Department of Defense Quality Systems Requirements for Advanced Geophysical Classification (DoD QSR)

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Errata Sheet (12/7/15)

Department of Defense Quality Systems Requirements
for
Advanced Geophysical Classification (DoD QSR)

1. Section 5.6.2.2.2 – removed text “When constructing the IVS, the GCO shall use the serially numbered objects provided by the manufacturer of the advanced geophysical sensors.”

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DoD Requirements, Clarifications, and Guidance [Note: This DoD Quality Systems Requirements (QSR) document supplements, and is intended for use in conjunction with, the International Standardization Organization/International Electrotechnical Commission (ISO/IEC) Standard 17025:2005, "General requirements for the competence of testing and calibration laboratories".]
4. MANAGEMENT REQUIREMENTS **4.1 Organization**
4.1.1 Clarification: For the purposes of this standard, the term "laboratory" contained in the ISO/IEC 17025 text refers to the organization (i.e., the geophysical classification organization (GCO)) performing advanced classification.
4.1.2 Clarification: For the purposes of this standard, the term "customer" refers to the DoD client.
4.1.3 Clarification: For the purposes of this standard, the term "management system" contained in the ISO/IEC 17025 text is equivalent to "quality system". [See Appendix A - Glossary]
4.1.4 Clarification: For the purposes of accreditation, key personnel (however named) normally will include top management (i.e., the level of management having authority to commit resources), the technical manager having oversight of the GCO, corporate quality manager, project geophysicist, and quality control (QC) geophysicist. With appropriate training and qualifications, personnel may fill more than one role. Requirement: The GCO shall maintain current job descriptions defining roles and responsibilities for key personnel as noted in QSR Section 5.2.4.
4.1.5
a)
b)
c)
d)
e)
f)
g)
h)

i) Guidance: Roles and responsibilities of the corporate quality manager generally will include, but are not limited to, the following: • Participates in project-planning activities • Approves project-specific measurement performance criteria (MPCs) that will meet the data quality objectives (DQOs) • Approves the sampling design • Approves all technical standard operating procedures (SOPs) developed by the GCO • Verifies the selection of appropriately qualified subcontractors • Coordinates field quality assurance surveillance, per contract specifications • Notifies the government quality assurance manager (QAM) of any problems or nonconformance issues • Directs the performance of data review, and • Monitors corrective action Requirement: If the corporate quality manager has technical duties, he/she may not perform oversight of his/her own technical work.
j)
k)
4.1.6 Clarification: Top management is the level of management having authority to commit resources.
4.2 Management system
4.2.1 Clarification: The GCO (if part of a parent organization) is permitted to have its own quality system as long as roles and responsibilities for key personnel (e.g. top management) in the parent organization are included.
4.2.2
a)
b)
c)
d)
e)
4.2.3
4.2.4
4.2.5

4.2.6 Clarification: In this usage, technical management refers to the person or persons responsible for direct oversight of geophysical data collection [See ISO/IEC 17025 Section 4.1.5(h)].
4.2.7 Clarification: Top management generally will evaluate the integrity of the management system during management reviews. [See ISO/IEC 17025 Section 4.15, Management Reviews.]
4.3 Document control
4.3.1
4.3.2
4.3.2.1 Requirement: The corporate quality manager and the technical manager shall approve all technical SOPs prior to issue.
4.3.2.2
a) Requirement: Quality systems documents describing detailed procedures for performing work in the field (e.g., technical SOPs) shall be available to all personnel performing work in the field. The use of electronic copies of SOPs is permitted.
b) Requirement: Technical SOPs shall be reviewed at least every year. All other quality systems documents shall be reviewed at least every two years.
c)
d)
4.3.2.3
4.3.3
4.3.3.1
4.3.3.2
4.3.3.3 Requirement: Pen and ink amendments to documents that form part of the management system are not permitted. (As noted in ISO/IEC 17025 Section 4.3.1, these documents include regulations, standards, other normative documents, test methods, drawings, software, specifications, instructions, and manuals.) Any amendments to quality systems documents shall be issued in the form of a written notice signed by the quality manager and showing the date of issuance and the effective date of the amendment. Electronic signatures are acceptable. Project-specific (one-time) amendments to quality systems documents (e.g. technical SOPs) shall also provide justification for the amendment. The corporate quality manager shall notify all affected personnel of amendments to quality systems documents.
4.3.3.4

4.4 Review of requests, tenders and contracts
4.4.1 Requirement: Either a project geophysicist or the QC geophysicist shall participate in this review.
a)
b)
c)
4.4.2
4.4.3
4.4.4
4.4.5
4.5 Subcontracting of tests and calibrations
4.5.1 Requirement. If a GCO subcontracts work to another GCO, the subcontracted GCO shall be accredited, and it shall operate under its own quality system. The DoD customer shall provide written approval of the arrangement (prior to field work).
4.5.2
4.5.3
4.5.4
4.6 Purchasing services and supplies
4.6.1 Guidance: Examples of supplies that affect the quality of tests include QC seeds (e.g., industry standard objects (ISO), serially numbered objects, and inert munitions) and equipment (e.g. geophysical sensors and global positioning systems), whether purchased or rented. Examples of services include registered surveyors and intrusive investigation teams. Clarification: No consumable items are used.
4.6.2
4.6.3
4.6.4
4.7 Service to the customer
4.7.1
4.7.2

4.8 Complaints
4.9 Control of nonconforming testing and/or calibration work
4.9.1 Requirement: Appendix B: Equipment, Inspection, and Quality Control includes specifications, criteria, and procedures for controlling non-conforming work.
a)
b)
c)
d) Requirement: The GCO shall notify the DoD customer within 7 calendar days when any nonconforming work occurs, other than a missed validation seed. [See Appendix C: Requirements for Monitoring and Reporting Ongoing Performance on Validation Seeds]. The GCO shall notify the DoD customer and the AB within 7 calendar days if it discovers that any inappropriate practice(s) have taken place. [See Appendix D: Prohibited Practices.] Clarification: Either the DoD customer or the GCO may determine when it is necessary to recall work.
e)
4.9.2
4.10 Improvement
4.11 Corrective action
4.11.1
4.11.2
4.11.3
4.11.4
4.11.5
4.12 Preventive Action
4.12.1 [See also QSR Section 5.9.1.]
4.12.2
4.13 Control of records
4.13.1
4.13.1.1 Clarification: Technical records include hard-copy and electronic documentation of work as it is performed (e.g., raw data and results) and reports.

4.13.1.2 Requirement: Organizations shall retain all quality and technical records for a minimum of five years.
4.13.1.3
4.13.1.4
4.13.2
4.13.2.1 Requirement: Appendix E: Data Management, Project Documents, and Records provides minimum record-keeping requirements.
4.13.2.2
4.13.2.3
4.14 Internal audits
4.14.1 Clarification: Internal audits and management reviews are separate activities. Requirement: Internal audits shall be performed by, or under the direction of, the corporate quality manager. Internal audits shall be performed at least once every two years and include on-site audits of technical activities. Internal audits may be conducted in phases.
4.14.2
4.14.3
4.14.4
4.15 Management review
4.15.1 Requirement: Management reviews shall be conducted at least once every year. Management reviews shall include evaluation of ongoing performance on validation seeds. Management reviews may be conducted in phases. Requirement: Appendix C provides requirements for monitoring and reporting performance on validation seeds.
4.15.2
5. TECHNICAL REQUIREMENTS
5.1
5.1.1
5.1.2
5.2 Personnel
5.2.1

5.2.2 Requirement: Training procedures shall address both ISO/IEC 17025 and the supplemental DoD quality systems requirements contained in this document, including prohibited practices identified in Appendix D.

The GCO shall have SOPs for conducting individual (internal) demonstrations of capability (DOC). [Note: The internal DOC is not the same as the corporate DOC that shall be performed as part of the accreditation process.] Internal DOC shall be performed by all personnel responsible for collecting or analyzing data, or procedures shall be performed under direct supervision by personnel who have successfully performed an internal DOC. SOPs shall describe the circumstances under which the internal DOC shall be repeated. All internal DOC, whether successful or unsuccessful, shall be documented.

For field personnel, the internal DOC shall demonstrate the following minimum skills:

- Instrument assembly and operation
- Continuous operation within specifications
- Dynamic operation
- Cued operation

For personnel performing data processing and analysis, the internal DOC shall demonstrate the following minimum skills:

- Quality control checks of field data (unknown targets and background)
- Background correction
- Source selection (dynamic survey only)
- Parameter extraction
- Appropriate use of the Parameter
- Classification

The internal DOC for the project geophysicist shall demonstrate all of the above. In addition, the project geophysicist shall have documented experience in the following:

- Geophysical survey design and management
- Data usability assessment

The QC geophysicist shall have general familiarity with the skills listed above, but an internal DOC is not required. The QC geophysicist shall have documented experience in the following:

- Design and placement of the Instrument Verification Strip (IVS) and QC seeds
- Data processing and analysis
- Data validation and verification
- Approving corrective action

5.2.3 Requirement: Subcontracted personnel shall be trained in accordance with this standard and shall complete internal DOC. If the GCO uses subcontracted personnel as either temporary or permanent extensions of its own staff, subcontracted personnel shall operate under the GCO's quality system. The GCO shall maintain records documenting the training and competency, including internal DOC, for all subcontracted personnel, and these records shall be available for review and provided to assessors upon request. The DoD customer shall provide written approval of the arrangement (prior to field work).

5.2.4 Clarification: For the purposes of accreditation, key technical personnel include the technical manager, quality manager, project geophysicist, and QC geophysicist. With appropriate training and qualifications, personnel can fill more than one role.

5.2.5 Requirement: The effectiveness of training actions shall be documented prior to authorizing personnel to perform testing. A project geophysicist shall sign records documenting satisfactory completion of the internal DOC by field personnel and personnel performing data processing and analysis. The technical manager shall sign records documenting satisfactory completion of the internal DOC by the project geophysicist(s). Electronic signatures are acceptable.

5.3 Accommodation and environmental conditions

5.3.1

5.3.2 Requirement: Procedures for monitoring environmental conditions shall require that a qualitative assessment of moisture and any potential sources of interferences (e.g., power lines, electrical fences, etc.) be recorded in the field notes, whether electronic or hard copy.

Guidance: Examples of environmental conditions that may affect test results include the following:

- Rapid (over the course of an hour) changes in soil moisture levels. This could result from heavy rains or thunderstorms, or heavy dew that dries up during the first hour of testing. Depending on the magnitude of the change, it could make the background variation too severe to compensate.
- Interference from overhead high-voltage lines. To assess this interference, two background measurements should be collected closely in time.
- Interference from intermittent radar sources or other high-power microwave sources (this would most likely occur at or near airports).

5.3.3 Requirement: Procedures shall address the minimum separation between testing units [See Appendix B, Table 22-2].

5.3.4

5.3.5

5.4 Test and calibration methods and method validation
5.4.1 Requirement: Technical SOPs shall include the minimum QC requirements contained in Appendix B as well as any contract-specific requirements. (Project-specific amendments to SOPs are permitted, with justification, based on project-specific DQOs.) SOPs shall be available to personnel at all times, at all sites where they are used. The use of electronic SOPs is acceptable as long as they can be readily accessed by personnel using them. Requirement: Any instructions provided by the manufacturer shall be attached to SOPs and available as noted above. Requirement: Technical SOPs shall be reviewed at least annually. Records of reviews shall be maintained.
5.4.2 Requirement: For the purposes of this document, a standard method is one that a) has been successfully demonstrated during an Environmental Security Technology Certification Program (ESTCP) demonstration and b) is capable of meeting all minimum recommended specifications contained in Appendix B. Any other method is considered to be a non-standard method. The use of library-matching has been successfully demonstrated by the (ESTCP), it is considered to have been appropriately validated, and therefore, it is considered to be a standard method. Requirement: Technical SOPs shall be provided to the DoD customer upon request, to be included in the project-specific Geophysical Classification for Munitions Response Quality Assurance Project Plan (GCMR-QAPP).
5.4.3
5.4.4 Requirement: The use of any non-standard methods shall be approved by the DoD Environmental Data Quality Workgroup (EDQW) Advanced Geophysical Classification Subgroup (AGCS).
5.4.5
5.4.5.1
5.4.5.2 Requirement: When methods referred to in this paragraph (i.e., non-standard methods) are used on a project-specific basis, both the corporate quality manager and DoD QAM shall provide written approval before the procedure is considered validated. When methods referred to in this paragraph are intended to be used on a DoD-wide basis, both the corporate quality manager and the EDQW AGCS shall provide written approval before the procedure is considered validated.
5.4.5.3
5.4.6
5.4.6.1

5.4.6.2 Guidance: Appendix F: Factors Affecting Measurement Uncertainty provides guidance on potential sources of measurement uncertainty.
5.4.6.3
5.4.7
5.4.7.1
5.4.7.2
a) Clarification: Where used, commercial, off-the-shelf software (e.g.,UXAnalyze) and software used successfully in ESTCP demonstrations are considered to have been validated; however, formulas (e.g., those used in spreadsheets developed and used by GCOs) require validation.
b)
c)
5.5 Equipment
5.5.1
5.5.2 Requirement: Appendix B provides equipment inspection, maintenance, and QC checks.
5.5.3
5.5.4
5.5.5
a)
b)
c)
d)
e)
f)
g)
h)
5.5.6
5.5.7
5.5.8
5.5.9

5.5.10 Requirement: Intermediate checks include ongoing function tests and ongoing operation at the IVS.
5.5.11
5.5.12
5.6 Measurement traceability
5.6.1 Clarification: Calibration is not performed. Requirement: Appendix B describes checks to ensure that equipment is in proper working order prior to use. These include the initial function test and initial operation at the IVS.
5.6.2
5.6.2.1
5.6.2.1.1
5.6.2.1.2
5.6.2.2
5.6.2.2.1
5.6.2.2.2 Clarification: Traceability of measurements to the International System of Units (SI) is not possible or relevant. Traceability in measurements is achieved through the use of the DoD Target of Interest (TOI) Library and serially numbered objects provided with the advanced geophysical sensors. Requirement: The GCO shall use the DoD TOI Library as the source of polarizabilities for munitions used in classification decisions. ~~When constructing the IVS, the GCO shall use the serially numbered objects provided by the manufacturer of the advanced geophysical sensors.~~
5.6.3
5.6.3.1
5.6.3.2 Clarification: Reference materials include serially numbered objects. These items are not traceable to the SI.
5.6.3.3
5.6.3.4 N/A
5.7 Sampling
5.7.1
5.7.2
5.7.3

5.8 Handling of test and calibration items
5.8.1
5.8.2
5.8.3
5.8.4
5.9 Assuring the quality of test and calibration results
5.9.1 Requirement: The organization shall monitor its ongoing performance on quality control procedures for the purpose of identifying trends in performance so that preventive actions can be taken where practicable. At a minimum, GCOs shall monitor ongoing performance on the IVS, QC seeds, and validation seeds. Guidance: The regular and routine analysis of quality control data can often permit trends to be spotted before a nonconformity occurs. There are several tools available for the analyzing quality control data including check sheets, control charts, and histograms. The American Society for Quality (ASQ) provides information and links to resources addressing the analysis of quality control data on its website.
a)
b)
c)
d)
e)
5.9.2 Requirement: Appendix B provides QC procedures, acceptance criteria, and corrective action.
5.10 Reporting the result
5.10.1 Requirement: The organization shall have SOPs that describe responsibilities and procedures for performing internal data review before data are transmitted to the client. Personnel performing internal data review shall be independent of the activity generating the data. The SOP shall describe who performs internal review, how it is performed, and how it is documented.
5.10.2 Requirement: The organization shall have an SOP for determining and specifying the format and contents of all test reports including databases and electronic deliverables. Appendix E provides minimum requirements for test reports. Clarification: Project-specific reporting requirements will be specified in contract documents and the project-specific QAPP.
a)

b)
c)
d)
e)
f)
g)
h)
i)
j)
k)
5.10.3
5.10.3.1
a)
b)
c) Clarification: [As noted in QSR Section 5.4.6.2, Appendix F provides guidance on factors affecting measurement uncertainty.]
d) Requirement: The QC Geophysicist shall make a qualitative evaluation of the match between the predicted and actual properties of every item that is excavated. This comparison shall be reported.
e)
5.10.3.2
a)
b)
c)
d)
e)
f)
5.10.4
5.10.4.1

a)
b)
c)
5.10.4.2
5.10.4.3
5.10.4.4
5.10.5 Requirement: This requirement applies to the inclusion of opinions and interpretations in any record provided to the DoD client.
5.10.6 Clarification: The requirement pertaining to calibration certificates is N/A – No calibration is performed.
5.10.7
5.10.8
5.10.9

Appendix A: Glossary

Part 1 – Abbreviations and Acronyms

A	Ampere
AB	Accreditation Body
AGCS	Advanced Geophysical Classification Subgroup
BG	Background
ASQ	American Society for Quality
CA	Corrective action
cm	centimeter
DFW	Definable feature of work
DGM	Digital geophysical mapping
DOC	Demonstration of capability
DOP	Dilution of precision
DQO	Data quality objective
DUA	Data usability analysis
EDQW-AGCS	Environmental Data Quality Workgroup Advanced Geophysical Classification Subgroup
ESTCP	Environmental Security Technology Certification Program
GCMR-QAPP	Geophysical Classification for Munitions Response – Quality Assurance Project Plan
GCO	Geophysical classification organization
GIS	Geographical information system
GPS	Global positioning system
ISO	Industry standard object
ISO/IEC	International Organization for Standardization/International Electrotechnical Commission
ITRC	Interstate Technology Research Council
IVS	Instrument verification strip
m	meter
mV	Millivolt
MPC	Measurement performance criteria
MQO	Measurement quality objective
N/A	Not applicable
pdf	Portable document format
QAM	Quality assurance manager

QC	Quality control
RCA	Root cause analysis
RTK	Real-time kinematic
Rx	Receive
SERDP	Strategic Environmental Research Demonstration Protocol
SI	International System of Units
SOP	Standard operating procedure
SNR	Signal to noise ratio
Tx	Transmit
UXO	Unexploded ordnance

Part 2 - Definitions

Accreditation	Third-party attestation related to a conformity assessment body conveying formal demonstration of its competence to carry out specific conformity assessment tasks. [ISO/IEC 17025]
Accreditation body (AB)	Authoritative body that performs accreditation. [ISO/IEC 17000]
Advanced classification	The use of data from a geophysical sensor system to make a decision about the likely source of a signal; specifically, to determine whether the source is a potentially hazardous munition that must be removed or other non-hazardous item that can be left in the ground. Advanced classification requires three essential components: 1) a geophysical sensor system, 2) a model to estimate intrinsic properties of a buried item based on its EMI fingerprint, and 3) classification algorithms to assign likelihood that a buried item is a target of interest. [SERDP, ESTCP]
Anomaly	As used in geophysics, a deviation from an expected background condition that can result from either a real, physical change (e.g. buried metallic item) in the subsurface, or various kinds of interference related to the geophysical equipment or external sources.
Blind quality control (QC) seed	Industry standard object or inert munition buried at a recorded location, depth, and general declination and orientation, used as a process quality control check for munitions response tasks, including detection surveys, cued surveys, and anomaly recovery operations. The identity, location, and depth of the seed item are blind (not known) to all members of the field team. [EDQW]

Classification validation	A qualitative assessment of the EMI fingerprints predicted from geophysical inversions used to evaluate overall investigation performance. This is achieved by making one or more predictions about the size or general shape of selected non-TOI items, followed by excavation of the items and comparison of actual intrinsic characteristics to predicted characteristics. It may also include a comparison of actual to predicted extrinsic properties such as location and depth of the item. [EDQW]
Classifier	Software (algorithm) used during advanced classification to assign likelihood, based on the EMI fingerprint of a buried metallic item, that the item is a target of interest. [SERDP, ESTCP]
Data quality objectives (DQOs)	Qualitative and quantitative statements of the overall level of uncertainty that a decision-maker will accept in results or decisions based on environmental data. They provide the statistical framework for planning and managing environmental data operations consistent with user's needs. [EPA]
Dilution of precision (DOP)	A term used in satellite navigation to specify the multiplicative effect of navigation satellite geometry on positional measurement precision. [various]
Electromagnetic induction (EMI) sensor	Geophysical sensors that operate by emitting magnetic fields and detecting the response from electric currents generated when these fields interact with metallic objects. They are often referred to as "all-metals locators." [SERDP, ESTCP]
EMI fingerprint	Set of three magnetic polarizabilities which express how an object responds following electromagnetic excitation along each of its three principal axis directions. These intrinsic properties of the object are determined by geophysical inversion of multi-axis EMI sensor data. [SERDP, ESTCP]
Geophysical inversion	A process that uses geophysical data and a physics-based model to iteratively estimate intrinsic properties of a buried item. [SERDP, ESTCP]
Industry standard object (ISO)	An object, constructed from steel pipe manufactured to ASTM specifications, used as a munitions surrogate for the purpose of quality assurance or quality control. [ESTCP] [Note: DoD uses the following three types of ISO: 1-inch diameter X 4-inch long Schedule 80 pipe nipple (a surrogate for 37mm projectiles), 2-inch diameter X 8-inch long Schedule 40 pipe nipple (a surrogate for 60-mm mortars), and 4-inch diameter X 12-inch long Schedule 40 pipe nipple (a surrogate for 105mm projectiles)]. ESTCP GSV Final Report.pdf

Instrument verification strip (IVS)	A constructed series of buried inert munitions or industry standard objects used to verify proper functioning of the geophysical sensor system. [SERDP, ESTCP]
Inversion	Fitting measured sensor data from an object to an EMI response model to obtain the model parameters including the object's location and depth, orientation of its principal axes, and its principal axis response functions. [ITRC]
Laboratory	For the purposes of this standard, the term "laboratory" contained in the ISO/IEC 17025 text refers to the organization performing advanced classification (the geophysical classification organization, or GCO).
Library matching	Comparing the derived polarizabilities of a detected buried metal object (i.e., unknown object) with the polarizabilities of a collection of known items in a library. The objective is to classify the unknown object based on the similarity of its polarizabilities to a library entry.
Management system	See "quality system".
Measurement performance criteria (MPC)	Qualitative and quantitative specifications for measurement activities developed during systematic planning to ensure collected data will satisfy the data quality objectives. MPCs are stated in terms of data quality indicators, including precision, accuracy, representativeness, completeness, comparability and sensitivity. [EPA, various]
Nonconformity	Deviation from a specification or standard. [various]
Polarizabilities	Three principal axis responses returned by the inversion process, which relate directly to the physical attributes of the object under investigation. Information inferred from the responses (e.g. size, shape, aspect ratio and wall thickness) is the basis for classification decisions. [ITRC]
Quality system (also management system)	The means by which an organization ensures the quality of the products or services it provides and includes a variety of management, technical, and administrative elements such as policies and objectives, procedures and practices, organizational authority, responsibilities, and accountability. [EPA QA G-4]

Source selection	The process of using data from geophysical sensors (primarily electromagnetic induction sensors) to determine the location and orientation (extrinsic properties) and size and wall thickness (intrinsic properties) of buried metal objects (sources). Sources that are too small or thin-walled to be TOI can be eliminated from further consideration. [ESTCP]
Target of interest (TOI)	Any item that must be removed from a munitions response site. Common TOI include UXO, other inert munitions that must be excavated to be identified as inert, QC and validation seeds, and substantial components of munitions that the site manager selects for removal. [SERDP, ESTCP]
Standard method	For the purposes of this document, a method for performing advanced classification that has been successfully performed in an ESTCP demonstration and is capable of meeting the minimum specifications contained in Appendix B of this document.
Threshold verification	A quality assurance measure involving the excavation of buried items predicted to be non-TOIs, to verify correct placement of the threshold dividing the ranked anomaly list into TOI and non-TOI. [EDQW]
Top management	The level of management having authority to commit resources on behalf of a GCO. [EDQW]
Validation seed	Industry standard object or inert target of interest buried at a recorded location, depth, and general declination and orientation, by, or on behalf of, the government, which is used to evaluate overall contractor performance on advanced classification. The identity, location, and depth, declination, and orientation of the seed item are blind to the contractor. [EDQW]

Appendix B: Equipment Inspection, Maintenance, and Quality Control[1]

This table is reprinted from the Beta Draft DoD Geophysical Classification for Munitions Response Quality Assurance Project Plan (GCMR-QAPP) template, Worksheet #22, and it is subject to change based on updates to the GCMR-QAPP template. It documents procedures for performing testing, inspections and quality control for all field data collection activities. References to the applicable definable feature of work (DFW) and standard operating procedures (SOP) must be included in the project-specific QAPP. Where appropriate, the failure response column prescribes a corrective action (CA); otherwise a root cause analysis (RCA) must be conducted to determine the appropriate CA. Minimum recommended specifications are provided in black text. For the purpose of accreditation, the organization must demonstrate the ability to comply with all minimum recommended specifications. Minimum recommended specifications may be modified on a project-specific basis if necessary to accommodate data quality objectives; however, the project-specific QAPP must explain and justify any modifications.

Table 22-1: **Dynamic Survey**

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Verify correct assembly		Once following assembly	Field Team Leader/ instrument assembly checklist/Project Geophysicist	As specified in Assembly checklist	CA: Make necessary adjustments, and re-verify
Initial Instrument Function Test TEMTADS (Instrument response amplitudes)		Once following assembly	Field Geophysicist/ Initial IVS Memorandum/ Project Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response for all monostatic Tx/Rx combinations	CA: Make necessary adjustments, and re-verify

[1] For ease of reference, a list of abbreviations and acronyms used in this table is presented at the end of the table.

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Initial Instrument Function Test MetalMapper		Once following assembly	Field Geophysicist/ Initial IVS Memorandum/ Project Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response for all monostatic Tx/Rx combinations	CA: Make necessary adjustments, and re-verify
Initial dynamic positioning accuracy (IVS)		Once prior to start of dynamic data acquisition	Project Geophysicist/ IVS Memorandum/QC Geophysicist	Derived positions of IVS target(s) are within 25cm of the ground truth locations	CA: Make necessary adjustments, and re-verify
Ongoing Instrument Function Test (Instrument response amplitudes) TEMTADS		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ running QC summary (Excel/Geosoft) /Project or QC Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response for all monostatic Tx/Rx combinations	CA: Make necessary repairs and re-verify
Ongoing Instrument Function Test (MetalMapper)		Beginning and end of each day and each time instrument is turned on	Field Team Leader/ running QC summary/Project or QC Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response for all monostatic Tx/Rx combinations	CA: Make necessary repairs and re-verify
Ongoing dynamic positioning precision (IVS)		Beginning and end of each day	Project Geophysicist / running QC summary/QC Geophysicist	Derived positions of IVS target(s) within 25 cm of the average locations	RCA/CA

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
In-line measurement spacing (TEMTADS)		Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data positions	Project Geophysicist/ running QC summary/ QC Geophysicist	100% ≤ 0.20m between successive measurements	RCA/CA CA assumption: data set fails, (re-collect portions that fail)
In-line measurement spacing (MetalMapper)		Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data positions	Project Geophysicist/ running QC summary/ QC Geophysicist	100% ≤ 0.25m between successive measurements	RCA/CA
Coverage (TEMTADS)		Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data	Project Geophysicist/running QC summary and survey unit validation report/QC Geophysicist	100% at ≤0.7m cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain)	RCA/CA
Coverage (MetalMapper)		Verified for each survey unit using [describe tool to be used] based upon monostatic Z coil data	Project Geophysicist/running QC summary and survey unit validation report/QC Geophysicist	100% at ≤0.7m cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain)	RCA/CA
Sensor Tx current (TEMTADS)		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	Current must be ≥5.5A	CA: out of spec data rejected

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
Sensor Tx current (MetalMapper)		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	Current must be ≥3.5A	CA: out of spec data rejected
Dynamic detection performance		Evaluated by survey unit	QC Geophysicist/ survey unit validation report/ lead agency QA Geophysicist	All blind QC seeds must be detected and positioned within 40 cm radius of ground truth	RCA/CA
Valid position data (1)		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	GPS status flag indicates RTK fix and DOP less than 4.0	Out-of-spec data rejected
Valid orientation data (2)		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	Orientation data reviewed and appear reasonable within bounds appropriate to site	Unreasonable data rejected
Size and decay rate threshold verification (when advanced anomaly selection is used)		Collect cued data from an additional 200 anomalies excluded on the basis of advanced anomaly selection		Cued data analysis confirms100% of excluded anomalies are non-TOI	RCA/CA

Table 22-2: Cued Survey

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Verify correct assembly		Once following assembly	Field Team Leader/ instrument assembly checklist/ Project Geophysicist	As specified in instrument assembly checklist	CA: Make necessary adjustments, and re-verify
Initial sensor function test (TEMTADS)		Once following assembly	Field Team Leader/ instrument assembly checklist/ Project Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response for all monostatic Tx/Rx combinations	CA: make necessary repairs/ adjustments and re-verify
Initial system functionality test (MetalMapper) (Five measurements over a small ISO80 target, 1 each directly under each coil and 1 directly under center of array). Derived polarizabilities for each measurement are compared to the library using UX-Analyze		Once following assembly	Field Team Leader/ instrument assembly checklist/ Project Geophysicist	Library match metric ≥ 0.95 for each of the five sets of inverted polarizabilities	CA: make necessary repairs/ adjustments and re-verify

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Initial IVS background measurement (five background measurements, one centered at the flag and one offset at least 35cm in each cardinal direction)		Once during initial system IVS test	Field Team Leader/ Initial IVS memorandum/ Project Geophysicist	All decay amplitudes lower than project threshold (threshold dependent upon soil response)	CA: reject/replace BG location
Initial derived polarizabilities accuracy (IVS)		Once during initial system IVS test	Project Geophysicist/ Initial IVS memorandum/ QC Geophysicist	Library Match metric ≥ 0.9 for each set of inverted polarizabilities	RCA/CA
Derived target position accuracy (IVS)		Once during initial system IVS test	Project Geophysicist/ Initial IVS Memorandum/ QC Geophysicist	All IVS item fit locations within 0.25m of ground truth locations	RCA/CA
Ongoing IVS background measurements		Beginning and end of each day as part of IVS testing	Project Geophysicist/ tracking summary/ QC Geophysicist	All decay amplitudes lower than project threshold	RCA/CA CA assumption: rejection of BG measurement (unless RCA indicates system failure)
Ongoing derived polarizabilities precision (IVS)		Beginning and end of each day as part of IVS testing	Project Geophysicist/ tracking summary/ QC Geophysicist	Library Match to initial polarizabilities metric ≥ 0.9 for each set of three inverted polarizabilities	RCA/CA
Ongoing derived target position precision (IVS)		Beginning and end of each day as part of IVS testing	Project Geophysicist/ tracking summary/ QC Geophysicist	All IVS items fit locations within 0.25m of average of derived fit locations	RCA/CA

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Initial measurement of production area background locations (five background measurements: one centered at the flag and one offset at least 35cm in each cardinal direction)		Once per background location	Field Team Leader/ background location report/ Project Geophysicist	All decay amplitudes lower than project threshold	CA: reject BG location and find alternate
Ongoing production area background measurements		Background data collected a minimum of every two hours during production	Field Team Leader/failures noted in field log and tracking summary/ Project Geophysicist	All decay amplitudes lower than project threshold	CA: BG measurement rejected and re-collected
Ongoing instrument function test (TEMTADS)		Each time instrument is restarted	Field Team Leader/ tracking summary/ Project Geophysicist	Response (mean static spike minus mean static background) within 20% of predicted response for all monostatic Tx/Rx combinations	CA: make necessary repairs and re-verify
Ongoing instrument function test (MetalMapper)		Each time instrument is restarted	Field Team Leader/ tracking summary/ Project Geophysicist	Response within 20% of predicted response	CA: Make necessary repairs and re-verify
Transmit current levels (TEMTADS)		Evaluated for each sensor measurement	Field Team Leader/ tracking summary/ Project Geophysicist	Peak transmit current between 5.5 and 8A	CA: stop data acquisition activities until condition corrected
Transmit current levels (MetalMapper)		Evaluated for each sensor measurement	Field Team Leader/ tracking summary/ Project Geophysicist	Peak transmit current between 4.0 and 4.5A	CA: stop data acquisition activities until condition corrected

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Confirm all background measurements are valid		Evaluated for each background measurement	Project Geophysicist/ Background summary/ QC Geophysicist	Develop threshold	CA: BG measurement rejected and removed from active BG measurements
Confirm adequate spacing between units (TEMTADS)		Evaluated at start of each day (or grid)	Field Team Leader/ Field Logbook/ Project Geophysicist	Minimum separation of 50 m	CA: Recollect all coincident measurements
Confirm adequate spacing between units (MetalMapper)		Evaluated at start of each day (or grid)	Field Team Leader/ Field Logbook/ Project Geophysicist	Minimum separation 25m	CA: Recollect all coincident measurements
Confirm inversion model supports classification (1 of 3)		Evaluated for all models derived from a measurement (i.e. single item and multi-item models)	Project Geophysicist/ Measurement QC summary/ QC Geophysicist	Derived model response must fit the observed data with a fit coherence ≥ 0.8*	Follow procedure in SOP or RCA/CA
Confirm inversion model supports classification (2 of 3)		Evaluated for derived target	Project Geophysicist/ Measurement QC summary/ QC Geophysicist	Fit location estimate of item ≤ 0.4m from center of sensor	Follow procedure in SOP or RCA/CA
Confirm inversion model supports classification (3 of 3)		Evaluated for all seeds	QC Geophysicist/ Measurement Inversion model QC summary/ lead agency QA Geophysicist	100% of predicted seed positions ≤ 0.25m from known position (x, y, z).	RCA/CA

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Confirm reacquisition GPS precision		Daily	UXO tech or field tech/ Daily QC Report/ Project Geophysicist	Benchmark positions repeatable to within 10cm	RCA/CA
Classification performance		Evaluated for all seeds	QC Geophysicist; USACE QA Geophysicist/ Ranked dig list/ USACE QA Geophysicist	100% of QC and validation seeds placed on dig list	RCA/CA

***** Fit coherence is defined as the square of the correlation coefficient between data and model

Table 22-3: **Intrusive Investigation**

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
Confirm derived features match ground truth (1 of 2)		Evaluated for all recovered items	Project Geophysicist/ Measurement QC Summary or intrusive database/ QC Geophysicist	100% of recovered (excluding inconclusive category) item positions ≤ 0.25m from predicted position (x, y).	RCA/CA
Confirm derived features match ground truth (2 of 2)		Evaluated for all recovered items	UXO Dig Team/ Dig List and intrusive database/ Project or QC Geophysicist	100% of recovered object size estimates (excluding inconclusive category) qualitatively match predicted size	RCA/CA
Verification of TOI/non-TOI threshold		Dig 200 anomalies beyond last TOI on Dig List	Project Geophysicist/ Verification and Validation Report/ QC Geophysicist	100% of predicted non-TOI intrusively investigated are non-TOI	Adjust threshold
Classification validation		Random selection of 200 non-TOI	Project Geophysicist/ Verification and Validation Report/ QC Geophysicist	100% of predicted non-TOI qualitatively matches predictions	Document in DUA

Abbreviations and acronyms:

A – ampere
BG – background
CA – corrective action
cm – centimeter
DOP – dilution of precision
DUA – data usability analysis
GCMR-QAPP – Geophysical Classification for Munitions Response Quality Assurance Project Plan
GPS – global positioning system

Abbreviations and acronyms:

ISO – industry standard object
IVS – instrument verification strip
m – meter
QA – quality assurance
QAPP – quality assurance project plan
QC – quality control
RCA – root cause analysis
RTK – real time kinematic
Rx – receive
SOP – standard operating procedure
TBD – to be determined
TOI – target of interest
Tx – transmit
UXO – unexploded ordnance

Appendix C: Requirements for Monitoring and Reporting Ongoing Performance on Validation Seeds

1. Geophysical classification organization (GCO) receives award or task order, and notifies Accreditation Body (AB) of upcoming project (site name, basic information, and approximate date for beginning site work).
2. GCO conducts detection survey, by survey unit.
3. Following data verification and validation, GCO reports detection survey results to DoD customer in accordance with the site-specific GCMR-QAPP.
4. DoD customer reports validation seed detection results to the GCO within 14 days of receiving detection survey results.
5. DoD customer reports validation seed failures to EDQW.
6. GCO reports validation seed failures to AB within 7 days.
7. If the GCO failed to detect any validation seeds, GCO shall stop work, conduct RCA, and identify CA.
    a. GCO provides RCA/CA to DoD customer and AB.
    b. AB coordinates with EDQW.
    c. If the RCA reveals the failure resulted from a government error, the DoD customer implements CA, and work resumes.
    d. If the RCA reveals the failure resulted from an error on the part of the GCO), the GCO implements corrective action and the DoD customer implements contract remedies, if applicable.
8. Process is repeated for cued survey.
9. AB tracks and reports validation seed failures.

Appendix D: Prohibited Practices

The following is a list of practices that are inappropriate for the collection of environmental data, and are therefore prohibited. Inappropriate practices are deliberate activities undertaken with the objective of misrepresenting data, i.e., making it appear that all required specifications were followed or acceptance criteria achieved, when they were not. The major bullets identify categories of inappropriate practices. Sub-bullets provide examples.

- Fabrication, falsification, or misrepresentation of data.
    - Creating data for a field measurement that was not performed.
    - Using data from one field measurement to represent a measurement at another location (e.g. changing the measurement location coordinates of one data file to represent a measurement at another location).
    - Altering or deleting original (i.e. raw) field measurement data (i.e. the measured transients, also known as receiver decays) in any way.
    - Changing the time stamp of a field measurement in either the field data file or subsequent processing data file(s) or database(s).
    - Altering, changing or deleting the output of an inversion process or inversion routine (i.e. the betas or polarizabilities reported from the inversion process).
    - Renaming a data file.
    - Altering a file's creation date or a file's modification date.
- Improper clock setting or improper date and time recording.
    - Resetting the internal clock on an instrument or computer to make it appear that field measurements were taken within some given background measurement interval other than the true interval, or to make it appear that background measurements were taken at intervals other than those actually performed.
    - Changing the actual time or recording a false time to make it appear that a field measurement was taken at some time other that the true time it was taken.
- Altering library data or library information.
    - Altering in any manner the library signature (also known as betas or polarizabilities), the library transients (also known as receiver decays), or metadata of a Government-furnished library signature.
- Unwarranted manipulation of analyses, software, or firmware
    - Changing or altering the measurement instrument's operating or recording parameters without documenting the reasons for doing so in accordance with SOPs.
    - Changing or altering the inversion software in any manner without following the SOP for doing so.
    - Using inversion software or an inversion routine that has not been accepted by the Government in accordance with Sections 5.4.4 and 5.4.5.2 of this standard.

    - Changing or altering the inversion parameters without documenting the change following the standard operating procedure (SOP) for doing so.
    - Turning off, or otherwise disabling or manipulating, electronic or software-controlled audit or tracking functions.
- Misrepresenting or misreporting quality control (QC) information
    - Substituting previous instrument verification strip (IVS) results for non-compliant IVS results.
    - Repeating a quality control (QC) task multiple times until a specification is met (i.e., intentionally replacing non-compliant QC results with compliant QC results) without performing required corrective action.
    - Deleting or failing to record non-compliant QC data for any reason.
    - Tampering with QC data or QC results to make it appear they are compliant with project specifications.
- Misrepresenting or overstating personnel competencies or personnel experience or expertise.
    - Misrepresenting, overstating, or falsifying training records.
    - Misrepresenting, overstating, or falsifying work experience.
    - Misrepresenting, overstating, or falsifying education credentials.
- Concealing a known measurement or analysis problem.
- Concealing a known improper or unethical behavior or action.
- Failing to report the occurrence of a prohibited practice or known improper or unethical act to the appropriate contractor representative or to an appropriate government official.
- Sharing blind seed information in violation of the firewall.

Appendix E: Data Management, Project Documents, and Records

This appendix is based on the GCMR-QAPP template, Worksheet #29, and it is subject to updates as the GCMR-QAPP is updated. This appendix presents data management specifications and lists minimum required documents and records for geophysical investigations. Where applicable, specific versions or dates of software used shall be documented.

Part 1: Data Management Specifications

Computer Files and Digital Data: All final document files, including reports, figures, and tables, will be submitted in electronic format on CD/DVD-ROM or as specified by the DoD client. Data management and backup must be performed in accordance with the organization's documented quality system.

TOI Library: The project-specific QAPP shall document the version (date) of the DoD Target of Interest (TOI) library used and describe or reference procedures to be used to update the library. The TOI libraries used shall be included in data deliverables.

Part 2: Control of Documents, Records, and Databases

[Organizations should complete this table for use in their quality system and project-specific QAPPs.]

Minimum Required Documents and Records			
Document/Record	**Purpose**	**Completion/ Update Frequency**	**Format/ Storage Location/ Archive Requirements**
Site Manager Log			
Quality Control (QC) Seed Plan			
QC Firewall Plan			
Daily Status Reports			
Daily QC Reports			
Weekly Geophysical QC Report			
Team Leader Log(s)			
Field Change Request Form			
Root Cause Analysis			
Photograph Log			
Production Area QC Seeding Report			
Surface Sweep Technical Memorandum			
Land Survey/Control Point Data Report			
Instrument Verification Strip (IVS) Technical Memorandum			
SOP Checklists			
Seed Tracking Log			
Data Usability Assessments (dynamic survey, cued survey and final DUA)			

Minimum Required Documents and Records			
Document/Record	**Purpose**	**Completion/ Update Frequency**	**Format/ Storage Location/ Archive Requirements**
Target Selection Technical Memorandum			
Final Ranked Dig List			
Reacquisition Results			
Intrusive Investigation Results			
Anomaly Resolution Results			
Digital Geophysical Mapping (DGM) Data Deliverable			
DGM QC Deliverable			
Supporting Classification Images			

Appendix F: Factors Affecting Measurement Uncertainty

[Note: This appendix provides guidance for implementing ISO/IEC 17025, Section 5.4.6.2. It discusses examples of factors affecting measurement uncertainty, but it is not an exhaustive list.]

The primary decision in Advanced Geophysical Classification is the decision to dig, or not dig, a detected item. Because of this, the uncertainties of most concern are uncertainties in the estimated polarizabilities for the unknown item which are the basis for the decision. Of lesser concern are uncertainties in positioning which impact the time required for excavation and the likelihood of recovering the correct item.

Recovered Polarizabilities: Analyses starting with a high signal-to-noise measurement routinely yield precise polarizabilities. As the signal-to-noise ratio degrades, the uncertainties in the recovered polarizabilities increase until the results are too poor to use as inputs to classification. In this limit, the item is marked for excavation. The two contributors to low signal-to-noise ratio are incorrect background subtraction and weak or contaminated signal from the unknown item, as discussed below.

Background Uncertainties: For large targets with high amplitude signals, minor variations in background are negligible. For the smallest targets of interest at their deepest depths of concern however, signal amplitudes are low and minor variations in background result in large variation in the input to the geophysical inversion routine that is used to estimate polarizabilities. Common causes of background variation in decreasing importance include:

- short spatial scale variability in the soil response such that a nearby background measurement is not representative of the soil response at the site of the unknown measurement
- the presence of small pieces of metal at the site of the background measurement resulting in a background that is the sum of the soil response and the signal from the metal contamination
- rapid change in soil conductivity due to moisture changes associated with dew burn off or a passing rainstorm
- long spatial scale variability in soil response making a background collected on one side of the field unsuitable for use correcting an unknown measurement on the other side of the field.

Weak or Contaminated Signal: Selecting anomalies too deeply into the noise in an attempt to stretch the detection depth of the instruments can lead to measured data with insufficient amplitude for analysis. Even for stronger signals, external noise sources such as nearby radars and transmission towers, high-power overhead transmission lines, and even faulty electric fences can add noise to the measurement and compromise the SNR. Even those sources in very different frequency bands (radar and radio) can leak sufficient energy into the measurement band to impact the SNR.

The best diagnosis of uncertainty in recovered polarizabilities is to compare the results for the QC and validation seeds. If a large number of the seeds are identical items (Industry Standard Objects for example) the measured variation in the recovered polarizabilities will be a direct measure of the uncertainties in polarizabilities.

Location Uncertainties: In areas with good sky view cm-level GPS can be used for sensor geolocation. This, coupled with an affordable orientation measurement, results in a location estimate uncertainty that is negligible for the purposes of classification. There is a continuing check of this result from comparison of the derived position of the blind seeds against their known emplaced positions.

For other positioning systems such as robotic total stations or fiducial methods that must be employed in GPS-compromised environments, the location uncertainties can be large (decimeters to meters) which can impact the ability of the intrusive team to efficiently return to the intended excavation target and even to the recovery of incorrect items. These uncertainties will have to be evaluated on a case-by-case basis depending on the particular conditions encountered at the site.