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THE MARSAME METHODOLOGY

Fundamentals, Benefits, and Applications

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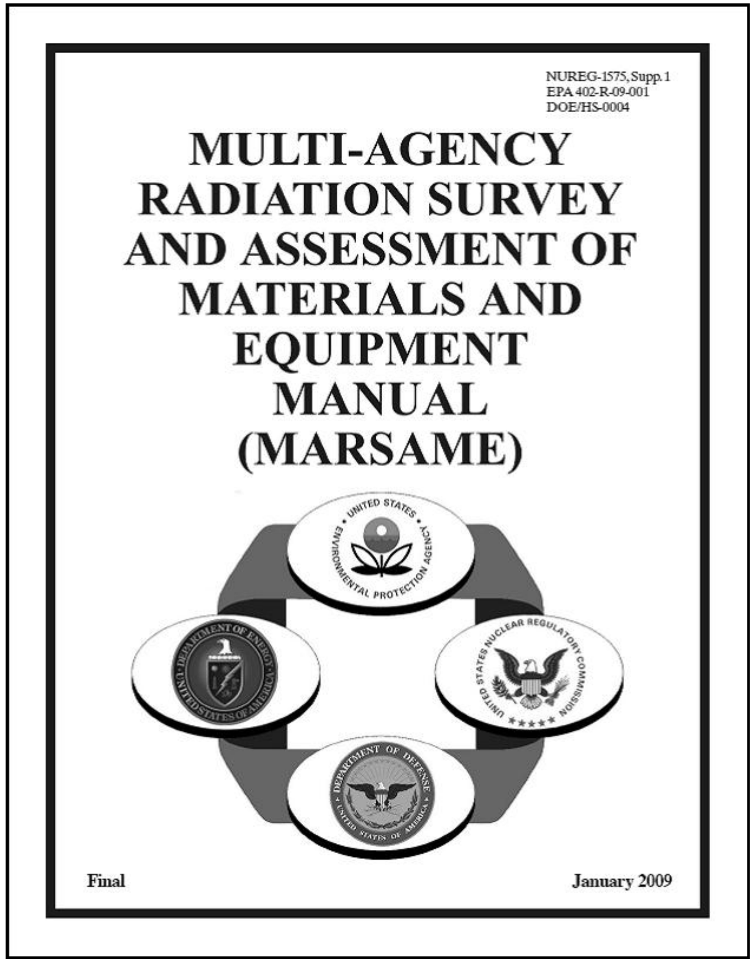
What is MARSAME?

MARSAME is an acronym for “Multi-Agency Radiation Survey and Assessment of Materials and Equipment”.

Brief History

- MARSAME was a collective effort of the Department of Energy (DOE), Department of Defense (DoD), Environmental Protection Agency (EPA), and the Nuclear Regulatory Commission (NRC).
- It is a tool to aid sites in the clearance of materials and equipment (M&E).
- The MARSAME manual was published in January 2009.

The MARSAME Manual



NUREG-1575, Supp. 1
EPA 402-R-09-001
DOE/HS-0004

MULTI-AGENCY RADIATION SURVEY AND ASSESSMENT OF MATERIALS AND EQUIPMENT MANUAL (MARSAME)

Final

January 2009

MARSAME-MARSSIM RELATIONSHIP

The MARSAME manual *supplements* the Multi-Agency Radiation Survey and Site Investigation Manual ("MARSSIM").

While MARSSIM is applicable to *real* property (buildings and land), MARSAME applies to *non-real* materials and equipment.

M&E Examples

- Typically encountered M&E include:
  - Metals
  - Concrete
  - Tools
  - Equipment
  - Piping
  - Conduit
  - Furniture

M&E Examples

- Other M&E includes dispersible bulk materials:
  - Trash
  - Rubble
  - Roofing materials
  - Sludge

M&E Examples

- A third category of M&E consists of:
  - Liquids (in drums)
  - Gases (pressurized gas cylinders)
  - Solids (containerized soil)

MARSAME MANUAL (Chapter Breakdown)

- Roadmap
- Chapter 1: Introduction and Overview
- Chapter 2: Initial Assessment of Materials and Equipment
- Chapter 3: Identify Inputs to the Decision
- Chapter 4: Develop a Survey Design

MARSAME MANUAL (Chapter Breakdown)

- Chapter 5: Implement the Survey Design
- Chapter 6: Evaluate the Survey Results
- Chapter 7: Statistical Basis for MARSAME Surveys
- Chapter 8: Illustrative Examples

MARSAME Appendices

- Appendix A: Statistical Tables
- Appendix B: Sources of Background Radioactivity
- Appendix C: Examples of Common Radionuclides
- Appendix D: Instrumentation and Measurement Techniques
- Appendix E: Disposition Criteria

Part 1: Fundamentals

- **MARSAME:**
  - **Uses a *graded approach* and *flexibility* in the design and implementation of disposition surveys**
  - **Employs the *data life cycle***

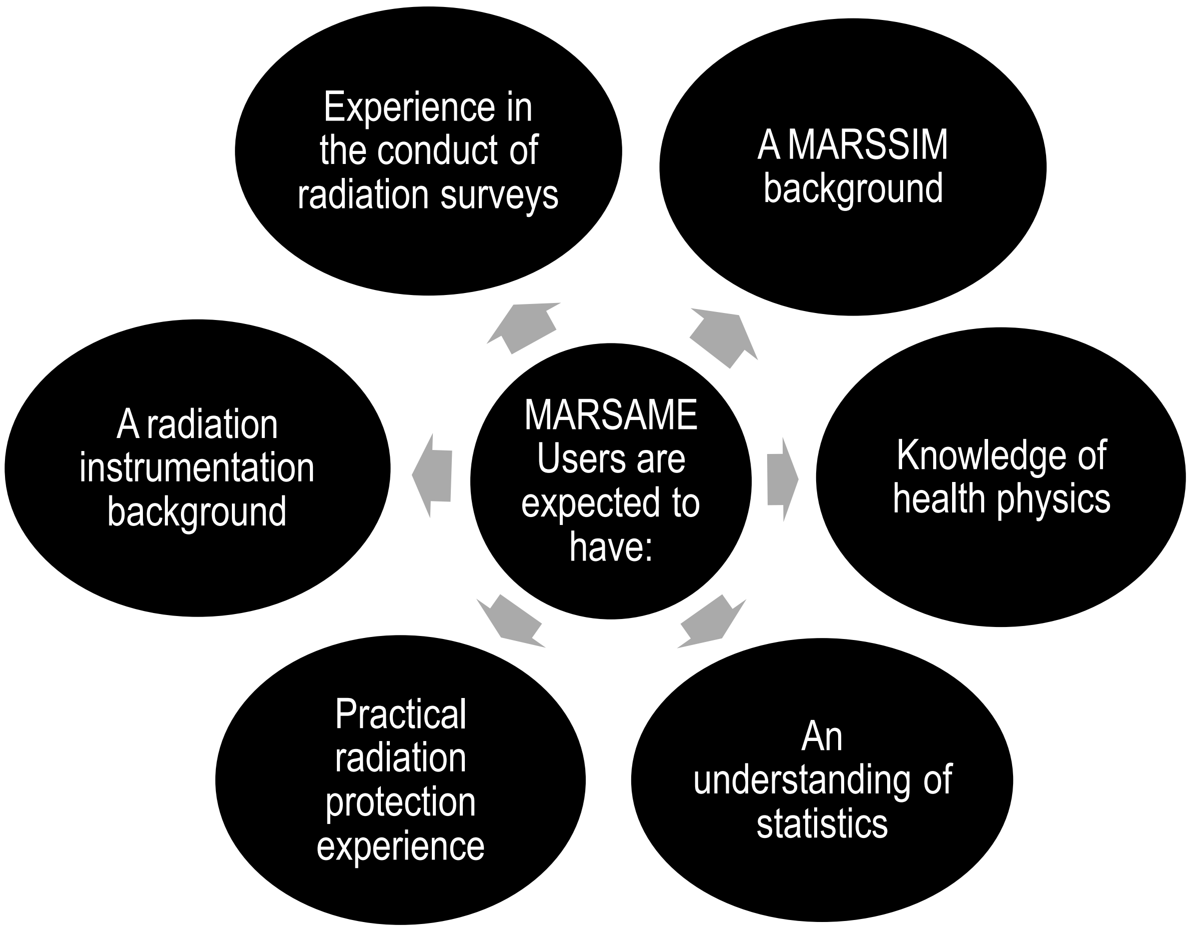
Data Life Cycle

- Planning
- Implementation
- Data Assessment
- Decision Making

Planning

- The "team" concept is encouraged to successfully plan a MARSAME disposition survey.
- Depending on complexity, significant effort is often required.
- Also encouraged: The EPA "Data Quality Objectives" (DQO) seven step process (or equivalent).

MARSAME-MARSSIM (The Challenge to Us All)



Initial Assessment or "IA"

- By definition, it is "an investigation to collect existing information describing M&E and is similar to the Historical Site Assessment (HSA) described in MARSSIM".
- First significant step in the M&E investigation process.

Initial Assessment

- Employs:
  - Initial "categorization" of the M&E (impacted vs. non-impacted)
  - Visual inspections
  - Historical records reviews
  - Process knowledge evaluations

Classes of Impacted M&E

- If the M&E has been categorized as *impacted*, three classes exist, equivalent to the MARSSIM approach:
  - Class 1
  - Class 2
  - Class 3
- The classification determines the relative level of survey effort (greatest effort for Class 1).

IA: Preliminary Surveys

- Basic approach:
  - Preliminary survey *design* addresses questions regarding the existing data.
  - Possible conclusion: data gaps exist!
  - If so, utilize a preliminary survey to acquire the necessary data.

IA: Preliminary Surveys

- The *physical* characteristics of the M&E to be described by the survey consist of four attributes:
- Dimensions
- Complexity
- Accessibility
- Inherent Value

IA: Preliminary Surveys

- The *radiological* characteristics of the M&E to be described by the survey consist of four attributes:
- Radionuclides
- Activity (or concentration)
- Distribution
- Location

Disposition Options

- **MARSAME provides several potential M&E disposition options under "Release" and "Interdiction" Scenarios *for impacted M&E*.**
- **Under release (9 examples):**
  - **Reuse in a controlled environment**
  - **Reuse without radiological controls (i.e., clearance)**
  - **Recycle for use in a controlled environment (i.e., authorized disposition)**
  - **Recycle without radiological controls**

Disposition Options

- **Under release (continued):**
  - **Disposal as industrial or municipal waste**
  - **Disposal as low-level radioactive waste**
  - **Disposal as high-level radioactive waste**
  - **Disposal as transuranic (TRU) waste, and lastly………**
  - **Maintain current radiological controls**

Disposition Options

- **Under interdiction (4 examples):**
  - **Remove M&E from general commerce and initiate radiological controls**
  - **Decide to accept M&E for a specific application**
  - **Decide NOT to accept M&E for a specific application**
  - **Continue unrestricted use of M&E (no action)**

MARSSIM Flashback: Relative Shift

- **MARSSIM uses *preliminary radiological data* to calculate a Relative Shift. This is used later for planning surveys.**
- **The Relative Shift represents a summary of estimated radiological conditions versus a potential limit or action level.**

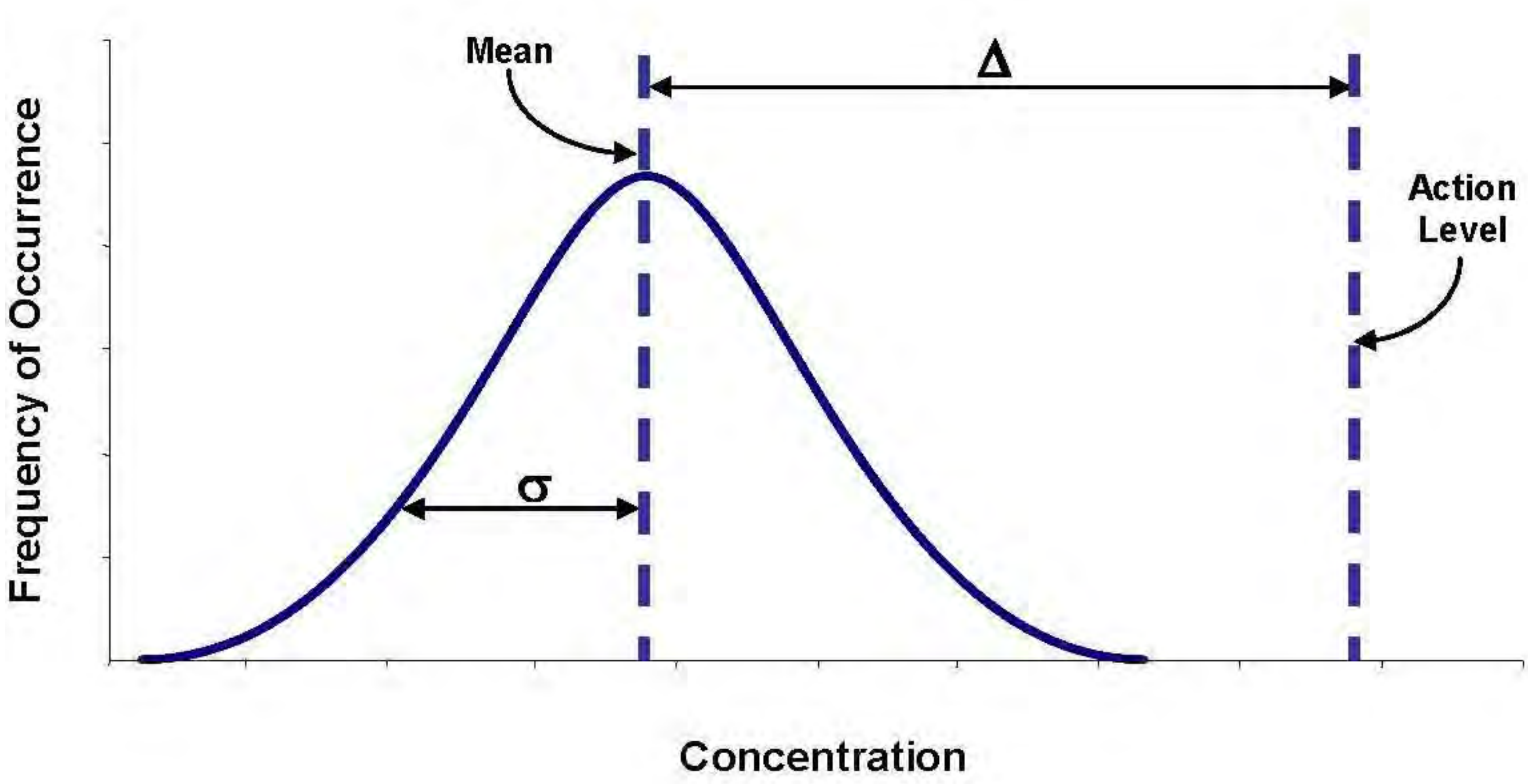
$$\frac{\Delta}{\sigma} = \frac{\mathrm{UBGR} - \mathrm{LBGR}}{\sigma}$$

UBGR = Upper Bound of the Gray Region = Action Level (i.e. limit)

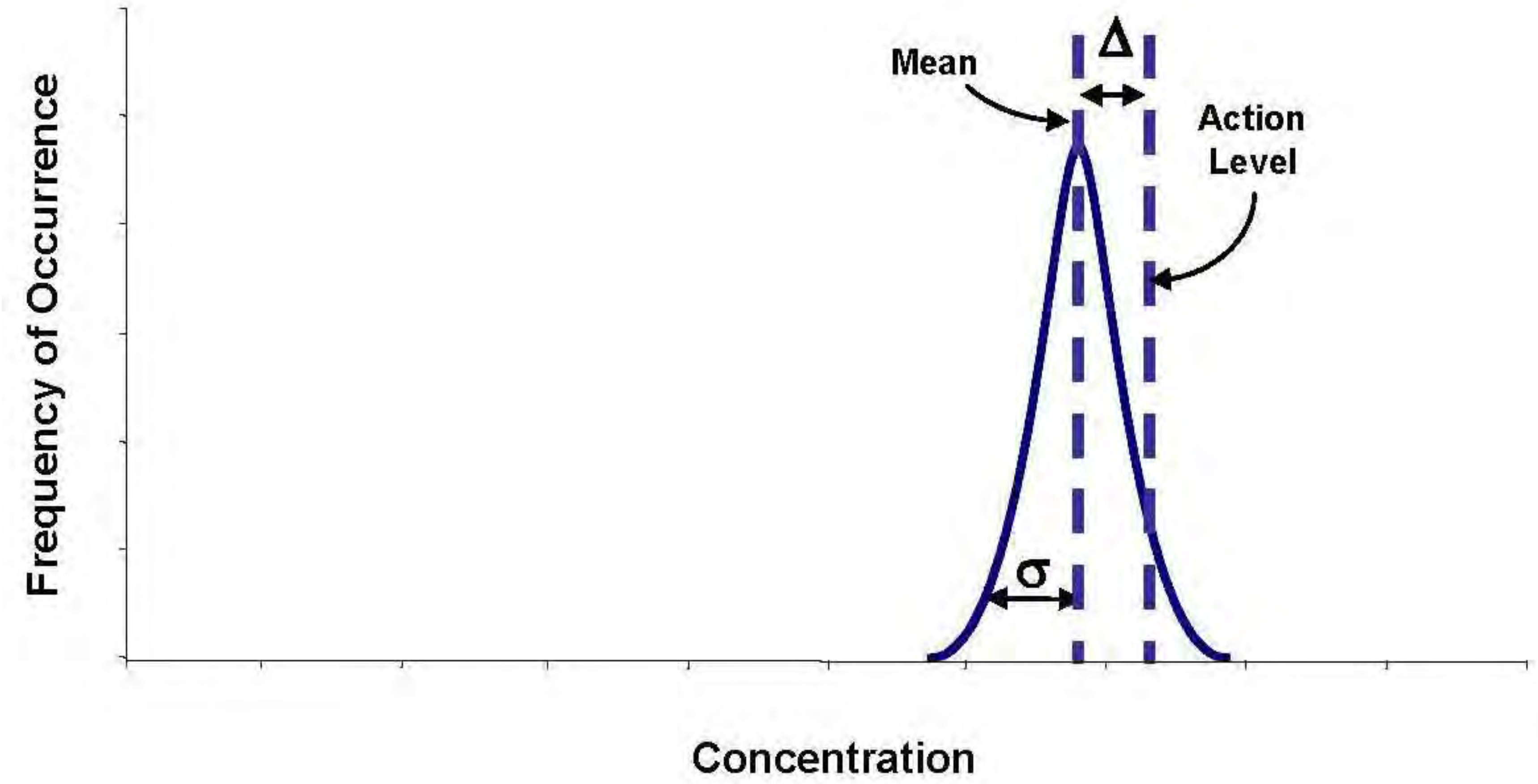
LBGR = Lower Bound of the Gray Region (= best guess of average levels)

LBGR and σ are based on data from characterization or remediation surveys

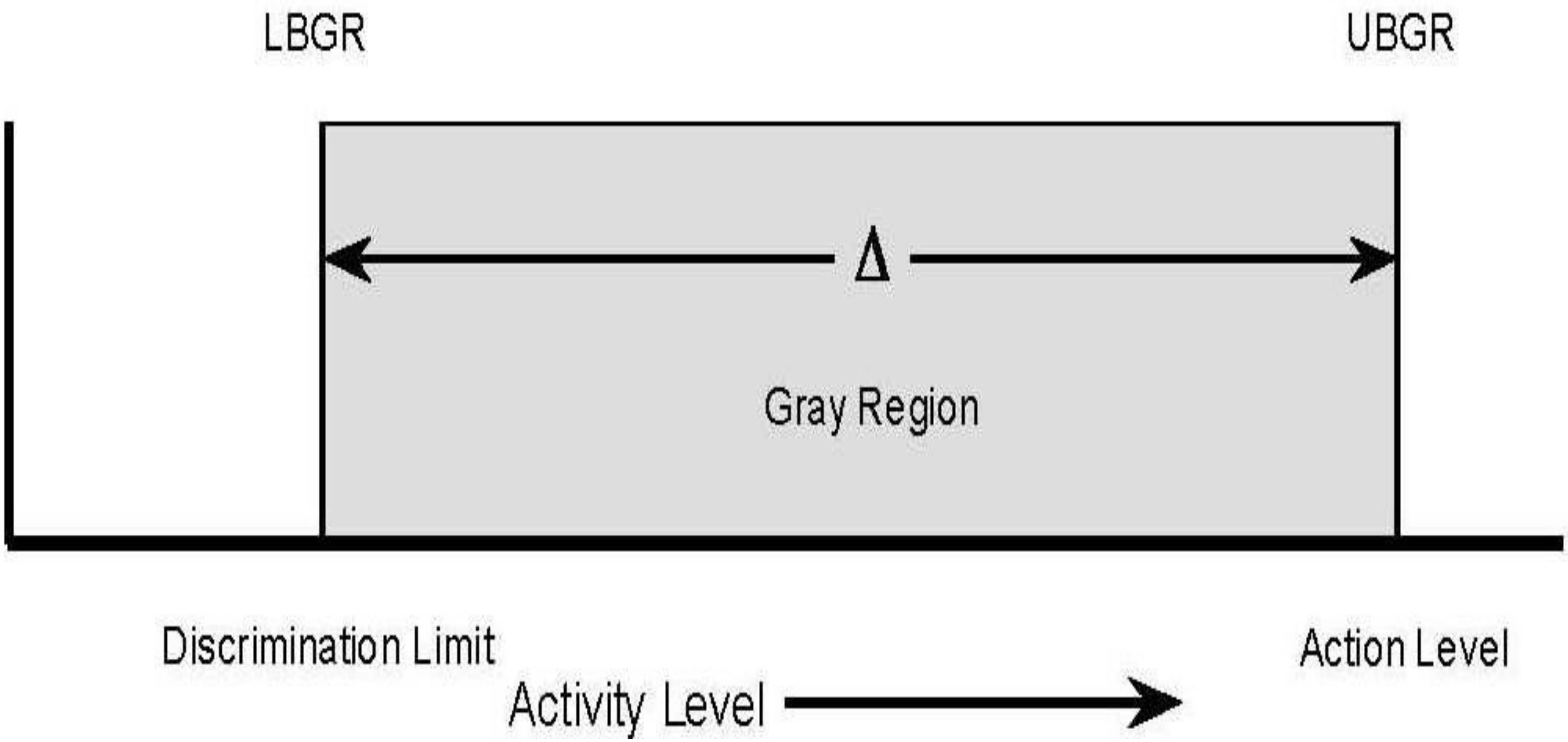
Graphic of Large Relative Shift



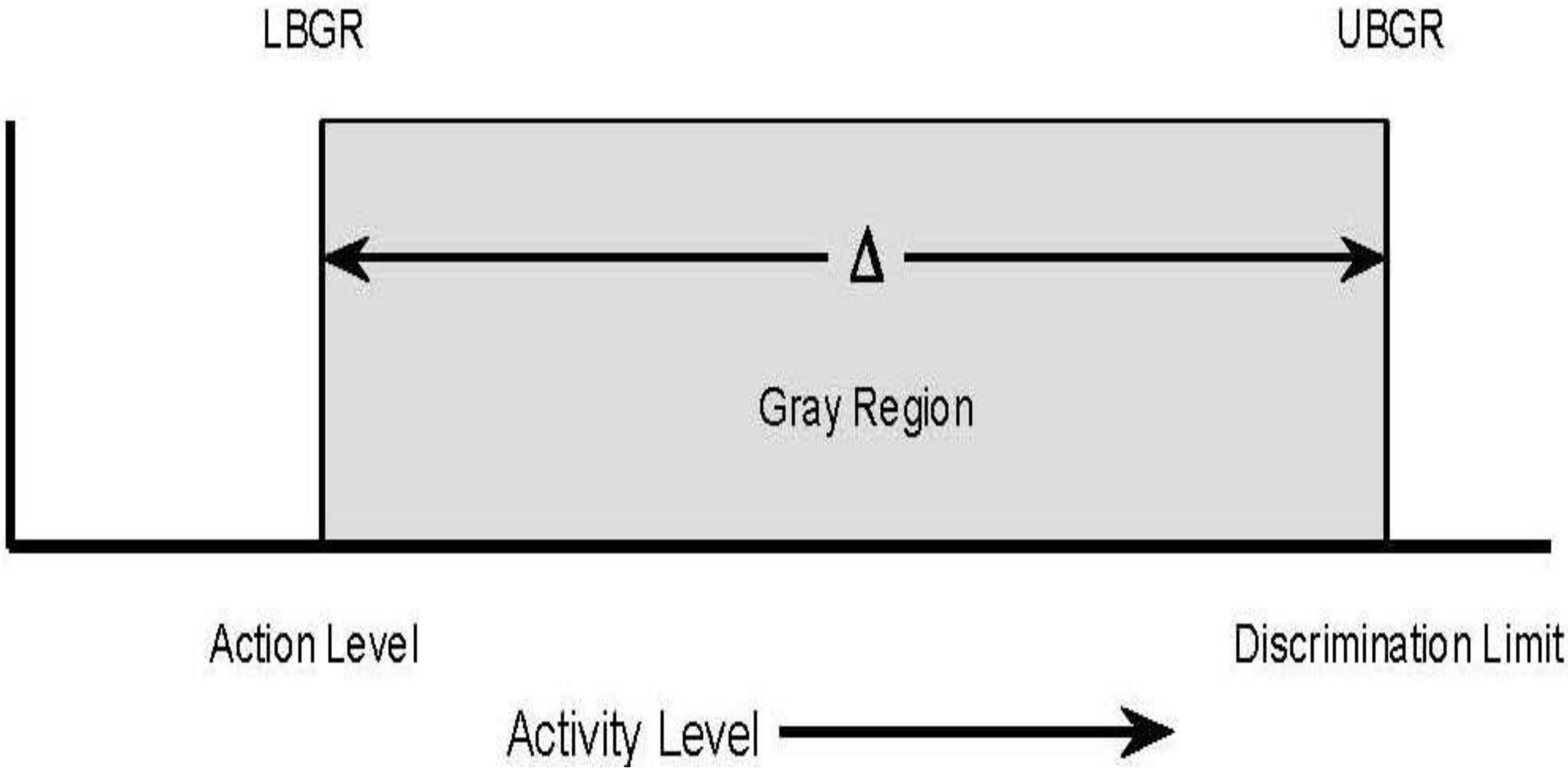
Graphic of Small Relative Shift



LBGR and UBGR Under "Scenario A"



LBGR and UBGR Under "Scenario B"



Measurement Quality Objectives (MQOs)

- **MARSAME states that "MQOs can be viewed as the *measurement* portion of the overall project DQOs"**
- **MQOs are "characteristics of a *measurement method* required to meet the *objectives* of the survey"**

  Note: MQO is a *new* term (not used in MARSSIM)

- **Two key words are "measurement method" as this relates directly to the successful development of a disposition survey design.**

What does MARSAME mean by "Measurement Method"?

- In MARSAME, a *measurement method* refers to the combination of:
  - Instrumentation
    - Examples: Geiger-Mueller (G-M), Sodium Iodide (NaI)

with a

  - Measurement technique
    - Examples: scan, in situ, sample collection*

      *followed by a separate laboratory analysis

Typical Radiological Contamination Instrumentation

MQOs: The Big Six!

- Measurement Method Uncertainty
- Detection Capability (MDC)
- Quantification Capability (MQC)
- Range
- Specificity
- Ruggedness

Implementation Phase

- Refers specifically to implementation of the selected survey design.
- Includes:
  - Health and safety considerations
  - Handling, preparing, transporting, and segregating M&E
  - Control of Measurement Uncertainty and MQOs

Examples of Disposition Surveys

- MARSAME discusses three principal survey designs:
  - Scan-only
  - In Situ
  - “MARSSIM-Type” (combines scans and static measurements)
- Note: A fourth design, “Method Based”, is also mentioned.

Assessment Phase

- Follows the implementation phase.
- Assessment refers to “Data Quality Assessment” (DQA).
- DQA is used to evaluate generated data to determine if it is of the right:
  - type
  - quality
  - quantity

Assessment Phase

- **Recommended: Independent Verification and Validation!**

Decision-Making Phase

- **Follows the assessment phase.**
- **This phase is designed to reach a "technically defensible decision regarding disposition of the M&E".**

Part 2: Applications!

- To date, practical applications of the MARSAME approach have been limited (examples I am aware of include a DOE contractor and NRC licensee facility).
- Two examples include:
  - Rail car survey (Hanford, WA); and
  - M&E surveys at Humboldt Bay (Eureka, CA)

Hanford Rail Car Survey (DOE Contractor)

- Utilized an *in situ* rail monitoring system to survey over 100 miles of track with possible surface contamination.
- The MARSAME approach included a reuse scenario (consistent with its intended purpose) and a disposal option.

Hanford Rail Car Survey (DOE Contractor)

Part 3: Benefits!
(Hanford Rail Car)

- **The rail car survey culminated with the following reported benefits:**
  - **protection of workers and the public;**
  - **reduction of 80,000 cubic feet of waste disposed, resulting in projected savings of $500,000;**
  - **reuse of materials that sustained valuable materials;**
  - **significant cost reduction (88%) by surveying the rails with a moving monitoring system rather than a 100% hand survey;**
  - **reduced impact to the environment.**

Humboldt Bay
(NRC-licensee)

- Regarding Humboldt, a *survey package* was developed based on the MARSAME methodology to specifically evaluate several large transformers at the facility.
- The survey package included:
  - an IA;
  - categorization into impacted and non-impacted surfaces;
  - classification of impacted surfaces as Class 3;
  - a description of physical and radiological attributes;
  - the implementation of preliminary surveys;

Humboldt Bay (NRC-licensee)

- The survey package included (continued):
  - selection of a preferred disposition option; and
  - a detailed survey design, including discussion and selection of:
    - measurement quality objectives,
    - the survey implementation approach,
    - results, and
    - a DQA to determine an appropriate disposition decision.

Part 4: Conclusions!

- While not without flaws, the MARSAME methodology was developed to promote consistency among several federal agencies in the design and implementation of disposition surveys for Materials and Equipment.
- It is an "evolutionary" outgrowth of the MARSSIM approach applied to non-real property.
- The methodology employs a greater reliance on statistical approaches……….a challenge for most of us!

Conclusions

- **If the MARSAME methodology is appropriately planned and implemented, several benefits related to waste management can result.**
- **These include:**
  - **worker and public protection,**
  - **reduction in the amount of disposed radioactive waste,**
  - **reuse of materials (with associated environmental and material sustainability advantages), and identified cost savings.**

Thank You!

- It has been a pleasure to have the opportunity to speak to you today!

Partnerships for Innovation

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