DERP Forum

Strengthening Relationships with our Regulatory Partners

St. Louis, Missouri

May 8-9, 2019

Munitions Response 101/201

DERP Forum

May 7, 2019

Purpose of Session

- **Overview of the current terminology, technology, and approaches to investigate and clean up munitions response sites (MRSs)**
- **This session will cover:**
  - Types of Munitions and Munitions Hazards
  - Detection Technologies
  - Quality Programs
  - New Risk Methodology
- **Provide insights into regulatory oversight considerations**

Military Munitions Response Program Overview

What is MMRP?

- **Defense Environmental Restoration Program (DERP)**
  - Installation Restoration Program (IRP)
  - Military Munitions Response Program (MMRP)
- **DoD developed the MMRP Inventory in 2001 (10 USC 2710)**
  - Unexploded ordnance (UXO)
  - Discarded military munitions (DMM)
  - Munitions constituents (MC)
- **MMRP addresses Munitions Response Areas (MRAs) and Munitions Response Sites (MRSs) on:**
  - Active Installations
  - Base Realignment and Closure (BRAC) Locations
  - Formerly Used Defense Sites (FUDS) Properties

Military Munitions Response Program Overview

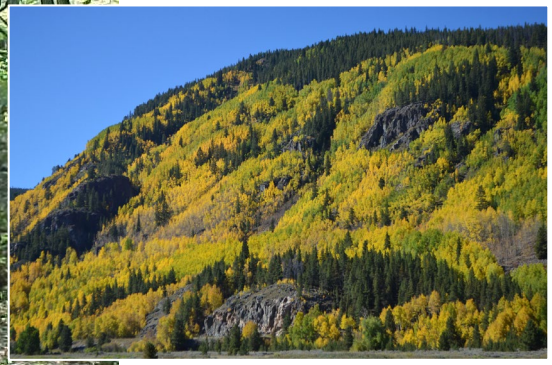
How Munitions are Unique

- **Acute vs. chronic risks**
- **Unique explosive hazard**
- **Individual discrete items, not a plume**
- **Direct correlation of hazard to exposure**

Military Munitions Response Program Overview

Diversity of MRSs

Geology, Terrain, Vegetation, Size, Land Use



Military Munitions Response Program Overview

Types of Munitions and Munitions Hazards

Brian Jordan

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What Are Munitions?

Munitions Include:

Artillery & Mortar Rounds

Grenades

Bombs

Small Arms Ammunition

What is UXO?

Recognize
Retreat
Report

What is Unexploded Ordnance?

- **Munitions (ammo) that failed to function properly;**
- **Can be of any type;**
- **May just be a component of a munition (e.g., fuse or exposed explosive fill).**

Munitions Vary in Appearance

Recognize
Retreat
Report

Munitions are dangerous regardless of appearance:

- **Munitions type, shape, size, age, or condition don't matter.**
- **Flares, simulators, and blasting caps are all dangerous.**
- **War souvenirs can be dangerous.**

Characteristics to Consider

Key considerations when evaluating the hazards of munitions

- **Practice vs. High Explosive**
- **Severity**
- **Sensitivity**

What To Do If You Encounter Munitions

Recognize that munitions are dangerous.

Munitions may:

- not look like a bullet or bomb.
- be shiny or rusty.
- be clean or dirty.
- look harmless, but are dangerous

Regardless of whether a munition has been moved, it may still explode. In fact, used munitions can be more dangerous than new.

What To Do If You Encounter Munitions

Retreat and carefully leave the area.

- **Do not approach, touch, move, or disturb the munition, but carefully leave the area the same way you entered it.**
- **In remote surroundings, mark the general area where you encountered a munition so local authorities can locate it. DO NOT go closer to a munition when marking the area.**

What To Do If You Encounter Munitions

Report what you saw and where you saw it.

Call 911

Authorities will clear the area and trained EOD personnel will dispose of the munition.

Additional Resources

3Rs.mil

- General Educational Resource Materials (Posters, Safety Guides, Fact Sheets, Videos etc.)
- Gallery of Photos
- UXO Incidents
- Contact Us Page
- Safety Clubhouse for Kids

QUESTIONS

Military Munitions Response Program Overview

Types of Munitions and Munitions Hazards

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Detection Technologies

Acknowledgement & Credits

US Army Corps of Engineers

U.S.ARMY

NAVFAC

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SERDP DOD • EPA • DOE

ESTCP

CDPHE CO

COLORADO Department of Public Health & Environment

INTERSTATE COUNCIL ITRC TECHNOLOGY REGULATORY

Detection Technologies

Geophysical Technology Overview

- **Used to detect subsurface metal items that could be military munitions or explosives of concern (MEC) or evidence of MEC**
- **During Characterization**
  - Detect anomalies
  - Estimate anomaly densities
  - Distinguish areas of high anomaly density (HD areas) from areas of low anomaly density (LD areas)
- **During Removal/Remedial Action**
  - Detect anomalies
  - Classify anomaly sources (targets of interest vs. non-targets of interest)

Detection Technologies

Geophysical System Types

- **Analog handheld ‘magnetometers’**
- **‘Traditional’ Digital Geophysical Mapping (DGM)**
- **Advanced Geophysical Classification (AGC)**

Detection Technologies

Analog Magnetometers

Commonly referred to as 'Mag and dig'

(May also use All-Metals detectors)

+ Used in difficult terrains (e.g., dense vegetation)

- No digital record

- Not conducive to robust quality system controls

Detection Technologies

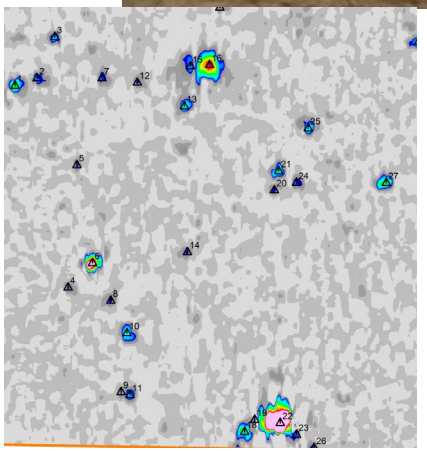
Traditional Digital Geophysical Mapping

Electromagnetic induction (EMI) technologies most-commonly used

+ Provides digital record

+ Conducive to quality system controls

+ Better detection performance



Detection Technologies

Advanced Geophysical Classification

Multi-axis, purpose built advanced EMI systems

+ Provides digital record

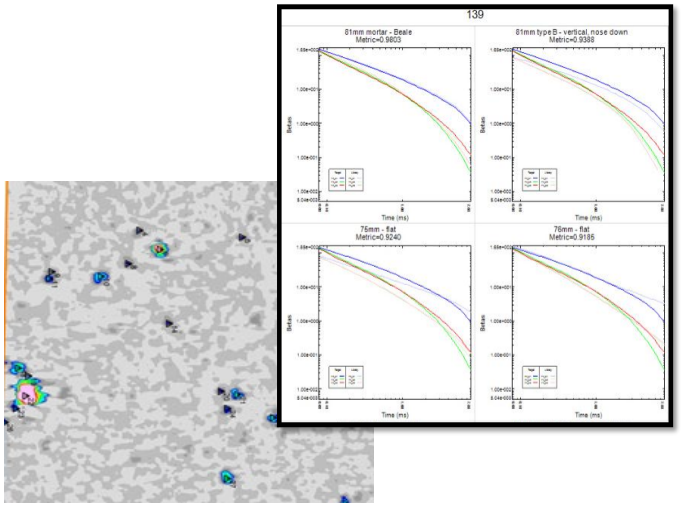
+ Reduces unnecessary digs

+ Mature quality management system

- provides realistic prediction / assessment of performance

- Not suitable for all sites

- Steeper learning curve



Detection Technologies

Detection System Components

- Sensor
- Platform
- Navigation/ Geolocation
- Data Logger
- Data Processor

Analog System

DGM System

AGC System

Detection Technologies

Detection System Components

Sensor | **Platform** | **Navigation/ Geolocation** | **Data Logger** | **Data Processor**

Schonstedt GA-52Cx

Analog System

Geonics EM-61Mk2

DGM System

Geometrics – MetalMapper

AGC System

Detection Technologies

Detection System Components

Sensor	Platform	Navigation/ Geolocation	Data Logger	Data Processor

Hand-Held / Man Portable

Analog System

Wheeled Cart

DGM System

Tractor Mounted / Vehicle Mounted

AGC System

Detection Technologies

Detection System Components

Sensor	Platform	Navigation/ Geolocation	Data Logger	Data Processor

Rope Lanes / Tape Measure

Analog System

GPS Location

DGM System

GPS & IMU Location & Navigation

AGC System

Detection Technologies

Detection System Components

Sensor	Platform	Navigation/ Geolocation	Data Logger	Data Processor

Operator interprets audio tone / pin flag

Analog System

Digital DAS / UXO Land (i.e., Geosoft)

DGM System

Digital DAS / UXO Land (i.e., Geosoft)

AGC System

Detection Technologies

Example Deployments











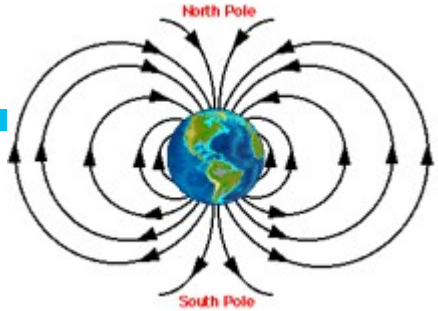
Detection Technologies

Munitions Detection

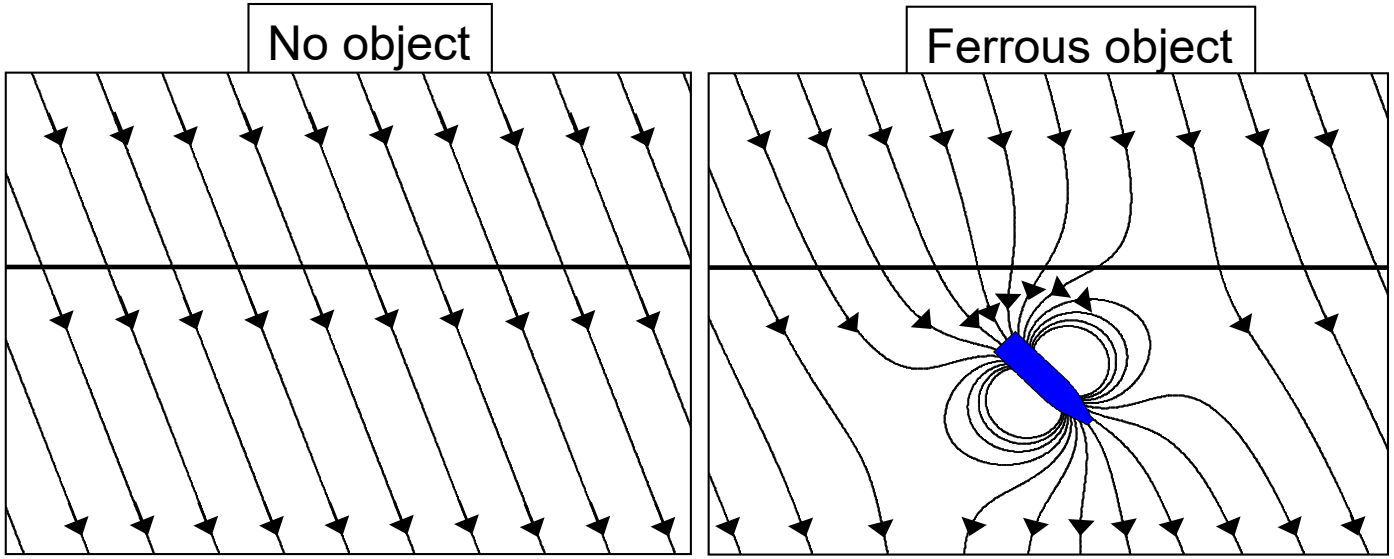
- **Munitions can be detected because most contain metal**
- **Two categories of metal detectors**
  - **Magnetometers** can detect presence of ferrous metal
  - **Electromagnetic induction** can detect presence of both ferrous and non-ferrous metal

Detection Technologies

Munitions and Magnetism



- **Munitions made of ferrous metal (steel) are detectable with magnetometers**
- **The Earth's magnetic field becomes distorted in the presence of ferrous metal**

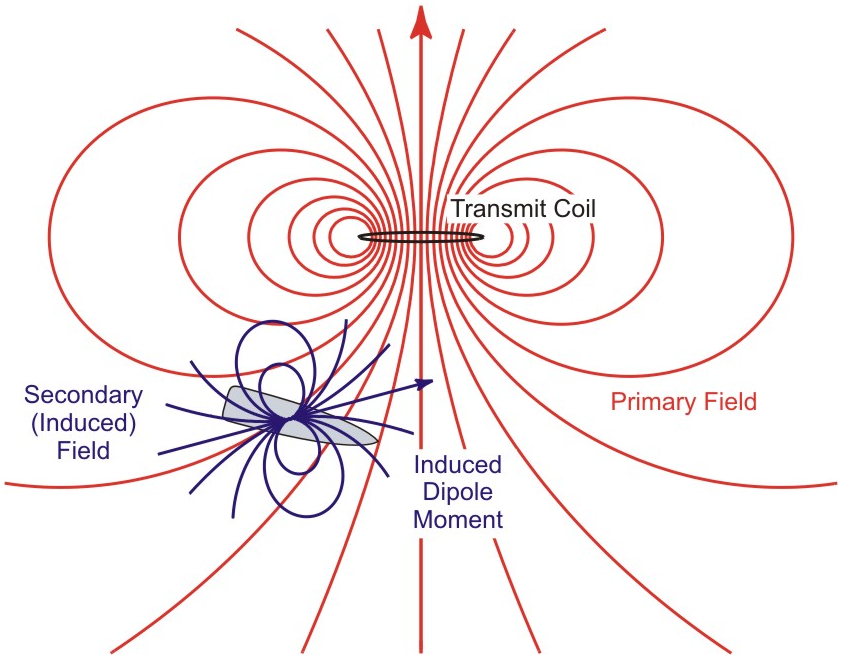


Detection Technologies

Munitions and Electromagnetics

- **EMI can detect munitions made of both ferrous and non-ferrous metal**
- **EMI Basics:**
  - Primary Field from Transmit Coil excites Eddy Currents in Object
  - Receive Coil measures Induced Field due to Eddy Currents

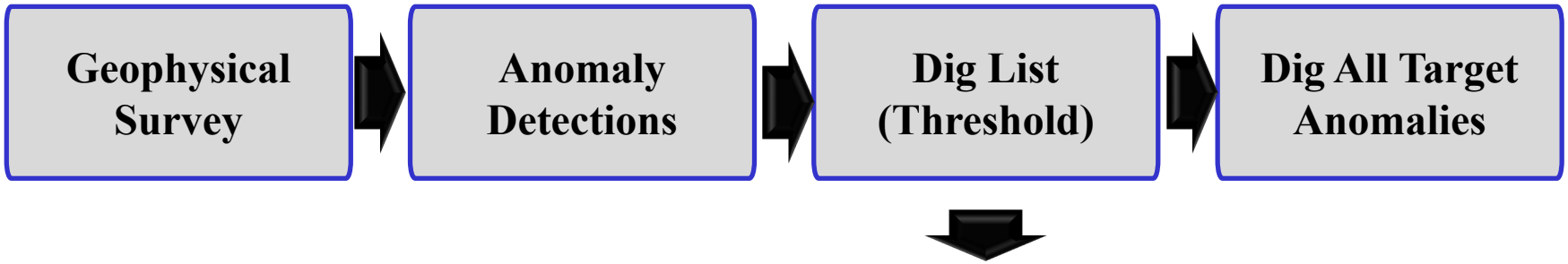
Typical Electromagnetic Induction Sensor



Detection Technologies

Basic Survey Project Steps

Traditional DGM Detection Survey



AGC Classification Survey

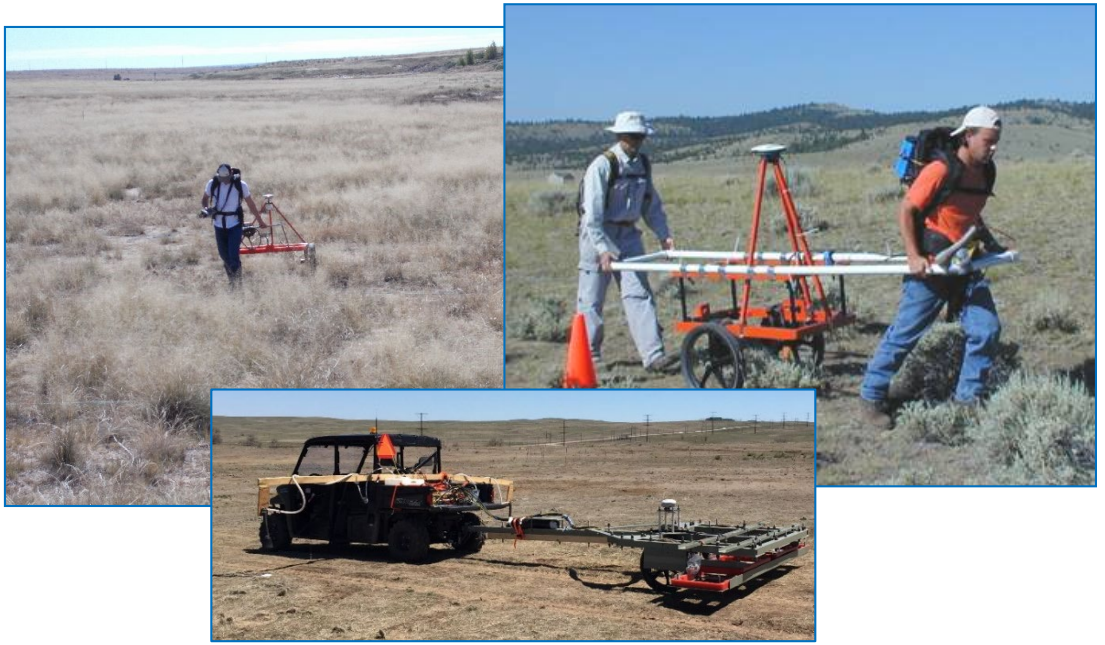
Detection Technologies

Geophysical Survey Considerations

Traditional DGM Detection Survey

Geophysical Survey → **Anomaly Detections** → **Dig List (Threshold)** → **Dig All Target Anomalies**

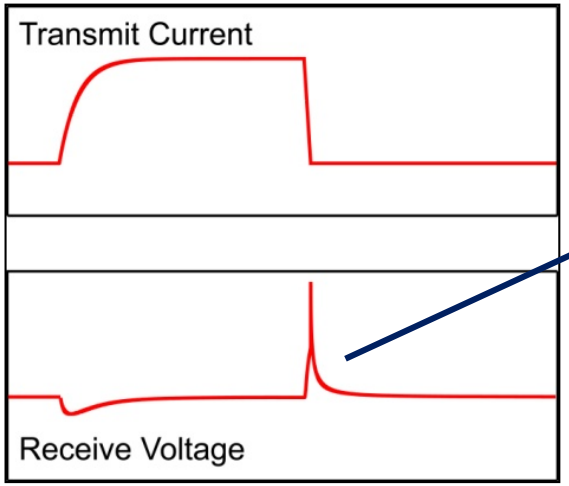
- **Surface clearance**
- **DGM Mapping**
  - Area or Transects
  - Sensor / Platform
  - Geolocation (GPS)
  - Line Spacing
  - Sensor Height

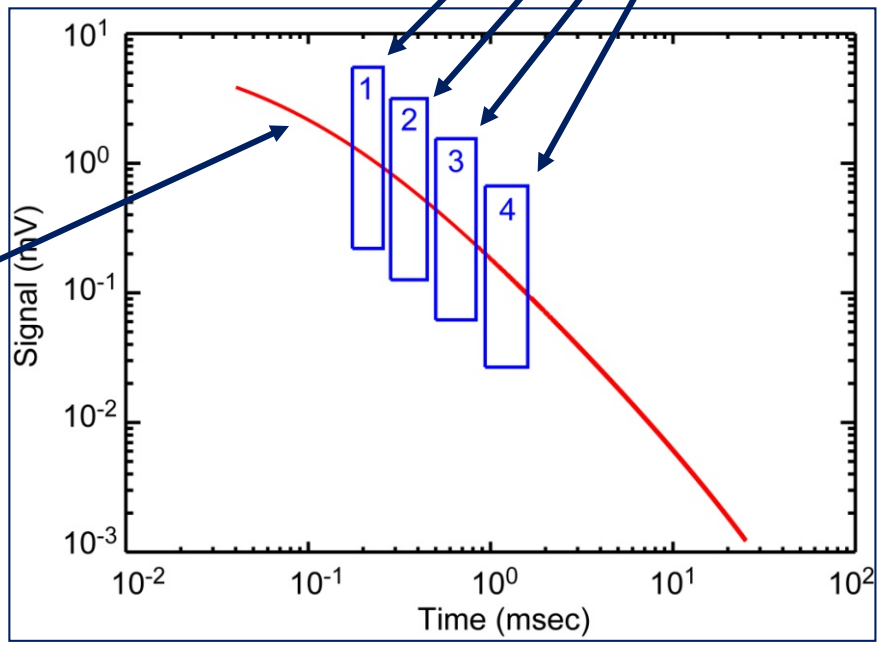


Detection Technologies

EM61-MK2 Sensor Data

- **The standard EM61 averages response over four time windows or gates following the primary field cutoff**
- **EM61MK2 data typically collected at 10 Hz**



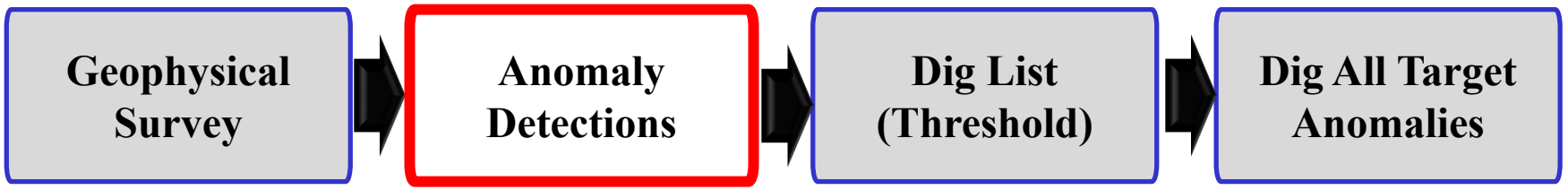


Note change to a logarithmic axis

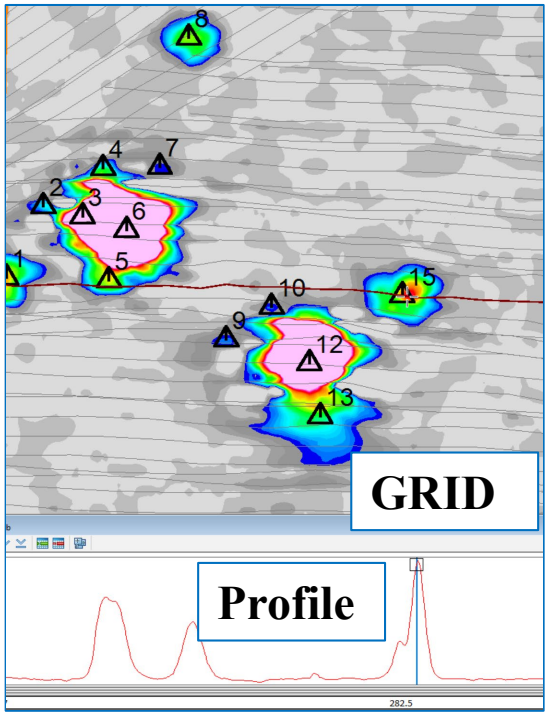
Detection Technologies

Anomaly Detection Considerations

Traditional DGM Detection Survey



- EMI sensor data combine with precise positioning (GPS or RTS) to provide digital geophysical maps
- 'Anomalies' are selected from grid or profile representations
- DGM survey 'Targets of Interest (TOI)' are anomalies above a target anomaly selection criteria (i.e., Threshold)



Detection Technologies

Primary Factors Impacting Detection

- **Survey Target-of-Interest**
- **Size of the source item**
  - Diameter, shape
- **Depth of the item**
  - Distance from sensor
- **Item Orientation**
  - To the sensor (EM)
  - To Earth's field (mag)
- **Noise Level**
- **Magnetometers**
  - Ferrous metal content
  - Remnant magnetization

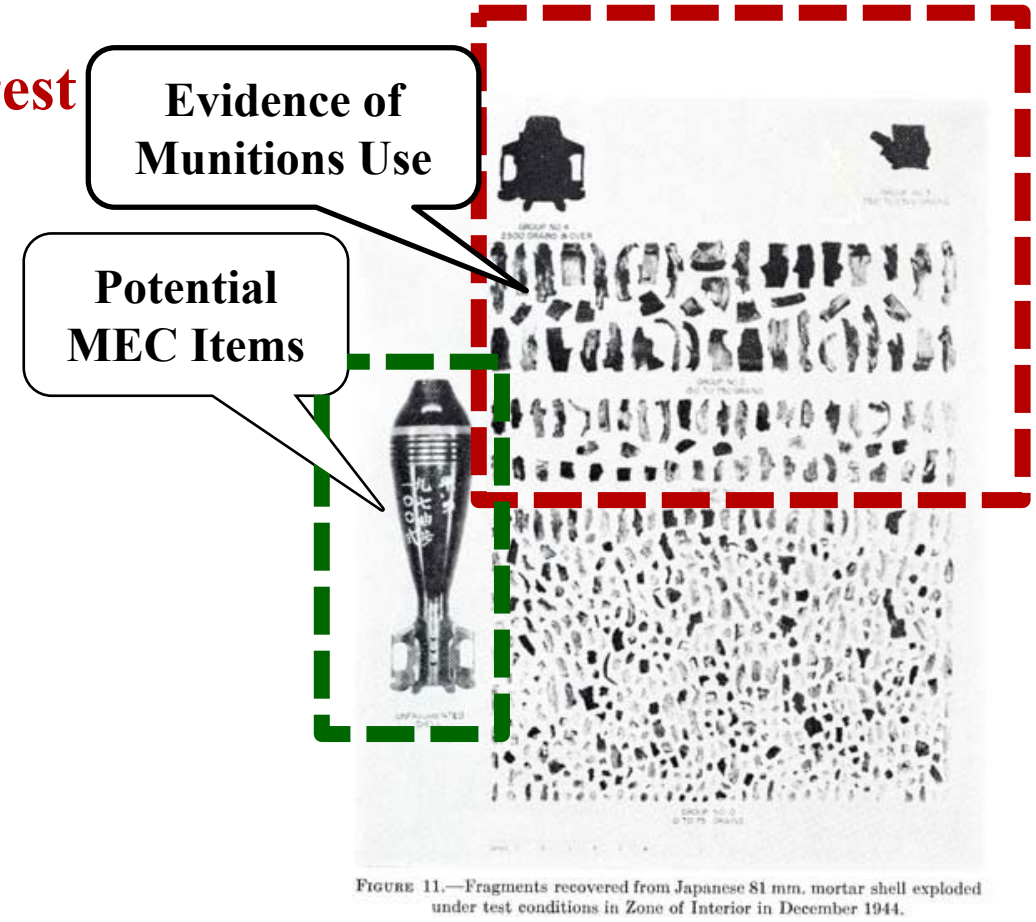


FIGURE 11.—Fragments recovered from Japanese 81 mm. mortar shell exploded under test conditions in Zone of Interior in December 1944.

Fragment Size Distribution

Detection Technologies

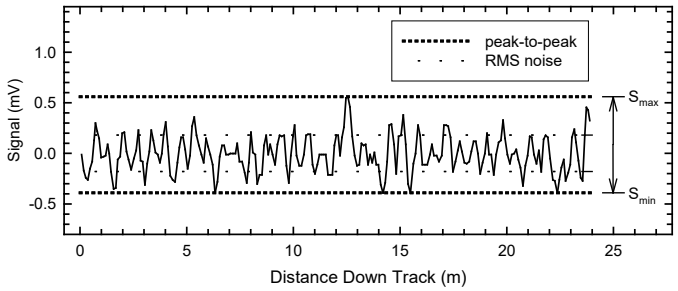
Signal-to-Noise Ratio

- **Noise is the detector's nemesis**
  - Intrinsic noise is internal to the instrument and generated by circuitry, connections, etc.
  - Background noise is external to the instrument and generated by geologic sources, electrical transmission lines, etc.
- **The signal-to-noise ratio (SNR) of desirable to undesirable (or total) energy can be expressed mathematically as S/N or S/(S+N)**
- **Noise expressed as Peak-to-Peak or RMS**

Detection Technologies

Example of EM Noise

- **Detectability limited by noise fluctuations in the sensor output**
- **Noise measured as Peak-to-Peak or RMS**
- **Reliable anomaly detection requires peak signal 5-6 times RMS noise level**



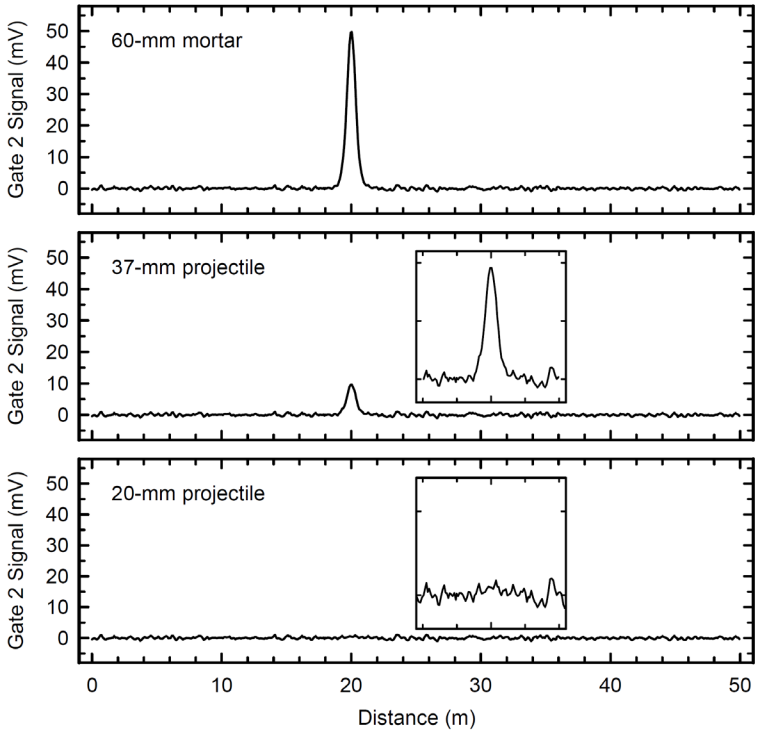


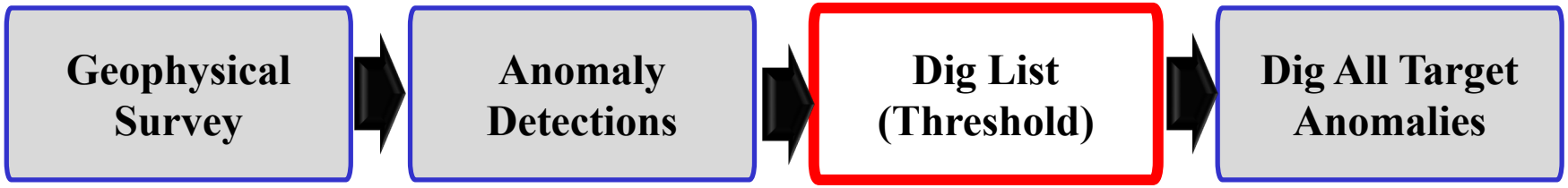
Figure 2-4. Example signal plus noise traces: (top) 60-mm mortar, (center) 37-mm projectile, (lower) 20-mm projectile. All targets are buried at 26 cm depth oriented horizontal across the survey track direction. The peak-to-peak noise level is 2 mV, and the RMS noise level is 0.35 mV.

ESTCP: Final Report Geophysical System Verification, July 2009

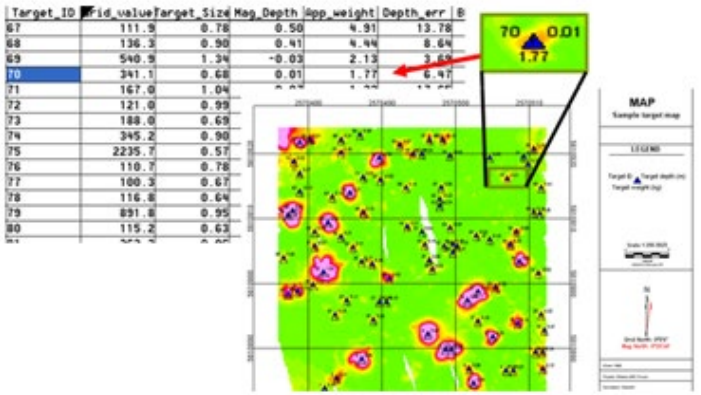
Detection Technologies

Target-of-Interest Considerations

Traditional DGM Detection Survey



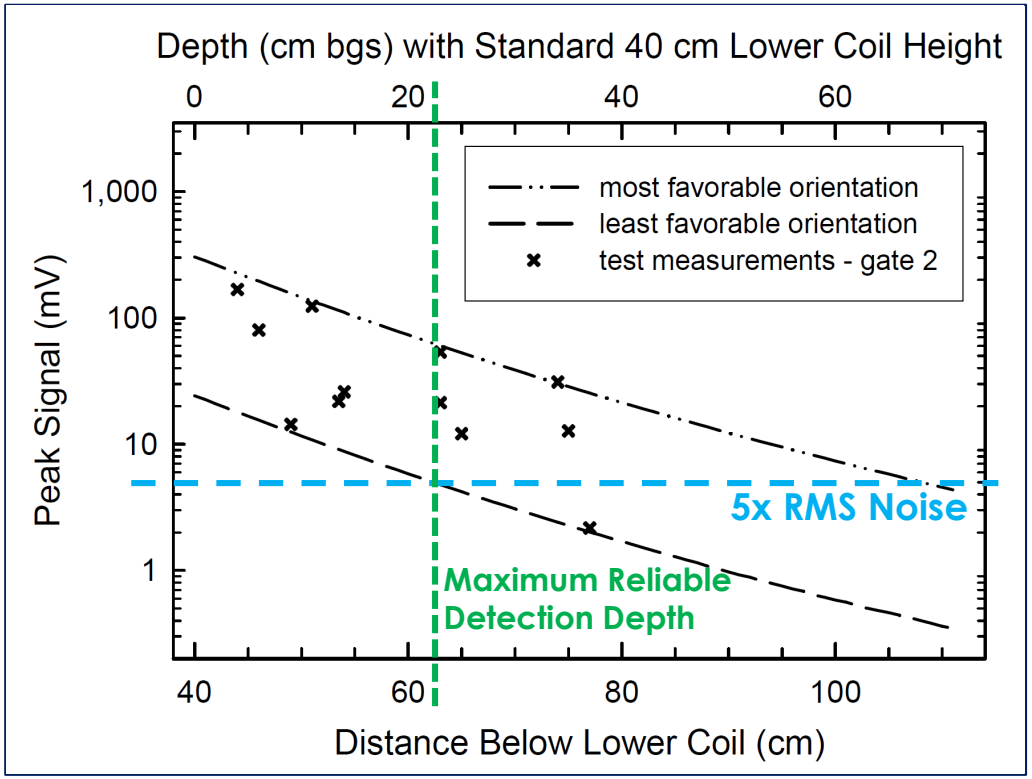
- **DGM TOI selection criteria (i.e., Threshold)**
- **Characterization (Investigation) Survey**
  - TOI = Evidence of munitions use (MD)
  - 5-7 x RMS Noise
- **Removal Action:**
  - TOI = Smallest Munition of Interest
  - Sensor Response Curves



Detection Technologies

Sensor Response Curves

- **Establish threshold for TOI selection**
- **Estimate reliable detection depths for TOI**
- **Factors**
  - Sensor/Channel
  - Munition Item
  - Orientation of item to sensor
  - Noise levels



Sensor Response Curve - EM61-MK2 response curve for small Industry Standard Object (ISO; 1"x4" steel pipe nipple).

Detection Technologies

Target-of-Interest Considerations

Traditional DGM Detection Survey

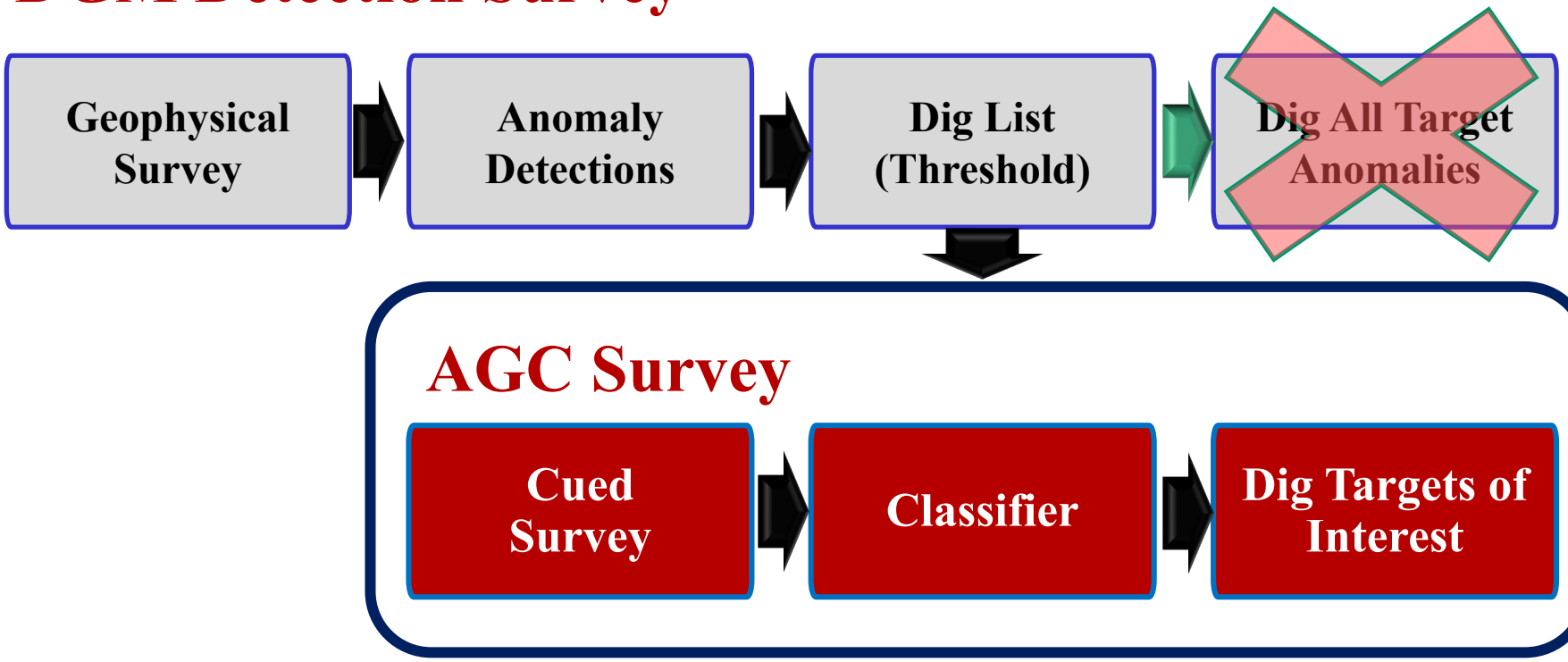
Geophysical Survey → Anomaly Detections → Dig List (Threshold) → Dig All Target Anomalies

- All DGM TOI locations investigated
- Reacquire TOI location
- UXO qualified personnel investigate location (dig)
- Anomaly source visually identified

Detection Technologies

Advanced Geophysical Classification

DGM Detection Survey



Caution: Before you can classify, you must still detect.

Detection Technologies

Big Picture – AGC Survey

- **Technology Acceptance & Adoption**
  - It works, really good!
  - Not a “silver bullet”, not appropriate everywhere
- **Quality Systems is the key to success**
  - Accreditation is a game changer
  - QAPP provides the quality framework
  - Sustain with policy, training, and implementation
- **Implementation & Oversight**
  - Focus on decision points
  - Classification is hands-on technology
  - Requires active stakeholder participation

Detection Technologies

Advantages of AGC

- **Fewer digs**
  - Reduced costs
  - Less environmental impacts
  - Less disruption to local communities

- **Technical benefits**
  - Reduces cost-per-dig with greater accuracy in source locations
  - Increased safety during digs (likely source & depth)
  - AGC data provides opportunity for QC of dig results
  - Associated quality management practices provide defensible results and realistic understanding of residual hazard

Detection Technologies

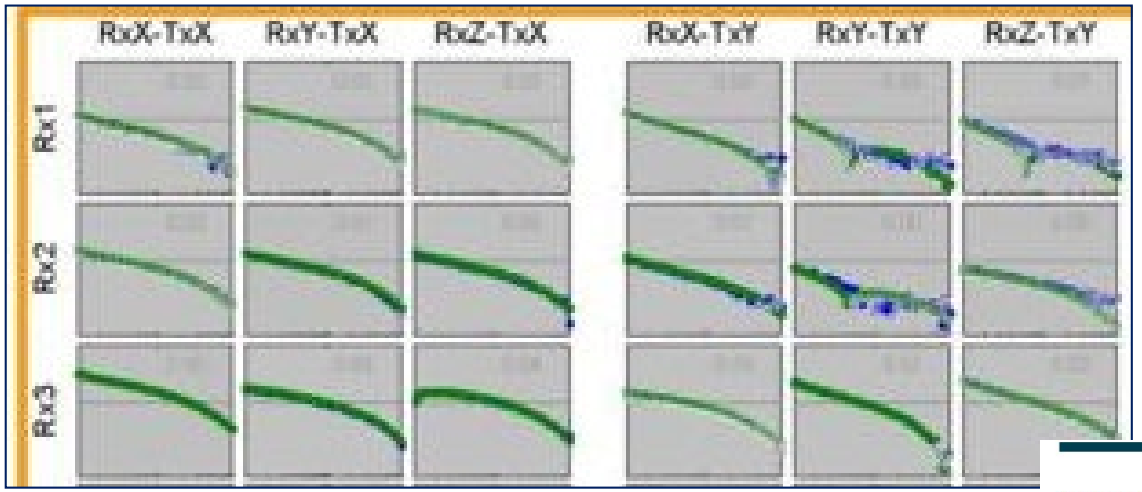
How Do We Classify?

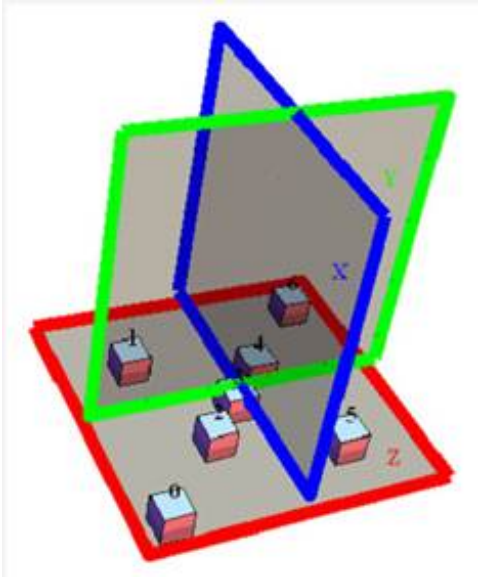
- **Visually, we use physical attributes such as size and shape**
- **Because we cannot see buried objects, we must rely on attributes determined from geo-physical data**

Detection Technologies

Advanced EMI Sensors

- **Designed for classification**
  - Multi-axis transmit/receive coils for complete target illumination
  - Measures complete decay signal
  - Fixed arrays for precise positioning





Detection Technologies

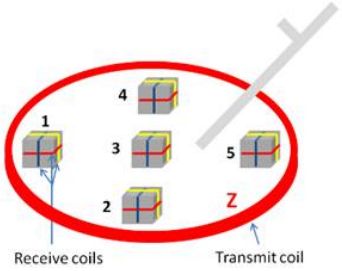
What do Advanced EMI Sensor looks like

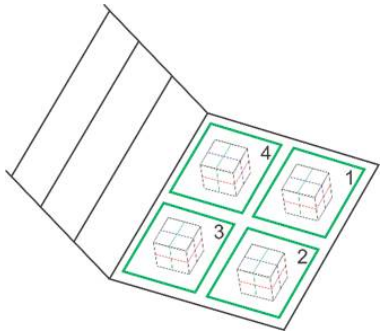
- **Multiple coils measure the complete response of buried items (spatially and temporally)**

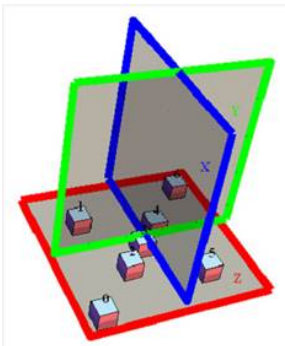
Person-portable

Cart-mounted

Vehicle-towed

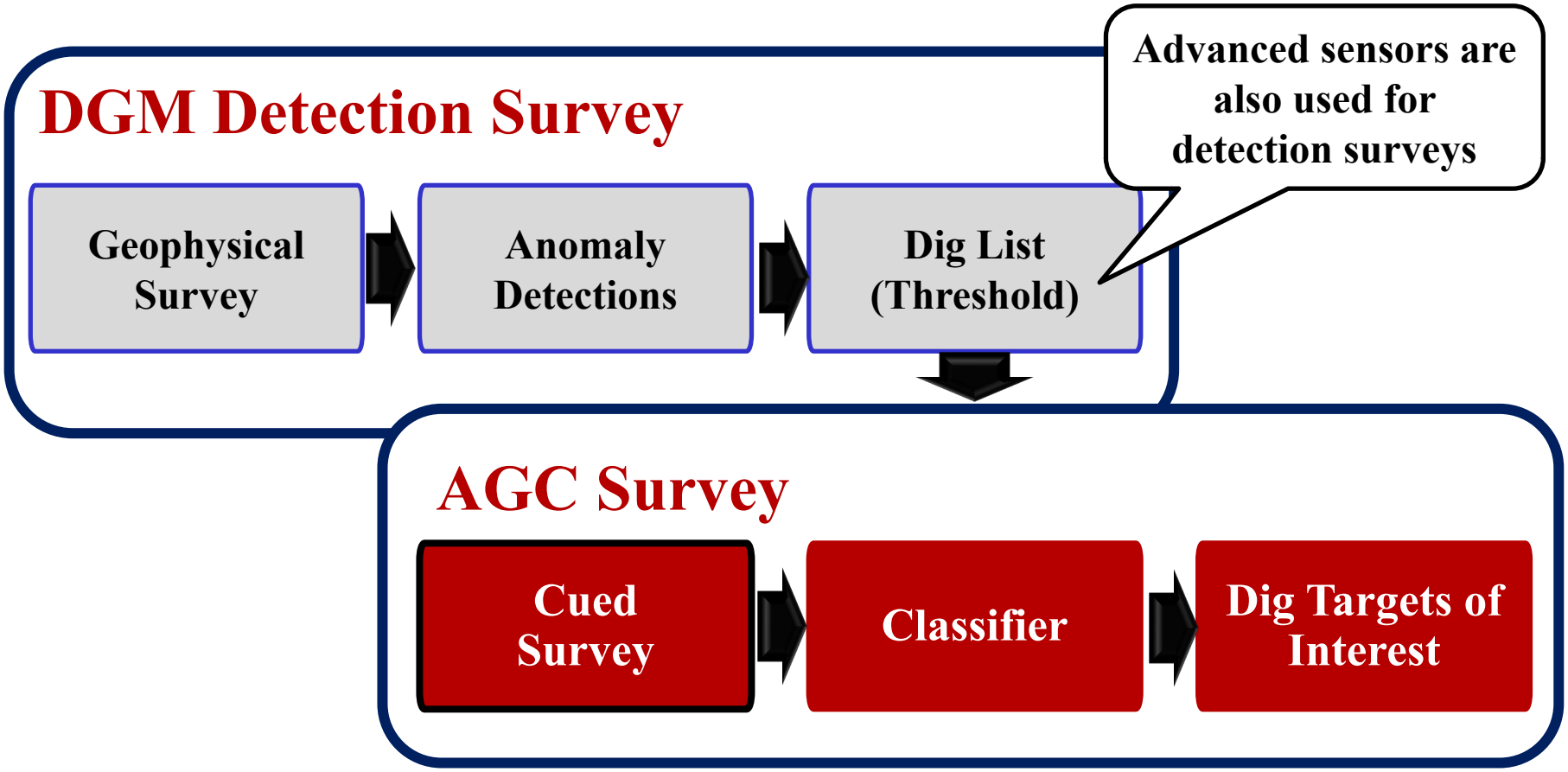






Detection Technologies

Advanced Geophysical Classification



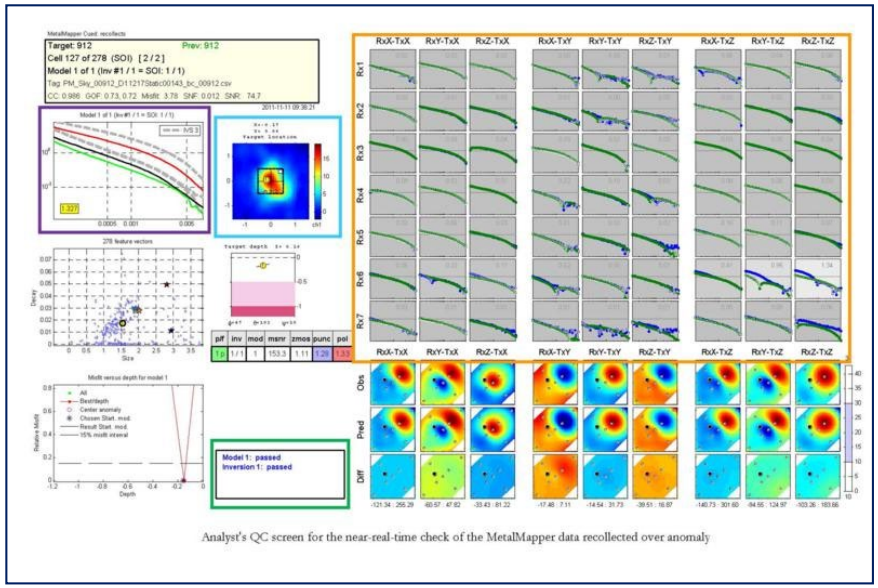
Caution: Before you can classify, you must still detect.

Detection Technologies

AGC Cued Survey Considerations

Cued Survey

- Reacquire targeted anomaly locations
- Cued Survey of each targeted anomaly location with advanced sensor



Analyst's QC screen for the near-real-time check of the MetalMapper data recollected over anomaly

Detection Technologies

AGC Classifier Considerations

Parameter Extraction

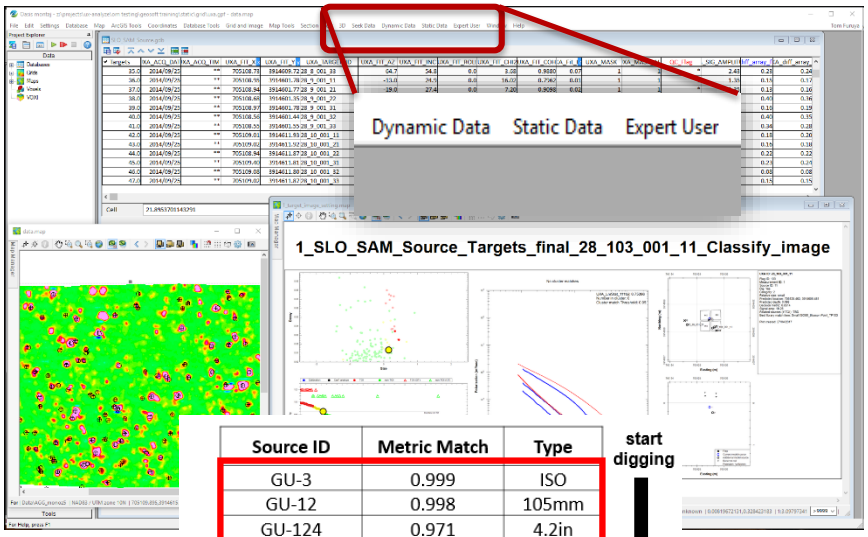
- Extract target (source object) features from measured response (polarizabilities)

Target Classification

- Classify source objects based on extracted features

Dig List Decision

- Select TOI for digging and validate decisions



Source ID	Metric Match	Type
GU-3	0.999	ISO
GU-12	0.998	105mm
GU-124	0.971	4.2in
GU-383	0.962	105mm
GU-465	0.955	Lg ISO
GU-470	0.952	4.2in
GU-534	0.923	75mm
GU-621	0.908	75mm
GU-663	0.896	Lg ISO
GU-719	0.885	105mm
GU-755	0.876	81mm
GU-799	0.749	
GU-810	0.732	
GU-845	0.645	
GU-868	0.622	
GU-884	0.618	
GU-1007	0.512	
GU-1111	0.451	
GU-1112	0.421	

Dig

Do Not Dig

start digging

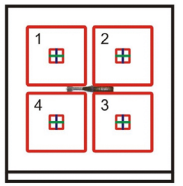
?

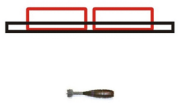
Detection Technologies

Parameter Extraction

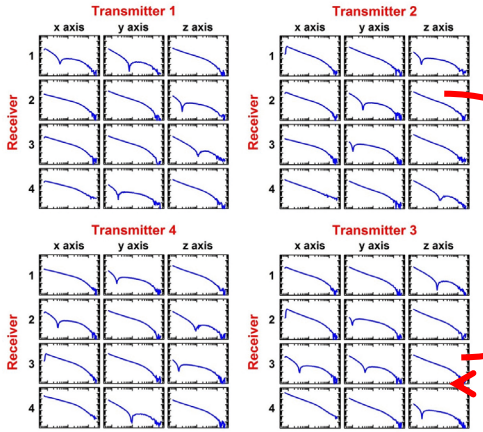
Geophysical Inversion

- Calculate magnetic polarizability (β) using EMI response model

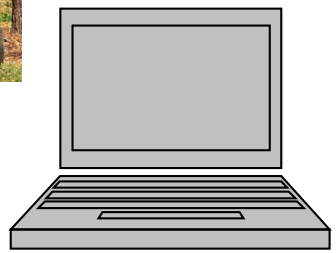




Extrinsic properties (location and orientation)

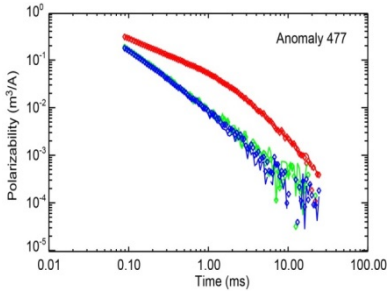


Sensor data



$$V(t) = \mu_0 n_R n_T I_0 C_R \cdot C_T \mathbf{P}(t)$$

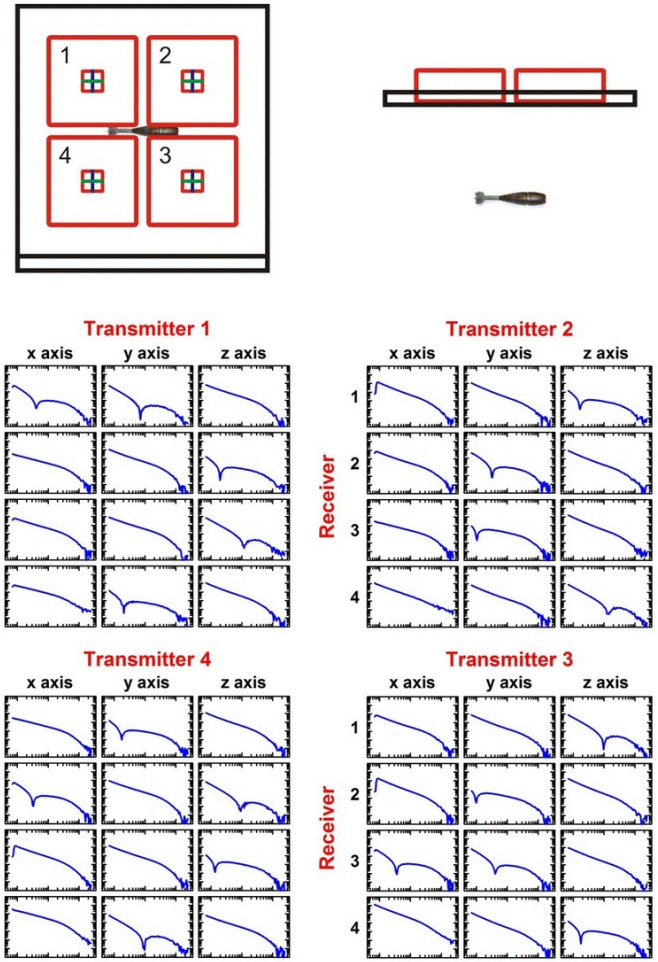
EMI response model

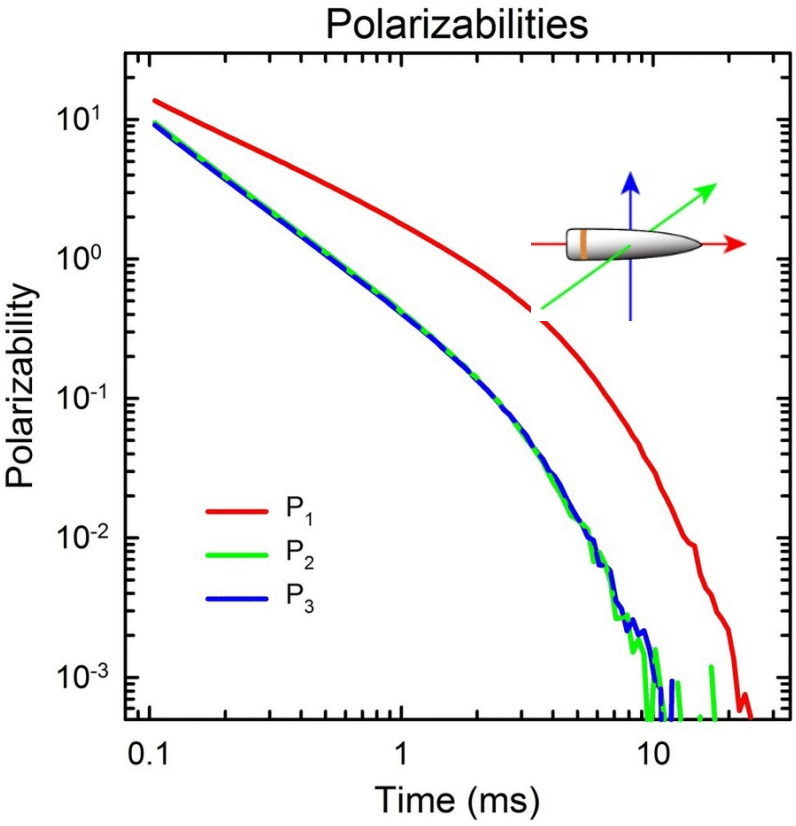


Intrinsic source object response (polarizability)

Detection Technologies

Geophysical Inversion Outputs

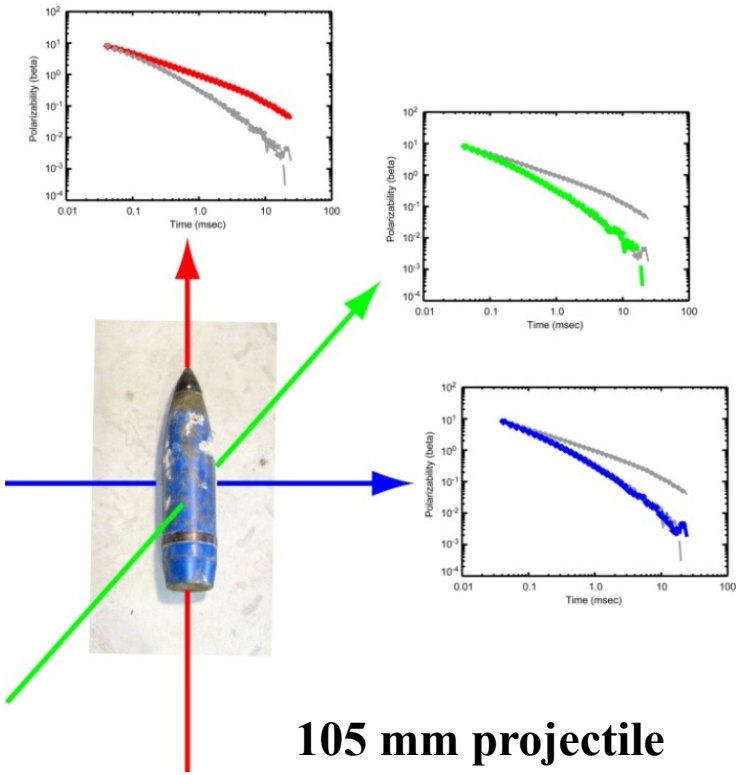




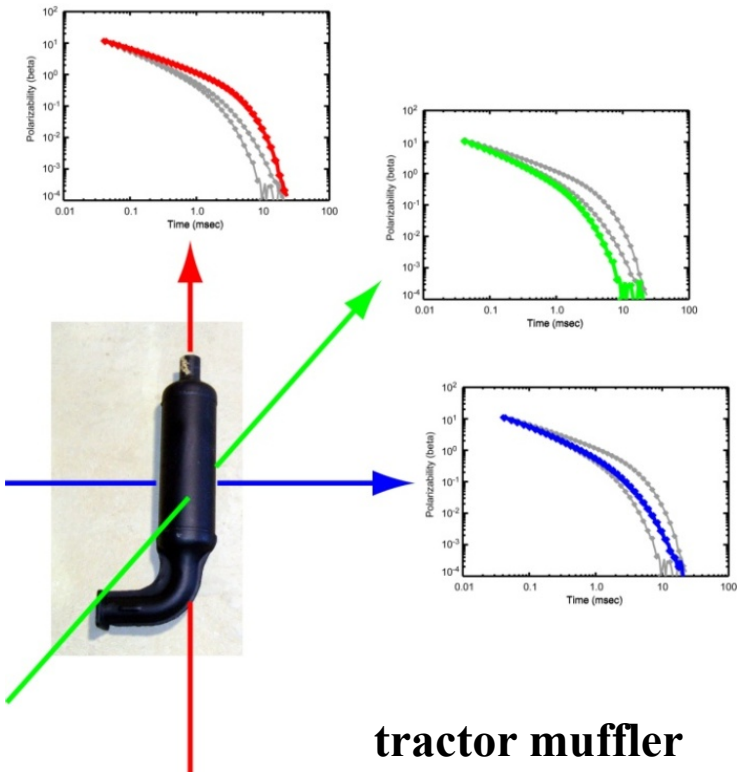
Detection Technologies

Polarizabilities - EM Signature

- **Polarizabilities constitute the basic EM signature of a source object (three primary axis responses).**



105 mm projectile



tractor muffler

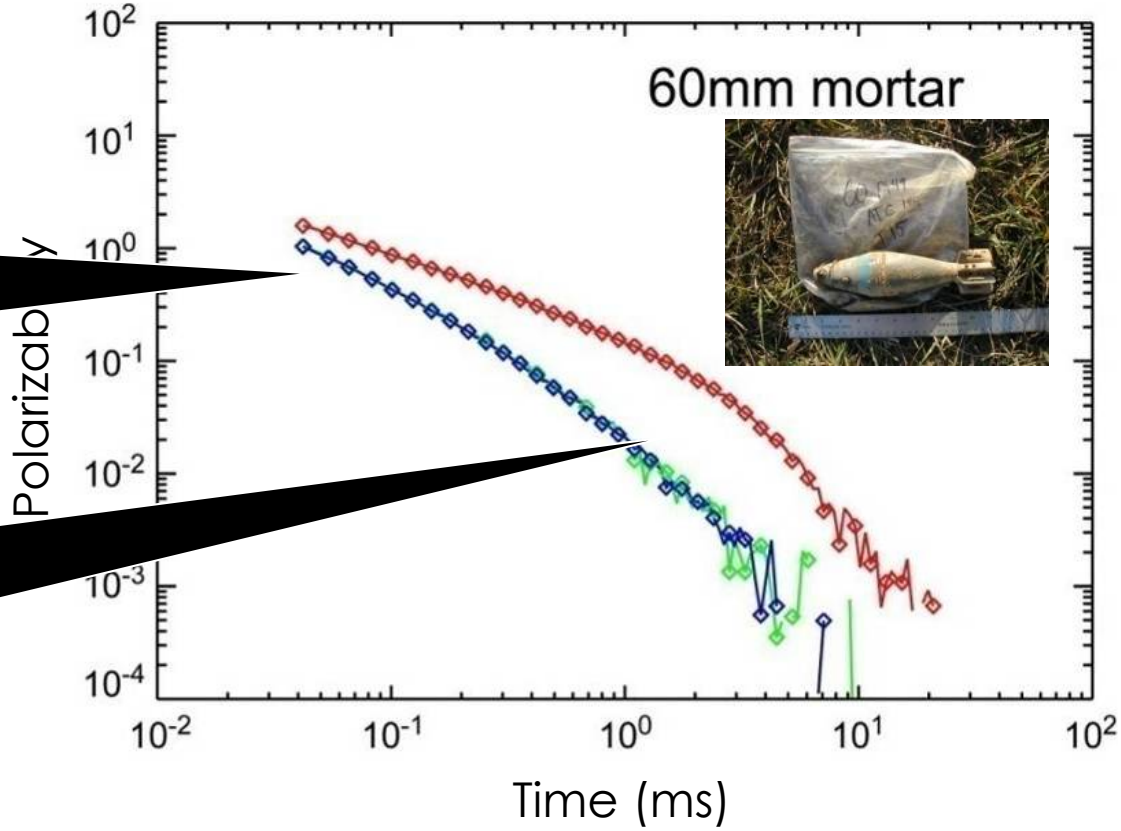
Detection Technologies

How do we classify?

- **We utilize a source objects Polarizabilities**
- **Attributes derived from Polarizabilities**
  - Size, Shape
  - Symmetry
  - Decay Rate

Early Time
- **Eddy currents at surface**
- **Response reflects target size and shape**

Later Time
- **Eddy currents diffused thru target**
- **Decay rates determined by thickness of target**



Detection Technologies

How do we classify?

- **We utilize a source objects Polarizabilities**
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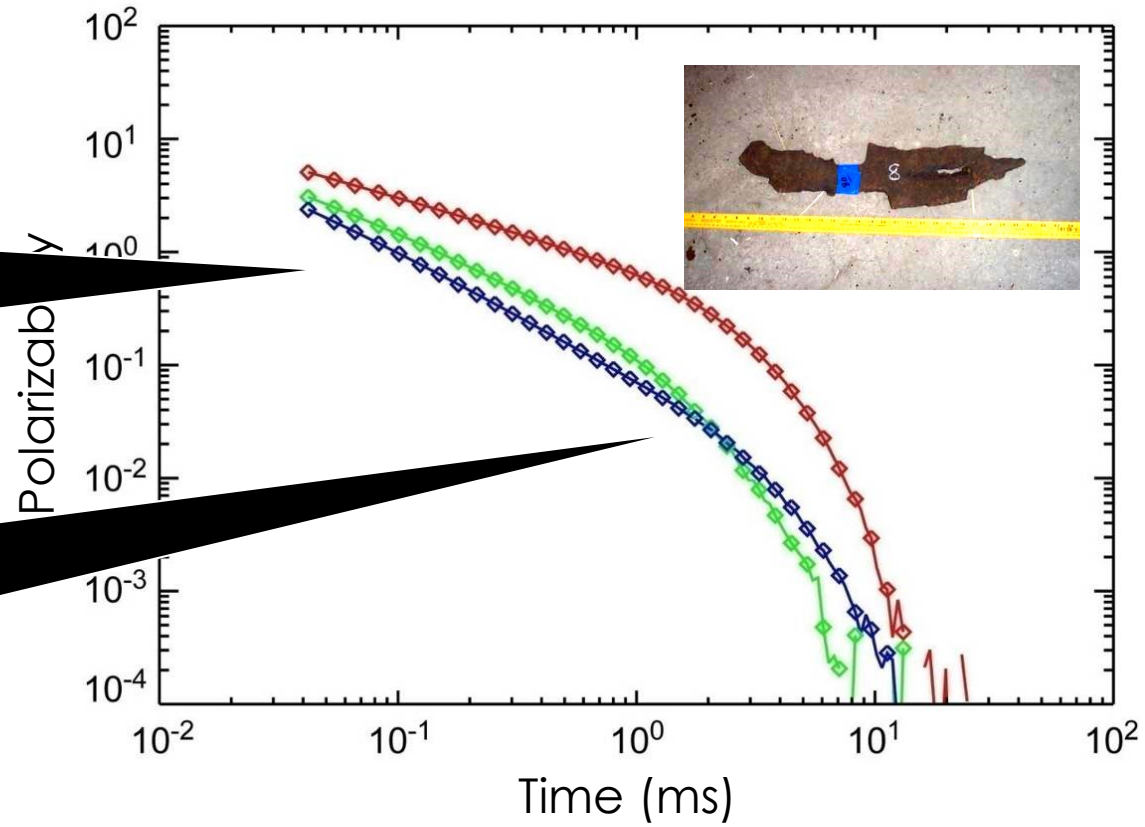
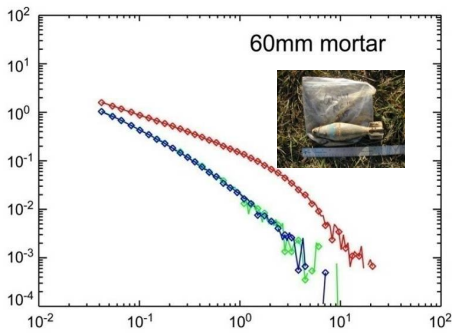


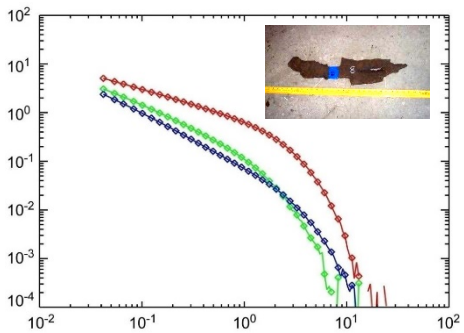
Detection Technologies

Polarizability Relationships

- **Basic relationship between properties of the polarizabilities and the source object**

Polarizability Property	Target Property
Decay rate	Wall thickness
Relative magnitude	Shape
Total magnitude	Size (volume)

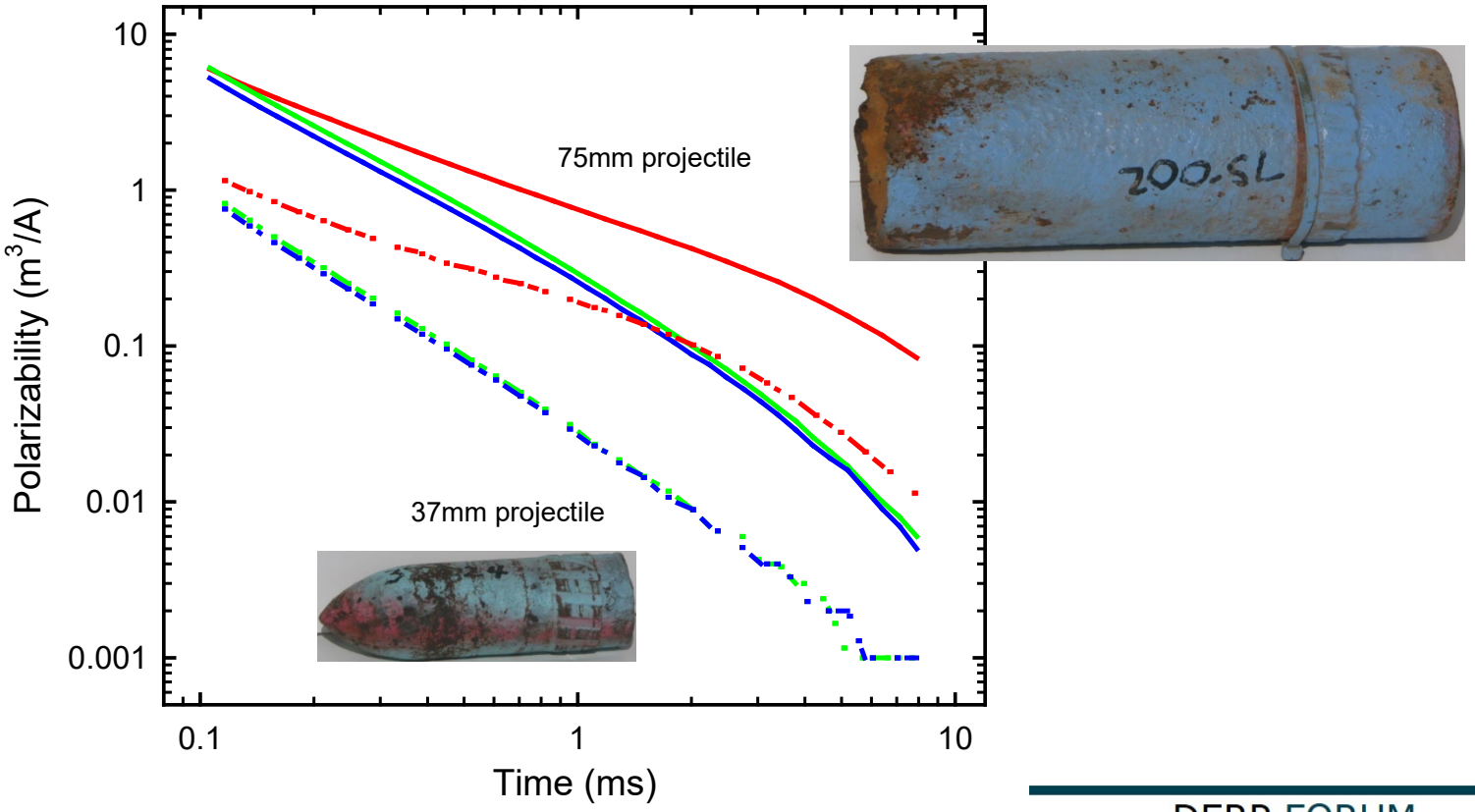




Detection Technologies

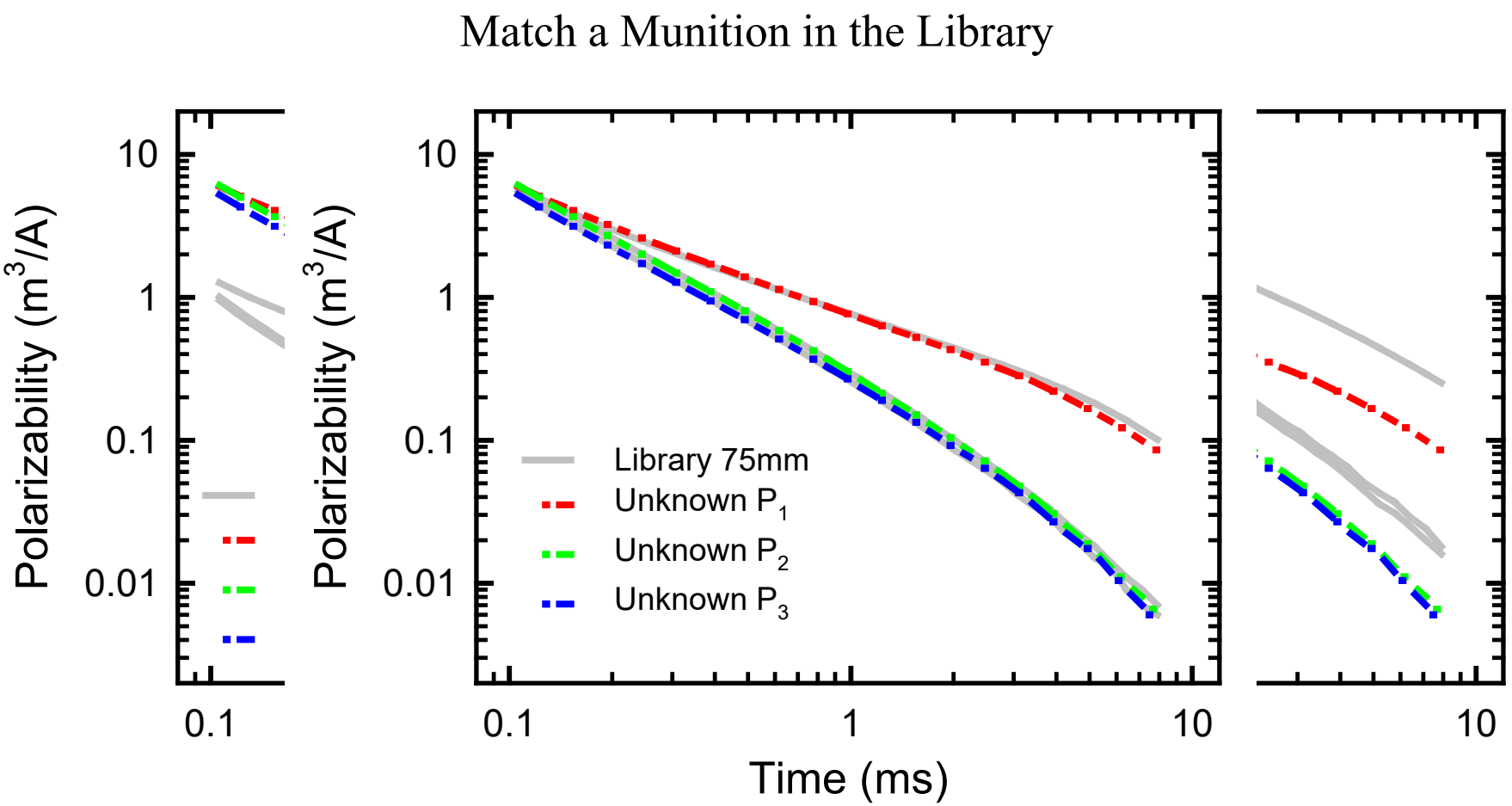
Example: Size Comparison

- **Amplitude scales with the source objects volume**



Detection Technologies

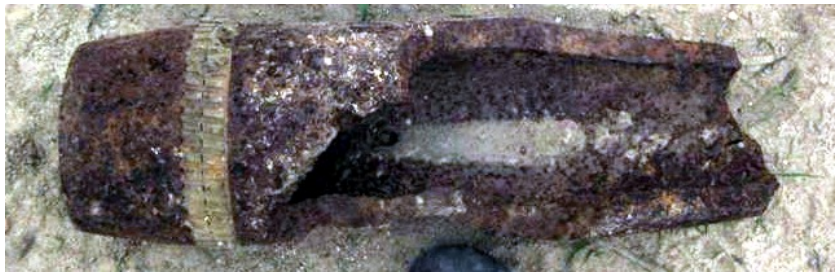
How Do You Get Classified as a TOI?

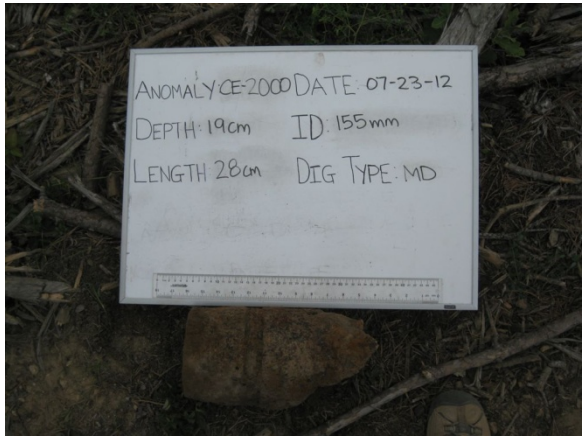


Detection Technologies

Don’t Have To Be Whole to Match Library

Classified as TOI, Type = 155

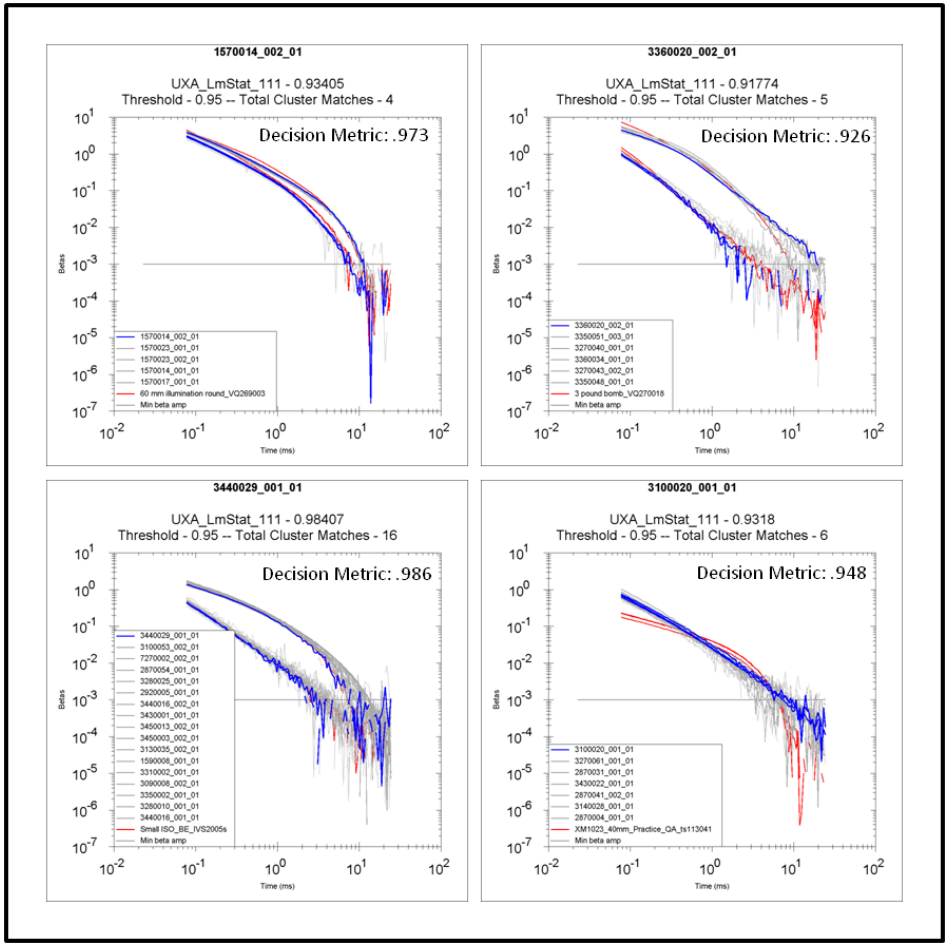




Classified as TOI, Type = 105

Detection Technologies

Library Validation – "Cluster" Analysis

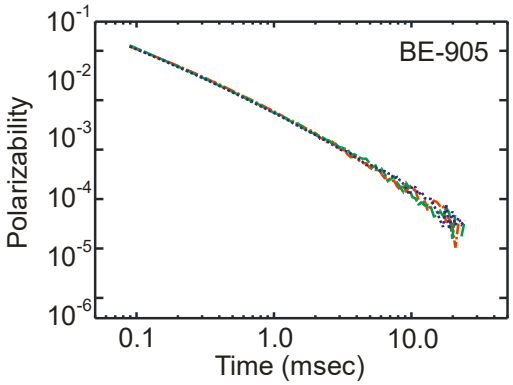


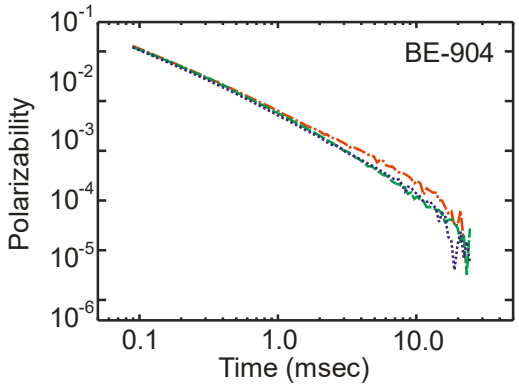
- **Multiple items with similar signatures identified at site?**
- **Representative samples are identified for intrusive investigation**
- **Signatures of recovered TOI not already represented in the library are added to the library**

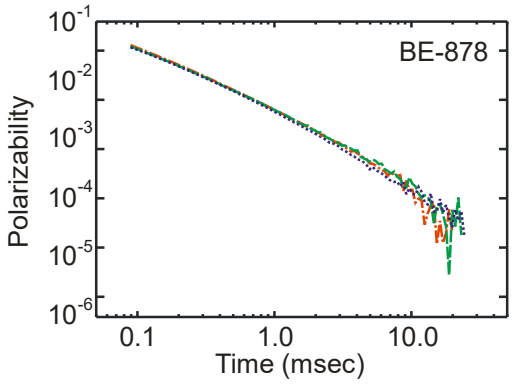
Detection Technologies

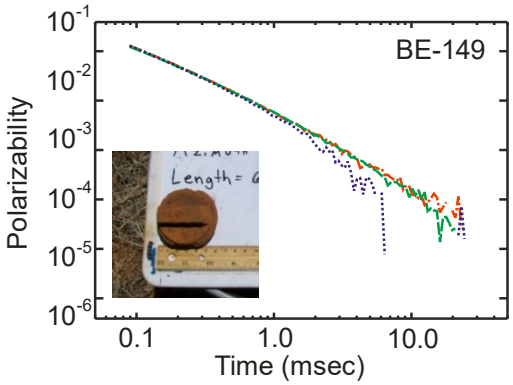
Example "Cluster" Analysis

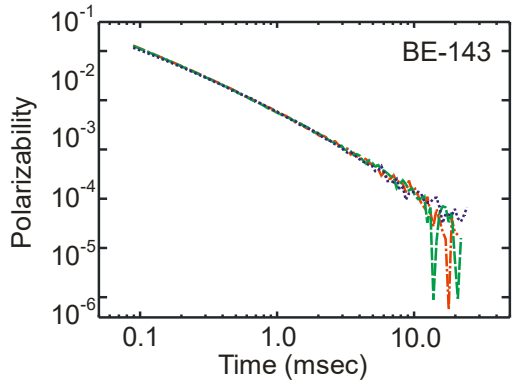
- **25 items with similar polarizability identified at the site but they did not match project library**

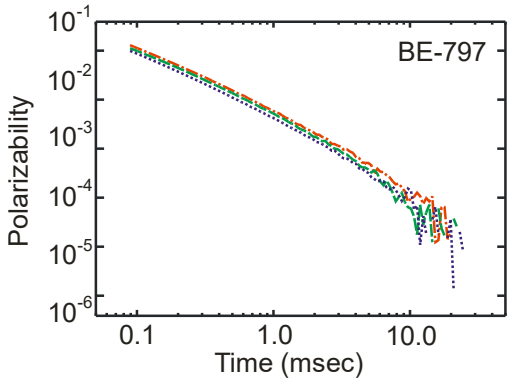








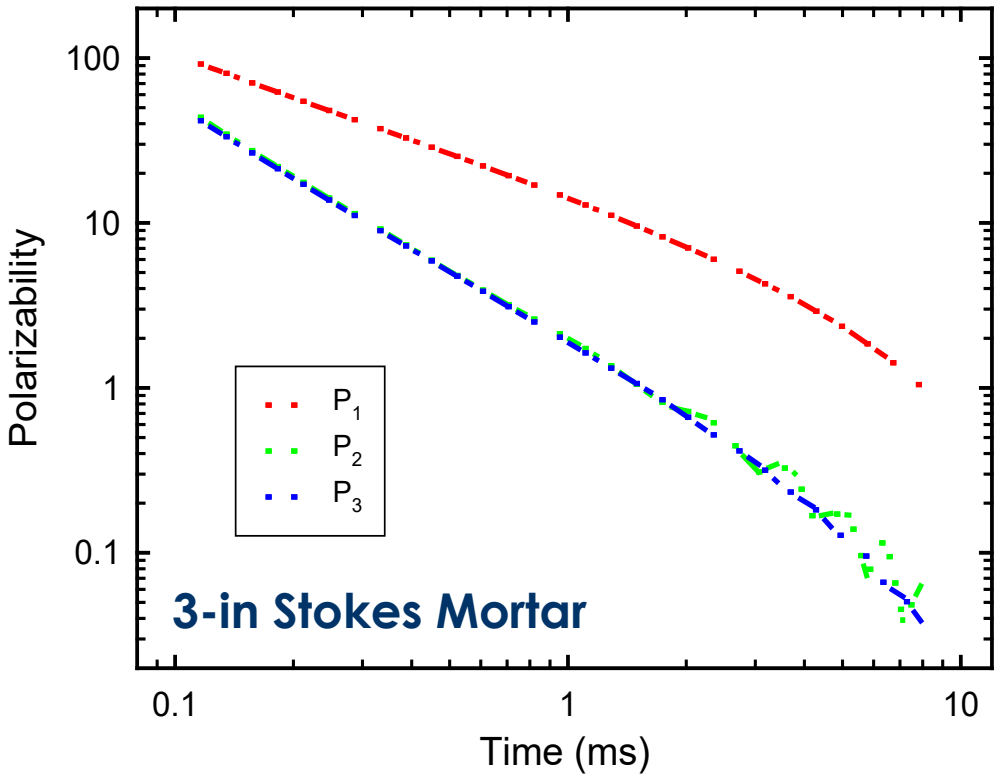




Detection Technologies

Library Validation – Outliers

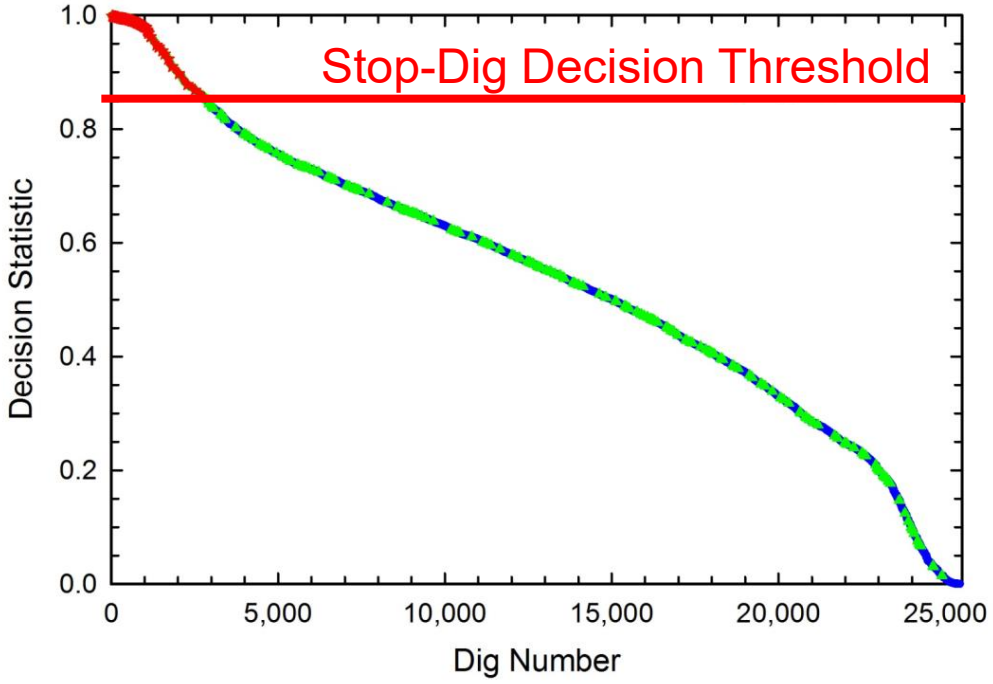
- **Polarizability shows very large, heavy-walled and symmetrical item, that doesn't match project library**
- **Signatures of recovered TOI added to the library**
- **CSM for site reviewed**



Detection Technologies

ACG Prioritized Dig List

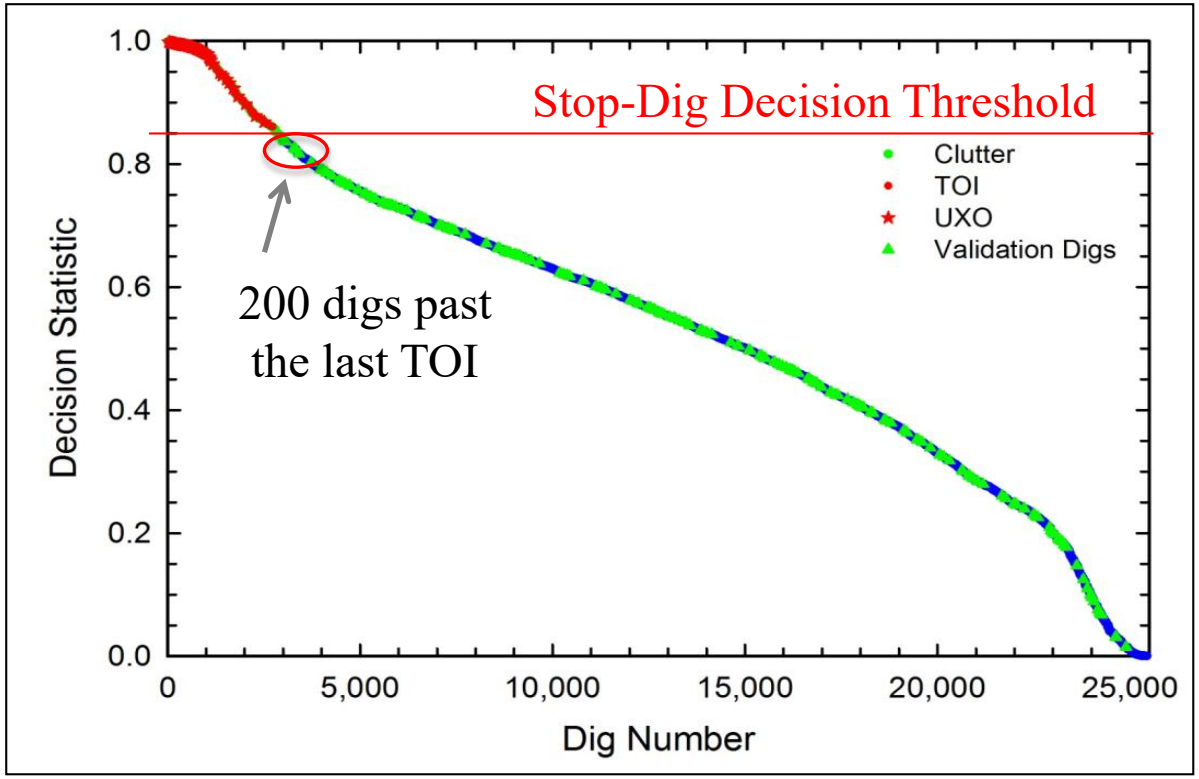
- Derived sources are ranked according to the 'decision metric' – usually a measure of goodness of fit to the munitions library
- 'Stop-dig Threshold' – point at which all remaining dig list entries are considered non-TOI (no dig required)
- Decision Threshold Verification
- Classifier Validation



Detection Technologies

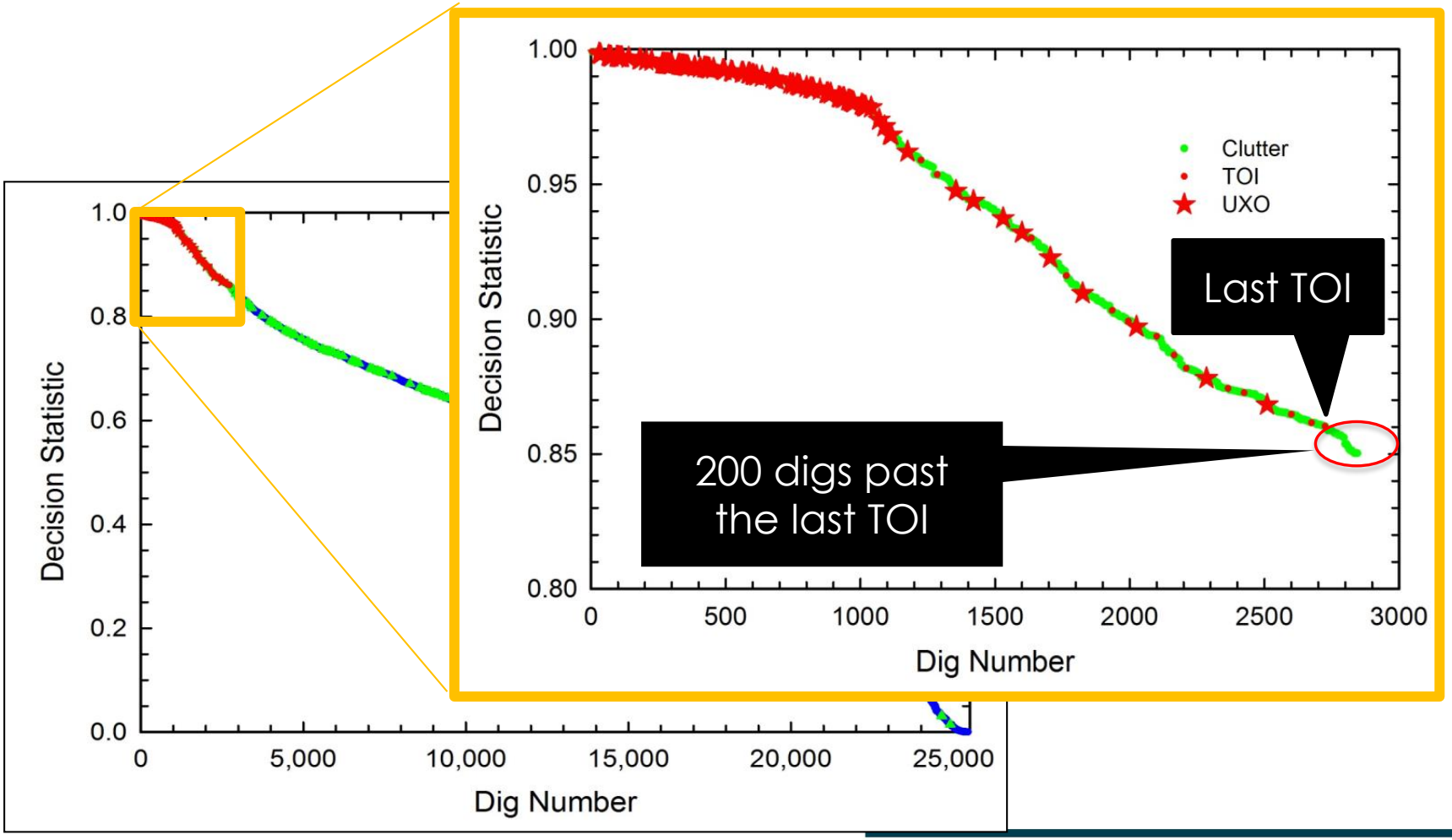
Stop-Dig Threshold Validation

- **Dig an additional 200 items beyond the last TOI**
  - If necessary, reset threshold and start intrusive investigation again
- **The number 200 is a consensus number reached by the members of the IQDTF Advanced Classification Subgroup.**



Detection Technologies

Example: Threshold Validation

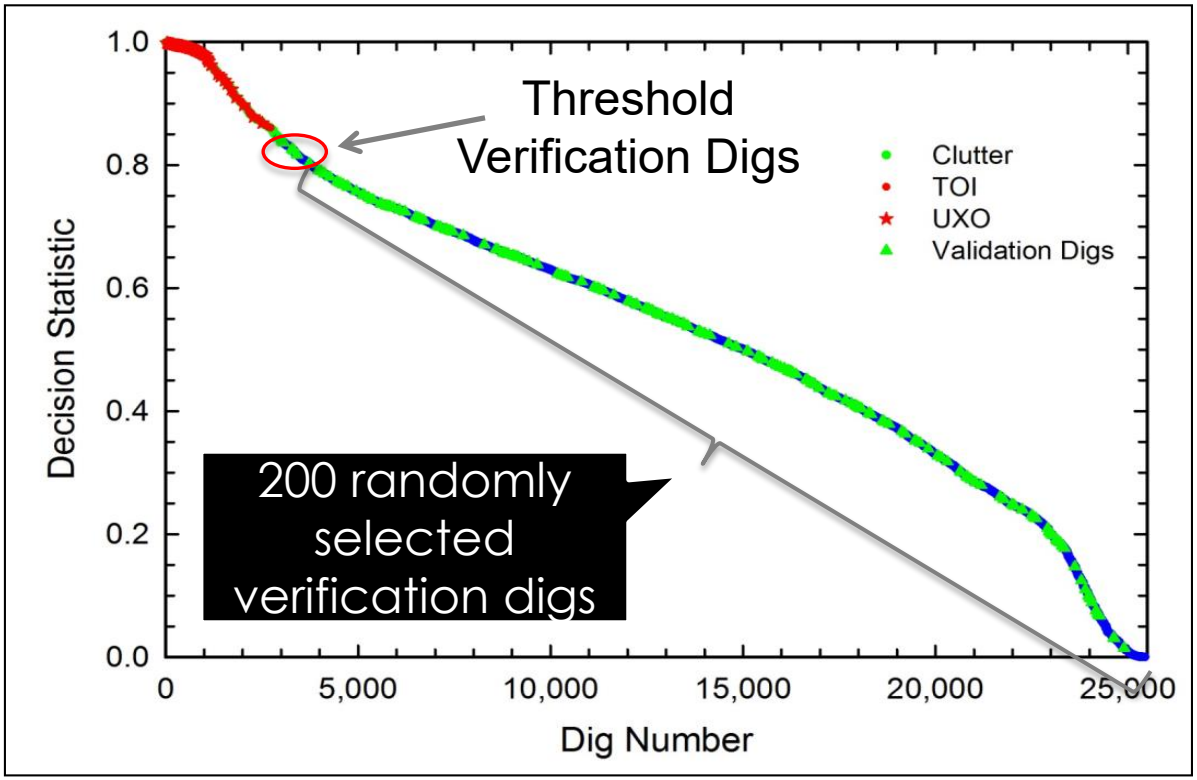


Detection Technologies

Classification Process Validation

- **Validation digs are randomly selected additional 200 non-TOI for qualitative decision confirmation**

- **Confirm reasons for no-dig decisions**
- **Validation of the entire process!**



"Make the right decisions, for the right reasons."
Aristotle

Detection Technologies

AGC Quality Program

- **Quality System is key to success**
  - Accreditation and QAPP provide the framework
  - Sustain with policy, training and implementation
- **QAPP template provides necessary framework**
  - QAPP template is not a tutorial, doesn't teach quality
  - Focus on transparent design, clear DQOs and SOPs
- **Accreditation is a game changer**
  - Requires company wide commitment to quality
  - Independent accreditation body
  - Opportunity for continual quality improvement

Detection Technologies

AGC Quality Program

- ***IDQTF and EDQW Efforts***
- ***Developed and implemented a quality system based on national and international standards for the performance of Advanced Classification at DoD Munitions Response Sites***
  - ***Developed a Quality Assurance Project Plan template using the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)***
    - ***Implements ANSI/ASQ E4 (IDQTF)***
  - ***Developed quality systems documentation for the 3rd-party accreditation of organizations performing advanced classification***
    - ***Implements ISO/IEC 17025 (EDQW)***

AGC Quality Program - Accreditation

DoD Advanced Geophysical Classification Accreditation Program (DAGCAP)

- **Modeled after DoD Environmental Laboratory Accreditation Program (ELAP)**
- **Third-party Accreditation Bodies (ABs) conduct assessments**
- **Applies to all testing organizations regardless of size or volume of business**
- **Applies to use of advanced geophysical classification at all MRSs**

AGC Quality Program - Accreditation

DoD Advanced Geophysical Classification Accreditation Program (DAGCAP)

- **Ensures organizations will have quality systems in place**
- **Requires demonstration of capability**
- **Standard Operating Procedures**
- **Corrective actions and continual improvement is a condition of accreditation**

Detection Technologies

AGC Quality Program Update

DoD Advanced Geophysical Classification Accreditation Program (DAGCAP)

- **12 companies currently accredited (7 large, 5 small)**
- **DoD Quality Systems Requirements (QSR) 2.0 published**
- **Software validation SOP currently in place (3 software suites currently validated)**
- **Hardware validation on its way**

Detection Technologies
Keys to Regulatory Acceptance

- **Classifier Decision Points**
  - No "Black Box" analysis or decisions
- **Transparent decisions - Detection & Classification**
  - Understand all decision points
  - Establish decision thresholds, criteria and standards
  - Well documented decision trees
- **Verification and Validation Strategy**
  - Specifications for data quality and monitoring
  - Classifier models and decision thresholds
  - Final project results

"Make the right decisions, for the right reasons."
Aristotle

Detection Technologies
Concluding Thoughts

- **Fully-integrated Project Delivery Team (PDT), including regulators and stakeholders, is important for success**
- **Preference given to technologies for which performance can be modeled/predicted and validated**
- **Success dependent on detailed plans and adherence to those plans**

For more detailed information regarding Advanced Geophysical Classification, please attend the Munitions Response session of the DERP Forum

QUESTIONS

Military Munitions Response Program Overview

Data Quality

Dr. Jordan Adelson

Chair, Environmental Data Quality Workgroup

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IDQTF and EDQW Efforts for Advanced Classification

Developed and implemented a quality system based on national and international standards for the performance of Advanced Classification at DoD Munitions Response Sites

- Developed a Quality Assurance Project Plan template using the ***Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)***
  - Implements ANSI/ASQ E4 (IDQTF)
- Developed quality systems documentation for the 3rd-party accreditation of organizations performing advanced classification
  - Implements ISO/IEC 17025 (EDQW)

DAGCAP Overview

- **Modeled after DoD Environmental Laboratory Accreditation Program (ELAP)**
- **Third-party Accreditation Bodies (ABs) conduct assessments**
- **Applies to all testing organizations regardless of size or volume of business**
- **Applies to use of advanced geophysical classification at all MRSs**

DAGCAP Overview

- **DAGCAP**
  - Ensures organizations will have quality systems in place
  - Requires demonstration of capability
  - Standard Operating Procedures
  - Corrective actions and continual improvement is a condition of accreditation

AGCMR QAPP Template Highlights

- **Based on the Optimized Uniform Federal Policy for Quality Assurance Project Plan (UFP-QAPP) (IDQTF 2012)**
- **All decision-makers (DoD, contractors, regulators and stakeholders) participate in planning**
- **Facilitates and documents the *systematic planning process* leading to detection and classification of buried MEC**
- **Provides structured, transparent, reproducible process for decision-making in the field**

Ensures a scientific basis for decision-making

AGCMR-QAPP Template Features

- **Includes "crosswalk table" identifying where required quality system elements are addressed**
- **Green text provides instructions and guidance for completing each worksheet**
- **Blue text provides examples of the type of information needed**
- **Black text identifies minimum recommended requirements (where applicable)**

Template is based on the RA phase of investigation
Project teams should modify as needed for other phases

MR-QAPP Toolkit?

- **MR-QAPP Toolkit will contain multiple modules and fact sheets that will help project teams plan data collection efforts and generate QAPPs for all phases of MRS investigations**
- **Module 1 - Remedial Investigation (RI)/Feasibility Study (FS)**
- **Module 2 - Remedial Action (RA)**
  - Updating the AGCMR-QAPP as MR-QAPP Module 2
  - Will expand AGCMR-QAPP beyond just the use of AGC

MR-QAPP Toolkit Module 1

Example

- **Blue text in Module 1 is based on a fictional site, "Camp Example"**
- **Example designed to illustrate an RI/FS at a complex munitions response site**
  - Several different types of target areas, maneuver areas, and other areas of concern.
- **SPP and data collection activities are conducted in phases, requiring planning steps and QAPP revisions between phases.**
- **While a phased investigation is well-suited to a complex MRS, the process of QAPP development is scalable, however, and may be simplified for smaller, less complex projects.**

MR-QAPP Toolkit Module 1
Weight of Evidence Decision Making

- **Unlike traditional chemical cleanups, MRS do not have a clearly defined endpoint based on acceptable risk**
- **A weight of evidence approach is a familiar concept found in scientific and regulatory literature.**
- **It is a method for decision-making that involves consideration of multiple sources of information and lines of evidence.**
  - CSM
- **Avoids relying solely on any one piece of information.**
- **Will allow us to make informed defensible decisions on MRS**

QUESTIONS

Military Munitions Response Program Overview

MMRP RMM

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Project Manager and MMRP Response Process Trainer

U.S. Army Corps of Engineers

Environmental and Munitions Center of Expertise

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Munitions Response Risk Management Method (RMM)

- **Tool to Assess Risks presented by**
  - Presence of explosive hazards
  - In presence of receptors and pathway

Site Characterization & Remediation Tools

Risk Management Method (RMM)

- **Currently in trial/pilot phase: initial results**
  - Supports various conditions
  - Promotes communication
  - Promotes data quality objective (DQO) development
  - Supports definition of remedial action objectives (RAOs)
  - Uses real data
  - Keeps “no further action” (NFA) as a possible outcome
- **Differentiates and justifies Acceptable Vs. Unacceptable**

Site Characterization & Remediation Tools

Risk Management Method (RMM)

Likelihood to Encounter

Matrix 1

Likelihood of Encounter (Amount of MEC versus Access Conditions)		Access Conditions (frequency of use)			
		Regular	Often	Intermittent	Rare
Amount of MEC	Category I (Most)	Frequent	Frequent	Likely	Occasional
	Category II	Frequent	Likely	Occasional	Seldom
	Category III	Likely	Occasional	Seldom	Unlikely
	Category IV	Occasional	Seldom	Unlikely	Unlikely
	Category V	Seldom	Seldom	Unlikely	Unlikely
	Category VI (Least)	Unlikely	Unlikely	Unlikely	Unlikely

Severity of Incident

Matrix 2

Severity of Explosive Incident (Severity vs. Likelihood of Encounter)		Likelihood of Encounter (from Matrix 1)				
		Frequent	Likely	Occasional	Seldom	Unlikely
Severity	Catastrophic/Critical	A	A	B	B	D
	Modest	B	B	B	C	D
	Minor	B	C	C	C	D
	Improbable	D	D	D	D	D

Site Characterization & Remediation Tools

Risk Management Method (RMM)

Likelihood for Incident

Matrix 3

Likelihood of Detonation (Sensitivity vs. Likelihood to Impart Energy)		Likelihood to Impart Energy on an Item		
		High	Modest	Inconsequential
Sensitivity	High	1	1	3
	Moderate	1	2	3
	Low	1	3	3
	Not Sensitive	2	3	3

Resulting Site Conditions

Matrix 4

Acceptable and Unacceptable Site Conditions		Result from Matrix 2			
		A	B	C	D
Result from Matrix 3	1	Unacceptable	Unacceptable	Unacceptable	Acceptable
	2	Unacceptable	Unacceptable	Acceptable	Acceptable
	3	Unacceptable	Acceptable	Acceptable	Acceptable

Site Characterization & Remediation Tools

Risk Management Method (RMM)

Supports Remedial Action Objectives

- **RAOs established for each exposure scenario**
- **Identify acceptable conditions for each scenario**

MRS	Receptors	Location	Pathways	MEC Hazard	Vertical (ft bgs)	Baseline Risk	Acceptable Remediation Goals
Impact Areas (HUA)	Recreational users	All portions of impact area	Interaction during hiking, camping, hunting (Non-intrusive)	60mm HE mortar	1.5	Unacceptable (A-2)	B-3 or D-2
				75mm HE projectile	3.0	Unacceptable (A-2)	B-3 or D-2
	Maintenance Crews	Roads and trails plus 15 m buffer	Interaction during trail maintenance (Intrusive)	60mm HE mortar	1.5	Unacceptable (A-1)	B-3 or D-1
				75mm HE projectile	3.0	Unacceptable (A-1)	B-3 or D-1

Site Characterization & Remediation Tools

Risk Management Method (RMM)

- **Looking for additional sites (preferably FUDS) to use the RMM during the trial/pilot phase**
- ***For more detailed information regarding the Risk Management Model (RMM), please attend the "Risk Management Method (RMM)" session of the DERP Forum***

Summary

Key Messages & Oversight Considerations

- **Detection capabilities have dramatically increased**
- **Quality assurance and risk management tools evolving**
- **Oversight considerations:**
  - Confirm munitions-of-interest and depths-of-interest
  - Verify approach for detection and classification
  - Ensure QAPP fully documents project upfront
  - Verify full implementation of QAPP
  - Rigorous root-cause analysis and corrective actions
  - Verify data quality objectives are met
  - Validate detection & classification decisions

References

- **Memorandum dated 3 January 2018, signed by Karen Baker, Subject: Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects**
- **Memorandum dated 7 February 2019, signed by Karen Baker, Subject: Trial Period Extension for Risk Management Methodology (RMM) at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects**

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS 441 G STREET NW
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF

FEB 07 2019

CEMP-CED

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Trial Period Extension for Risk Management Methodology (RMM) at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects

REFERENCES:

a. Memorandum dated 3 January 2017, signed by Karen Baker, Subject: Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects

QUESTIONS