GENERAL ATOMICS

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Document Control Desk
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Subject: **Docket No. 50-89, Facility License R-38, and Docket No. 50-163, Facility License R-67; Submittal of General Atomics TRIGA® Reactor Facility Final Status Survey Plan (FSSP), Revision 1, dated September 13, 2019**

Reference: **TRIGA Reactor Facility Final Status Survey Plan, Revision 0, dated July 15, 2019**

Dear Ms. Vaaler:

As a result of the August 2019 NRC inspection of the TRIGA Reactor Facility, General Atomics (GA) has revised the Final Status Survey Plan (reference) for the TRIGA Reactor Facility at GA. Revision 1 includes the addition of two new survey units and minor changes throughout the document based on recommendations during the inspection. To assist with your review, enclosed is list of updates to the TRIGA Reactor Facility FSSP Revision 0.

Should you need additional information concerning the above, please contact me at (858) 455-2809 or by email michael.grogan@ga.com, or Mr. Paul Pater at (858) 455-2758 or at paul.pater@ga.com.

Very truly yours,

Michael Grogan, Senior Director
Licensing, Safety and Nuclear Compliance

Enclosures: 1) Updates to the TRIGA Reactor Facility Final Status Survey Plan Revision 0.
2) TRIGA® Reactor Facility Final Status Survey Plan, Revision 1, September 13, 2019

cc: Dr. Robert Evans (NRC)

Updates to the TRIGA Reactor Facility Final Status Survey Plan Revision 0.

September 13, 2019

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- Page 8 - Table 5.1 – Ludlum 43-93 (plastic scintillator) and Ludlum 44-159-1 (gamma pipe detector) added to instrumentation specifications table
- Page 8 - Table 5.2 - Ludlum 43-93 and Ludlum 44-159-1 operating parameters and sensitivities added to instrumentation operating parameters table
- Page 10 - Section 8.1 – Background surfaces were updated (ambient, concrete, cinder block, and metal)
- Page 10 - Section 8.2 – "Primary contaminants/activation products" sentence added to first sentence
- Page 12 - Table 8.1 – Added two survey units, #15 (Mark I and Mark F Roof) and #16 (Trenches and Sub-Critical Pit)
- Page 17 - Section 8.9 – Added that a portable HEPA unit will be utilized during any subsequent remediation in order to meet the condition of the Technical specifications
- Page 18 - Section 8.9.2 – The gamma pipe detector was added to determine if the drain lines are contaminated
- Page 18 - Table 8.5 – Drain and trench surveys updated to include a 100% scan survey of accessible internal surfaces of all existing trenches

TRIGA® REACTOR FACILITY FINAL STATUS SURVEY PLAN

Revision 1

September 13, 2019

Approval:	John Greenwood, Decommissioning Manager	Date:	13SEPT 19
Approval:	Paul Pater, Radiation Safety Officer	Date:	9/13/19
Approval:	Junaid Razvi, C&RS-Working Group Chair	Date:	13 Sept 19
Approval:	Michael Grogan, LSNC Senior Director	Date:	09/13/19

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ACRONYM LIST

γ	Gamma emission
ALARA	As Low As Reasonably Achievable
β^-	Beta-minus decay
β^+	Beta-plus decay
CDPH-RHB	California Department of Public Health – Radiological Health Branch
Cs-137	Cesium-137
CFR	Code of Federal Regulations
Cm	Centimeter
Co-60	Cobalt-60
cpm	counts per minute
D&D	Decontamination and Decommissioning
$DCGL_{EMC}$	Derived Concentration Guideline Level – Elevated Measurement Comparison
$DCGL_W$	Derived Concentration Guideline Level – Wilcoxon Rank Sum
dpm	disintegrations per minute
DQO	Data Quality Objective
DSV	Default Screening Value
ϵ	Electron capture
Eu-152	Europium-152
Eu-154	Europium-154
FLAIR	Flashing Advanced Irradiation Reactor
FSSP	Final Status Survey Plan
GA	General Atomics
HSA	Historical Site Assessment
HVAC	Heating , Ventilation, Air Conditioning
LBGR	Lower Bound of the Gray Region
m	meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
MkF	TRIGA Mark F Reactor
MkI	TRIGA Mark I Reactor
Mrem	Millirem
NIST	National Institute of Standards & Technology
NNSS	Nevada National Security Site
NMSS	Nuclear Materials Safety and Safeguards
NRC	U.S. Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
NUREG	Nuclear Regulatory Commission Guidance Document
pCi/g	picocuries per gram
POL	Possession Only License
TEDE	Total Effective Dose Equivalent
TRF	TRIGA Reactor Facility
TRIGA	Training, Research, Isotope Production, General Atomics
USAEC	United States Atomic Energy Commission
yr.	year

1.0 Introduction

In 1997, General Atomics (GA) ceased all TRIGA reactor operations at its main site located on the Torrey Pines mesa in San Diego, CA. The two reactors shutdown at this time (a third one was shut down in 1972) were located in what is currently designated Building G21. In 2010, removal of irradiated fuel from these reactors from G21 to an offsite location was completed. Previous as well as subsequent to the removal of nuclear fuel from the facility, all activated and contaminated hardware, startup neutron sources and BOP components had been removed from the facility to a nuclear waste disposal site, thus permitting decontamination and decommissioning of the reactor pool and remaining reactor room related structures, systems and components. The goal of this final status survey project is to achieve unrestricted release of the TRIGA® reactor pools, reactor rooms, and adjoining G21 that supported reactor operations and utilization thus permitting the termination of GA's NRC current reactor licenses R-38, amendment #37 and R-67, amendment #46.

The property, on which is situated the General Atomics TRIGA Reactor building and associated facilities, was acquired in 1956 from the City of San Diego as part of a 290 acre tract, by the General Dynamics Corporation, with the expressed purpose of the establishment of the John J. Hopkins Laboratory for Pure & Applied Science, later named General Atomics Division of the General Dynamics Corporation. One of the first goals of the newly established General Atomic Division of General Dynamics was the development of a new family of small nuclear reactors which could be utilized in both industrial and academic applications for training, research, and isotope production. Between 1957 and 1966 three TRIGA reactors were constructed in what is now Building G21, also known as the TRIGA Reactor Facility (TRF), although this final status survey plan (FSSP) addresses the two reactors which are currently licensed (Possession Only), i.e., the TRIGA Mark I (R-38) and Mark F (R-67) reactors. The third reactor, Mark III (and associated areas), was shut down in 1972 and has previously been decommissioned with its license terminated at that time.

This plan was developed using the guidance provided in NUREG-1757 [6], "Consolidated NMSS Decommissioning Guidance" and NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM). It provides the approach, methods, and techniques for the radiological decontamination and decommissioning (D&D) of all remaining impacted areas of the TRF. Final status surveys are designed to implement the protocols and guidance provided in MARSSIM to demonstrate compliance with the default screening values specified in NUREG-1757, Volume 2, Appendix H. These methods ensure technically defensible data is generated to aid in determining whether or not these facilities meet the release criteria (25 mrem/yr) for unrestricted use specified in 10 CFR 20 Subpart E.

1.1 TRIGA Mark I Reactor

As part of early nuclear reactor development efforts, GA initiated plans to design, build, and operate a prototype reactor unit on the company's Torrey Pines Mesa (main) site. To this end, in late 1957, GA requested and obtained a Construction Permit and Utilization Facility License from the U.S. Atomic Energy Commission (USAEC) to authorize this activity. Immediately thereafter, GA proceeded with construction of the Isotope Reactor Building, later named the TRIGA Reactor Facility (now Building G21), to house the Prototype TRIGA Reactor and supporting systems. Following building construction and reactor hardware installation, the Prototype TRIGA Reactor was brought to initial criticality on May 3, 1958. Continuously operational from that date until late 1997, the Prototype TRIGA Reactor was later designated as the Torrey Pines TRIGA Reactor, and later yet, as the TRIGA Mark I Reactor. At GA's request, the USNRC issued an amendment to the TRIGA Mark I utilization facility license on October 29, 1997, which placed the reactor in Possession-Only-License (POL) status that, through later amendments, allowed decontamination and decommissioning activities to proceed with the goal of release of the area to unrestricted use.

1.2 TRIGA Mark F Reactor

In March 1960, GA submitted an application to the USAEC requesting a Construction Permit and Utilization Facility License for the Flashing Advanced Irradiation Reactor (FLAIR). These documents were issued to GA by the USAEC and Building 21 was modified by the addition of Rooms 21/107 and 21/108 to house the FLAIR Reactor and Reactor Instrumentation & Control Systems, respectively. This reactor, which was brought to initial criticality on July 2, 1960, was continuously maintained and operated by GA from that time until March 22, 1995 (including round-the-clock operations from 1987 – 1993 to support various utilization programs), when the Utilization Facility License was amended, at the request of GA, to authorize Possession-Only-License activities status that, through later amendments, allowed decontamination and decommissioning activities to proceed with the goal of release of these areas to unrestricted use. During the operating period, the reactor installation was designated as the Advanced TRIGA Prototype Reactor and also later referred to as the TRIGA MkF Reactor.

Both cores were defueled when the reactors were placed in POL status, and moved to a secured underwater storage location. In 2010, all irradiated fuel elements from both reactors were shipped from storage in G21 to an authorized off-site storage facility at the Idaho National Laboratory.

2.0 Historical Site Assessment

The purpose of a historical site assessment (HSA) is to determine the current status of the site including potential, likely, or known sources of radioactive contamination by gathering data from various sources. This data includes physical characteristics and location of the site as well as information found in site operating records, including radiological surveys.

General Atomics prepared the TRIGA Reactors Facility Process Knowledge Report in 1996 [1] which presented all of the available historical data and process knowledge information pertaining to the TRIGA site. This report identified the type, quantity, condition, and location of radioactive and hazardous materials which are, or which may be, present as residual surface contamination.

The information from the Process Knowledge Report was incorporated into General Atomics TRIGA Reactor Facility Decommissioning Plan [2] which was approved by the NRC in January 2000. Additional historical site information can be found in either of these two documents.

2.1 Potential Contaminants

Based on the HSA a list of potential contaminants was determined and are shown in the Table below:

Table 2.1 Potential Contaminants

Nuclide	Half-Life	Decay Mode	Notes
Cobalt-60	5.27 years	β^-, γ	Activation product found in rebar
Cesium-137	30.17 years	β^-, γ	Fission product, expected to be predominant radionuclide
Europium-152	13.52 years	β^-, γ, β^+, e^-	Activation product found in concrete
Europium-154	8.593 years	β^-, γ, e^-	Activation product found in concrete

2.2 Prior Decommissioning Activities

GA submitted a Final Status Report to the NRC on November 20, 2006 [3] for the release of a portion of the TRIGA land area under GA's SNM-696 NRC license. The NRC performed a confirmatory survey February 29-March 2, 2007 and subsequently released that portion of the site to unrestricted use on May 14, 2007 [SNM-696 license Amendment # 88] [3]. At that time, the rest of the land area was previously referred to as the "Nuclear Reactor Regulation (NRR) area". In this survey plan, the land is called the "Remaining Portion of the TRIGA Land Area" because the land area is under 10CFR50.83 release criteria and was not transferred from the TRIGA License to the SNM-696 license and subsequently not subject to the General Atomics Decommissioning Plan for SNM-696 license. [4].

The radiologically impacted areas at the TRIGA Reactor Facility (G21) are split over three different radioactive material licensees. General Atomics surveyed and the NRC released the "Non-Reactor Portion of the TRIGA Reactor Site" in November 2006 which included Rooms 109 – 115 and the Mark III reactor (See Attachment 1).

Following shutdown of the Mark I in 1997, all irradiated fuel elements were consolidated in the fuel storage canal of the TRIGA Mk F pool. In 2010, GA shipped the entire inventory of irradiated TRIGA reactor fuel to a DOE interim storage facility. In 2012/2013 the MkF Pit and Canal were drained and the water dispositioned. After the water was drained and the pit and canal were vacuumed, several core samples were collected from selected locations for initial characterization studies in which both radiological and chemical analyzes were performed.

The walls of the TRIGA Mark F Reactor pool and fuel storage canal are constructed of a ¼" thick carbon steel liner with a 4" thick layer of steel-reinforced Gunite on the liner. The Gunite was sealed by a thin coating of Epocast. The floors of the Pit and Canal are also sealed with a thin coating of Epocast. As a result of preliminary characterization that was performed by GA, it was determined that the Epocast coating contained not only low levels of radioactive contamination, but also levels of cadmium and lead contaminants, that potentially exceeds the State and Local land disposal limits, and was determined to be mixed waste (a combination of radiological and hazardous components).

In 2015, the top layer of Gunite and Epocast were removed by an outside contractor, removing all of the mixed waste and leaving only the remaining Gunite, activated concrete and steel liner in the MkF pit. The MkI pit had an aluminum tank which, when removed, left the activated concrete biological shield.

Based on scoping survey data from core samples acquired in 2017 as well as from historical core sampling conducted in 2000, it was determined the lower walls of the MkI reactor from the floor to two meters in height and potentially some soil behind the concrete needed to be removed. The floor of the MkI reactor was also determined to require removal in its entirety in addition to some soil below the floor. Because of the extent of the excavation, a micropile system was put in place prior to removal of the pit concrete to provide stability to the remaining upper concrete cylinder.

The MkF reactor, which has three times the volume as the MkI reactor, only needed remediation on the north side of the pit. During operation, the location of the reactor core was skewed in this direction. In 2015, 20 core samples were acquired from the walls and floor of the MkF pit and fuel storage canal. Wall samples were taken up to five meters from the floor of the MkF pit. Analysis of the core samples showed the fuel storage canal did not require remediation, nor did the reactor pit wall above two meters. Portions of concrete wall was removed from the pit floor to two meters in height from the west to east side. The removal depth varied but in no case required removal to soil. In addition to the concrete removed from the walls, the pit floor was removed to varying depths in the northern section of the reactor pit, again not requiring removal to soil.

3.0 Release Criteria

The radiological release criteria of NRC 10CFR20 Subpart E [5] for unrestricted use will be used for decommissioning the TRIGA facility. Specifically the buildings and facilities being released under this decommissioning effort will be surveyed in accordance with the guidance contained in MARSSIM to demonstrate compliance with the criteria specified in 10CFR20.1402 Radiological Criteria for Unrestricted Use. The specified criteria is that residual radioactivity results in a TEDE to an average member of the critical group that does not exceed 25 mrem per year and that the residual radioactivity has been released to levels that are as low as reasonably achievable (ALARA).

The default screening values are the basis for developing the derived concentration guideline levels (DCGL's) or release criteria for the project. The $DCGL_W$ is the radionuclide specific surface area concentration that could result in a dose equal to the release criterion. $DCGL_W$ is the concentration limit if the residual activity is essentially evenly distributed over a large area.

In the case of non-uniform contamination, higher levels of activity are permissible over small areas. The $DCGL_{EMC}$ is derived separately for these small areas. The $DCGL_{EMC}$ is the $DCGL_W$ increased by an area factor depending on the size of the elevated area. $DCGL_{EMC}$ is not expected to be used for the TRIGA Facility decommissioning project since contamination levels throughout the facility are expected to be significantly less than the chosen release criteria.

For surfaces and structures, we will be using the release criteria listed in GA's approved TRIGA Reactor Facility Decommissioning Plan for surfaces and structures which specifies 5,000 dpm/100 cm^2 for fixed contamination and 1,000 dpm/100 cm^2 for removable contamination.

3.1 Default Screening Values

The NRC has published default screening values in NUREG-1757, Volume 2, for commonly used radionuclides [6]. DandD v.2.1 software was used to determine default screening values for nuclides that are not listed in NUREG 1757.

The nuclides of concern screening values for surfaces and structures under default conditions (generic screening levels) are provided in Table 3.1.

Table 3.1 Default Surfaces & Structures Screening Values for Nuclides of Concern

Nuclide	(dpm/100 cm²)		
	Average	Maximum	Removable
U-nat, ^{235}U, ^{238}U, & assoc. decay products	5,000	15,000	1,000
Transuranics, ^{226}Ra, ^{228}Ra, ^{230}Th, ^{228}Th, ^{125}I, ^{129}I	100	300	20
Th nat, ^{232}Th, ^{90}Sr, ^{223}Ra, ^{224}Ra, ^{232}U, ^{126}I, ^{133}I, ^{131}I	1,000	3,000	200
Beta/gamma emitters (nuclides with decay modes other than alpha) except ^{90}Sr and others noted above	5,000	15,000	1,000

The nuclides of concern screening values for concrete and soil under default conditions (generic screening levels) are provided in Table 3.2. GA requested [4] and received approval from NRC [7], to modify the release limits for concrete and soil from the values listed in GA's previously approved Decommissioning Plan [2], which allowed GA to use NUREG-1757 screening DCGLs as the isotope specific radiological release criteria to be used for release to unrestricted use of the residual soil and concrete.

Table 3.2 Default Concrete & Soil Screening Values for Nuclides of Concern

Isotope	Half-life	Radiation Type	Default Screening Value (pCi/g)
Co-60	5.27 years	β^-, γ	3.8
Cs-137	30.1 years	β^-, γ	11.0
Eu-152	13.516 years	β^-, γ, β^+, e^-	7.0*
Eu-154	8.593 Years	β^-, γ, β^+, e^-	8.0

*This value is lower than the value listed in NUREG-1757 (8.7 pCi/g) due to the memorandum of understanding between the EPA and the NRC (2002).

4.0 ALARA Analysis

Due to the low doses associated with the release criteria used for this D&D project, a quantitative ALARA analysis is not required. Default screening values are being used to establish DCGLs.

NUREG-1727 [8] states in part: "*In light of the conservatism in the building surface and surface soil generic screening levels developed by the NRC staff, the staff presumes, absent information to the contrary, that licensees or responsible parties that remediate building surfaces or soil to the generic screening levels do not need to demonstrate that these levels are ALARA. However, licensees or responsible parties should remediate their facility below these levels through practices such as good housekeeping. In addition, licensees or responsible parties should provide a description in the final status survey report of how these practices were employed to achieve the final activity levels.*"

5.0 Survey Instrumentation

5.1 Instrument Calibration

Laboratory and portable field instruments will be calibrated at least semi-annually with National Institute of Standards and Technology (NIST) traceable sources, where feasible, and to radiation emission types and energies that will provide detection capabilities similar to the nuclides of concern.

5.2 Functional Checks

Functional checks will be performed at least daily when in use. The background, source check, and field measurement count times for radiation detection instrumentation will be specified by procedure to ensure measurements are statistically valid. Background readings will be taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions. If an instrument fails a functional check, all data obtained with the instrument since the last satisfactory check will be invalidated.

5.3 Determination of Counting Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and counting times for measurement of total and removable contamination will be chosen to provide a minimum detectable concentration (MDC) that meets the criteria specified in this Plan. MARSSIM equations relative to building surfaces have been modified to convert to units of dpm/100cm^2. Count times and scanning rates are determined using the following equations:

5.3.1 Static Counting

Static (or fixed) counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is an expansion of NUREG-1507, Table 3.1 (Strom & Stansbury, 1992 [9] [10]):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100cm^2}}$$

Where:

MDC_{static}	=	minimum detectable concentration level in dpm/100cm^2
B_r	=	background count rate in counts per minute
t_b	=	background count time in minutes
t_s	=	sample count time in minutes
E_{tot}	=	total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and 0.25 surface efficiency for beta emitters or 0.5 for gamma emitters)
A	=	detector probe area in cm^2

5.3.2 Ratemeter Scanning

Scanning Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation which is a combination of MARSSIM equations 6-8, 6-9, and 6-10 in Ref. 7:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100cm^2}}$$

Where:

MDC_{scan} = minimum detectable concentration level in dpm/100 cm^2
d' = desired performance variable (1.38)
b_i = background counts during the residence interval
i = residence interval
p = surveyor efficiency (0.5)
E_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and 0.25 surface efficiency for beta emitters or 0.5 for gamma emitters)
A = detector probe area in cm^2

5.3.3 Wipe Counting

Wipe counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, which is NUREG-1507 [9], Table 3.1 (Strom & Stansbury, 1992 [10]):

$$MDC_{smear} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E}$$

Where:

MDC_{Wipe} = minimum detectable concentration level in dpm/wipe
B_r = background count rate in counts per minute
t_b = background count time in minutes
t_s = sample count time in minutes
E = instrument efficiency for radionuclide emission of interest

5.4 Counting Uncertainty

The counting uncertainty for both total and removable measurements will be calculated using equation 6-15 from MARSSIM:

$$\sigma = 1.96\sqrt{\frac{C_{s+b}}{T_{s+b}^2} + \frac{C_b}{T_b^2}}$$

Where:

σ = uncertainty
1.96 = multiplier to achieve 95% confidence level
C_{s+b} = gross counts of the sample (cpm)
T_{s+b} = Sample time (minutes)
C_b = Gross background counts (cpm)
T_b = Background count time (minutes)

5.5 Instrumentation Specifications

The instrumentation to be used for facility decommissioning surveys is summarized in the following tables. Table 5.1 lists the standard features of each instrument such as probe size and efficiency. Table 5.2 lists the typical operational parameters such as scan rate, count time, and the associated Minimum Detectable Concentrations (MDC). Alternate or additional instrumentation with similar detection capabilities may be utilized as needed for survey requirements with Radiation Safety Officer (RSO) approval.

Table 5.1 – Instrumentation Specifications

Detector Model	Detector Type	Detector Area	Meter Model	Window Thickness	Typical Total Efficiency
Ludlum 43-68	Gas Flow Proportional	100 cm^2	Ludlum 2221	0.8 mg/cm^2	20 % (Sr-90/Y-90)
Ludlum 43-37 Floor Monitor	Gas Flow Proportional	434 cm^2	Ludlum 2221	3.4 mg/cm^2	30 % (Sr-90/Y-90)
Ludlum 44-10	NaI	20 cm^2	Ludlum 2221	NA	900 cpm/uR/hr (Cs-137)
Ludlum 43-93	Scintillation	100 cm^2	Ludlum 2221	1.2 mg/cm^2	20% $^{90}Sr/^{90}Y$
Ludlum 44-159-1	Scintillation	3.24 cm^2	Ludlum Model 3	NA	5% (Cs-137)
Canberra Tennelec	Gas Flow Proportional	NA	NA	NA	45% (Sr-90/Y-90)

Table 5.2 – Typical Instrument Operating Parameters and Sensitivities

Measurement Type	Detector Model	Meter Model	Scan Rate	Count Time	Background (cpm)	MDC ($dpm/100cm^2$)
Surface Scans	Ludlum 43-68	Ludlum 2221	2 in./sec.	NA	350	1,475 (Sr-90)
Surface Scans	Ludlum 43-37	Ludlum 2221	4 in./sec.	NA	1,000	465 (Sr-90)
Soil & Concrete Scans	Ludlum 44-10	Ludlum 2221	2 in./sec.	NA	6,000	6.4 pCi/g (Cs-137)[1]
Total Surface Activity	Ludlum 43-93	Ludlum 2221	NA	1 Minute	300	418 (Sr-90)
Gamma Pipe Detector	Ludlum 44-159-1	Ludlum Model 3	NA	1 Minute	750	805 (Cs-137) dpm/cm^2
Exposure Rate	Ludlum Model 9-3	Ludlum Model 9-3	NA	NA	NA	NA
Removable Activity	Canberra Tennelec	NA	NA	5 Minutes	0.1 (Alpha) 1.0 (Beta)	4 (Sr-90)

[1] - Value obtained from NUREG-1507, Table 6.4 [9]

6.0 Characterization Surveys

The survey protocol for building surfaces consisted of performing the scanning portion of the final status survey, with judgmental wipes and static measurements on the highest probability areas for residual radioactivity. Judgmental static measurements and wipes were also taken on vertical surfaces as part of the modified Class 2 and Class 3 final status survey protocols described in Section 8.7.5.2.

The purpose of scanning is to identify locations of elevated activity. Where elevated activity is identified, a static measurement and wipe will be taken at the location of highest activity identified during the scan and the boundary of the elevated area will be marked to aid in locating the area for remedial actions. Based on the contamination potential, at least three locations in each survey unit will be judgmentally selected to perform static measurements and removable contamination measurements.

The survey protocol for building systems will consist of performing removable contamination surveys of internal surfaces of ventilation and drain systems. Static measurements will be collected where practical. The percentage of building system surveys will be consistent with the final status survey protocols contained in this plan.

In survey units with areas that are partially contaminated, the characterization survey data can be used as part of the final status survey measurements provided the data used is only from areas with contamination levels below the release criteria, and decontamination work is controlled such that the survey location could not have become cross-contaminated.

Each survey unit will have an independent survey package that has specific survey instructions. The survey package will contain, at a minimum:

- Survey unit number (e.g., Building and Room Number, System Number, etc.)
- Percentage of surface requiring scan surveys
- Number of static and removable contamination measurements
- Instrumentation to be used with static count times and scan rates
- Any additional specific survey instruction
- Maps of the survey unit surfaces

If the results of the initial characterization survey indicate that contamination is not present in excess of the release criteria, then data from the survey may be used as part of the final status survey.

7.0 Remedial Action Surveys

Remediation will be conducted in such a manner to control the spread of contamination and keep personnel exposures ALARA. Remedial action surveys are conducted in support of remediation activities to help determine when the area is ready for a final status survey and to provide updated estimates for final status survey planning. Remedial action surveys serve to monitor the effectiveness of decontamination efforts and ensure that surrounding areas are not cross-contaminated from remediation actions.

Remedial action surveys will consist of scan surveys, static measurements and removable contamination measurements. These will be conducted following remediation activities to establish the success or failure of the efforts to decontaminate the applicable survey area. Results of the survey will be the decision basis for either continued remediation or to conduct the final status surveys.

Remedial action surveys will be designed to meet the objectives of the final status surveys. To the extent allowed by MARSSIM, the results of the remedial action surveys will be used to supplement the final status survey.

8.0 Design and Performance of Final Status Surveys

Final status surveys are performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use. The final status survey will be conducted using the Data Quality Objective (DQO) process. Characterization and remedial action survey data will be used as final status survey data to the maximum extent possible in order to minimize overall project costs.

Final status surveys will be conducted by performing required scan surveys, total direct surveys, removable contamination surveys, exposure rate measurements, and gamma spectroscopy analysis. All survey data shall be documented on survey maps and associated data information sheets.

8.1 Background Determination for Surfaces and Structures

The use of reference background areas for surfaces and structures will be necessary for the purposes of this plan and while every effort will be made to ensure there are no radiation sources present that may impact the measurements, a finite and ambient material background can be expected to be present at some level in comparison to the DCGLs.

Surface background will be determined for each survey material (ambient, concrete, cinder block, and metal) and subtracted from the gross CPM. These background measurements will be taken in non-impacted areas with similar physical, chemical, geological, radiological and biological characteristics as the survey unit being evaluated. Background values for each type of instrument will be provided to the survey technicians as reference. In areas where ambient background varies significantly due to construction materials, multiple background measurements may be collected and applied to the applicable survey measurement.

8.2 Background Determination for Land Areas

The use of reference background areas for land areas will not be necessary for the purposes of this plan since the primary contaminants/activation products are not present in background. Reference areas and reference samples are not needed when there is sufficient information to indicate there is essentially no background concentration for the radionuclide being considered. With only a single set of survey unit samples, the statistical test used here will be the Sign test.

8.3 Data Quality Objectives (DQO)

The Data Quality Objective Process as described in MARSSIM [12] is used throughout the design and implementation of survey design. The following is a list of the major DQOs for the survey design described in this plan:

- Static measurements will be taken to achieve an MDC_{Static} of less than 50% of the DCGLs.
- Scanning will be conducted at a rate to achieve an MDC_{Scan} of less than 50% of the DCGLs.
- Individual measurements will be made to a 95% confidence interval.
- Decision error probability rates will initially be set at 0.05 for both α and β.
- The null hypothesis (H_0) and alternate null hypothesis (H_A) are that of NUREG 1505 [11] scenario A:

  H_0 is that the survey unit does not meet the release criteria

  H_A is that the survey unit meets the release criteria
- Characterization and remedial action support surveys will be conducted under the same quality assurance criteria as final status surveys such that the data may be used as final status survey data to the maximum extent possible.

8.4 Area Classifications

Based on the results of the historical site assessment [1,2] and previous characterization survey results, facility areas have been classified as impacted areas or non-impacted areas.

8.4.1 Non-Impacted Area

Non-impacted areas are areas without residual radioactivity from licensed activities and are not typically surveyed during final status surveys. These areas have no radiological impact from site operations and are typically identified early in decommissioning. Areas with reasonable potential for residual contamination are classified as impacted areas.

The TRIGA facility has a number of rooms (109 – 115) that were previously released for unrestricted use in 2006 which included the Mark III reactor in Room 111. Normally these areas would be considered non-impacted; however, as a conservative measure, we have classified these areas as Class 3 even though they were previously released for unrestricted use. "Best practices" static and removable surveys will be performed to ensure the remediation that was performed in other areas of the facility did not affect the previously released rooms.

8.4.2 Impacted Areas

Impacted areas are those areas that have potential residual radioactivity from licensed activities. Impacted areas are subdivided into Class 1, Class 2 or Class 3 areas. Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey using a graded approach, followed by Class 2, and then by Class 3. Impacted sub-classifications are defined, for the purposes of this plan, as follows:

8.4.3 Class 1 Area

Areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) a potential for delivering a dose above the release criterion; (3) a potential for small areas of elevated activity; and (4) insufficient evidence to support classification as Class 2 or Class 3.

8.4.4 Class 2 Area

Areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

8.4.5 Class 3 Area

Areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

8.5 Survey Units

A survey unit is a geographical area of specified size and shape for which a separate decision will be made whether or not that area meets the release criteria. A survey unit is normally a portion of a building or site that is surveyed, evaluated, and released as a single unit. For the purposes of this plan, areas of similar construction and composition will be grouped together as survey units and tested individually against the DCGLs and the null hypothesis to show compliance with the release criteria. Survey units will be homogeneous in construction, contamination potential, and contamination distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity exists within a survey unit does not depend on the survey unit size. However, the sampling density should reflect the potential for small elevated areas of residual radioactivity. Survey units will be sized according to the potential for small elevated areas of residual radioactivity. MARSSIM's recommended maximum survey unit sizes for building structures, based on floor area, are Class 1: up to 100 m^2, Class 2: 100 m^2 to 1000 m^2 and Class 3: no limit. For land areas, the maximum survey areas are Class 1: up to 2,000 m^2, Class 2: 2,000 to 10,000 m^2, and Class 3: no limit.

The survey units and their initial classification have been listed in the table below.

Table 8.1 – Scan Survey Coverage by Classification

Survey Unit #	Description	Initial Class	Area (m^2)
1	Mark I Reactor Pit	1	9.0 m^2 (96.7 ft^2)
2	Mark F Reactor Pit	1	14.8 m^2 (159.6 ft^2)
3	Mark I Reactor Room (Floors and lower walls)	1	84.8 m^2 (913.3 ft^2)
4	Mark I Reactor Room (Upper walls and ceiling)	1	93.8 m^2 (1,010 ft^2)
5	Mark F Reactor Room (Floors and lower walls)	1	72.7 m^2 (782.4 ft^2)
6	Mark F Reactor Room (Upper walls and ceiling)	1	87.5 m^2 (942 ft^2)
7	Soil Lab	1	27.4 m^2 (295 ft^2)
8	Mezzanine 1	1	23.6 m^2 (254 ft^2)
9	Mezzanine 2	2	30.6 m^2 (329 ft^2)
10	TRIGA Waste Yard	1	117.7 m^2 (1,267 ft^2)
11	TRIGA Front Yard (Asphalt)	2	546 m^2 (5,883 ft^2)
12	TRIGA Back Yard (Soil)	2	886 m^2, (9,539 ft^2)
13	Room 112	2	36.47 m^2 (392.61 ft^2)
14	Non-Impacted Areas	Non-impacted	283.6 m^2 (3,053 ft^2)
15	TRIGA Mark I and Mark F Roof	2	350.4 m^2 (3,771.75 ft^2)
16	All Trenches and Sub-Critical Pit (Room 102)	1	Trenches 60.7 m (199.2 ft.) Pit 1.98 meter diameter x 3.89 meter depth (6.5 ft. x 12.75 ft.)

8.6 Surface Scans

Scanning is used to identify locations within the survey unit that exceed the screening level. These locations are marked and receive additional investigations to determine the concentration, area, and extent of the contamination. For Class 1 areas, scanning surveys are designed to detect small areas of elevated activity that are not detected by the measurements using the systematic pattern.

Table 8.2 summarizes the percentage of accessible building structural surfaces to be scanned based on classification.

Table 8.2 – Scan Survey Coverage by Classification

Structure	Class 1	Class 2	Class 3
Floors	100%	100%	50%
Other Structures	100%	50%	10%

The surface percentage in a survey unit to be scanned may increase based on suspected elevated activity. For Class 2 and Class 3 areas, surfaces with the highest potential to contain residual contamination will receive a scanning survey.

Floor areas near building entrances and exits will receive a 100% scan survey regardless of the area classification. These surveys will provide indications of potential migration of residual contamination to the outside grounds.

If elevated activity is detected while scanning, the location shall be marked and the total and removable surface activity measurements will be taken to quantify the activity. However, total surface activity measurements are in addition to the static measurements required for the statistical test.

8.7 Total Surface Activity Measurements

Static measurements will be taken on building surfaces and system internals to the extent reasonably possible in impacted areas utilizing instrumentation of the best geometry based on the surface at the survey location. Additionally, locations of elevated activity identified and marked during the scan survey will require static survey measurements.

8.7.1 Determining the Number of Samples

A minimum number of samples are needed to obtain sufficient statistical confidence that the conclusions drawn from the samples are correct. The number of samples will depend on the Relative Shift (the ratio of the concentration to be measured relative to the statistical variability of the contaminant concentration).

The minimum number of samples is obtained from MARSSIM tables or calculated using the methodology presented in Section 5 of MARSSIM [12].

8.7.2 Determination of the Relative Shift

The number of required samples will depend on the ratio involving the activity level to be measured relative to the variability in the concentration. The ratio to be used is called the Relative Shift, Δ/σ_S and is defined in MARSSIM as:

$$\Delta / \sigma_S = \frac{DCGL - LBGR}{\sigma_S}$$

Where:

DCGL = derived concentration guideline level

LBGR = concentration at the lower bound of the gray region. The LBGR is the average concentration to which the survey unit should be cleaned in order to have an acceptable probability of passing the test

σ_S = an estimate of the standard deviation of the residual radioactivity in the survey unit

8.7.3 Determination of Acceptable Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by failing a unit that should pass (β decision error) or passing a unit that should fail (α decision error). MARSSIM uses the terminology α and β decision errors; this is the same as the more common terminology of Type I and Type II errors, respectively. The decision errors are 0.05 for Type I errors and 0.05 for Type II errors.

8.7.4 Determination of Number of Data Points (Sign Test)

The number of measurements for a particular survey unit, employing the Sign Test, is determined from MARSSIM Table 5.5, which is based on the following equation (MARSSIM equation 5-2):

$$N = \frac{\left(Z_{1-\alpha} + Z_{1-\beta}\right)^2}{4\left(SignP - 0.5\right)^2}$$

Where:

N	=	number of samples needed in the survey unit
$Z_{1-\alpha}$	=	percentile represented by the decision error α
$Z_{1-\beta}$	=	percentile represented by the decision error β
SignP	=	estimated probability that a random measurement will be less than the DCGL when the survey unit median is actually at the LBGR

Note: SignP is determined from MARSSIM Table 5.4

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. The values in MARSSIM Table 5.5 already includes an increase of 20% of the calculated value.

8.7.5 Determination of Sample Locations

Determination of Class 1 survey unit sample locations is accomplished by first determining sample spacing and then systematically plotting the sample locations from a randomly generated starting point. (See Section 8.7.5.1) The random starting point of the grid provides an unbiased method for obtaining measurement locations to be used in the statistical tests. Class 1 survey units have the highest potential for small areas of elevated activity, so the areas between measurement locations may be adjusted to ensure that these areas can be detected by scanning techniques.

Similar systematic spacing methods are used for Class 2 survey units because there is an increased probability of small areas of elevated activity. The use of a systematic grid allows the decision-maker to draw conclusions about the size of the potential areas of elevated activity based on the area between measurement locations.

The guidance in MARSSIM recommends simple random measurement patterns for Class 3 survey units to ensure that the measurements are independent and support the assumptions of the statistical tests. However, for the purposes of this plan, GA will choose measurements locations on a judgmental basis. GA feels that selecting measurement locations in areas of higher contamination potential will better assess residual contamination in Class 3 areas (high traffic areas, potential spill areas, areas with limited housekeeping and collection points, such as floor cracks or crevices). The Project Manager will choose these locations at the time of the survey.

For Class 2 and Class 3 survey units, the sensitivity for scanning techniques is not tied to the area between measurement locations as they are for Class 1 areas. The scanning techniques selected will represent the best reasonable effort based on the survey data quality objectives.

Table 8.3 – Survey Sample Placement Overview

Survey Unit Classification		$DCGL_w$ Comparison	Elevated Measurement Comparison	Measurement Locations
Impacted	Class 1	Yes	N/A	Systematically determined from a random starting point
	Class 2	Yes	N/A	Systematically determined from a random starting point.
	Class 3	Yes	N/A	Judgmental
Non-Impacted		None	None	None

The majority of the furniture and fixtures will be removed and either free-released or sent out as radioactive waste prior to starting the final status surveys. Areas where permanent counter tops and other horizontal surfaces block the floor surface will be included as a replacement to the blocked floor surface. Likewise, fixed cabinetry faces and other permanent equipment will replace blocked wall surfaces.

Internal surfaces of permanent furnishings (i.e., drawer or cabinetry interior surfaces) are not included in the systematic measurement location placement. However, these surfaces will be included in the scan surveys and judgmental measurements may also be taken.

Additional static measurements will be collected at each area of elevated activity identified during the scan surveys.

8.7.5.1 Determining Class 1 Sample Locations

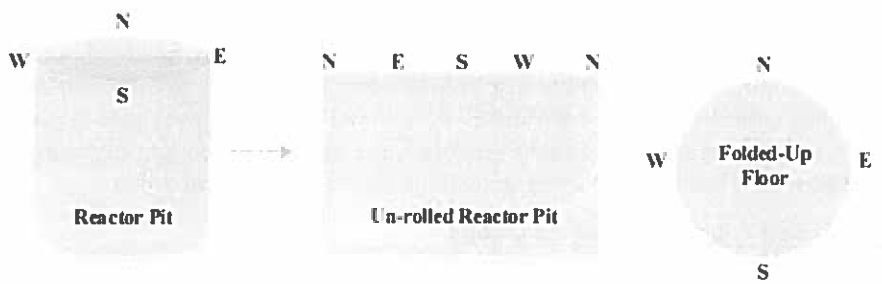
In Class 1 survey units, the sampling locations are established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L = sample spacing interval
A = the survey unit area
N = number of samples needed in the survey unit

Maps will be generated of the survey unit's permanent surfaces included in the statistical tests (floors, walls, ceilings, fixed cabinetry, etc.) and un-rolled into a 2-dimensional view. For survey units that are not reactor pits, the walls will be folded-down to create a two dimensional map of the room. For the reactor pit survey units, the cylindrical reactor walls will be "un-rolled" and the floor "folded-up" (See cartoon below) to create a two dimensional surface. A random starting point is determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid is plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location is plotted at each intersection of the grid plot.



8.7.5.2 Determining Sample Locations

Class 1 and Class 2 survey units generally consist of one or two rooms or laboratories. Class 3 survey units generally consist of many rooms. Representing each room in a "folded-out" view to show all surfaces presents a difficult and time-consuming mapping challenge. The process to identify, map and locate measurement coordinates in survey units with many rooms is complicated due to the noncontiguous nature of the survey unit once walls are "folded-out".

For the reasons above, the MARSSIM sample measurement locations (i.e., random static and wipe measurements) for Class 3 survey units will be determined on horizontal surfaces only as determined on overhead floor maps. This protocol will increase the sample density on the surfaces with the highest probability for residual contamination. The appropriate percentage of all survey unit surfaces (including vertical surfaces) will be scanned according to the survey unit classification.

During the characterization process, the Project Manager will judgmentally select locations with the highest probability of contamination on vertical surfaces for a static measurement and wipes such as light switches, door knobs, door pulls and push plates, and other locations. These measurements are in addition to and not included in the statistical analysis of the locations selected by MARSSIM protocols.

<u>Determining Class 2 Sample Locations</u>

In Class 2 survey units, the sampling locations are established in a unique pattern beginning with the random start location and the determined systematic spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L	= sample spacing interval
A	= the survey unit floor area
N	= number of samples needed in the survey unit

Maps will be generated of the survey unit's permanent surfaces included in the statistical tests. Only horizontal surfaces (e.g., floors, countertops, etc.) are included in the statistical tests. A random starting point is determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid is plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location is plotted at each intersection of the grid plot.

Determining Class 3 Sample Locations

For Class 3 areas, maps will be generated of the survey unit floor surfaces and applicable permanent equipment and/or furnishings. Sample locations will be chosen on floor, lower wall (<2m) and permanent equipment surfaces at the discretion of the survey technician. Measurement locations will be biased towards areas with the highest potential of residual contamination. Each chosen location will be identified on the applicable survey map.

8.8 Removable Contamination Surveys

Removable contamination surveys (wipes) will be collected on building structural surfaces at each sample location established by 8.7.5.2. Additionally, removable contamination surveys will be collected for building system internals. An area of approximately 100 cm^2 shall be wiped if possible. If an area of less than 100 cm^2 is wiped, a comment shall be added to the survey data sheet estimating the surface area wiped to allow for area correction of the results. Swabs may be used when system or component access points are not large enough to allow for a wipe of a 100 cm^2 surface area.

8.9 Surveys of Building Mechanical System Internals

Surveys of various building system components will need to be performed. Survey design for these systems is out of the scope of MARSSIM. For the purposes of identifying potential residual contamination within these systems, a survey protocol has been established and is presented in the following sections. If additional remediation is needed following removal of the building ventilation system, a portable HEPA system will be used to ensure GA complies with conditions of the Mark I and Mark F Technical Specifications. All future remediation will be performed under Radiological Work Permits.

8.9.1 Ventilation Systems

It is expected that all ventilation (blowers, duct work, and exhaust fans) and fume hoods will be completely dismantled and sent out as radioactive waste during the remediation phase. If necessary, any remaining HVAC system will be surveyed using the requirements listed in Table 8.4 below.

Surveys of building ventilation and fume hood ventilation will consist of scan surveys, static measurements and removable contamination measurements of accessible ventilation exhaust points and at locations of potential collection buildup. The frequency of the survey effort will depend on the classification of the surrounding area. Ventilation system initial survey requirements are summarized in Table 8.4.

Table 8.4 – Ventilation System Survey Requirements

Component(s)	Classification of Area in Which Components Exist	Survey Requirements		
		Scan Surveys	Static (Total Activity) Measurements	Removable Contamination Measurements
General ventilation and fume hood exhaust ducts	Class 1	100% scan survey of accessible[1] internal surfaces of all existing exhaust ducts	At least one static measurement taken on the internal surfaces of 100% of existing exhaust duct openings	One wipe taken at each static measurement location
	Class 2	100% scan survey of accessible[1] internal surfaces of at least 50% of existing exhaust ducts	At least one static measurement taken on the internal surfaces of 50% of existing exhaust duct openings	One wipe taken at each static measurement location
	Class 3	100% scan survey of accessible[1] internal surfaces of at least 10% of the existing exhaust ducts	At least one static measurement taken on the internal surfaces of 10% of the existing exhaust duct openings	One wipe taken at each static measurement location
Collection points within ventilation fan units	All	100% scan survey of accessible[1] internal surfaces of all applicable ventilation fan units	At least one static measurement taken on each internal surface of each accessible[1] opening on the units	One wipe taken at each static measurement location

[1] Within reach of duct or component opening

Components will be de-energized prior to access. Lock-out/Tag-out procedures will be initiated prior to any access to mechanical or electrical components.

8.9.2 Drains, Sinks, and Trenches

Surveys will consist of accessible floor drains, sinks, and trenches in the impacted areas. Removable contamination surveys of drains will be collected, since scan surveys and static measurements are not practical due to their small geometry. A pipe detector will be used, when applicable, to determine if the drain pipes are contaminated. The trenches are large enough for scans and static measurements in addition to performing removable contamination surveys. The frequency of the survey effort will be dependent on the classification of the surrounding area. Drain system survey requirements are summarized in Table 8.5.

Table 8.5 – Drain & Trench Survey Requirements

Component(s)	Classification of Area in Which Components Exist	Survey Requirements	
		Scan Surveys and Static Measurements	Removable Contamination Measurements
Drains & Trenches	Class 1	100% scan survey of accessible[1] internal surfaces of all existing trenches.	At least one wipe on the internal surfaces of 100% of the existing sink drains, sink drain traps and floor drains[1].

Component(s)	Classification of Area in Which Components Exist	Survey Requirements	
		Scan Surveys and Static Measurements	Removable Contamination Measurements
	Class 2	100% scan survey of accessible[1] internal surfaces of all existing trenches.	At least one wipe on the internal surfaces of 50% of the existing sink drains, sink drain traps and floor drains[1].
	Class 3	100% scan survey of accessible[1] internal surfaces of all existing trenches.	At least one wipe on the internal surfaces of 10% of the existing sink drains, sink drain traps and floor drains[1].
Drain system collection points such as accumulator tanks, sumps and outfalls	All	Scan surveys, static measurements and removable contamination measurements will be collected in sumps and at drain system outfalls as applicable. Sediment samples will be collected at these locations, if possible.	

[1] Some disassembly of system components may be necessary to complete these surveys.

The mechanical system survey frequencies described above are the minimum survey requirements. Additional surveys may be necessary to adequately access internal contamination levels. If additional survey locations are determined to be necessary, the survey package instructions will provide guidance.

If contamination is detected during the previous survey schemes, then additional surveys or removal of components may be required at various locations. This may require disassembly of components downstream of the affected location. Additional instructions will be provided in the survey package instructions.

8.10 Survey Action Levels

Investigation levels are used to flag locations that require special attention and further investigation to ensure areas are properly classified and adequate surveys are performed. These locations are marked and receive additional investigations to determine the concentration, area, and extent of the contamination. The survey investigation levels for each type of measurement are listed by classification in Table 8.6.

Table 8.6 – Survey Action Levels

Survey Unit Classification	Flag Static Measurement or Sample Result When:	Flag Scanning Measurement Result When:	Flag Removable Measurement Result When:
Class 1	> 50% of DCGL	> 50% of DCGL	> 100 dpm/100cm^2
Class 2	> 20% of DCGL	> 20% of DCGL	> 100 dpm/100cm^2
Class 3	>MDC	>MDC	> 100 dpm/100cm^2

8.11 Survey Documentation

A survey package will be developed for each survey unit containing the following:

- Survey Instruction Sheets
- General survey requirements
- Instrument requirements with associated MDCs, count times and scan rates, action levels
- Survey Maps

- Overview maps detailing survey locations and placement methodology
- Survey sub-unit maps with additional sample location information, as needed
- Survey Data Sheets
- Signature of Data Collector and Reviewer

8.12 Data Validation

Field data will be reviewed and validated to ensure:

- Completeness of forms and that the type of survey has correctly been assigned to the survey unit
- The MDCs for measurements meet the established data quality objectives; independent calculations will be performed for a representative sample of data sheets and survey areas
- Instrument calibrations and daily functional checks have been performed accurately and at the required frequency

9.0 Data Quality Assessment (DQA) and Interpretation of Survey Results

The statistical guidance contained in Section 8 of MARSSIM will be used to determine if areas are acceptable for unrestricted release, and whether additional surveys or sample measurements are needed.

9.1 Preliminary Data Review

A preliminary data review will be performed for each survey unit to identify any patterns, relationships or potential anomalies. Additionally, measurement data is reviewed and compared with the DCGLs and action levels to identify areas of elevated activity and confirm the correct classification of survey units. If an area is misclassified with a less restrictive classification, the area will be upgraded and surveyed accordingly.

The following preliminary data reviews will be performed for each survey unit:

- Calculations of the survey unit mean, median, maximum, minimum, and standard deviation for each type of reading.
- Comparison of the actual standard deviation to the assumed standard deviation used for calculating the number of measurements. If the actual standard deviation is greater than estimated, the minimum number of samples shall be calculated using the actual standard deviation to ensure a sufficient number of samples have been obtained.
- Comparison of survey data with applicable action levels.

9.2 Determining Compliance

For Class 1 areas, if it is determined that all static results are less than the applicable DCGL, then no further statistical tests are required. If any of the static measurements are greater than the $DCGL_W$, then the survey unit fails and the null hypothesis is not rejected. The survey unit is determined to meet the release criterion provided that the application of any unity rules result in values less than 1.

The Sign test is used to determine the minimum number of sample locations. However, the Sign test will not be performed in this survey design because the total activity DCGL is used as a maximum. If all measurements are less than the DCGL, performance of the Sign test is not necessary because the survey unit will pass the Sign test by definition.

For Class 2 and Class 3 areas, data results are initially compared to the action levels. These action levels are provided to help ensure that survey units have been properly classified. If all data results in Class 2 or 3 areas are less than the action levels, then the survey unit is determined to meet the release criterion. If these action levels are exceeded, then an investigation is performed to verify the initial assumptions for classification and determine the appropriate resolution (e.g., additional scans or survey unit reclassification).

Class 3 survey units, by definition, are not expected to contain residual activity above a small fraction of the DCGL(s). Therefore, if contamination is detected exceeding the DCGLs, then reclassification is required. However, reclassification of the entire survey unit may or may not be appropriate. The area containing the residual activity may have been an isolated case and reclassification of the entire survey unit would be inappropriate. More appropriately, the affected portion of the survey unit may be separated and only that portion reclassified. The Project Manager will evaluate the survey results, assign additional scan surveys, as appropriate, and determine the appropriate course of action.

Removable contamination measurements will be compared directly to the applicable DCGL. No contingency is established for elevated removable contamination. If any removable contamination is detected which exceeds a removable contamination action level, then the survey unit is determined not to meet the release criterion. However, if all removable contamination measurements are less than the removable contamination DCGL, then compliance shall be determined based on total activity measurements.

Table 9.1 – Building Surfaces and Structures Data Compliance Overview

Classification	Survey Result	Conclusion
Class 1	• All measurements < $DCGL_W$ and • Results of applicable unity rules ≤ 1	Survey unit meets release criterion
	• Any measurement > $DCGL_W$, or • Result of unity rule >1	Survey unit does not meet release criterion
Class 2	• All measurements < applicable action levels, and • Results of applicable unity rules ≤ 1	Survey unit meets release criterion
	• Average > applicable action levels, and • All measurements < $DCGL_W$	Survey unit may meet release criterion. Perform evaluation of elevated activity and determine if additional surveys and/or reclassification are warranted.
	• Any measurement > $DCGL_W$, or • Results of applicable unity rule >1	Survey unit does not meet release criterion
Class 3	• All measurements < applicable action levels, and • Results of applicable unity rules ≤ 1	Survey unit meets release criterion
	• Average > applicable investigation levels, and • All measurements <$DCGL_W$	Survey unit may meet release criterion. Perform evaluation of elevated activity and determine if additional surveys and/or reclassification are warranted.
	• Any measurement >$DCGL_W$, or • Results of applicable unity rules ≥ 1	Reclassify survey unit or portion of survey unit, if justification for splitting the survey unit is provided. Survey unit does not meet release criterion as it exists

10.0 Final Status Survey Report

A Final Report of all D&D activities performed at the facility following termination of operations and conversion of the operating licenses to POL shall be prepared and submitted to the U.S. Nuclear Regulatory Commission. The guidance provided in NUREG 1727 will be used to prepare the final report. The Final Report will include, at a minimum:

- Historical Site Assessment and Operational History
- Pre-FSS D&D activities
- FSS plan and overview of the results of the FSS
- A summary of the screening values for the facility (if screening values are used)
- A discussion of any changes made in the FSS from what is proposed in this plan
- A description of the method by which the number of samples was determined for each survey unit
- A summary of the values used to determine the number of samples and a justification for these values
- The survey results for each survey unit including the following:
  - The number of samples taken for the survey unit;
  - A description of the survey unit, including (a) a map or drawing showing the reference system and random start systematic sample locations for Class1 and 2 survey units and reference area, as applicable, for the random locations shown for Class 3 survey units and reference areas, (b) discussion of remedial actions and unique features, and (c) areas scanned for Class 3 survey units and reference areas;
  - The measured sample concentrations, in units comparable to the screening values;
  - The statistical evaluation of the measured concentrations;
  - Judgmental and miscellaneous sample data sets reported separately from those samples collected for performing the statistical calculations;
  - A discussion of anomalous data including any areas of elevated activity detected during scan surveys that exceeded the investigation levels or any measurement locations in excess of the screening values; and
  - A statement that a given survey unit satisfies the screening values and the elevated measurement comparison if any sample points exceeded the screening values
- A description of any changes in initial survey unit assumptions relative to the extent of residual activity (e.g., material not accounted for during site characterization)
- A description of how ALARA practices were employed to achieve final activity levels.

11.0 References

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TRIGA Survey Units