Review of MARSAME by EPA-SAB-RAC

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UNDERLYING PRINCIPLES

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Rationale

- Instrument sophistication continues to improve
- Scanning sensitivities are approaching action levels (DCGLs) in many practical applications, especially for interior surfaces most like those that would be encountered on materials and equipment
- Analysis of *true* measurement sensitivities has improved
- MARSAME applies these evolutionary changes to a MARSSIM supplement on surveys of materials and equipment

MARSAME IS A MARSSIM SUPPLEMENT FOR MATERIALS AND EQUIPMENT

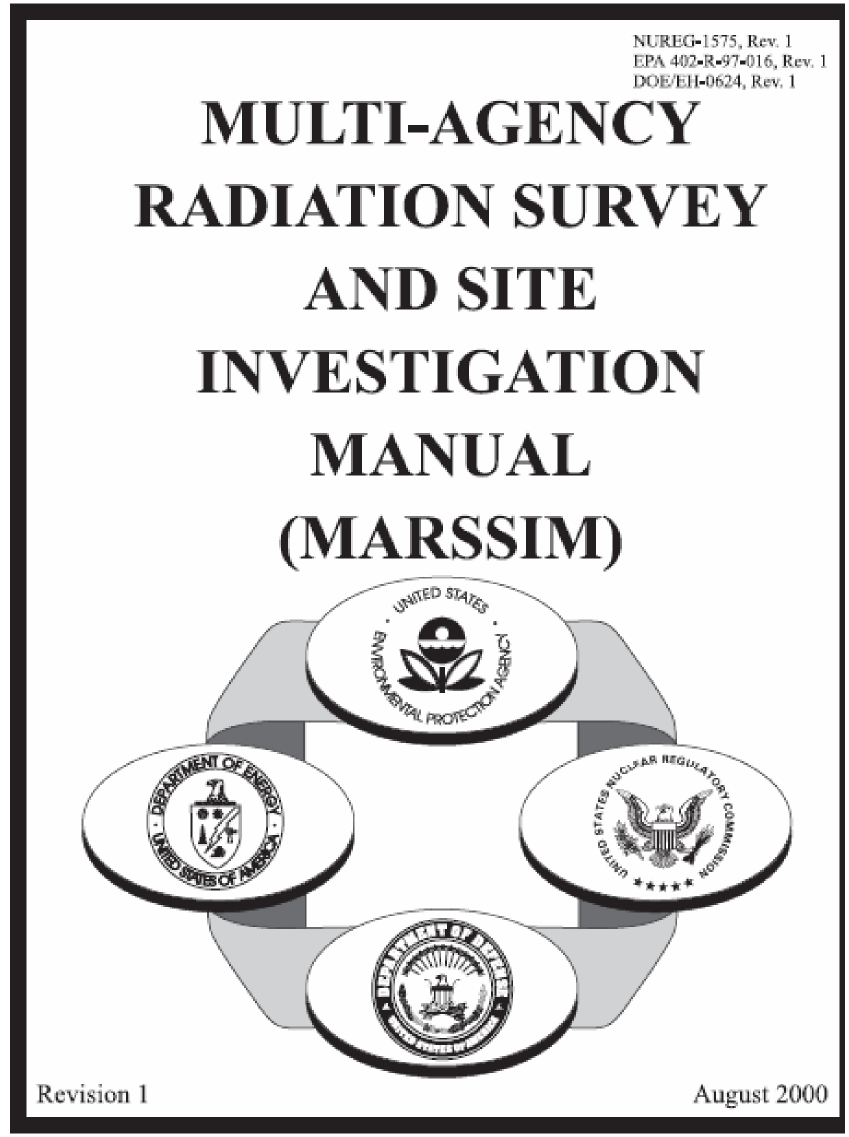
- MARSSIM provides a nationally consistent consensus approach to conducting radiation surveys and investigations at potentially contaminated sites

- This approach has proven be both scientifically rigorous and flexible enough to be applied to a diversity of site cleanup conditions

- ***Basic design, implementation and assessment in MARSAME is based on DQOs, QAPPs, and DQAs, as originally discussed in MARSSIM***

- Guidance documents have been updated

- New Guidance documents have become available

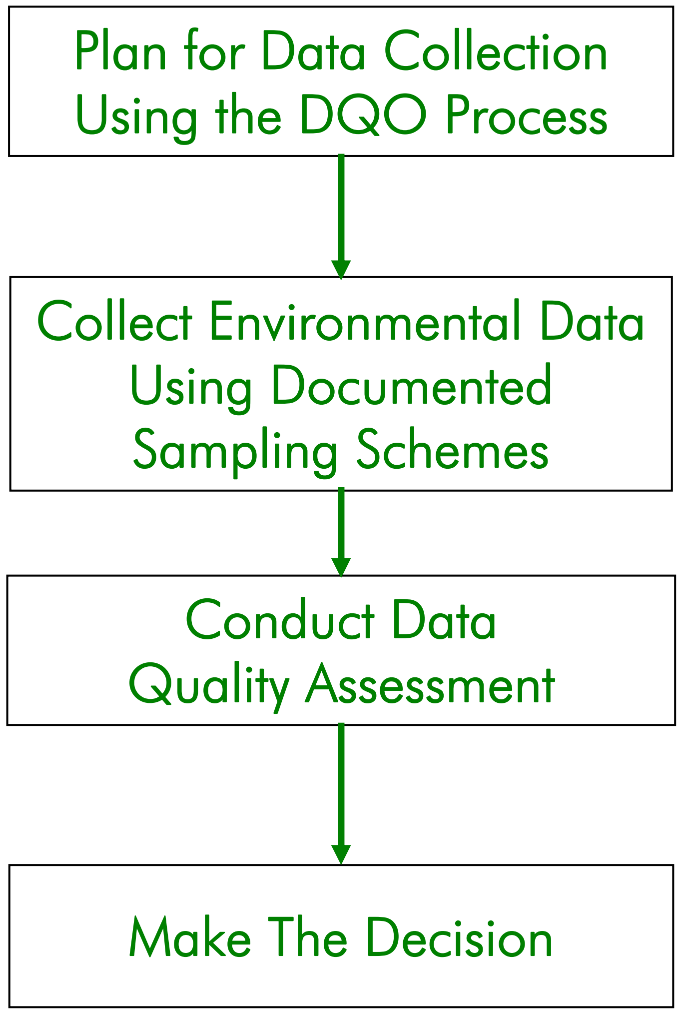


DQOs in the Context of the Project Life Cycle

Planning

Implementation

Assessment



EPA QA/G-4

Guidance on Systematic Planning Using the Data Quality Objectives Process

February 2006

EPA QA/G-5

Guidance for Quality Assurance Project Plans

December 2002, under revision

EPA QA/G-9

Data Quality Assessment: Statistical Methods for Practitioners

EPA QA/G-9S

February 2006

Data Quality Assessment: A Reviewer's Guide

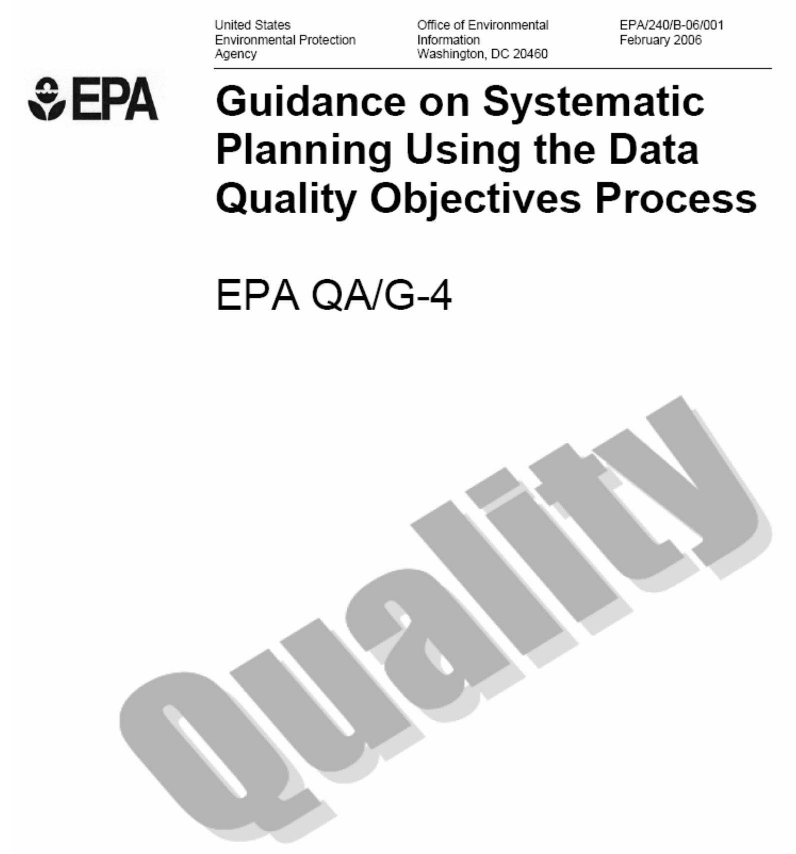
EPA QA/G-9R

February 2006

Data Quality Objectives

DQOs define the performance criteria that limit the probabilities of making decision errors by:

- Considering the purpose of collecting the data
- Defining the appropriate type of data needed
- Specifying tolerable probabilities of making decision errors


United States Environmental Protection Agency | Office of Environmental Information Washington, DC 20460 | EPA/240/B-06/001 February 2006

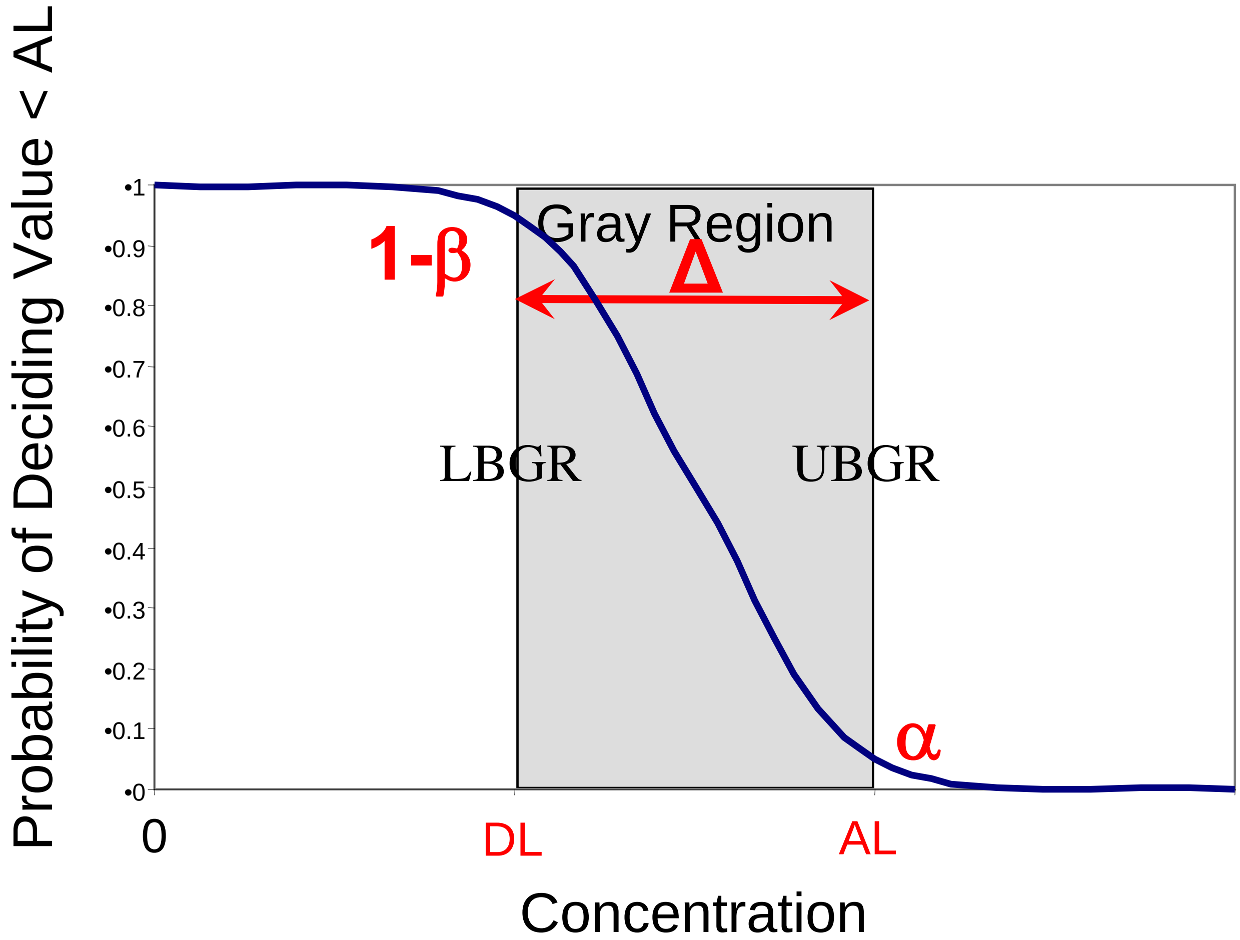
EPA

Guidance on Systematic Planning Using the Data Quality Objectives Process

EPA QA/G-4

Quality

Key Parameters for DQOs



Δ is measured in units of data uncertainty, σ , so the width of the gray region is commonly expressed as **Δ/σ**

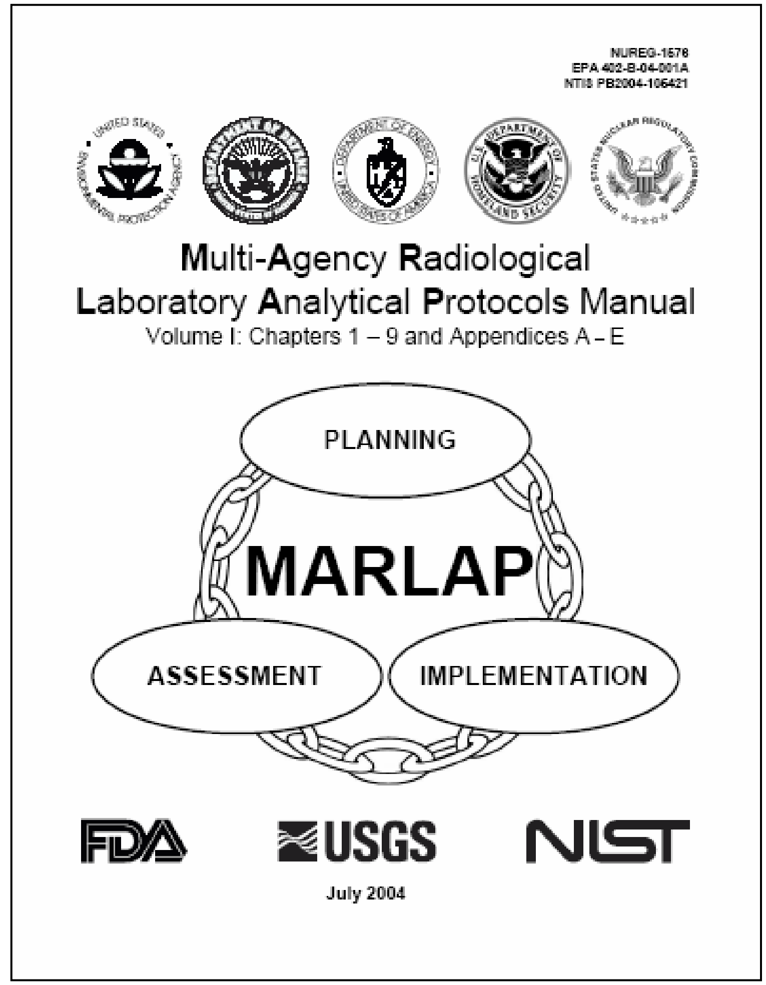
Measurement Quality Objectives

DQOs apply to both sampling and analysis activities

MQOs can be viewed as the analytical portion of the overall project DQOs

MQOs are the part of the project DQOs that apply to the measured activity concentration and its associated uncertainty

The required method uncertainty, u_{MR} , and the required method relative uncertainty, φ_{MR} , can be used for both method selection and to develop acceptance criteria for QC sample results



Measurement Quality Objectives

The principal MQOs in any project will be defined by:

- The *required method uncertainty*, u_{MR}, below the *action level*

AND

- The *relative method uncertainty*, φ_{MR}, above the *action level*

$$\varphi_{MR} = u_{MR} / \mathrm{AL}$$

When making decisions about *individual samples* when **α=β=0.05** …$u_{MR} \sim 0.3\Delta$

When making decisions about the *mean of several samples* . . ………$u_{MR} \sim 0.1\Delta$

Where Δ is the width of the gray region . . . . ……..$\Delta = \mathrm{AL} - \mathrm{DL}$

<u>If in addition the DL=0, this implies that:</u>

When making decisions about *individual samples* the MDC must be less than the action level

When making decisions about the *mean of several samples* the MQC must be less than the action level

Measurement Uncertainty

Uncertainty defined:

"A parameter associated with the result of a measurement that characterizes the dispersion of values that could reasonably be attributed to the measurand." [GUM]

The uncertainty of a measured value is typically expressed as an estimated standard deviation, called a *standard uncertainty*

Guide to the Expression of Uncertainty in Measurement

First edition 1995
ISBN 92-67-10188-9

Printed in Switzerland

NIST Technical Note 1297
1994 Edition

Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results

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Barry N. Taylor and Chris E. Kuyatt

Physics Laboratory
National Institute of Standards and Technology
Gaithersburg, MD 20899-0001

(Supercedes NIST Technical Note 1297, January 1993)

September 1994

To Evaluate Uncertainty
Use The GUM

- *Guide to the Expression of Uncertainty in Measurement* (GUM)
  - Published in 1993 by ISO in the name of 7 international organizations
  - Presents terminology, notation, and methods for evaluating and expressing measurement uncertainty
- Promotes more complete uncertainty evaluations and comparability of uncertainty statements

DQOs and Uncertainty

If there were ***no*** *measurement uncertainty and* ***no*** *spatial variability, how many measurements would be needed to find the average concentration of a radionuclide in a sample or in an area?*

How difficult would it be to decide if regulatory requirements were being met?

$\sigma = [\sigma_S^2 + \sigma_M^2]^{1/2}$ is the total standard deviation of the data

σ_S is the standard deviation of the contaminant concentration in the sampled population (i.e., the contribution of spatial and temporal variability to uncertainty)

σ_M is the "true" standard deviation of the measurement process (i.e., the analytical contribution to uncertainty)

In MARSAME, the objective is to eliminate as much as possible the contribution of σ_S.

This then elevates the importance of making good estimates of σ_M, using the principles of the GUM.

$\boldsymbol{\sigma} = [\boldsymbol{\sigma}_S^2 + \boldsymbol{\sigma}_M^2]^{½}$ is the total standard deviation of the data

$\boldsymbol{\sigma}_S$ is the standard deviation of the contaminant concentration in the sampled population (i.e., the contribution of spatial and temporal variability to uncertainty)

$\boldsymbol{\sigma}_M$ is the "true" standard deviation of the measurement process (i.e., the analytical contribution to uncertainty)

$\boldsymbol{u}_{MR}$ is the required method uncertainty at and below the Action Level. Upper bound to the value of σ_M

$\varphi_{MR} = [\,\boldsymbol{u}_{MR} / \mathbf{AL}]$ is the required relative method uncertainty above the Action Level

In MARSAME, the objective is to eliminate as much as possible the contribution of σ_S.

This can be accomplished by measuring most if not all of the population and eliminating the effect of sampling variation.

- **100% scans over material**
- **Conveyorized sampling**
- **Whole sample counters (box counters, portal monitors, gamma-ray spectrometers)**

If this is done, then σ_M is the dominant source of uncertainty, and the onus falls on the user to show that he can actually detect what he says he can.

Uncertainty MDCs and MQCs

- When σ_M **is driving the defensibility of the process, it becomes essential to have assurance that the measurement uncertainty, detectability and quantifiability are being done with complete and verifiable procedures.**
- **Hence, the information from GUM and MARLAP on these topics becomes more important than in cases where spatial variability is driving the possibility of decision error.**

Advances in Scanning Instrumentation

- Have brought levels of detectability within range of action levels
- Verification that this is actually the case in a given situation results in a different hypothesis test being emphasized than in MARSSIM, namely that underlying the MDC calculations are valid

Advantages

- If one can really detect at the MDC, can survey all of the material, and get results all below the critical level (no detects), it is very unlikely that the material surveyed will exceed the action level anywhere

- If one can really detect at the MDC, can survey all of the material at once, and get a result below the critical level (non-detect), it is very unlikely that the material surveyed will exceed the action level on average

Adjustments

- In class 2 and 3 areas, there should be less spatial variability, and the percentage of area scanned can be reduced as **Δ/σ** becomes larger
- If scan sensitivities cannot be achieved, MARSSIM design and analysis would apply.

Questions?


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