	161	137	117	97	67	137	114	97	78	52	117	97	81	64	40	97	78	64	49	29	67	52	40	29	14
0.7	121	103	88	73	51	103	86	73	59	39	88	73	61	48	30	73	59	48	37	22	51	39	30	22	11
0.8	95	81	69	57	40	81	68	57	46	31	69	57	48	38	24	57	46	38	29	17	40	31	24	17	8
0.9	77	66	56	47	32	66	55	46	38	25	56	46	39	31	20	47	38	31	24	14	32	25	20	14	7
1.0	64	55	47	39	27	55	46	39	32	21	47	39	32	26	16	39	32	26	20	12	27	21	16	12	6
1.1	55	47	40	33	23	47	39	33	27	18	40	33	28	22	14	33	27	22	17	10	23	18	14	10	5
1.2	48	41	35	29	20	41	34	29	24	16	35	29	24	19	12	29	24	19	15	9	20	16	12	9	4
1.3	43	36	31	26	18	36	30	26	21	14	31	26	22	17	11	26	21	17	13	8	18	14	11	8	4
1.4	38	32	28	23	16	32	27	23	19	13	28	23	19	15	10	23	19	15	12	7	16	13	10	7	4
1.5	35	30	25	21	15	30	25	21	17	11	25	21	18	14	9	21	17	14	11	7	15	11	9	7	3
1.6	32	27	23	19	14	27	23	19	16	11	23	19	16	13	8	19	16	13	10	6	14	11	8	6	3
1.7	30	25	22	18	13	25	21	18	15	10	22	18	15	12	8	18	15	12	9	6	13	10	8	6	3
1.8	28	24	20	17	12	24	20	17	14	9	20	17	14	11	7	17	14	11	9	5	12	9	7	5	3
1.9	26	22	19	16	11	22	19	16	13	9	19	16	13	11	7	16	13	11	8	5	11	9	7	5	3
2.0	25	21	18	15	11	21	18	15	12	8	18	15	13	10	7	15	12	10	8	5	11	8	7	5	3
2.25	22	19	16	14	10	19	16	14	11	8	16	14	11	9	6	14	11	9	7	4	10	8	6	4	2
2.5	21	18	15	13	9	18	15	13	10	7	15	13	11	9	6	13	10	9	7	4	9	7	6	4	2
2.75	20	17	15	12	9	17	14	12	10	7	15	12	10	8	5	12	10	8	6	4	9	7	5	4	2
3.0	19	16	14	12	8	16	14	12	10	6	14	12	10	8	5	12	10	8	6	4	8	6	5	4	2
3.5	18	16	13	11	8	16	13	11	9	6	13	11	9	8	5	11	9	8	6	4	8	6	5	4	2
4.0	18	15	13	11	8	15	13	11	9	6	13	11	9	7	5	11	9	7	6	4	8	6	5	4	2

GENERAL SECTION

Survey Area No.:	Survey Unit No.:
Survey Unit Name:	
Survey Unit Type:	

☐ - Open Land ☐ - Structural Interior ☐ - Structural Exterior ☐ - System

Classification: ☐ - Class 3 ☐ - Class 2 ☐ - Class 1

PREPARATION FOR FINAL STATUS SURVEY ACTIVITIES
(a checked box signifies an affirmative response)

☐ Reference Grid and/or Reference Coordinates have been established (if appropriate).

☐ A walk-down has been performed of the survey unit and a completed *"Pre-Turnover Walk-Down"* form completed in accordance with ZS-LT-300-001-003, *"Isolation and Control for Final Radiation Survey"* is included with this Sample Plan.

☐ "Area Turnover and Control Checklist" completed in accordance with ZS-LT-300-001-003, *"Isolation and Control for Final Radiation Survey"* is included with this Sample Plan and all items and issues that were identified have been resolved.

☐ All preparation activities (clear vegetation, erect scaffolding, etc.) necessary to perform Final Radiation Surveys have been completed.

☐ Area has been cleared of all non-essential materials and equipment.

☐ Area has been posted and access control measures have been implemented.

ALL ABOVE ACTIONS ARE COMPLETE AND SURVEY UNIT IS PREPARED AND READY FOR FRS ACTIVITIES (signature signifies affirmative response)

__________________________________ ____________
Radiological Engineer (Print Name/Signature) Date

SURVEY PACKAGE APPROVAL

THIS SAMPLE PLAN HAS BEEN COMPLETED, INDEPENDENTLY REVIEWED AND APPROVED FOR IMPLEMENTATION.

Prepared:	__________ (Print Name)	__________ (signature)	Date:	______
Peer Review:	__________ (Print Name)	__________ (signature)	Date:	______
Approved:	__________ Characterization/License Termination Manager (Print Name)	__________ (signature)	Date:	______

Survey Unit No: ________________________

DATA QUALITY OBJECTIVES

1.0 STATE THE PROBLEM

The problem:

Stakeholders:

The Planning Team:

Schedule:

Resources:

2.0 IDENTIFY THE DECISION

Principal Study Question:

Alternate Actions:

The Decision:

3.0 IDENTIFY INPUTS TO THE DECISION

Information Needed:

Historical Information:

Radionuclides of Concern:

Release Criteria:

Radiological Survey Data:

Basis for the Action Level:

Basis for Scan Measurements:

Basis for Quality Control (QC) Measurements:

Investigation Levels:

Sampling and Analysis Methods to Meet the Data Requirements:

4.0 DEFINE THE BOUNDARIES OF THE SURVEY

Boundaries of the Survey:

Temporal boundaries:

Constraints:

5.0 DEVELOP A DECISION RULE

Decision Rule:

6.0 SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

The Null Hypothesis:

Type I Error:

Type II Error:

Lower Bound of the Grey Region

7.0 OPTIMIZE DESIGN

Type of statistical test:

Wilcoxon Rank Sum Test (WRS) ☐ Sign Test ☐

Basis including background reference location if WRS test is specified:

Number of Systematic samples:

Number of Biased samples and locations:

Number of samples for Quality Control:

Survey Area **No.:** ______________ **Description:** ____

Survey Unit **No.:** ______________ **Description:** ____

Survey Unit Type:

☐ - Open Land ☐ - Structure Interior ☐ - Structure Exterior ☐ - System

Survey Unit Classification:

Classification: ☐ - Class 3 ☐ - Class 2 ☐ - Class 1

General Instructions:

1. Personnel will follow all relevant safety directives and procedures while performing this work.
2. Survey and sampling will be performed by qualified technicians under the direction of Characterization/FSS Supervision.
3. Instrumentation used in the field will be used in accordance with applicable procedures.
4. Detailed field notes and observations will be documented during survey and sampling.
5. Photographs should be taken as necessary to clarify survey and sampling activities or survey constraints.
6. Samples will be controlled under Chain-of-Custody in accordance with procedure ZS-WM-131, *"Chain-Of-Custody"*.
7. Documents generated during the performance of survey and sampling will be complete and legible. Corrections will be made using a single line-out followed by an initial and date.
8. Sample & measurement locations will be identified using coordinates consistent with the established reference coordinate system. Sample and measurement locations will be identified by marks or flags prior to and during survey implementation.

Survey Area No..: ______________ **Description:** ____

Survey Unit No.: ______________ **Description:** ____

Specific Instructions:

1. Proceed to the survey unit.
2. Initialize and utilize a "Field Log" document.

Survey Area **No.:** ______________ **Description:** ____

Survey Unit **No.:** ______________ **Description:** ____

Field Log: **Date:**_________

Time:	Observation or Comment:	Technician

Attachment 15
FRS Samples/Measurement Identification & Coordinates
Page ___ of ___

Survey Area **No.:** ______________ **Description:** ____

Survey Unit **No.:** ______________ **Description:** ____

No.	Type	Media	Sample/Measurement ID Number	Northing	Easting

Type: B = Background, R = Random, S = Systematic, J = Biased, I = Investigation, V = Verification, Q = QA/QC

Media: SS = Surface Soil, SB = Subsurface Soil, SM = Sediment, WT = Water, CV = Volumetric Concrete, AV = Volumetric Asphalt, MT = Metal, PT = Paint, SW = Smear, TB = Direct Beta-gamma Measurement, TA = Direct Alpha Measurement, GM = Static Gamma Measurement

Attachment 16
FRS Scan Area Identification & Coordinates
Page ___ of ___

Survey Area No.: ______________ **Description:** ____

Survey Unit No.: ______________ **Description:** ____

Scan Area No.:	Surface Area (m2)	% of Total Survey Unit Area	Coordinates							
			Corner 1		Corner 2		Corner 3		Corner 4	
			Northing	Easting	Northing	Easting	Northing	Easting	Northing	Easting