Standard Operating Procedure
DAGCAP-3

Advanced Geophysical Classification Validation of Sensor Capability at Aberdeen Proving Ground Demonstration Site

Version 1
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DoD Environmental Data Quality Workgroup

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1 Introduction

The US Department of Defense (DoD) developed advanced geophysical classification (AGC) to improve the efficiency of cleaning up munitions and to focus its resources on addressing the potential explosives safety risks at munitions response sites (MRSs). To ensure quality data, the Office of the Deputy Assistant Secretary of Defense for Environment, Safety and Occupational Health created the DoD Advanced Geophysical Classification Accreditation Program (DAGCAP) to accredit organizations that use AGC at MRSs. A critical part of this accreditation program is the requirement to have a reliable, repeatable sensor with which to perform geophysical classification. The purpose of this standard operating procedure (SOP) is to specify the methods and procedures to be employed when a hardware vendor, or demonstrator, uses the Aberdeen Proving Ground (APG) unexploded ordnance (UXO) test site for its Validation of Sensor Capability (VoSC) in conjunction with the DAGCAP.

2 Personnel, Equipment, and Materials

This section describes the personnel, equipment, and materials required to implement this SOP.

2.1 Personnel and Qualification

The hardware vendor must determine what personnel are required for the hardware validation. The following personnel are typically required for the full sensor VoSC:

- Project Geophysicist
- QC Geophysicist
- Field Technicians/Engineers
- Data Processor

Personnel involved in the VoSC should be competent in the tasks they will perform, and it is recommended that they meet the personnel qualifications as described in the DoD Quality System Requirements (QSR) v3.0.

The following additional personnel will be required for the Full VoSC:

- APG site personnel required for safety and security
- Any other personnel (e.g., DoD oversight personnel) as designated by the DAGCAP Program Manager

2.2 Equipment and Materials

The following is a list of required equipment and materials to be provided by the demonstrator

- Advanced electromagnetic induction sensor (one-pass AGC and/or dynamic detection followed by cued AGC) and all associated equipment and materials listed in each vendor's respective SOP and user's manual
- Reference file for sensor function test

- SOPs for all operations to be performed as part of the VoSC, including the sensor operating manual(s) and an abbreviated QAPP (*i.e.,* worksheet #22)
- Validated software package for data analysis and reporting. Prior to mobilization to the APG site, the demonstrator should consult with the DAGCAP Program Manager to determine whether data analysis software planned for use at the VoSC is considered validated by the DoD. In many scenarios, the VoSC may be performed in tandem with validation of new software
- If requested, the demonstrator shall provide DAGCAP access to the above-mentioned software package during the VoSC and for a limited time afterwards

3 Hardware Validation Procedures

3.1 Prior to Arrival at the Site

3.1.1 Communication with DAGCAP

When a hardware vendor is ready for the VoSC, the demonstrator will contact the DAGCAP Program Manager to schedule a demonstration slot.

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At the time of this communication, the demonstrator will confirm they have the most recent DoD TOI Library in their possession. If a more recent version is available, the DAGCAP Program Manager will provide it in the HDF5 V1 or later format. If the DoD TOI Library is not compatible with the sensor configuration, the demonstrator will submit a plan to develop the sensor specific library.

The DAGCAP Program Manager will coordinate with the staff at Aberdeen Test Center (ATC) to schedule a time slot for the VoSC. For adequate flexibility to react to potential adverse weather, each hardware demonstrator will request a primary week, and secondary, back-up week at the APG site.

Once a demonstration is scheduled, the demonstrator will receive a package of information from the ATC staff covering site access requirements, hours of operation, safety requirements, etc. This information is attached as Appendix A to this document, but the demonstrator should examine the package from ATC carefully in the event of any changes. Also included in the package from ATC will be the conceptual site model (CSM) for the site which is attached as Appendix B and data sheets for the three GPS monuments which are attached as Appendix C.

3.1.2 Sensor Documentation

DAGCAP recognizes that not all the required documentation for a typical Demonstration of Capability (DOC) pertains to newer generation sensors. Prior to coordinating a time slot for the VoSC, the following documents must be submitted to the DAGCAP Program Manager:

- Revised Measurement Quality Objective (MQO) tables (from the Munitions Response – Quality Assurance Project Plan Toolkit: Module 2)
- Instrument Operating Manual, which shall include reliable depths of detection and classification

munitions contained in the DoD TOI Library
- Performance objectives (*e.g.,* SOP-1 requires 60% elimination of clutter, what does the new sensor propose to demonstrate?)
- Plan to develop sensor specific DoD TOI Library (if necessary)
- Raw HDF5 v1 or later files and processed test stand data and instrument verification strip or blind test plot data demonstrating classification objectives.

The hardware vendor shall also provide the SOP for the manufacture, quality control testing, and shipment of the sensor.

3.2 At the Site

3.2.1 Onsite Preparation

Upon arrival at the site, demonstrator personnel will participate in any required safety and operational briefings and be given an introductory tour of the demonstration site and office building.

At this time, ATC staff will provide details of the demonstration area. Sensors performing in only dynamic mode will be provided a 1.0-acre area and sensors performing in dynamic and cued modes will be provided a 0.5-acre area. In addition, a CD will be provided containing the IVS configuration and a CSV template that the demonstrator shall use to construct their table of detected locations. The QC geophysicist will also be provided the location, depth, orientation, and item description of the 2 QC seeds within the demonstration area. ATC personnel will mark the corners of the demonstration area with pin flags and provide corner coordinates (UTM Zone 18N, meters).

3.2.2 Validation of Sensor Capability

The demonstration is designed to require approximately one week on site. The demonstrator shall conduct all survey and analysis operations on site, in accordance with their approved SOPs. All operations will be monitored by the DAGCAP Program Manager, or his designee, to ensure that the SOPs are being followed and validated survey and analysis procedures are being employed. To ensure compliance with this provision, data transfer from the sensor to the analyst will only be permitted using a removable drive controlled by the DoD and all analysis computers will remain under control of the DoD until the VoSC is complete. At the end of the demonstration, all data generated by the demonstrator will be retained by the APG staff with no data to remain on the demonstrator's computers.

The QC geophysicist will monitor the detection and correct classification of the QC seeds, which will be placed by the government. The government will provide no feedback (for example, no training data will be provided) during the VoSC. If the QC seeds are not included with a Dig Decision of 1, they will be counted as false negatives during scoring (see Section 4.1 – Scoring).

The demonstrator may employ plastic pin flags to mark locations on the demonstration site, but no intrusive activities are allowed. The use of yellow pin flags is prohibited.

The demonstrator will notify ATC staff as soon as possible if the VoSC will extend beyond one week (5 working days) so that arrangements can be made for site access and appropriate resources.

4 Scoring of the Demonstration Results

4.1 Demonstrator Report for Scoring

At the conclusion of data analysis, the demonstrator shall submit a table of detected locations in order to accomplish the remedial objectives as outlined in the CSM. The table will be submitted on CD media generated, if necessary, from a CD burner provided by APG staff. The demonstrator shall construct the table of detected locations using the CSV template on the CD that the ATC staff provided upon arrival at the test site. The table shall be formatted as follows:

1. The first four header rows should include the demonstrator's name, demonstrator POC, and DoD Technical and Process Observers.
2. Each row in the table corresponds to one detected location.
3. The rows will be ordered according to priority (the first location is the location most likely to contain TOI).
4. The first column contains a Rank Number (beginning with 1 and ascending down).
5. The second and third columns hold easting and northing coordinates, respectively (UTM Zone 18N, meters).
6. The fourth column contains the Dig/Cue Decision (1 = dig/cue, 0 = do not dig/cue) for that location. All rows with 1s should be above all rows with 0s.
7. Columns five and beyond can contain any optional information the demonstrator wishes to include (depth, munition type, etc.). The contents of these columns do not affect the scoring.
8. The table must be in CSV format.

4.2 Scoring

The list submitted by the demonstrator will be compared to site ground truth and three values calculated: 1) the number of detected locations marked to be dug that were truly TOI (True Positives, TP), 2) the number of detected locations marked to be dug that were not truly TOI (False Positives, FP), and 3) the number of TOI that were not marked to be dug (False Negatives, FN). A successful demonstration of capabilities will require that all TOI are marked for digging (FN = 0) and that the total FPs are less than or equal to 40% (or otherwise agreed upon percentage from Section 3.1.2) of the emplaced clutter (rounded down to the nearest integer).

The following rules will be used to calculate the three values listed above.

1. For each location on the list with a "1" in the dig decision column:
    a. The scoring software will draw a 0.25-m radius circular halo around the location from the list.
    b. If there are 0 TOIs in or on the halo, then the scoring software will count the location as 1 FP (regardless of how many clutter items are in or on the halo).
    c. If there is 1 TOI in or on the halo *and*
        i. The TOI is outside the 1.0/0.5-acre test area, then the scoring software will ignore this location (the location will not be counted at all)
        ii. The TOI is inside the 1.0/0.5m-acre test area *and*
            A. If this TOI has already been found in or on another location's halo further up the list (i.e., another location considered more likely to be TOI), then the scoring software will count this location as 1 FP.
            B. If this TOI has *not* already been found in or on another location's halo further up the list (i.e., another location considered more likely to be TOI), then the scoring software will count this location as 1 TP.
2. The scoring software will count each "leftover" TOI as 1 FN. A "leftover" TOI is a TOI in the 1.0/0.5- acre test area that was *not* in or on any location's halo with a 1 in the Decision column.

4.3 Reporting

At the conclusion of scoring, APG personnel will report the VoSC results (i.e., pass/fail) to the DAGCAP Program Manager. APG staff will provide two copies of the report (one for the demonstrator and the other for the DoD to retain for their records), which in addition to a pass/fail conclusion will provide a basis for failure. The DAGCAP Program Manager will report to the demonstrator whether the DOC was successful or not as part of its demonstration outbrief.

4.4 Failure of APG Demo

The basis for failure in the report from APG staff will be expressed as, "too many false positives (FPs)" and/or "one or more false negatives (FNs)." A Failure due to FNs will be further explained as "one or more false negatives (FNs) caused by a failure to detect"; or "one or more false negatives (FNs) caused by misclassification"; or "one or more false negatives (FNs) caused by failure to detect and misclassification". Scoring results will be considered final when reported at the outbrief – no rework of data or reporting will be entertained. If the demonstrator wishes to pursue a follow-up opportunity for a demonstration at APG, they will coordinate with the DAGCAP Program Manager on the Root Cause Analysis (RCA) and Corrective Action for the failure and request a follow-up demonstration as described above. The follow-up demonstration will not be scheduled or permitted until DAGCAP has approved all RCAs and CAs regarding the VoSC non-conformance. In the event the RCA determines that a failure is due to data analysis and not the sensor's capabilities, the Corrective Action Plan may outline an option for validating the hardware without returning to APG.

5.0 Maintaining Hardware Validation

To maintain hardware validation, the hardware shall maintain a log of known hardware and data acquisition

(DAQ) software bugs and unexpected behaviors. This log shall be attached to the operating manual. The vendor shall provide the updated list to the DAGCAP Program Manager whenever it is updated or annually, at a minimum. The list shall also include the severity, fix (if available), and the hardware/data acquisition software configuration it applies to.

When changes are made to hardware or DAQ, the developer shall submit a memo to the DAGCAP Program Manager describing the below items, at a minimum.

- Updated change log documenting what changes were made to the hardware and/or DAQ software since the initial hardware validation
- New version number of the DAQ software, if applicable.
- Internal verification and validation results for the hardware/software changes.
- Raw HDF5 v1.0 or later files and processed data for any tests that were performed to verify and validate the hardware and/or software changes that demonstrate the sensor has the same detection and classification capabilities as the prior version of the hardware/DAQ software.
- Updated user's manual.

The DAGCAP Program Manager will review and assess the document submittal. Once assessed, the EDQW AGC subgroup will communicate the outcome of the validation evaluation. Potential outcomes include, but are not limited to:

- The updated hardware/DAQ software version is validated.
- Additional information is required.
- A new validation of the sensor is required.

Upon validation, the DAGCAP Program Manager will update the DENIX DAGCAP webpage to list the newly validated software version.

Acronyms

APG	Aberdeen Proving Ground, MD
ATC	Aberdeen Test Center
CSM	conceptual site model
DAGCAP	DoD Advanced Geophysical Classification Accreditation Program
DOC	demonstration of capability
DoD	Department of Defense
EDQW	DoD Environmental Data Quality Workgroup
FN	false negative
FP	false positive
GCO	geophysical classification organization
QC	quality control
QSR	Quality System Requirement
SOP	standard operating procedure
TOI	target of interest. Items including munitions, QC seeds, validation seeds, etc. that must be removed from the site to accomplish the remedial objective.
TP	true positive
UXO	unexploded ordnance
VoSC	Validation of Sensor Capability

Appendix A.

A1. Site Access

A1.1 Hours of Operation

The US Army Aberdeen Test Center (ATC) operates under a condensed work schedule resulting in a regular day off (RDO) every other Friday. The hours of operation for Monday through Thursday are 0700 to 1630. For the working Fridays, the hours of operation are 0700 to 1530.

In addition, ATC observes the following federal holidays:

1. New Year's Day
2. Birthday of Martin Luther King, Jr.
3. Washington's Birthday
4. Memorial Day
5. Independence Day
6. Labor Day
7. Columbus Day
8. Veterans Day
9. Thanksgiving Day
10. Christmas Day

Lastly, at the discretion of the commander, ATC may be under a reduced operations or mandatory safety stand downs. As a result, early coordination with ATC personnel is recommended.

A1.2 Security Considerations

The UXO test site is located within a restricted area on Aberdeen Proving Ground, MD. As a result, all personnel desiring access must submit a visit request. In addition, additional coordination may be required for any Foreign Nationals who wish to gain access to the test site. Below is a link with additional information.

http://www.atc.army.mil/visitorGuide/visitor_badge.html

No photos may be taken by anyone other than APG staff. APG staff can be requested to take photos necessary for the demonstration (e.g. sensor assembly photo as may be required in a GCO SOP) and provide to the GCO team.

A2. Safety Considerations

ATC has conducted a Job Hazard Analysis (JHA) for the UXO Site. Upon arrival, all GCO personnel must read the JHA and agree to follow the corrective measures to mitigate the risk of injury. An example of a corrective measure is wearing appropriate safety shoes. In addition, the UXO Site has an Emergency Action Plan that will be followed in case of emergency.

Appendix B. Abbreviated Conceptual Site Model

The demonstration of capability (DOC) site at Aberdeen Proving Ground is comprised of two subareas as shown in the image below.

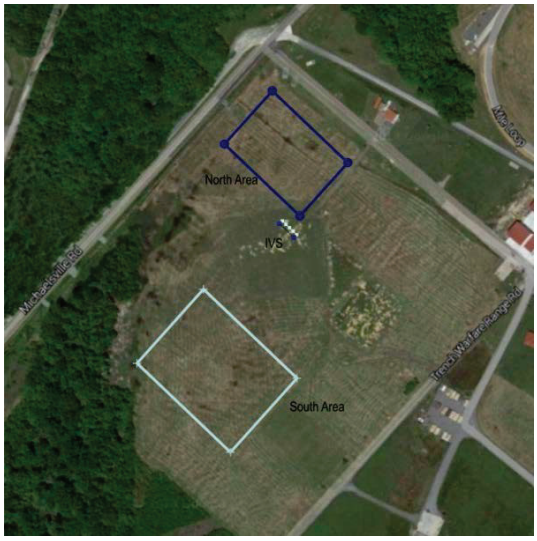

Figure B-1 - Aerial photo of the demonstration of capabilities site showing the two subareas and the location of the IVS

The area containing the DOC site has been used for training and testing for many years. There have been numerous, overlapping ranges at various times at this site. Based on historical records and the Remedial Investigation, at a minimum, the following munitions are expected to be found on the site, although this list may not be comprehensive. Both subareas are expected to have similar munitions.

Munitions Expected on the Site	
Name	Mark/Mod
37mm	M74 HETP
37mm	M74 AT,TP
37mm	M55A1
37mm	M59
37mm	M80A1
60mm	M49A4
81mm	M82
105mm	M1
105mm	M84

The site has been surfaced cleared allowing non-intrusive work to be performed without a UXO escort. There is a small building (shown in the upper right of the image above) set up for storage of equipment, battery charging, and data analysis.

An instrument verification strip (IVS) has been established on the site containing a 37-mm projectile and two small ISO80s. Location and depths of the IVS items will be provided to GCO analysts on site. Small ISO80s have been emplaced as QC seeds. The positions and depths of these QC seeds will be provided to the team QC Geophysicist. Additional validation seeds have been emplaced on the site. The details of these items will remain blind to the GCO.

The remedial objective for 37-mm projectiles is removal to 30 cm below ground level. Any munition detected using a threshold designed to accomplish this objective must also be marked for removal. For the purposes of the DOC, the smallest munition of concern is a 37-mm projectile. At this site, fuzes are not considered TOI.

Appendix C. Data Sheets

Survey Control Card

MONUMENT NUMBER: 477
MONUMENT NAME: 477
STATE: MARYLAND
AREA: ABERDEEN
APG GRID:

HORIZONTAL ORDER: FIRST
VERTICAL ORDER: +/- 6cm

Horizontal information: Method Established: GPS NETWORK

UTM DATUM: NAD83
UTM UNITS: METERS
UTM ZONE: 18 NORTH

STATE PLANE DATUM: NAD83
STATE PLANE UNITS: US SURVEY FEET
STATE PLANE ZONE: MARYLAND 1900

GEOGRAPHIC DATUM: NAD83

UTM NORTHING: 4369749.013
UTM EASTING: 402810.038

STATE PLANE NORTHING: 658613.109
STATE PLANE EASTING: 1557961.953

LATITUDE: 39 28 18.63880
LONGITUDE: 76 07 47.71815

Vertical Information: Method Established: GPS OBSERVATION

METHOD ESTABLISHED (ELLIPSOID HT):

VERTICAL DATUM: NAVD88
VERTICAL UNITS: METERS
ELEVATION: 10.669

ELLIPSOIDAL HT UNITS:
ELLIPSOIDAL HT:

Local Coordinate Systems:

B1 DU UNITS:
B1 DU NORTHING:
B1 DU EASTING:

B1 NONDU UNITS:
B1 NONDU NORTHING:
B1 NONDU EASTING:

B2 POPUP UNITS:
B2 POPUP NORTHING:
B2 POPUP EASTING:

TW2 UNITS:
TW2 NORTHING:
TW2 EASTING:

IMAGE:

Survey Control Card

MONUMENT NUMBER: 478
MONUMENT NAME: 478
STATE: MARYLAND
AREA: ABERDEEN
APG GRID:

HORIZONTAL ORDER: FIRST
VERTICAL ORDER: +/- 6cm

Horizontal information: Method Established: GPS NETWORK

UTM DATUM: NAD83
UTM UNITS: METERS
UTM ZONE: 18 NORTH

STATE PLANE DATUM: NAD83
STATE PLANE UNITS: US SURVEY FEET
STATE PLANE ZONE: MARYLAND 1900

GEOGRAPHIC DATUM: NAD83

UTM NORTHING: 4369305.416
UTM EASTING: 402785.686

STATE PLANE NORTHING: 657155.914
STATE PLANE EASTING: 1557914.178

LATITUDE: 39 28 04.24219
LONGITUDE: 76 07 48.50439

Vertical Information: Method Established: GPS OBSERVATION

METHOD ESTABLISHED (ELLIPSOID HT):

VERTICAL DATUM: NAVD88
VERTICAL UNITS: METERS
ELEVATION: 11.747

ELLIPSOIDAL HT UNITS:
ELLIPSOIDAL HT:

Local Coordinate Systems:

B1 DU UNITS:
B1 DU NORTHING:
B1 DU EASTING:

B1 NONDU UNITS:
B1 NONDU NORTHING:
B1 NONDU EASTING:

B2 POPUP UNITS:
B2 POPUP NORTHING:
B2 POPUP EASTING:

TW2 UNITS:
TW2 NORTHING:
TW2 EASTING:

IMAGE:

Survey Control Card

MONUMENT NUMBER: 515
MONUMENT NAME: TRAV PT #6 TW MILE LOOP
STATE: MARYLAND
AREA: ABERDEEN
APG GRID: 12-5

HORIZONTAL ORDER: FIRST
VERTICAL ORDER: FIRST, CLASS I

Horizontal information: Method Established: GPS NETWORK

UTM DATUM:	WGS84	STATE PLANE DATUM:	NAD83	GEOGRAPHIC DATUM:	WGS84
UTM UNITS:	METERS	STATE PLANE UNITS:	METERS		
UTM ZONE:	18 NORTH	STATE PLANE ZONE:	MARYLAND 1900		
UTM NORTHING:	4369642.555	STATE PLANE NORTHING:	200643.761	LATITUDE:	39 28 15.26982
UTM EASTING:	403015.999	STATE PLANE EASTING:	475076.073	LONGITUDE:	76 07 39.04383

Vertical Information: Method Established: ELECTRONIC LEVELING
METHOD (ELLIPSOID HT): GEOID 03 (CONUS)

VERTICAL DATUM: NAVD88
VERTICAL UNITS: METERS
ELEVATION: 11.555
ELLIPSOIDAL HT UNITS: METERS
ELLIPSOIDAL HT: -21.652

Local Coordinate Systems:

B1 DU UNITS:	B1 NONDU UNITS	TW2 UNITS:
B1 DU NORTHING:	B1 NONDU NORTHING:	TW2 NORTHING:
B1 DU EASTING:	B1 NONDU EASTING:	TW2 EASTING:
B3 DU UNITS:	B3 NONDU UNIT	
B3 DU NORTHING:	B3 NONDU NORTHING	
B3 DU EASTING:	B3 NONDU EASTING: