DoD QSR 3.0 One-Pass AGC Equipment Inspection, Maintenance, and Quality Control

The below tables document minimum procedures and acceptance criteria for performing testing, inspections and quality control for one-pass AGC. Where appropriate, the failure response column prescribes a corrective action (CA); otherwise a root cause analysis (RCA) shall be conducted to determine the appropriate CA. For the purpose of accreditation, the organization shall demonstrate the ability to comply with all minimum specifications.

Table 1-1: **One-Pass AGC**

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
1	Verify correct assembly		Once following assembly	Field Team Leader/ instrument assembly checklist/ Project Geophysicist	As specified in SOP, Assembly checklist	RCA/CA
2	Geodetic Equipment Function Test		Daily for RTK GPS	Operator/QC Database/QC Geophysicist	Confirm base station alignment with control point +/- 10 cm	RCA/CA
3	Initial sensor function test		Once following assembly	Field Team Leader/ instrument assembly checklist/ Project Geophysicist	For all channels tested, the response (mean static spike minus mean static background) is within 20% of reference response.	RCA/CA
4	Initial derived polarizabilities accuracy (IVS)		Once during initial system IVS test	Project Geophysicist/ IVS Technical Memorandum/ QC Geophysicist	Library match metric ≥ 0.9 for each set of inverted polarizabilities	RCA/CA

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
5	Initial derived target position accuracy (IVS)		Once during initial system IVS test	Project Geophysicist/IVS Technical Memorandum/QC Geophysicist	All IVS item fit locations within 0.25m of ground truth locations	RCA/CA
6	Ongoing derived polarizabilities accuracy (IVS)		Beginning and end of each day as part of IVS testing	Project Geophysicist/ QC Database/QC Geophysicist	Library match metric of 0.9 or higher for each set of inverted polarizabilities	RCA/CA
7	Ongoing derived target position accuracy (IVS)		Beginning and end of each day as part of lVS testing	Project Geophysicist/ QC Database/ QC Geophysicist	All IVS items fit locations within 0.25m of ground truth locations	RCA/CA
8	Ongoing instrument function test		Beginning and end of each day as part of IVS testing	Field Team Leader/ QC Database/ Project Geophysicist	For all channels tested, the response (mean static spike minus mean static background) is within 20% of reference response.	RCA/CA
9	Battery Voltage/ Transmit current levels		Evaluated for each file	Field Team Leader/Field Logs/ Project Geophysicist	**APEX**: Battery voltage maintained above 12.5V **TEMSense**: Current ≥ 5.5A **UltraTEM Classifier**: Current ≥ 15A	RCA/CA
10	Valid orientation data		Evaluated for each sensor measurement	Field Team Leader/ QC Database/ Project Geophysicist	Orientation data reviewed and appear reasonable within bounds appropriate to site (e.g., roll and pitch <15 degrees absolute value)	RCA/CA

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
11	Dynamic Noise Assessment		Verified for each selected background window	GDA/QC Database/Project or QC Geophysicist	All receiver channels exceeding pre-defined dynamic noise threshold for (Define time gate: e.g., APEX = 3.43 ms) time gate are flagged for review	RCA/CA; (SOP must address process for flagging and recollecting data as necessary)
12	Valid position data		Per measurement	GDA/QC Database/QC Geophysicist	GPS status flag indicates RTK fix quality 4. RTS passes Geodetic Function Test.	RCA/CA
13	In-Line Measurement Spacing		Verified for each transect, based upon sensor head center positions.	Geophysical Data Analyst (GDA)/QC Database/QC Geophysicist	100% ≤ 0.2m between successive measurements (excluding background areas of the transect) with mean ≤ 0.1m	RCA/CA
14	Dynamic One-Pass Coverage		All transects	GDA/QC report/QC Geophysicist	Instrument Specific cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain, etc.) **APEX (Standard and Light/Ultralight):** 100% at ≤ 0.8m **APEX Array (3 sensors):** 100% at ≤ 2.25m **APEX Mini:** 100% at ≤ 0.4m **TEMSense:** 100% at ≤ 0.7m **UltraTEM Classifier Towed Array:** 100% at ≤2.25m **UltraTEM Person Portable Classifier:** 100% at ≤1.65m	RCA/CA

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
					UltraTEM XC: 100% at ≤0.8m Transects: 100% of planned transect paths within receiver swath.	
15	Size and decay rate threshold verification (when ISS is used)		Collect cued data or intrusively investigate an additional 200 anomalies excluded on the basis of ISS	Project Geophysicist/QC report/QC Geophysicist	Cued data analysis or intrusive results confirm all 200 anomalies are non-TOI	RCA/CA
16	Confirm adequate spacing between units		Evaluated at start of each day (or grid)	Field Team Leader/ Field Logbook/ Project Geophysicist	Minimum separation of 50m	CA: Recollect all coincident measurements
17	Confirm inversion model supports classification (1 of 3)		Evaluated for all models derived from a measurement and used to make TOI/non-TOI decisions (i.e. single item and multi-item models)	Project Geophysicist/ Measurement QC summary/ QC Geophysicist	Derived model response shall fit the observed data with a fit coherence ≥0.8*	Follow procedure in SOP or RCA/CA

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
18	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
19	Confirm inversion model supports classification (3 of 3)		Evaluated for all seeds	QC Geophysicist/ Seed Tracking Log/ Lead agency QA Geophysicist	100% of predicted seed (QC and validation) positions ≤ 0.25m radially from known position (x,y). Z ≤ 0.15m	RCA/CA
20	Classification performance		Evaluated for all seeds	QC Geophysicist; USACE QA Geophysicist/ Ranked dig list/ USACE QA Geophysicist	100% of QC and validation seeds classified as TOI and the correct size is predicted	RCA/CA

Table 1-2: **Intrusive Investigation**

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
21	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 item positions (excluding inconclusive category) ≤0.25 m from predicted position (x, y); Recovered item depths are recorded within 15 cm of predicted depth	RCA/CA
22	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	AGC data analysis shows 100% of seeds & recovered items have polarizability parameters that are consistent with their actual size, shape/symmetry, and wall thickness	RCA/CA
23	Verification of TOI/non-TOI threshold		Dig 200 anomalies beyond the last recovered IOC on the Dig List per delivery unit	Project Geophysicist/ Verification and Validation Report/ QC Geophysicist	100% of predicted non-TOI intrusively investigated qualitatively matches predicted size/shape and are non-IOC	Adjust threshold
24	Classification validation		Selection of 200 non-TOI per delivery unit	Project Geophysicist/ Verification and Validation Report/ QC Geophysicist	100% of predicted non-TOI intrusively investigated qualitatively matches predicted size/shape and they are not IOC	Document in DUA

Abbreviations and acronyms:

A – ampere
BG – background
CA – corrective action
cm – centimeter
DOP – dilution of precision
DUA – data usability analysis
GPS – global positioning system
IOC – Item of Concern
ISO – industry standard object
IVS – instrument verification strip
m – meter
MR-QAPP –Munitions Response Quality Assurance Project Plan
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

DoD QSR 3.0 Two-Pass AGC Equipment Inspection, Maintenance, and Quality Control[1]

The below tables document minimum procedures and acceptance criteria for performing testing, inspections and quality control for two-pass AGC. Where appropriate, the failure response column prescribes a corrective action (CA); otherwise a root cause analysis (RCA) shall be conducted to determine the appropriate CA. For the purpose of accreditation, the organization shall demonstrate the ability to comply with all minimum specifications.

Table 2-1: **Dynamic Survey**

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
1	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
2	Geodetic Equipment Function Test		Daily	UXO tech or field tech/Daily QC Report/Project Geophysicist	Benchmark positions repeatable to within 10cm	RCA/CA

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
3	Initial Instrument Function Test Five measurements over a small ISO80 target, one in each quadrant of the sensor and one directly under the center of the array; Derived polarizabilities for each measurement are compared to the library		Once following assembly	Field Geophysicist/ Initial IVS Memorandum/Project Geophysicist	Library matrch metric ≥0.95 for each of the five sets of inverted polarizabilities	CA: Make necessary adjustments, and re-verify
4	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
5	Ongoing Instrument Function Test (Instrument response amplitudes)		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	For all channels tested, the response (mean static spike minus mean static background) is within 20% of reference response.	CA: Make necessary repairs and re-verify

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
6	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
7	In-line measurement spacing		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% ≤ 0.2m between successive measurements (excluding background areas of the transect) with mean ≤ 0.1m	RCA/CA CA assumption: data set fails, (re-collect portions that fail)
8	Dynamic Detection Coverage		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	Instrument Specific cross-track measurement spacing (excluding site specific access limitations, e.g., obstacles, unsafe terrain, etc.) **MetalMapper 2x2, MPV**: 100% at ≤ 0.7-m **UltraTEM Screener Person-Portable:** 100% at ≤ 1.75m (1-Tx man-portable) **UltraTEM Screener Towed Array:** 100% at ≤ 2.05	RCA/CA

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
9	Dynamic Noise Assessment		Verified for each selected background window	GDA/QC Database/Project or QC Geophysicist	All receiver channels exceeding pre-defined dynamic noise threshold for (Define time gate) time gate are flagged for review	
10	Sensor Tx current		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	**MetalMapper 2x2** current shall be ≥6A **MPV** current shall be ≥4A **TEMSense**: ≥ 5.5A **UltraTEM Screener**: Current ≥ 15A	CA: out of spec data rejected
11	Dynamic detection performance		Evaluated by survey unit	QC Geophysicist/ survey unit validation report/lead agency QA Geophysicist	All blind seeds shall be detected and positioned within 40 cm radius of ground truth	RCA/CA
12	Valid position data		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	GPS status flag indicates RTK fix quality 4. RTS passes Geodetic Function Test.	Out-of-spec data rejected
13	Valid orientation data		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	Orientation data reviewed and appear reasonable within bounds appropriate to site	Unreasonable data rejected

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by	Acceptance Criteria	Failure Response
14	Size and decay rate threshold verification (when informed source selection is used)		Collect cued data or intrusively investigate an additional 200 anomalies excluded on the basis of ISS	Project Geophysicist/QC report/QC Geophysicist	Cued data analysis or intrusive results confirm all 200 anomalies are non-TOI	RCA/CA
15	Confirm adequate spacing between units		Per measurement	Field Team Leader/ Field Logbook/Project Geophysicist	Minimum separation of 50m	CA: Recollect all coincident measurements

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

Table 2-2: **Cued Survey**

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
16	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
17	Geodetic Equipment Function Test		Daily	UXO tech or field tech/ Daily QC Report/ Project Geophysicist	Benchmark positions repeatable to within 10cm	RCA/CA
18	Initial sensor function test (1) (APEX, UltraTEM)		Once following assembly	Field Team Leader/ instrument assembly checklist/Project Geophysicist	For all channels tested, the response (mean static spike minus mean static background) is within 20% of reference response.	CA: make necessary repairs/ adjustments and re-verify

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
19	Initial sensor function test (2) Five measurements over a small ISO80 target, one in each quadrant of the sensor and one directly under the center of the array; Derived polarizabilities for each measurement are compared to the library (MetalMapper 2x2, MPV, TEMSense)		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	RCA/CA: Make necessary adjustments, and re-verify
20	Initial IVS background measurement (five background measurements, one centered at the flag and one offset at least 35 cm in each cardinal direction)		Once during initial system IVS test	Field Team Leader / Initial IVS Memorandum, Project Geophysicist	Receiving a pass from the UX-Analyze Background Validation Tool or validated equivalent	CA: reject/replace BG location
21	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

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
22	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
23	Ongoing IVS background measurements		Beginning and end of each day as part of IVS testing	Project Geophysicist/ tracking summary/ QC Geophysicist	Receiving a pass from the UX-Analyze Background Validation Tool or validated equivalent.	RCA/CA CA assumption: rejection of BG measurement (unless RCA indicates system failure)
24	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
25	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
26	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	Receiving a pass from the UX-Analyze Background Validation Tool or validated equivalent.	CA: reject BG location and find alternate

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
27	Ongoing production area background measurements		Background data collected a minimum of every two hours during production MetalMapper 2x2: minimum of every 1 hour	Field Team Leader/failures noted in field log and tracking summary/Project Geophysicist	Receiving a pass from the UX-Analyze Background Validation Tool or validated equivalent.	CA: BG measurement rejected and re-collected
28	Ongoing instrument function test		Each time instrument is restarted	Field Team Leader/ tracking summary/ Project Geophysicist	For all channels tested, the response (mean static spike minus mean static background) is within 20% of reference response.	CA: make necessary repairs and re-verify
29	Valid position data		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	GPS status flag indicates RTK fix. RTS passes Geodetic Function Test.	Out-of-spec data rejected
30	Valid orientation data		Per measurement	Field Team Leader/running QC summary/Project Geophysicist	Orientation data reviewed and appear reasonable within bounds appropriate to site (e.g., roll and pitch < 15 degrees absolute value)	Unreasonable data rejected

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
31	Battery Voltage/ Transmit current levels		Evaluated for each sensor measurement	Field Team Leader/ tracking summary/ Project Geophysicist	**APEX:** Battery voltage maintained above 12.5V **MetalMapper 2x2** current shall be ≥6A **MPV** current shall be ≥4A **TEMSense**: Current ≥ 5.5A **UltraTEM Classifier**: Current ≥ 15A	CA: stop data acquisition activities until condition corrected
38	Confirm adequate spacing between units		Evaluated at start of each day (or grid)	Field Team Leader/ Field Logbook/ Project Geophysicist	Minimum separation of 50m	CA: Recollect all coincident measurements
32	Cued Interrogation		Evaluated for all non-TOI on cued list	Project Geophysicist/ Source database/ QC Geophysicist	Offset between center of the sensor and the flag, or target, location must be 0.40 m	RCA/CA: Recollect data
33	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 shall fit the observed data with a fit coherence ≥0.8*	Follow procedure in SOP or RCA/CA
34	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

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
35	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 (QC and validation) positions ≤ 0.25m radially from known position (x,y). Z ≤ 0.15m	RCA/CA
36	Classification performance		Evaluated for all seeds	QC Geophysicist; USACE QA Geophysicist/ Ranked dig list/ USACE QA Geophysicist	100% of QC and validation classified as TOI and the correct size is predicted	RCA/CA
37	In-Line Measurement Spacing (Dynamic-Cued)		Verified for each transect, based upon sensor head center positions.	Geophysical Data Analyst (GDA)/QC Database/QC Geophysicist	100% ≤ 0.2m between successive measurements (excluding background areas of the transect) with mean ≤ 0.1m	RCA/CA
38	Dynamic-cued survey coverage (Dynamic- Cued)		All cued transects	GDA/QC report/QC Geophysicist	All flag locations are >1m from transect ends and <0.4m from center of sensor at closest point of approach	Recollect transects

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

Table 2-3: **Intrusive Investigation**

MQO #	Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified by:	Acceptance Criteria	Failure Response
39	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 item positions (excluding inconclusive category) ≤0.25 m from predicted position (x, y); Recovered item depths are recorded within 15 cm of predicted depth	RCA/CA
40	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	AGC data analysis shows 100% of seeds & recovered items have polarizability parameters that are consistent with their actual size, shape/symmetry, and wall thickness	RCA/CA
41	Verification of TOI/non-TOI threshold		Dig 200 anomalies beyond the last recovered IOC on the Dig List per delivery unit	Project Geophysicist/ Verification and Validation Report/ QC Geophysicist	100% of predicted non-TOI intrusively investigated qualitatively matches predicted size/shape and are non-IOC	Adjust threshold
42	Classification validation		Selection of 200 non-TOI per delivery unit	Project Geophysicist/ Verification and Validation Report/ QC Geophysicist	100% of predicted non-TOI intrusively investigated qualitatively matches predicted size/shape and they are not IOC	Document in DUA

Abbreviations and acronyms:

A – ampere
BG – background
CA – corrective action cm – centimeter
DOP – dilution of precision DUA – data usability analysis
GPS – global positioning system
IOC – Item of Concern
ISO – industry standard object
IVS – instrument verification strip
m – meter
MR-QAPP –Munitions Response Quality Assurance Project Plan
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