Comment on

Application of Measurement Quality Objectives (MQOs)
in MARSAME
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The application of Measurement Quality Objectives (MQOs) is an important element of the MARSAME process. Although the MARSAME process is founded on the Data Quality Objectives (DQO) process, it utilizes MQOs in lieu of DQOs for designing measurements that provide adequate data for MARSAME decision-making. The fundamental difference between DQOs and MQOs is that DQOs constrain the data at the decision point in order to meet certain criteria, while MQOs constrain the measurement process at the data source. These are two approaches to obtain the same objective, decision-making at a specified decision error. MARSAME, for reasons not entirely explained, chooses to utilize the MQOs for data quality management. Therefore, to effectively implement MARSAME, application of MQOs to the design of measurements must be carried out with confidence.

Furthermore, the application of MQOs is fairly new to D&D planning. It was employed in MARLAP in 2004 for laboratory-based measurements and now has been extended to field measurements in MARSAME. The GUM, which forms the basis for much of the conceptual and statistical framework of MQOs, was published by ISO and NIST in 1995 and 1994 respectively. It is expected that the application of MQOs may be unfamiliar to many users of MARSAME. For this reason, it is important to provide a sound basis for its use and effective guidance on how it is to be applied.

Comments on MQOs address the Charge Question 2a: Discuss the adequacy of the procedures outlined for determining measurement uncertainty, detectability, and quantifiability, as described in MARSAME, Chapter 5.

Comment: Application of MQOs

Application of MQOs, in MARSAME, for the design of measurements, is confusing to the reader. A lot of detail is provided in defining, explaining, and deriving the relevant concepts. Very little of this information appears to be directly applicable to setting MQOs for a specific measurement method. Although understanding concepts are important, effective use of the manual relies on the reader to be able to apply MQOs to their specific measurement problem. An organized summary or guide, inserted in Chapter 5, that focuses on the effective application of MQOs to the design of MARSAME measurements, is suggested.

Sections 5.5 to 5.8 of the document provide a discussion of Measurement Quality Objectives (MQOs). This discussion appears to focus on developing a conceptual and statistical framework for the use of MQOs in the design of MARSAME surveys.
For instance, in Section 5.5, appyling MQOs may be confusing when the document provides a discussion that defines eight different terms for uncertainty. The document defines 1) σ_m for true measurement method uncertainty, 2) σ_s for spacial uncertainty, 3) σ for overall uncertainty, 4) μ_m for estimated measurement method uncertainty, 5) σ_{mr} for the upper bound of the true measurement method uncertainty σ_m, 6) μ_{mr} for the upper bound of the estimated measurement method uncertainty μ_m, 7) Φ_{mr} for the relative upper bound of the estimated measurement method uncertainty μ_{mr}, and 8) μ_c for the combined standard uncertainty. In addition, there are over 30 assorted terms and parameters defined for use in the discussion on MQOs, from Sections 5.5 to 5.8. Although the large collection of terms and parameters may be useful for explaining fundamental concepts and derivations, the reader should be able to extract from the discussion, with some confidence, the important items to be used in the application of MQOs to the design of surveys for the various measurement conditions identified. It would be reasonable for the discussion to, in addition, focus on the application of MQOs by summarizing the important aspects of the current discussion which lead directly to setting MQOs.

The following is one approach to satisfying this comment by providing a Summary or Guide for identifying the important MQOs, and how to go about arriving at their values. Also, specific references to Sections in the document are provided. Care has been taken to provide an accurate representation of the concepts and expressions provided by the document. Attempts were made at consistency and simplification of the MQO process with references provided for more detailed investigation.

Summary / Guide

Application of Measurement Quality Objectives (MQOs) in MARSAME

- Identify Type of Measurement
- Identify MQOs of Interest
- Set Values for MQOs
- Design Measurement to Meet MQOs

σ is overall uncertainty;
σ_m is measurement method uncertainty;
σ_s is spacial uncertainty

IN SITU - Direct, Individual Measurements

MQOs: σ & MDC

1. σ at AL where $\sigma^2 = \sigma_m^2 + \sigma_s^2$

$\sigma < \Delta / Z_{1-\alpha} + Z_{1-\beta}$ where σ_s is negligible (avg. over sample) and $\sigma^2 = \sigma_m^2$ (Sec. 5.5.1)

$\sigma = 0.3\ \Delta$ for $\alpha=\beta=0.05$ (Sec. 5.5)

$\sigma = 0.3$ UBGR for $\alpha=\beta=0.05$ when background present (Sec. 5.5)

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2. MDC < AL (Simplest Case)

$S_c = 2.33 \sqrt{N_B}$ for $\alpha=\beta=0.05$ and $t_B = t_S$ (Table 5.1)

$S_d = Z_{1-\beta}^2 + 2\ S_c = 2.71 + 4.66 \sqrt{N_B}$ for $\alpha=\beta=0.05$ and $t_B = t_S$ (Table 5.2)

$MDC = S_d / t_S\ \varepsilon$ where ε is (counts/sec) / (Bq/cm^2) (Section 5.7.3)

SCAN-ONLY - Scanning Measurements

MQOs: σ & Scan MDC

1. σ at AL where $\sigma^2 = \sigma_m^2 + \sigma_s^2$

For 100% Scans σ_s is negligible; $\sigma^2 = \sigma_m^2$ (Sec. 5.5.1)

For 10% to nearly 100% Scans: σ_m made negligible if $\sigma_m < \sigma_s / 3$ (Sec. 5.5.1)

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2. Scan MDC < AL

MDCR = $(d \sqrt{b_i})(60 / i)$ (MARSSIM Sec. 6.7.2.1)

Scan MDC = MDCR / $(\sqrt{p})\ \varepsilon$ (probe area / 100 cm^2); in (dpm/cm^2)

MARSSIM-TYPE - Sampling Measurements

MQOs: σ & MQC

1. σ at AL where $\sigma^2 = \sigma_m^2 + \sigma_s^2$

$\sigma_m < 0.1\ \Delta$ where σ_s is unknown (Sec. 5.5)

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2. MQC < AL

$$Y_Q = [\, K_Q / 2\, t_s\, \varepsilon\, (1 - K_Q^2\, \Phi_s^2)\,]\ [\, 1 + \sqrt{\{\, 1 + (4(1 - K_Q^2\, \Phi_s^2) / K_Q^2)\, (N_B\, t_s / t_B\, (1 + t_s / t_B))\}}\,]$$

(Sec. 5.8.1)

MQC = C x Y_Q in (Bq/cm^2)

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