# MARSSIM AND NUREG CR 5849 COMPLIANT INACCESSIBLE SURFACE MONITORING FOR FINAL SURVEYS

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## ABSTRACT

Building decommissioning demands determination of the activity levels on hidden building surfaces, including sub slab surfaces. MARSSIM(Multi Agency Radiation Survey and Site Investigation Manual) and NUREG CR/5849 (Manual for Conducting Radiological Surveys in Support of License Termination) guidance for characterization and final survey requirements on the survey of inaccessible areas is vague. BWSI has developed Nuclear Regulatory Commission accepted, practical and cost-effective MARSSIM and NUREG CR/5849 compliant survey methods for inaccessible surfaces. The study includes the use of dual capable (simultaneous) beta and alpha survey meters to detect subsurface deposits of HEU and transuranics.

## INTRODUCTION

BWSI has developed Nuclear Regulatory Commission accepted, practical, and cost-effective MARSSIM and NUREG CR/5849 compliant survey methods for inaccessible structural surfaces. The surveys are designed as characterization and final surveys. MARSSIM (section 4.8.3.1) and NUREG CR/5849 (section 4.1.3) contain specific instructions to measure inaccessible surfaces. Neither MARSSIM nor NUREG CR/5849 provides guidance on the required survey density for such areas. MARSSIM (section 5.5.3.3) specifically states that guidance on conducting or evaluating these types of surveys is outside the scope of MARSSIM. The guidance states that "special situations may be evaluated by judgement sampling or measurements." The BWSI procedures follow this guidance.

It is impractical to survey hidden surfaces in the same manner as open surface survey units. Extensive building deconstruction would be required to provide the required access for scanning. Inaccessible area surveys combine judgmental survey and minimum survey densities to compensate for the inability to scan. The selection of biased survey locations ensures the detection of elevated activity areas. The survey density requirements ensure the adequacy of the survey as a characterization survey and the detection of significant elevated activity areas. Minimum survey densities are also used because experience has shown that additional measurements are far less expensive than finding areas of elevated activity later in the survey process. The combination is sufficient to determine the survey unit's radiological status to the accuracy level required by the site Data Quality Objectives(DQO). The process consists of the following principal steps:

### Survey Data Evaluation for Hidden Surface Contamination

The survey data is reviewed for indications of penetration of contamination into each type of hidden surface.

Inaccessible Surface Classification

The data is used to classify the inaccessible surfaces for contamination potential. Each type of inaccessible surface is classified as to contamination potential (MARSSIM Class 1-3) or NUREG CR/5849 Affected, LA(Low Activity) affected, and Unaffected areas.

Inaccessible Surface Survey Plan Development

The survey plan for each type of inaccessible surface is developed based upon the applicable guidance and contamination potential.

Survey Methods

The surveys are performed according to standard protocols, which reflect the surface classification and type of interface.

Data Evaluation

The data evaluation process, investigation levels, and response actions.

## METHODOLOGY

Survey Data Evaluation for Inaccessible Surface Contamination.

The survey data is reviewed for indications of penetration of contamination onto hidden surfaces. The activities that took place in the area are evaluated for the potential to contaminate hidden surfaces. Liquid and fine particle operations are likely to cause hidden surface contamination. Interface location, width, and category are determined. Open interfaces have higher contamination potential, than narrow interfaces. The area is inspected for signs of acids, liquids, and multiple layers of paint. The survey data is reviewed for evidence of activity at; surface to surface joins, cracks, expansion joints, and similar surfaces. Particular care is taken to review gamma and beta results. Unexpected elevated gamma or beta results are an indication of hidden activity. The presence of anomalous “beta” activity in Transuranic(TRU) and High Enriched Uranium(HEU) dominant areas is particularly significant, as detectable beta activity is not actually present. The “beta “ response is a strong indication of hidden or subsurface contamination. The “beta” response is due to gamma, X rays, and partially absorbed alpha particles.

Inaccessible Surface Classification

The structure open surfaces and associated inaccessible surfaces are classified, based upon the Historical Site Assessment HSA, survey data, and survey area inspection results. The classifications used are MARSSIM Class 1, MARSSIM Class 2, and MARSSIM Class 3. The NUREG CR-5849 equivalents are Affected area, Low activity affected area (section 4.2.3), and Unaffected area. The inaccessible surfaces are classified separately from the associated open

surface survey units. Due to the protected nature of hidden surfaces, the classification of the hidden surfaces is normally one classification lower than that of the associated open surfaces. For example, sub slab surfaces are protected from contamination by the concrete slab itself. Inaccessible surfaces that are judged to offer significant access to contamination or have significant signs of possible contamination receive the same classification as the associated open surface unit. Locations containing acid or liquid processes are very likely to be classified in this way.

- MARSSIM Class 1 inaccessible area survey units. Areas with high contamination potential, and significant inaccessible area access, are classified as MARSSIM Class 1 inaccessible area survey units. Most MARSSIM Class 1 inaccessible area survey units are associated with liquid or acid processing areas and associated spills. MARSSIM Class 1 areas are not surveyed, when the existing survey data, or professional judgement demonstrates that the surfaces exceed the $DCGL_w$.

- MARSSIM Class 2 inaccessible area survey units. In general, the inaccessible surfaces surrounding a MARSSIM Class 1 open surface survey unit are classified as a MARSSIM Class 2 inaccessible area survey unit. Experience has shown that these areas have a lower contamination potential than the associated open surface areas. The potential is similar to that of areas on the perimeter of former contamination control areas.

- MARSSIM Class 3 inaccessible area survey units. In general, the inaccessible surfaces surrounding a MARSSIM Class 2 open surface survey unit are classified as a MARSSIM Class 3 inaccessible area survey unit. Experience has shown that these areas have a lower contamination potential than the associated open surface areas. The areas have a low potential for contamination.

Inaccessible Surface Survey Plan Basis

The survey plan basis is a function of the classification of the inaccessible surfaces. The survey plans are designed as characterization and final survey plans. The plans are based upon: judgement survey (MARSSIM section 5.5.2.5), the need to obtain thorough coverage to satisfy the characterization requirements, and the need to detect locations of elevated activity. Dense survey coverage is used, as experience has shown that additional measurements are far less expensive than finding areas of elevated activity later in the survey process. Finding such areas later in the process forces additional survey. Scheduling disruptions will occur. Remediation may be required in areas that have been released on the basis of surface surveys.

- MARSSIM Class 1 inaccessible areas. The survey requirements for a MARSSIM Class I area are based upon the need to detect small areas of elevated activity by scanning and to determine the average contamination level by systematic survey. The density of the systematic survey is dictated by the need to detect small areas of elevated activity, and the capabilities of the scanning method. Scanning cannot be performed, as the surfaces to be scanned are inaccessible. Therefore, the maximum systematic sampling/measurement density required by the applicable guidance is needed. NUREG 1505 A Nonparametric

Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys section 5.5.4, gives a maximum required survey density of one location per 0.9 $m^2$ of interface area. NUREG CR-5849 requires a maximum survey density is one location per each 1.0 $m^2$ of surface area (section 4.2.3.). The survey location within each measurement area ( 0.9 - 1.0 $m^2$ ) is selected on the basis of professional judgement. Biased survey locations and a high survey density ensure detection of elevated activity areas.

- MARSSIM Class 2 inaccessible areas. The survey requirements for a MARSSIM Class 2 open surface survey unit are based upon the need to determine the average contamination level. Systematic and judgmental scanning to detect areas of elevated activity that were not detected by the systematic survey measurements is also required. Measurement locations are not adjusted on the basis of the sensitivity of the scanning technique. The level of scanning is a function of the potential for finding areas of elevated activity. Scanning cannot be performed, as the surfaces to be scanned are inaccessible. The minimum number of data points to be used for any Class 2 inaccessible area is that determined from MARSSIM sections 5.5.2.2 or 5.5.2.3. The default systematic minimum survey density in BWSI MARSSIM Class 2 inaccessible areas at the Parks Facility is one measurement location per each 20 $m^2$ of interface area. This is a conservative value based upon NUREG CR-5849 guidance. The survey density ensures the adequacy of the survey as a characterization survey. Experience has shown that, its use normally ensures that each survey unit is assigned an adequate number of data points to meet final survey requirements. The survey location within each 20 $m^2$ of interface area is selected on the basis of professional judgement. Biased survey locations and a conservative survey density ensure detection of elevated activity areas.

- MARSSIM Class 3 inaccessible areas. The survey requirements for a MARSSIM Class 3 area are based upon the need to determine the average contamination level by systematic survey. Judgmental scanning to detect areas of elevated activity that were not detected by the systematic survey measurements is required to provide a qualitative level of confidence that no areas of elevated activity were missed and that the survey unit was properly classified. Scanning cannot be performed, as the surfaces to be scanned are inaccessible. The minimum number of data points to be used for any Class 3 inaccessible area is that determined from MARSSIM sections 5.5.2.2 or 5.5.2.3. The default systematic survey density in BWSI MARSSIM Class 3 inaccessible areas at BWSI decommissioning projects is one measurement location per each 50 $m^2$ of interface area. This is a conservative value based upon NUREG CR-5849 guidance. The survey density ensures the adequacy of the survey as a characterization survey. Experience has shown that, its use normally ensures that each survey unit is assigned an adequate number of data points to meet final survey requirements. The minimum number of data points to be used for any Class 3 inaccessible area is that determined from MARSSIM sections 5.5.2.2 or 5.5.2.3. The survey location within each 50 $m^2$ measurement area is selected on the basis of professional judgement. Biased survey locations and a conservative survey density ensure detection of elevated activity areas.

Survey Methods

The final survey methods for inaccessible surfaces are a function of the surface classification, the type of hidden surface, and the makeup of the hidden surface. Table 1 "Interface Lengths Corresponding to Standard Survey Areas" contains the interface lengths that correspond to the standard survey area per measurement for each survey unit class for common wall thicknesses.

**Vertical surface to surface interfaces**. The default measurement location is within the bottom 2 meters of each interface for MARSSIM Class 1, 2, and 3 survey units. It is normally at the wall to wall to floor interface. The base of the vertical interface is considered the most likely contamination location, in the absence of other data. A block or wall section from the lowest level of the wall is removed. The exposed residual wall interface is measured for direct and removable contamination. Floor slab measurements are taken on the exposed floor for a wall to floor horizontal interface. Additional survey locations are accessed in a similar manner to maintain the required survey density for the survey unit class. In most cases, the biased measurement at the base of the interface is adequate to fulfill the MARSSIM Class 1, 2, and 3 survey density requirements.

**Vertical expansion joints.** The expansion joint material in MARSSIM Class 1 open, surface, survey units is normally removed. Experience has shown that the expansion joint material is often significantly more contaminated than the remaining surface. The remaining interface is surveyed as a vertical surface to surface interface. In MARSSIM Class 2 and 3 open surface survey units, the expansion material is used to characterize the wall to wall interface. The default measurement location is within the bottom 2 meters of each interface for MARSSIM Class 1, 2, and 3 survey units. It is normally at a wall to wall to floor interface. In most cases, the biased measurement at the base of the interface is adequate to fulfill the MARSSIM Class 1, 2, and 3 survey density requirements. A sample of expansion joint material is collected. A direct survey and gamma spectroscopy analysis of the material is performed. A smear is taken of the residual surface.

**Horizontal surfaces to surface interfaces**. The interface is divided into the size survey area/grids dictated by the classification of the interface. A biased location is selected within each survey area/grid. A block or section from the wall is removed. The exposed interface is measured for direct and removable contamination.

**Horizontal expansion joints.** The expansion joint materials in MARSSIM Class 1 open, surface, survey units are removed. Experience has shown that it is normally significantly more contaminated than the remaining surface. The remaining interface is surveyed as a horizontal surface to surface interface. In MARSSIM Class 2 and Class 3 open, surface, survey units the expansion material is used to characterize the interface. The interface is divided into the size survey area/grids dictated by the classification of the interface. A biased location is selected within each survey area/grid. A sample of expansion material

is collected. A direct survey and gamma spectroscopy analysis of the material is performed. A smear is taken of the residual surface.

**Vertical gaps.** Gaps have the same classification as the associated open surface survey unit. The interface is large enough that contamination access to the surface is unimpeded. Due to building construction, direct survey of the gap surfaces and remediation of the surface is not feasible. They are surveyed in the same locations and a similar manner as vertical surface to surface interface. A block is removed from the wall, to allow survey access to the residual surfaces. Ideally the block is brought out intact for the survey and the residual surface is surveyed/sampled. Sampling is often required, in addition to the instrument survey, as these locations are typically painted.

**Horizontal gaps.** Gaps have the same classification as the associated open surface survey unit. The interface is large enough that contamination access to the surface is unimpeded. Due to building construction, direct survey of the gap surfaces and remediation of the surface is not feasible. They are surveyed in the same locations and a similar manner as horizontal surface to surface interfaces. A block is removed from the wall, to allow survey access to the residual surface. Ideally the block is brought out intact for survey and the residual surface is surveyed/sampled. Sampling is often required, in addition to the instrument survey as these locations are typically painted.

**Base floor sub slab surfaces, interfaces, penetrations, or cracks**. Locations where the upper surfaces of the slab meet free release requirements are considered for a final survey for free release for unrestricted use. At least one sample/measurement is collected per survey area/grid. The measurement location is biased. Survey data, and a physical review of each survey area/grid is used to determine the most probable path of contamination to the sub slab surface. The possible pathway is usually an interface or crack. The measurement /sample location is accessed by removing portions of the slab using a concrete saw, coring machine, or equivalent. The sample embraces the suspect interface or crack. Ideally the selected sampling point is the meeting place of multiple interfaces, cracks, and penetrations. Direct and removable measurements are taken of the exposed surfaces, which are typically each side of the crack or interface, and the bottom of the cutout slab. The bottom of the slab is sampled for a gamma spectroscopic analysis, when instrument measurements are infeasible.

**Table 1**
**Interface Lengths Corresponding to Standard Survey Areas(1)(2)**

| MARSSIM Survey Unit Classification | 8" Wall Width | 12" Wall Width | 20" Wall Width |
|---|---|---|---|
| Class 1 | 4.9 meters | 3.3 meters | 2.0 meters |
| Class 2 | 98 meters | 65 meters | 39 meters |
| Class 3 | 246 meters | 164 meters | 98 meters |

1.0 The stated interface lengths are the maximum values used. They correspond directly to: one meter of surface area for MARSSIM Class 1 survey units, 20 meters of surface area for MARSSIM Class two survey units, and 50 meters of surface area for MARSSIM Class three survey units.

2.0 The survey of sub slab surfaces, and slab cracks and interfaces is based upon open surface area only. No attempt is made to determine the length of cracks/joins and to assign data measurement density upon the surface area of the cracks/joins.

Data Evaluation

The data evaluation is conservative due to the lack of scanning. The data evaluation is a function of the survey class and the survey results. The primary basis of the data analysis is MARSSIM section 5.5.2.5. All measurement locations in the inaccessible survey units are based on professional judgement. Data points are compared directly to the established DCGLs (Derived Concentration Guideline Level see Appendix I for definitions of acronyms and terminology). The biased method of measurement location selection invalidates the assumption of unbiased measurements that underlie the MARSSIM standard statistical tests. Data analysis to demonstrate that a survey unit meets free release for unrestricted use requirements, must demonstrate compliance with MARSSIM and NUREG CR-5849 criteria. Survey results which are entirely below the $DCGL_{w,}$, and the survey class investigation levels are subject to minimal analysis. Survey results, which clearly exceed the release criteria are subject to minimal analysis. If some survey results exceed the $DCGL_w$ or the investigation levels, they are subject to extended analysis.

MARSSIM Class 1 inaccessible survey units. The survey data is reviewed. No review of the adequacy of the number of measurement points is done. The survey density used is the maximum density required by published guidance. The data is primarily instrument data. The data is not isotope specific. Four primary cases exist;

**All net measurements are less than the $DCGL_w$.** The survey unit is concluded to meet release criteria. The average, standard deviation, and upper confidence limit are

calculated to demonstrate compliance with NUREG CR-5849 criteria. As the survey consists of judgmental measurements, MARSSIM compliance is demonstrated by a direct comparison of the results to the $DCGL_w$. The data is sufficient to demonstrate that the survey unit average activity does not exceed the $DCGL_w$.

**The net average measurement is less than the $DCGL_w$ and all measurements are less than $DCGL_{EMC}$.** The results trigger investigation. The activity distribution is reviewed by means such as a posting plot. A frequency distribution review is done on the survey unit and background data. The average, standard deviation, and upper confidence limit are calculated. The cause of trending is determined. If the elevated results are geographically associated, the survey unit may be split into sections of more equal contamination levels and contamination variability. Locations that exceed the $DCGL_w$ are investigated to ensure a complete understanding of the nature and extent of the elevated areas of contamination. Further sampling/measurements are unlikely due to the very high survey density. If after the investigation, the data is confirmed to be sufficient to demonstrate that the survey unit average activity is less than $DCGL_w$, no location exceeds the $DCGL_{EMC}$ and the Data Quality Objective(DQO) are met, the survey unit is accepted as meeting the free release for unrestricted use criteria. The average, standard deviation, and upper confidence limit are calculated to demonstrate compliance with NUREG CR-5849 criteria. As the survey consists of judgmental measurements, MARSSIM compliance is demonstrated by a direct comparison of the average results to the $DCGL_w$.

**The net average measurement is less than the $DCGL_w$ and some measurements are greater than the $DCGL_{EMC}$.** The default position is that all or a portion of the survey unit fails. The hidden surfaces clearly contain areas in excess of the $DCGL_{EMC}$. The activity distribution is reviewed by means such as a posting plot. A frequency distribution review is done. The average, standard deviation, and upper confidence limit are calculated. The cause of trending is determined. Locations that exceed the $DCGL_w$ are investigated to ensure a complete understanding of the nature and extent of the elevated areas of contamination. Additional measurements may be taken to determine the area and level of the elevated activity locations. If the elevated results are geographically associated, the survey unit may be split into sections of more equal contamination levels and variability. If the unit cannot be split, the entire survey unit fails final survey. The unit is scheduled for remediation, disposal as radioactive waste, or is completely accessed and surveyed as an open surface MARSSIM Class 1 survey unit.

**The net average measurement is greater than the $DCGL_w$.** The survey unit fails. The unit is scheduled for remediation, disposal as radioactive waste, or completely accessed and surveyed as an open surface MARSSIM Class 1 survey unit.

MARSSIM Class 2 inaccessible area survey units. The collected survey data is reviewed. There are two primary cases;

**All measurements are less than the investigation level.** The survey unit is concluded to be correctly classified and to meet release criteria. The average, standard deviation, and upper confidence limit are calculated to demonstrate compliance with NUREG CR-5849 criteria. As the survey consists of judgmental measurements, MARSSIM compliance is demonstrated by a direct comparison of the results to the $DCGL_w$. The data is sufficient to demonstrate that the survey unit average activity does not exceed 25% of the $DCGL_w$. The investigation level is 25% of the $DCGL_w$.

**Some measurements exceed the investigation level**. The default result is reclassification of all or part of the survey unit as a MARSSIM Class 1 survey unit. The survey is augmented to meet the requirements for the new classification. If the entire survey unit is not reclassified, the survey results are investigated to determine the validity of the classification. The activity distribution is reviewed by means such as a posting plot. A frequency distribution review is done on the survey unit and background data. The cause of trending is determined. Locations that exceed the investigative level of 25% of the $DCGL_w$ are investigated to ensure a complete understanding of the nature and extent of the elevated areas of contamination. Bounding measurements or an enhancement of the survey density in a suspect area may be taken. If the elevated results are geographically associated, the survey unit may be split into sections of more equal contamination levels and variability. If after the investigation, the data is confirmed to be sufficient to demonstrate that the survey unit average activity is less than the $DCGL_w$, individual measurements in excess of the $DCGL_w$ are unlikely, and meets the Data Quality Objective(DQO), the survey unit is accepted as meeting the free release for unrestricted use criteria. As the survey consists of judgmental measurements, MARSSIM compliance is demonstrated by a direct comparison to the $DCGL_w$. The average, standard deviation, and upper confidence limit are calculated to demonstrate compliance with NUREG CR-5849 criteria.

MARSSIM Class 3 Inaccessible Area Survey Units. The collected survey data is reviewed. There are two primary cases;

**All measurements are less than the investigation level.** The survey unit is concluded to be correctly classified and to meet release criteria. The average, standard deviation, and upper confidence limit are calculated to demonstrate compliance with NUREG CR-5849 criteria. As the survey consists of judgmental measurements, MARSSIM compliance is demonstrated by a direct comparison of the results to the $DCGL_w$. The data is sufficient to demonstrate that the survey unit average activity does not exceed 25% of the $DCGL_w$. The investigation level is 25% of the $DCGL_w$.

**Some measurements exceed the investigation level.** After confirmation of the measurements exceeding the investigation levels, the survey unit is concluded to be incorrectly classified. The default result is reclassification of all or part of the survey unit as a MARSSIM Class 1 or 2 survey unit. The survey is augmented to meet the requirements for the new classification. The activity distribution is reviewed by means such as a posting plot. A frequency distribution review is done on the survey unit and

background data. The cause of trending is determined. Locations that exceed the investigative level are investigated to ensure a complete understanding of the nature and extent of the elevated areas of contamination. The data is analyzed to ensure sufficient data points have been surveyed. If the elevated results are geographically associated, the survey unit may be split into sections of more equal contamination levels and variability.

## DISCUSSION

The main benefits of this approach are an early, thorough determination of the status of the inaccessible surfaces of a structure, and an early demonstration that some building surfaces meet free release for unrestricted use guidelines. The conservative and simple nature of the survey approach ensures rapid regulatory acceptance, as the base assumptions are not subject to dispute. It also allows simple, straightforward survey planning and implementation, which reduces the workload on the radiological engineering staff. Regulatory acceptance is an important cost and scheduling element. Early accurate determination of the status of inaccessible surfaces is critical, as unexpected contamination in hidden surfaces can have enormous effects on safety, compliance, decommissioning costs, and schedules. Careful survey planning can minimize the number of required survey locations, through selection of locations (when possible) which allow access for instrument survey to multiple potentially contaminated hidden surfaces.

## CONCLUSION

Hidden surface survey for site characterization and area release for unrestricted use can be accurate and cost effective. Early implementation of the survey plans is essential if maximum benefit is to be derived from the data

## Appendix 1

## Definitions

**Affected Area**
A NUREG CR-5849 term. Areas that have potential radioactive contamination based upon operating history or known radioactive contamination (based on past or preliminary radiological surveillance). This would normally include areas where radioactive materials were used and stored, where records indicate spills or other unusual occurrences that could have resulted in the spread of contamination. An affected area is directly comparable to a MARSSIM Class 1 area.

**Block on Top of Slab**
Surface to Surface interface evaluated under “Below-Slab” Inaccessible Area Surveys. This interface exists where a block wall(generally not a load-bearing wall) was built directly on top of a concrete slab.

**DCGL (derived concentration guideline level)**
A MARSSIM or NUREG-1575 term. 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(DCGLw) and the Elevated Measurement Comparison ($DCGL_{EMC}$). DCGLs are derived from activity/dose relationships through various exposure pathway scenarios.

**Final Radiation Survey**
A radiation and contamination survey, which is performed by a licensee at the conclusion of planned decommissioning or remediation work for which an NRC confirmatory survey may be performed. The purpose of the survey is to verify that the levels of radiation and contamination meet those which are acceptable (per applicable regulatory guidance) for release for unrestricted use.

**Floor Penetrations**
Openings used to run electric lines, ventilation ducts, process system piping, and other building utilities. Floor penetrations will generally be evaluated as Surface to Surface Interfaces due to sleeving cemented into the slab. Occasionally however, floor penetrations will be evaluated as a Large or Small Hole in the absence of sleeving, or as a Gap if the penetration has live utilities traversing it.

**Floor to Wall Interface**
Surface to Surface interface evaluated under "Below-Slab" Inaccessible Area Surveys. This interface exists where a wall is on the outside of a concrete slab. The wall would generally be a load-bearing wall, penetrating through a concrete slab and supported by a footer.

**Gaps**
Areas that can be cleaned for loose surface contamination but do not provide sufficient space to remove any fixed contamination and/or survey using standard radiation measurement instruments.

**Inaccessible Area**
Interior surfaces that are not 100% accessible to radiological survey instruments for a radiation/contamination survey.

**Low Activity Area(LA)**
An affected area for which there is no reason to suspect residual activity exceeding 25% of the guideline level. An example indicated in NUREG CR-5849(page 4.15 is a ceiling above a radioactive material use area. LA areas often serve as a buffer area around affected areas. A LA area is directly comparable to a MARSSIM Class 2 area.

**MARSSIM Class 1 Survey Unit**
A MARSSIM or NUREG-1575 term. Areas that have, or had prior to remediation, a potential for radioactive contamination (based on site operating history) above the $DCGL_w$. Examples of Class 1 areas include: 1) site areas previously subjected to

remedial actions, 2) locations where leaks or spills are known to have occurred, 3)former burial or disposal sites, 4)waste storage sites, and 5) areas with contaminants in discrete solid pieces of material and high specific activity. Class 1 areas are directly comparable to a NUREG CR-5849 affected area.

**MARSSIM Class 2 Survey Unit**

A MARSSIM or NUREG-1575 term. Areas that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed the $DCGL_w$. Examples of areas that might be classified as Class 2 for the final status survey include; 1) locations where radioactive materials were present in an unsealed form. 2) potentially contaminated transport routes, 3) areas downwind form stack release points, 4) upper walls and ceilings of buildings or rooms subjected to airborne contamination, 5) areas handling low concentrations of radioactive materials, and 6) areas on the perimeter of former contamination control areas. Class 2 areas are directly comparable to a NUREG CR-5849 Low Activity affected area(LA).

**MARSSIM Class 3 Survey Unit**

A MARSSIM or NUREG-1575 term. Any impacted areas that are not expected to contain any residual activity, or are expected to contain residual activity at a small fraction of the $DCGL_w$, based on site operating history and previous radiation surveys. Examples of areas that might be classified as Class 3 include buffer zones around Class 1 or Class 2 areas, and areas with very low potential for residual contamination but insufficient information to justify a non-impacted classification. Class 3 areas are directly comparable to a NUREG CR-5849 Unaffected area.

**Surface to Surface Interface**

Areas with a mortar to mortar interface or concrete to steel interface (where concrete block has been cast directly against a support, steel or other) that had the potential for liquid process fluids or other solid contaminants to have penetrated during facility operations. This category includes expansion joints and cracks in concrete. Floor openings (penetrations) where utilities penetrated the slab are generally included in this category due to sleeving cemented into the slab.

**Unaffected Area**

A NUREG CR-5849 term. An area in which site characterization did not show the presence of contamination in excess of an appropriate action level or limit, or where contamination is not expected based upon knowledge of site history and operations. It includes all onsite areas that are not Affected Areas. An unaffected area is comparable to a MARSSIM Class 3 area.

## REFERENCES

1.0 NUREG/CR-5849. “Manual for Conducting Radiological Surveys in Support of License Termination.” Washington D.C.:Nuclear Regulatory Commission. June 1992.

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3.0 NUREG-1505. “A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys.” Washington D. C.:Nuclear Regulatory Commission. August 1995.