EPA SCIENTIFIC ADVISORY BOARD – RADIATION ADVISORY COMMITTEE CHARGE TO THE PANEL – MARSSIM, REVISION 2

The Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) document (https://www.epa.gov/radiation/multi-agency-radiation-survey-and-site-investigation-manual-marssim) provides information on planning, conducting, evaluating and documenting building surface and surface soil[1] final status radiological surveys. MARSSIM is a multi-agency consensus document that was developed collaboratively by four Federal agencies having authority and control over radioactive materials: Department of Defense (DOD), Department of Energy (DOE), Environmental Protection Agency (EPA) and Nuclear Regulatory Commission (NRC). The MARSSIM document's objective is to describe a consistent approach for planning, performing and assessing building surface and surface soil final status surveys to meet established dose- or risk-based release criteria, while at the same time encouraging an effective use of resources.

The original MARSSIM document was published in 1997, with errata and addenda pages published in 1998 and 1999. Revision 1 to MARSSIM was published in 2000, and additional errata and addenda pages were published in 2001. None of the changes made from 1998 to 2001 reflect significant departures from the science and technology of the original MARSSIM document; instead, they provide additional clarification and correct errors in the original published document. No additional changes to the document itself have been made since 2001.

The Scientific Advisory Board (SAB) conducted the scientific peer reviews of the 1997 version of MARSSIM (EPA-SAB-RAC-97-008, dated 9/30/1997), its companion document addressing laboratory analytical protocols (MARLAP, EPA-SAB-RAC-03-009, dated 6/10/2003) and the MARSSIM Supplement addressing materials and equipment (MARSAME, EPA-SAB-08-010, dated 8/7/2008).

The MARSSIM Workgroup developed a three-day in-person or five-day (4 hours per day) internet-based technical training course on the document for radiation professionals seeking to learn more about final status surveys for surface soils and building surfaces. The EPA-sponsored MARSSIM training is offered three times a year to a total of 72 students.

The MARSSIM Workgroup conducted a thorough request for public input for the MARSSIM revisions in 2010. In addition, the MARSSIM Workgroup held a Consultation with the SAB in 2011 to request input on possible updates. After developing a draft of the proposed document, the MARSSIM Workgroup conducted an Internal Agency Review in 2016, which identified further areas of clarification and improvement. Finally, the MARSSIM Workgroup plans to make Revision 2 available for public comment and will incorporate suggested improvements as appropriate based on that review.

Previous scientific peer reviews have helped to shape the science behind the MAR- series of documents, and the four federal agencies involved in the MARSSIM Workgroup agree that input from the SAB should be sought for any significant changes, including those currently proposed for Revision 2 (outlined in the charge questions below). Scientific concepts remaining materially unchanged from Revision 1, (e.g., the use of non-parametric statistics, Scenario A) have already undergone review by the SAB and do not require review at this time.

[1] The MARSSIM document does not address volumetric or subsurface soils.

CHARGE QUESTIONS:

1) Are the revisions to MARSSIM concepts and methodologies **technically appropriate, useful and clear**, and do they provide a practical and implementable approach to performing environmental radiological surveys of surface soil and building surfaces?

1.1 Please identify whether the inclusion and proposed implementation of scan-only surveys (Section 5.3.6.1 and Section 8.5) is appropriate, adequate and clear, especially the discussion on sampling for scan-only measurement method validation or verification.

The MARSSIM Workgroup wrote MARSSIM, Revision 1, for 1995 technology, not envisioning that future instrumentation would be able to measure a statistically significant portion of the survey unit while meeting required Measurement Quality Objectives (MQOs), especially that the Minimum Detectable Concentration (MDC)/Minimum Detectable Activity (MDA) be less than 50% of the Derived Concentration Guidelines Level for wide areas (DCGLw). New methods for designing, implementing and assessing scan-only surveys are included in the revisions to make effective use of resources when employing these technologies.

Earlier reviewers misinterpreted the term "scan-only surveys" to mean that samples would not be taken as any part of the survey process. Revision 2 has been further revised to indicate that quality control samples may need to be collected as part of the method validation or verification process, as appropriate.

1.2 Please comment on the inclusion and proposed implementation of Scenario B (Chapter 4, Section 5.3, and Chapter 8). Is it appropriate to recommend that Scenario B be used only for those situations where Scenario A is not feasible? Are methods for considering background variability in assessing whether the site is indistinguishable from background reasonable and technically accurate? Is the inclusion and proposed implementation of added requirements for retrospective power analysis and the Quantile Test while using Scenario B technically appropriate and discussed adequately and clearly?

Under hypothesis testing in MARSSIM, Scenario B is defined as assuming that the survey unit meets the release criteria unless proven otherwise, and its use was discouraged in MARSSIM, Revision 1. However, this is the only viable option for sites where the criterion is effectively "no added radioactivity" or "indistinguishable from background".

In Scenario B, the Lower Bound of the Grey Region (LBGR) is often set to zero, but the document allows use of a non-zero LBGR that considers background variability in determining whether the survey unit is indistinguishable from background.

Since Scenario B assumes that the site meets the release criteria, there is a risk that the survey unit will pass simply because the survey did not have sufficient rigor. To guard against that, the revisions require that when using Scenario B, the survey unit must perform a retrospective power analysis to prove the survey has sufficient statistical power to detect a survey unit that should not have passed.

The non-parametric tests included in MARSSIM test the median instead of the mean. The release criteria are typically expressed as the mean. To guard against Scenario B situations

where the median will pass but the mean won't (this can occur in sample data distributions with a long tail in the higher concentration range), Revision 2 also requires that when using Scenario B, the survey unit must pass a quantile test to guard against excessive skewness.

1.3 Is the proposed implementation of the of the concept of Measurement Quality Objectives adequately and correctly described, including the concept of measurement uncertainty (Chapter 4 and Appendix D)? **Is the proposed calculation of measurement uncertainty consistent with the concept of Measurement Quality Objectives? Is the method appropriate and practical for both laboratory and field (including scan) measurements?** Please comment on the concerns of stakeholders that calculating measurement uncertainty for field measurements makes the survey process difficult to implement. In addition, please comment on whether recommendations provided by NIST, ANSI/IEEE and MARLAP for measurement quantifiability should be incorporated further into MARSSIM, Revision 2, or whether the current recommendations should be left as is (e.g., the original MARSSIM requirement that the MDC/MDA should be set at 10-50% of the action level).

The concept of MQOs as a subset of Data Quality Objectives (DQOs) originated after publication of MARSSIM, Revision 1. The use of MQOs ensures that each measurement taken is of sufficient quality to be used as part of the survey design. These MQOs include many familiar Data Quality Indicators, which were included in MARSSIM, Revision 1, such as range, specificity, ruggedness and detection capability, typically represented as MDC/MDA. However, the older Data Quality Indicators of bias and precision have been captured by a new MQO: measurement uncertainty, with bias indicating systematic uncertainty and precision indicating random uncertainty. The International Organization for Standardization published the Guide to Uncertainty in Measurement in 1995. The National Institute for Standards and Technology (NIST) published Technical Note 1297: Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results (GUM) in 1994, which provided guidance to the federal government to incorporate measurement uncertainty into their procedures. As a result, subsequent MAR-series documents MARLAP and MARSAME included information on the use of measurement uncertainty.

MARSSIM, Revision 1, indicated that the greater source of error for a survey was typically found in the sampling design, not in the measurements themselves, and as a result, did not emphasize concerns regarding measurement uncertainty. However, with the inclusion of scan-only surveys, the sampling design error decreases significantly as a greater percentage of the survey unit is covered. Consequently, the measurement error becomes critical, and thus the more quantitative method of assessing and controlling measurement uncertainty similarly becomes critical. Stakeholders have expressed concerns that calculating measurement uncertainty, specifically for field measurements, makes the survey process difficult to implement. The MARSSIM Workgroup agreed to include the MQO for measurement uncertainty and investigate future tools to make process easier.

The American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE) standard N42.23 recommends that interpretation of survey data involving environmental media, "such as soil, sediments, concrete and water, should not use the MDC/MDA to evaluate measurement results, and instead recommends use of the decision level or considering the confidence interval for the measurement result." The authors of MARSSIM, Revision 1, understood that for cases when the decision to be made concerns the mean of a population that is represented by multiple measurements, detection criteria

based on the MDC/MDA may not be sufficient and a somewhat more stringent requirement was needed. To meet this need, they introduced an additional requirement that the MDC/MDA should be set at 10-50% of the action level. This predated the concept of measurement quantifiability (as considered in MARLAP and ANSI/IEEE N42.23), but it results in comparable constraints on a Minimum Quantification Concentration (See MARSAME Section 7.6 for further discussion.) To minimize changes to current practice, the original MARSSIM requirement is left as is in Revision 2.

1.4. Is the discussion of survey requirements for areas of elevated activity technically accurate, appropriate and clear? In particular, please comment on the decision to maintain the use of the unity rule for multiple areas of elevated activity (Section 5.3.5, Section 8.6 and Appendix O.4). **Are there suggested alternatives to the use of the unity rule?**

While modeling is outside the scope of MARSSIM, depending on the modeling tool or methodology used to develop release criteria, the use of the Unity Rule for multiple areas of elevated activity in a single survey unit can lead to unrealistic or overly conservative assumptions. For example, the models may assume that the receptor is located directly above each area of elevated activity and stays there for the duration of their exposure period. This physically cannot occur in cases where there is more than one area of elevated activity per survey unit and results in concerns that this will cause an over-estimate of dose or risk, leading to an emphasis on remediating areas of elevated activity that don't incur additional significant dose or risk to receptors.

MARSSIM, Revision 2, does not change recommendations for the use of the unity rule, but emphasizes assessing whether criteria for areas of elevated activity apply to survey units, and when they do, using a common sense approach to applying these criteria, keeping in mind the limitations of the unity rule described above for multiple areas of elevated activity.

1.5. Is the discussion of the use of MARSSIM surveys for addressing sites containing discrete radioactive particles **technically sound and appropriate, and is the description accurate**? In particular, please comment on the rule-of-thumb for determining when use of MARSSIM may not be appropriate for survey units containing discrete radioactive particles (Section 4.12.8 and Appendix O.5).

Discrete radioactive particles have an extremely small size and contain enough activity that survey units containing discrete radioactive particles generate impractical survey designs under MARSSIM. Over MARSSIM's twenty-year history, several sites have attempted to utilize MARSSIM to address discrete radioactive particles, with predictably extreme survey designs as a result. In addition to being impractical, designs for discrete radioactive particles violate some of the assumptions commonly made during modeling, which includes parameters based on an areal source of radioactive material, e.g., length of the area of the elevated activity in the direction of overland flow. While modeling is outside of the scope of MARSSIM, it is nonetheless required that survey designs match the assumptions made during modeling, otherwise, the survey design does not meet the requirements of the action level.

To set a limit for determining when areas of elevated activity are too small to use the traditional MARSSIM methodology, the MARSSIM Workgroup used a traditional rule-of-thumb for instrumentation. When the length of the area of elevated activity is less than three

times the distance to the detector, the area of elevated activity is viewed by the detector as a point source instead of as an areal source. These point sources will need different receptor modeling and release requirements, and hence different survey designs than traditional areal sources.

At this time, MARSSIM does not provide guidance on designing discrete radioactive material surveys. It is the intention of the revision that additional information provided should prevent MARSSIM from being applied inappropriately to survey units involving discrete radioactive particles.

2) Does MARSSIM, Revision 2 provide **useful, appropriate and clear** examples and descriptions of technical approaches to implementing surveys and the statistics by which they are interpreted?

2.1 Please comment on **whether the** description of updated measurement methods and instrumentation information (Chapter 6 and Appendix H) **is useful, appropriate and clear**.

2.2. Please comment on **whether the** additional optional methodology for the use of Ranked Set Sampling **(Appendix E)** for hard-to-detect radionuclides is **useful, appropriate and clear**.

The Ranked Set Sampling methodology requires a close, reasonable and provable correlation between an easy-to-measure attribute of the sample (e.g., soil sample size distribution) and the activity level of a hard-to-detect radionuclide. While challenging to implement in practice, the revisions include this optional method to assist sites with designing surveys for hard-to-detect radionuclides, which can be difficult and resource intensive to implement.

2.3 Please comment on **whether the** new and additional examples provided in Chapter 5 **are useful, appropriate and clear**.

3) Is the information in MARSSIM, Revision 2 clear, understandable and presented in a logical sequence? How can the presentation and content of material be modified to improve the understandability of the manual?

3.1. Please comment on the revised description of how to set the Lower Bound of the Grey Region (LBGR) and its likely effectiveness in encouraging users to rely on site-specific information for doing so (Chapter 4 and Section 5.3).

One of the critical decisions made during site survey design under MARSSIM Scenario A is to set a value for the LBGR. Twenty years of training and review of survey plans have shown that this concept is not well understood by users, and that users tend to implement the standard rule of thumb of setting the LBGR to 50% of the DCGLw. This rule of thumb was provided in MARSSIM, Revision 1, for use only when additional information was not available. A poorly chosen value for the LBGR can affect the power of a survey resulting in unnecessary use of resources or a higher chance of failing a survey unit that meets the release criteria.

In Scenario A, the LBGR should be set equal to a conservative estimate of the average concentration remaining in the survey unit. This information is typically available from

historical site information, or a scoping or characterization survey if the survey unit is un-remediated, or the remedial action survey if the site has been remediated. The purpose of the revisions is to describe this concept in plain language, moving away from a statistics terminology description of the concept.

3.2. Please comment on whether avoiding the use of the term "area factor" improves understandability of the elevated measurement comparison concept (Section 8.6.1).

Area factors, which are simply the ratio of the Elevated Measurement Comparison (EMC) release criteria to the wide-area release criteria, should be based on site-specific modeling or calculations. Due to the misapplication of published area factors from the literature and to provide focus on the need for development of site-specific EMC criteria, MARSSIM, Revision 2 avoids the use of the term area factor. In addition, lessons learned from training MARSSIM show that describing the EMC concept in descriptive language, rather than by defining additional terminology, seems to improve understandability of the concept.

3.3 Please comment on the effectiveness of the new organization of Chapter 4 (Considerations for Planning Surveys) to improve the understandability of the Chapter.

Earlier reviews of Chapter 4 provided evidence that the fundamental organization of Chapter 4 made it difficult to find and understand vital information. After discussing the challenge with experts in training and explaining the material, Chapter 4 was completely rewritten or reorganized in an attempt to improve understandability without changing the fundamental purpose of or material in the Chapter. In an effort to streamline the presentation of material in Chapter 4, some information was moved to Appendix O.

3.4. Please comment on the effectiveness of moving derivations from Chapter 5 to Appendix O to improve the understandability of the Chapter.

In an effort to streamline the presentation of material in Chapter 5, some derivations of key concepts were moved to Appendix O.