

Document Title**AUDIT QUESTIONNAIRE FOR SYSTEM AND PERFORMANCE AUDITS OF ATMOSPHERIC TRACE GAS MEASUREMENTS AT WMO/GAW SITES****Version**

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SAG Greenhouse Gases: approved

SAG Reactive Gases: approved

Scope

This document contains a questionnaire for combined system and performance audits of trace gas measurements at WMO Global Atmosphere Watch (GAW) stations. It is recommended for use during audits of measurement systems that either use a gas chromatographic method and/or continuous gas analysers. This questionnaire has been optimized for audits of CH₄, CO, and N₂O.

Definitions

According to the GAW Strategic Implementation Plan (WMO/GAW Report 142), a *performance audit* is defined as a voluntary check of conformity of a measurement where the audit criteria are the DQOs for that parameter. In the absence of formal DQOs, an audit will at least involve ensuring the traceability of measurements to the Reference Standard. A *system audit* is more generally defined as a check of the overall conformity of a station with the principles of the GAW QA system. The reference for conformity of a station will evolve as the GAW QA system evolves.

Site		Compound
Date of Audit	Auditor	

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1 GENERAL AUDIT INFORMATION

- 1.1 Date of last audit for parameter under consideration.....
- 1.2 Last audit performed by
- 1.3 Changes since last audit.....
.....
.....
- 1.4 Have the station or any of the other measurements been audited by someone else before (Y/N)?
By whom?
Date of audit

2 SITE AND LABORATORY CHARACTERISTICS

- 2.1 Site name.....
- 2.2 Subsite.....
- 2.3 WMO GAW station status: global regional other.....
- 2.4 WMO station number.....
- 2.5 Coordinates (latitude, longitude, altitude)
- 2.6 Time zone.....
- 2.7 Description of surrounding.....
.....
.....
- 2.8 General appearance of laboratory (clean, orderly, etc)
- 2.9 Is the instrumentation operated in an environmentally controlled shelter or area (Y/N)?
- 2.10 Are the support devices, e.g. gas cylinders, kept in similar environment (Y/N)?
Modification necessary (Y/N)?.....
Recommendation.....
.....

3 DOCUMENTATION OF STATION

- 3.1 Homepage (URL) of station
- 3.2 Date of last update of GAWSYS
- 3.3 Overview of measurement program

<u>Parameter</u>	<u>Method</u>	<u>Instrument</u>	<u>Start</u>	<u>End</u>	<u>Contact</u>
.....
.....
.....
.....

<u>Parameter</u>	<u>Method</u>	<u>Instrument</u>	<u>Start</u>	<u>End</u>	<u>Contact</u>
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4 ORGANISATION AND PERSONNEL

4.1 Organisation (name and abbreviation, address).....

4.2 Station Manager

4.3 Personnel involved during audit

<u>Responsibility</u>	<u>Title, Name</u>	<u>Telephone</u>	<u>Fax</u>	<u>E-mail</u>
.....
.....
.....
.....
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.....
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.....
.....

4.4 What training has/have the operator(s) received? When?

 Years of experience.....
 Retirement/change in duties expected soon?.....
 Recommendation.....

5 AIR INLET SYSTEM

5.1 Location of air intake (including surroundings, height above station/roof etc.

5.2 Description (material, diameter, total length)

- 5.3 Inlet [& particle filter(s), if present] (material, dimensions).....

- 5.4 Material and dimensions (length, o.d, i.d.) of manifold and tubing

- 5.5 Is the ambient air pre-treated/dried (Y/N)?
 Description of cooling trap (design/temperature, make of chemical trap).....

 Trap (1) at °C, trap (2) at °C
 Chemical trap:.....
- 5.6 Frequency of trap changes?
 Documentation and log-book?

- 5.7 Location and type/manufacturer/material of pump

- 5.8 Volumetric flow rate in manifold?
 Volumetric flow rate in sampling line?
 Overall residence time?
- 5.9 Comments

- 5.10 Sketch of air inlet and lines up to the instrument

6 INSTRUMENTATION

6.1 Gas chromatographic systems

- 6.1.1 Manufacturer of GC system.....
Model and S/N.....
Installation date
Total number of channels/detectors
Total suite of species measured.....
.....
Is a converter used (Y/N)? If so, specify function, manufacturer, type.....
.....
.....
- 6.1.2 Detector type(s) and manufacturer.....
Model and S/N.....
Installation date
Temperature ° C
- 6.1.3 Pre-column type, dimensions (length, o.d, i.d)
.....
Installation date (year)
Temperature (isothermal/temperature programme) ° C
.....
- 6.1.4 Main column type, dimensions (length, o.d, i.d)
.....
Installation date
Temperature (isothermal/temperature programme) ° C
.....
- 6.1.5 Carrier gas
Type ambient air synth. air N2 He H2 Ar/CH4 other
Quality
Treatment/purification (material, manufacturer)
Flow rates mL min⁻¹
1) 2)
3) 4)
- 6.1.6 Make-up gas (Y/N)
Type.....
Quality
Treatment/purification (material, manufacturer)
Flow mL min⁻¹

- 6.1.7 Gas sampling valve(s) (GSV)
 - Number of valves
 - Number of ports.....
 - Manufacturer/Type
 - Type of actuator (pneumatic, electric)
 - Tubing (1/16" or other).....
 - Backflush (Y/N).....
 - Sample loop volumemL
 - Sample loop material.....
- 6.1.8 Peripheral devices
 - Valve units
 - Stream selection valve (SSV) / autosampler or others
 -
 -
- 6.1.9 Description of interface for start / stop / relay switching
-
-
-
- 6.1.10 Type, availability of documentation (manuals, flow diagram incl. peripheral devices, listing of GC methods, references, publications)
-
-
- 6.1.11 Sketch of GC setup including valves and flow diagram

6.1.12 Special instrument features and other comments
.....
.....

6.1.13 Sample chromatogram (reference, filename)

6.2 Continuous (monitor-based systems)

6.2.1 Manufacturer
Model and S/N.....
Analytical method
Concentration range
Analogue output range
Serial interface (RS232) available (Y/N) and in use (Y/N)?.....

6.2.2 Installation date

6.2.3 Initial calibration
Date
Who performed this calibration?
Initial calibration factors
.....

6.2.4 Current instrument parameters
Name and value Routinely recorded (Y/N)
Zero coefficient:
Span coefficient:
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

6.2.5 Difference between display reading and analogue output
At zero mV
At full range mV
Adjustments made during audit
.....
.....

6.2.6 Operation Gases (composition, quality)
Ar/CH₄.....

N2.....
.....
.....

6.2.7 Sketch of the system including valves and flow diagram

6.2.8 Special instrument features and other comments.....
.....
.....

7 OPERATION AND MAINTENANCE

7.1 General

- 7.1.1 Number of permanent staff at the site
- 7.1.2 Presenceduring working hours 24 h visit(s) per week
- 7.1.3 Is there a possibility for remote instrument control (Y/N)?.....
For which instrument functions / which devices?
- How?

7.2 Sampling and Calibration

- 7.2.1 Is a leak check performed regularly (Y/N)?
- Date of last check
- 7.2.2 Sequence of analyses (A: ambient; W: working standard; L: laboratory standard).....
.....
.....
- 7.2.3 Frequency of ambient samples
- 7.2.4 How is the instrument calibrated?
-

-

- 7.2.5 Zero checks
 Mode none manually automatically daily other
- Type of zero air supply (internal, external, absorber, catalyst, etc)
-
- 7.2.6 Target gas analysis (span checks)
 Mode none manually automatically daily other
- Source of target/span gas (cylinder, dilution unit, diffuser, etc).....
-
- Mole fraction of target/span gas (ppb)?
- 7.2.7 Frequency of working standard samples.....
- Working standard in operation (S/N, since when?)
- 7.2.8 Frequency of calibration (lab standard) samples / comparison with working standards? ...
-
- Number of calibration levels during routine operation
- Number of calibration levels for comparison of working stds. with lab stds.....
- 7.2.9 Repeatability of measurements
- Frequency of checks
- Date of last check
- Result (1 standard deviation, number of measurements).....
- Is this result within the control limits (Y/N, what are they)?
-
- 7.2.10 Abundance range tests (linearity of detector/response curve)
- Number of levels.....
- Frequency of checks
- Date of last check
- Result (1 standard deviation, number of measurements).....
- Is this result within the control limits (Y/N, what are they)?
-
- Are these data available?
- 7.2.11 Sketch of the system for the zero/span and/or calibration check procedure

7.3 Maintenance

7.3.1 Schedule monthly biweekly weekly other

7.3.2 What maintenance is being done (e.g. detector, column, filter change)?.....
.....
.....
.....

7.3.3 Inlet filter (material, frequency of exchange)

7.4 Corrective Actions

7.4.1 In case of instrument drift or instability?

7.4.2 In case of excessive baseline noise or peak shape degradation?

7.4.3 Are calibrations performed after instrument malfunction/repair (Y/N - details)?

7.4.4 Any corrections applied / indicated / foreseen ?

8 STANDARDS

8.1 Regulators and Connections

7.1.1 Type and material of pressure regulator

7.1.2 Type and material of tubing (from cylinder to valve unit)

8.2 Laboratory Standards

8.2.1 Storage location.....

8.2.2 Number of laboratory standards

8.2.3 Type of cylinder (size, material, treatment, manufacturer)

8.2.4 Gas mixture or whole air?.....

8.2.5 Cylinder S/N and mole fractions

CH4 CO2 SF6 N2O H2 CO

Calibration scale

Specified uncertainty

Stated period of stability

Last comparisons with other standards (when, where)

Last (re)-calibration at CCL

Results

8.3 Working Standards

8.3.1 Storage location.....

8.3.2 Number of working standards.....

8.3.3 Type of cylinder (size, material, treatment, manufacturer)

8.3.4 Gas mixture or whole air?.....

8.3.5 Cylinder S/N and mole fractions

CH4 CO2 SF6 N2O H2 CO

.....
 Calibration scale

 Specified uncertainty
 Last comparisons with other standards (when, where)

 Frequency of intercomparison of working and laboratory standards?
 (recommended frequency:)

8.4 Target Gases / Gases for Span Checks

8.4.1 Storage location.....
 8.4.2 Number of laboratory standards
 8.4.3 Type of cylinder (size, material, treatment, manufacturer)

8.4.4 Gas mixture or whole air?.....

8.4.5 Cylinder S/N and mole fractions
 CH4 CO₂ SF₆ N₂O H₂ CO

.....
 Calibration scale

 Last comparisons with other standards (when, where)

 Frequency of intercomparison of target gases to other standards?

8.5 Zero Air

8.5.1 Manufacturer / Laboratory
 Model and S/N.....
 Portable unit or installation at the station?.....
 Suite of main components (compressor, etc)

8.5.2 Components for Purification
 Sofnocat Hopkalit Act'd Charcoal Catalyst other

- 8.5.3 Components for drying
 - Drierite other
- 8.5.4 Interval for exchange of
 - Adsorbent
 - Drying agents
- 8.5.5 Comments
-
-
-

9 DATA ACQUISITION AND PROCESSING

9.1 General

- 9.1.1 Manufacturer
- Type.....
- Is a chart recorder used in addition (Y/N) ?.....
- 9.1.2 Which instrumental (system) parameters are recorded?.....
-
- 9.1.3 Remote access to data acquisition possible (Y / N)?
- For what parameters?
- From where?
- 9.1.4 Time zone of data acquired.....
- 9.1.5 What software (if any) is used for further data processing?
- 9.1.6 How is the quality of measurements/data assessed (data visualization, consistency checks, etc.)?
-
-
- Is the instrument logbook considered in data validation procedures (Y/N, how)?.....
-
- 9.1.7 Is a plot for different time intervals (month, year) available (Y/N)?.....
- 9.1.8 Data filtering techniques, if applied (reference?).....
-
-
- Are outliers identified and flagged? How?
-
-
- Fixed level (or other criteria) for the rejection of outliers?
-

9.1.9 Final data validation

Is this done at the site (Y/N)?

By whom?

Is a formal (statistical) time series review performed (Y/N)?

9.1.10 How are the final data re-calculated/corrected? On what grounds?.....

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.....
.....

9.1.11 Comments

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.....

9.2 Gas Chromatographic Systems

9.2.1 Chromatogram characteristics

Sequence of peaks (RT, name: either enumerated or identified).....

.....
.....
.....

O₂ peak cut-off by specific valve switching?.....

Separation of target analyte from other substances

Fully, return to baseline (Y/N).....

Partial overlap, accounted for by integration algorithm (Y/N, what algorithm).....

.....
Major interferences (Y/N, with what compounds, how are they dealt with)

.....
.....

9.2.2 Chromatogram evaluation

What chromatogram information is stored?

Chromatograms Report Summary Report Peak Area Peak Height

Retention time Peak start Peak end Other

.....

Is this information routinely used for data quality control (Y/N)?

Height of typical target peak (with unit)

Area of typical target peak (with unit)

Baseline noise level (with unit)

Typical signal-to-noise ratio.....

Reported mole fractions are based on Height Area

Is the peak integration performed automatically (Y/N)?

- Are single peak values averaged to a mean value?
- Are chromatograms routinely inspected by an operator (Y/N)?
- 9.2.3 Baseline reset after.....injection(s) / automatically by GC system
- 9.2.4 Column regeneration procedure/interval?

9.3 Continuous (Monitor-based) Systems

- 9.3.1 D/A board of the station analyser
 - Was it adjusted for the audit (Y/N)?
 - Zero reading of ADC board?
 - Full range reading of ADC board?
- 9.3.2 External A/D Converter
 - Manufacturer
 - Model and S/N.....
- 9.3.3 Comments
-
-
-

10 DATA MANAGEMENT AND SUBMISSION

- 10.1 Is there a provision for redundant, off-site data storage? (Y/N).....
 - Description of backup policy
 -
 -
 -
 - Is a data base management system in use?
 - Details:.....
 -
 -
- 10.2 Are graphical representations of the data available?.....
- 10.3 Has the data been submitted to a WMO World Data Centre (Y/N)?
- Name of centre
- Date of last submission.....
- Is the submitted data (as found at the WDC) reviewed (Y/N)?
- By whom?
- What metadata are submitted?.....
-
- What auxiliary parameters are submitted? Meteo Other
-

10.4 Calibration History (Discuss the treatment of data in the past; what calibration functions were used; if previously processed data were reprocessed after scale revisions; if previously submitted data were re-submitted after scale revisions)

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11 DOCUMENTATION

11.1 General

11.1.1 Are the WMO GAW Measurement Guidelines available to the operator (Y/N)?

11.1.2 Are the instrument manuals available (Y/N)?

11.1.3 Are field logbooks maintained on site / or in the office ?(Y/N).....

Type electronic hand-written

Are field logbooks maintained in an orderly manner (Y/N)?

Date of last entry

11.1.4 Are instrument logbooks maintained on site / or in the office ? (Y/N).....

Type electronic hand-written

Are instrument logbooks maintained in an orderly manner (Y/N)?

Date of last entry

Is instrument malfunction/repair reported (Y/N)?.....

Is any change/manipulation of the instrument reported (Y/N)?

Does the instrument logbook include a record of

Dates of data loss and reasons therefore (Y/N)?

Periods of questionable data and reason therefore (Y/N)?

Alternative location for storage of information on data loss and questionable data

.....

11.1.5 Have the staff prepared an SOP for the instrument (Y/N)?

Are check lists for routine inspection (daily / weekly /) of instrumentation available

(Y/N)?

Have copies of these documents been obtained?.....

11.1.6 Publications / Reports

.....

.....

11.1.7 Comments

.....

.....

.....

11.2 QA/QC Procedures

11.2.1 Are specific QC data forms & control charts used (Y/N)?

11.2.2 Are QC and field sheets current and available for audit review (Y/N)?

11.2.3 Are data quality objectives defined for the station's measurements (Y/N)?

Are the WMO/GAW DQOs known to the station staff (Y/N)?

11.2.4 Are data forms/checklists periodically reviewed (Y/N)?.....

By whom?

Date of last changes?.....

11.2.5 Are computer validation reports and/or data summaries reviewed by a site QA co-ordinator (Y/N)?

By whom?

11.2.6 Are internal QA/QC reports prepared?

12 ACTIONS TO BE TAKEN AFTER AUDIT

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