Standard Operating Procedure
DAGCAP-4

Advanced Geophysical Classification Validation of Software Capability

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 data analysis, quality control, and interpretation of AGC data to make informed decisions. The purpose of this standard operating procedure (SOP) is to specify the methods and   procedures to be employed when software used in the AGC process is developed and/or updated.

In accordance with section 7.11.2 of the DoD Quality Systems Requirements for AGC (DoD QSR) version 3.0, all AGC software used must be validated by DoD. The EDQW defines validated AGC software as a uniquely identified and controlled version of software that was either used successfully on a previous ESTCP demonstration, or one that is shown to produce equivalent or better results.

2 Procedures

2.1 General

Validation of Software (VoS) is required for all newly developed AGC software and when any changes are made to validated software. Upon initial VoS or the publication of this SOP, whichever occurs last, software developers shall submit an SOP containing their procedures to internally verify and validate their AGC software. These SOPs will be provided to the DAGCAP Program Manager for review and approval and whenever requested by the EDQW AGC Sub-Group. The SOP shall comply with the below sections of ISO 17025:2017 and the DoD QSR version 3.0.

- 7.2.1.6 and 7.2.1.7

- 7.2.2.1 through 7.2.2.4

Software developers will also develop and submit to the DAGCAP Program Manager a programming change log that documents changes made to each version of their software. To be validated, software must also have an audit trail feature that is not editable in order to recreate historical processing steps. Software developers will also develop and submit to the DAGCAP Program Manager a user's manual that will document default input parameters and guidance on when to change them, how changing them impacts the results, and documents limitations of the software (*e.g.,* should not be used on sites with high geologic noise).

When new AGC software is developed or when the developer has modified their validated software, they will contact the DAGCAP Program Manager to coordinate the appropriate VoS per this SOP.

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2.2 Full VoS

A Full VoS is required for the initial VoS for newly developed AGC software and when changes are made to the AGC programming code in validated software that includes dynamic data processing, dynamic target selection,

dynamic or cued inversion, and the validated AGC method (*e.g.,* library matching method). In addition, DAGCAP may request a Full VoS if a significant number of modifications and/or are made to other areas of the code that DAGCAP determines may impact how users use and/or the quality of the AGC process. All software operating manuals must document limitations in the software. These limitations may include, but are not limited to: Specific munitions, site conditions, munitions depths, etc.

The software vendor should perform analysis on a publicly available dataset collected at ATC that is available from the EDQW AGC sub-group or using synthetic datasets. The vendor will process data, create a ranked dig list, score their ranked dig list, and submit the required documentation to the DAGCAP Program Manager.

2.2.1 Full VoS Documentation

The following documentation is required for full VoS:

- Version number of the software

- A list of AGC sensors and methods (*e.g.,* dynamic detection, dynamic one-pass AGC, and cued AGC) for which the software is being submitted for validation

- Updated programming change log detailing all changes made to the software since a previous validation

- Internal verification and validation results for the software changes

- Software user's manual or training materials, as necessary. The software user's manual and/or training materials will include data use limitations (if any). Data limitations include, but are not limited to, small number of TOI/total anomalies, limited depth of TOI, incomplete ground truth information, and any file types (i.e., DQC, SFT, etc.) not able to be tested.

- Raw HDF5 v1.0 or later files containing the IVS, QC, and production area data,

- Processed AGC data

- Ranked dig list,

- Ground truth,

- Receiver operator characteristics (ROC) Curve, and

- Scoring report.

2.2.2 Full VoS Scoring Procedures

The ranked dig list the vendor uses to score themselves will be compared to site ground truth and three values calculated: 1) the number of detected locations marked to be dug that are TOI (True Positives, TP), 2) the number of detected locations marked to be dug that are not TOI (False Positives, FP), and 3) the number of TOI that are not marked to be dug (False Negatives, FN).

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 (*i.e.,* they are to be dug):
    a. Draw a circular halo around the location from the list with the correct radius for the type of data given
        i. **0.4 m radius for dynamic-mode detection lists**
        ii. **0.25 m radius for ranked anomaly lists based on dynamic- or cued-mode AGC data**
    b. If there are zero (0) TOIs from the ground truth in or on the halo, then count the location as 1 FP (regardless of how many clutter items are in or on the halo).

c. If there is one (1) TOI from the ground truth in or on the halo <u>and the</u> TOI is outside the 0.5-acre test area, then ignore this location (the location will not be counted at all).

d. If there is one (1) TOI from the ground truth in or on the halo <u>and the</u> TOI is inside the 0.5m-acre test area and

   i. 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 count this location as one (1) FP.

   ii. 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 count this location as one (1) TP.

2. Count each remaining or "leftover" TOI from the ground truth as one (1) FN. A "leftover" TOI is a TOI in the 0.5- acre test area that was not in or on any location's halo with a one (1) in the Dig Decision column

2.2.3 Full VoS Scoring Report

Below are the guidelines for the scoring and report generation.

1) The scoring will follow the procedures laid out in **Section 2.2.2**.

2) The scoring report shall include the following documentation pieces:

   a. A determination of pass or fail

      i. For detection lists, a pass indicates that all TOI were detected

      ii. For ranked anomaly lists, a pass indicates that all TOI were detected, and the total number of FPs is less than or equal to 40% of the emplaced clutter.

   b. When the test is failed, a reason for the failure, either:

      i. One or more FNs due to a failure to detect

      ii. One or more FNs caused by misclassification

      iii. Too many FPs

      iv. A combination of a and c or b and c as appropriate.

   c. A summary table of performance including the counts of TOI, Clutter, Maximum Number of Allowed FNs (0), Maximum Number of Allowed FPs, as well as calculated number of TPs, FPs, and FNs.

   d. A table of all submitted detections with the following pieces of information

      i. Detection coordinates

      ii. Detection decision (dig or no dig)

      iii. A list of any TOI or clutter objects within the appropriate halo detection radius

      iv. Library match information (library match confidence score, what library object the detection matched to, any other information used to support the decision)

      v. For any FP dig decisions and any FN no dig decisions, a brief explanation for the likely cause of the misclassification

   e. A table of all FN TOI with the following pieces of information

      i. TOI coordinates

      ii. TOI ID and caliber description

      iii. A list of any nearby no dig decisions

      iv. An explanation for the likely cause for the missed detection or misclassification

f. A Receiver Operating Characteristic (ROC) Curve, showing the probability of detection and classification as a function of the probability of false alarms

g. Site data and metadata that includes location of test plot, origin of data, ground truth of all seeds and known intrusive data, geodetic files and control points, and photos (if available).

The EDQW AGC Subgroup will review and assess the Full VoS submittal and scoring results. Once assessed, the EDQW AGC subgroup will communicate the outcome of the validation evaluation to include whether the software is now considered validated. Upon validation, the DAGCAP Program Manager will update the DENIX DAGCAP webpage to list the newly validated software version.

2.3 Partial VoS

A Partial VoS is required for all modifications to software that are not related to AGC decision making (*e.g.,* minor bug fixes, graphical user interface updates, etc.). When a partial VoS is performed, the developer shall submit a memo to the DAGCAP Program Manager describing the below items, at a minimum.

- New version number of the software.

- Justification for not performing the Full VoS.

- A clear and specific scope of what is being requested to be validated.

- Data use limitations (if any) are documented. Data limitations include, but are not limited to, small number of TOI/total anomalies, limited depth of TOI, incomplete ground truth information, and any file types (*i.e.,* DQC, SFT, etc.) not able to be tested.

- A list of AGC sensors and methods (*e.g.,* dynamic detection, dynamic one-pass AGC, and cued AGC) for which the software is being submitted for validation.

In addition, the below documentation shall be submitted to the DAGCAP Program Manager as an attachment to the memo for review and approval.

- Updated programming change log detailing all changes made to the software since its initial validation.

- Internal verification and validation results for the software changes.

- Raw HDF5 v1.0 or later files and processed data for any tests that were performed to verify and validate updated software when these changes do not require a Full VoS.

- Updated software user's manual or training materials, as necessary.

The DAGCAP Program Manager will review and assess the Partial VoS 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 software version is validated.

- Additional information is required.

- A Full VoS is required.

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

3.0 Maintaining Software Validation

To maintain validation, software vendors shall maintain a log of known software bugs and unexpected

behaviors that are attached to the user's manual. The vendor shall provide the updated list to the DAGCAP Program Manager whenever the software is updated, when new bugs/unexpected behaviors are identified, or annually, at a minimum. The list shall also include the severity, fix (if available), and the sensors/ software version that it applies to.

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   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

VoS   Validation of Software