

**QA/QC MANUAL:
QUALITY SYSTEM IN THE ICELANDIC
AIR EMISSION INVENTORY**



**ENVIRONMENT AGENCY
OF ICELAND**



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1. INTRODUCTION

Iceland has signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol to the Convention. One of the requirements under the Protocol is that each Party included in Annex I to the Convention must have in place, no later than one year prior to the start of the first commitment period, a national system for the estimation of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. Article 7 of the Kyoto Protocol and Decision 19/CMP.1 stipulates the reporting of “supplementary information” including details of the National System and QA/QC plans and procedures. Article 8 puts in place the mechanisms for annual review that will, amongst other things, assess the existence and adequacy of the Parties national inventory system which includes a structured and transparent QA/QC system consistent with chapter 8 of the [2000 IPCC Good Practice Guidance](#). The maintenance of a national inventory system in accordance with Article 5 and the requirements of the guidelines mentioned above is one of the eligibility criteria for participation in the Kyoto Protocol mechanisms (Clean Development Mechanism and Emissions Trading).

Quality assurance and quality control (QA/QC) procedures are a key component of national inventory systems.

Iceland prepares an inventory that adheres to the methodologies provided in the ‘Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories’ (1996), the IPCC ‘Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories’ (2000), the ‘Good Practice Guidance for Land Use, Land-Use Change and Forestry’ (2003) and the UNFCCC reporting guidelines (FCCC/SBSTA/2004/8).

The greenhouse gases included in the national inventory are the following: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆). Emissions of the precursors NO_x, NMVOC and CO as well as SO₂ are also included, in compliance with the reporting guidelines. Further emissions of Persistent Organic Pollutants (dioxin and PAH4) are included in the inventory.

Parties are responsible for the quality of activity data, emission factors and other parameters used for their inventories. They are also responsible for establishing national QA/QC programmes for their inventories as part of their national inventory systems. This document describes the quality assurance and quality control programme for the annual greenhouse gas inventory of Iceland. It includes the quality objectives and an inventory quality assurance and quality control plan. It also describes the responsibilities for the performance of QA/QC procedures. This manual is an integral part of Iceland’s National System.

2. DEFINITIONS

Chapter 8 of the [2000 IPCC Good Practice Guidance](#) defines Quality Assurance and Quality Control as follows:

Quality Control (QC) is a system of routine technical activities, to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

- (i) Provide routine and consistent checks to ensure data integrity, correctness, and completeness;
- (ii) Identify and address errors and omissions;
- (iii) Document and archive inventory material and record all QC activities.

QC activities include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardised procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. Higher tier QC activities include technical reviews of source categories, activity and emission factor data, and methods.

Quality Assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process. Reviews, preferably by independent third parties, should be performed upon a finalised inventory following the implementation of QC procedures. Reviews verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions and sinks given the current state of scientific knowledge and data available, and support the effectiveness of the QC programme.

Definitions of quality assurance, quality control and related terms are those provided in the IPCC Good Practice Guidance and Guidelines for National Systems under the Kyoto Protocol.

Audits - For the purpose of good practice in inventory preparation, audits may be used to evaluate how effectively the inventory agency complies with the minimum QC specifications outlined in the QC plan. It is important that the auditor be independent of the inventory agency as much as possible as to be able to provide an objective assessment of the processes and data evaluated. Audits may be conducted during the preparation of an inventory, following inventory preparation, or on a previous inventory.

Expert peer review - consists of a review of calculations or assumptions by experts in relevant technical fields. The objective of the expert peer review is to ensure that the inventory's results, assumptions, and methods are reasonable as judged by those knowledgeable in the specific field. Expert review processes may involve technical experts and, where a country has formal stakeholder and public review mechanism in place, these reviews can supplement but not replace expert peer review.

Good practice – is a set of procedures intended to ensure that GHG inventories are accurate in the sense that they are systematically neither over- nor underestimated as far as can be judged, and that uncertainties are reduced as far as possible. Good practice covers choice of estimation methods appropriate to national circumstances, quality assurance and quality control at the national level, quantification of uncertainties and data archiving and reporting to promote transparency.

Key source category - is one that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of direct GHG in terms of the absolute level of emissions, the trend in emissions, or both.

National system - includes all institutional, legal and procedural arrangements made within a Party for estimating anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol, and for reporting and archiving inventory information.

QA/QC plan – is an internal document to organise, plan and implement QA/QC activities. The plan should, in general, outline QA/QC activities that will be implemented, and include a scheduled time frame that follows inventory preparation from its initial development through to final reporting in any year.

QA/QC system - the major elements of a QA/QC system are:

- An inventory agency responsible for coordinating QA/QC activities;
- A QA/QC Plan;
- General QC procedures (Tier1);
- Source category-specific QC procedures (Tier 2);
- QA review procedures;
- Reporting, documentation and archiving procedures.

Quality assurance (QA) - activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process to verify that data quality objectives were met, ensure that the inventory represents the best possible estimates of emissions and sinks given the current state of scientific knowledge and data available, and support the effectiveness of the quality control (QC) programme. QA activities include audits and expert peer reviews.

It is good practice for inventory agencies to conduct a basic expert peer review (Tier 1 QA) prior to inventory submission in order to identify potential problems and make corrections where possible. Inventory agencies may also choose to perform more extensive peer reviews or audits or both as additional (Tier 2 QA) procedures within the available resources.

Quality control (QC) – is a system of routine technical activities, to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

- Provide routine and consistent checks to ensure data integrity, correctness, and completeness;
- Identify and address errors and omissions;
- Document and archive inventory material and record all QC activities.

QC activities - include general methods such as accuracy checks on data acquisition and calculations and the use of approved standardised procedures for emission calculations, measurements, estimating uncertainties, archiving information and reporting. Higher tier QC activities include technical reviews of source categories, activity data and emissions factors, and methods of estimation.

Tier 1 QC procedures

Tier 1 General Inventory Level QC procedures are checks that the inventory agency should use routinely throughout the preparation of the annual inventory. The focus of general QC techniques is on the processing, handling, documenting, archiving and reporting procedures that are common to all the inventory source categories.

Tier 2 QC procedures

Source category-specific QC procedures (Tier 2), are directed at specific types of data used in the methods for individual source categories and require knowledge of the emissions source category, the types of data available and the parameters associated with emissions. The source category specific QC measures are focusing on key source categories and on source categories where significant methodological and data revisions have taken place. Tier 2 QC activities are in addition to the general QC conducted as part of Tier 1.

Quality Objectives - The objectives of QA/QC activities on national greenhouse gas inventories are to improve transparency, consistency, comparability, completeness, accuracy, confidence and timeliness in national inventories.

Transparency - the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of information;

Consistency - an inventory should be internally consistent in all its elements over a period of years. An inventory is consistent if the same methodologies are used for the base year and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. The inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, in accordance with the IPCC GPG;

Comparability - estimates of emissions and removals reported by Parties in inventories should be comparable among Parties. For this purpose, Parties should use the methodologies and formats agreed by the COP for estimating and reporting inventories. The allocation of different source/sink categories should follow the split of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, and the IPCC GPG for Land Use, Land-Use Change and Forestry, at the level of its summary and sectoral tables;

Completeness - an inventory should cover all sources and sinks, as well as all gases, included in the IPCC Guidelines. Completeness also means full geographic coverage of sources and sinks;

Accuracy – is a relative measure of the exactness of an emission or removal estimate. Estimates should be accurate in the sense that they are systematically neither over nor under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable;

Timeliness - submission of the complete inventory by the deadlines specified in the relevant decisions or other documents.

Verification – verification processes are intended to help establish an inventory’s reliability. These processes may be applied at either national or global levels of aggregation and may provide alternative information on annual emissions and trends. The results of verification processes may:

- Provide inputs to improve inventories;
- Build confidence in emissions estimates and trends;
- Help to improve scientific understanding related to emissions inventories.

3. QUALITY SYSTEM

QA/QC activities are needed throughout the compilation, management and planning phases of the inventory preparation. Activities are either day-to-day procedures and practices, (to ensure that data compiled for the inventory is of an appropriate quality) annual cyclic activities (that are required at different phases of the inventory compilation) or specific less frequent activities to review the inventory or inventory systems.

The overall aim of the quality system is to maintain and improve the quality in all stages of the inventory work, in accordance with decision 19/CMP.1. The quality objectives of the QA/QC programme and its application are an essential requirement in the GHG inventory and submission processes in order to ensure and improve the inventory principles: transparency, consistency, comparability, completeness, accuracy, timeliness and confidence in the national emissions and removals estimates for the purposes of meeting Iceland’s reporting commitments under the UNFCCC and the Kyoto Protocol.

IMPLEMENTATION OF QA/QC SYSTEM

The quality system described here is designed according to the PDCA-cycle (Plan – Do – Check – Act) presented in figure 1. This is a generally accepted model for pursuing a systematic quality work according to international standards, in order to ensure the maintenance and development of the quality system. This structure is in accordance with structures described in decision 19/CMP.1 and in the IPCC GPG. Chapter 8 of the IPCC GPG, Quality Assurance and Quality Control, refers to ISO systems which are built upon the PDCA-cycle.

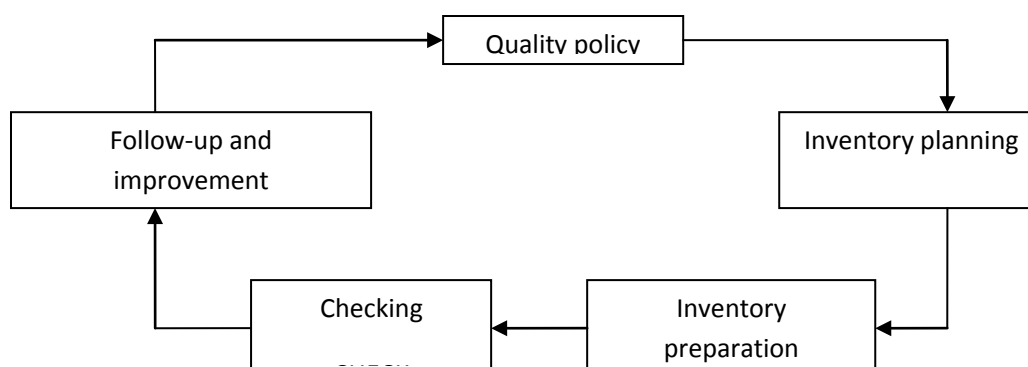


Figure 1. The PDCA-cycle.

The QA/QC system consists of inventory planning, inventory preparation, inventory quality checking and follow-up improvements which are integrated into the annual cycle and preparation as illustrated in the figure 2.

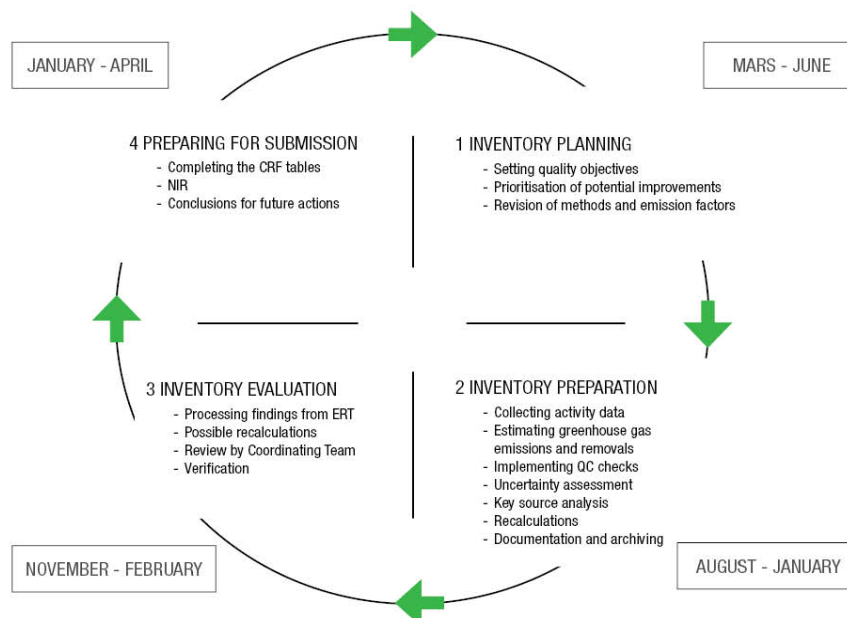


Figure 2. The Inventory-cycle

Inventory planning (PLAN)

Each year in May a planning meeting with the Coordinating team is held to plan next inventory's year's work. In the annual planning procedure, suggestions and issues for further consideration are derived from the work with the last inventory, including the audit of work documentation and QC-checklists by the QC-team, as well as from ERT reviews.

Inventory preparation (DO)

After data collection, selection of emission factors and calculations of emissions the quality is checked (units, sources, mass balances, methodology, emission factors, etc). Further uncertainties calculations and analysis are performed, CRF tables are filled and the National Inventory Report is prepared.

Checking (CHECK)

The inventory is reviewed by the coordinating team and inventory estimates re-evaluated if needed. The inventory is then subject to final checking, where i.e. data consistency, documenting, processing and archiving are checked.

Follow-up and improvement (ACT)

The final project evaluation takes places at the next year's inventory planning meeting.

4. QUALITY POLICY

The quality policy is aimed to ensure that the annual national greenhouse gas inventory meets the requirement of IPCC Good Practice Guidance. The goal is to achieve a system that ensures best possible estimates of emissions and sinks given the current state of scientific knowledge and data available. The system will ensure that transparency, consistency, comparability, completeness and accuracy, confidence and timeliness are maintained at all times. To achieve this continual improvements are maintained in line with the Quality System.

5. INVENTORY PLANNING (PLAN)

REQUIREMENTS, DECISIONS AND GUIDELINES

This document is the main guidance document for the air emission inventory work covering the inventory itself as well as development projects for inventory improvement.

It is the responsibility of the EA to provide information regarding any changes in the reporting requirements.

In all work documentation (appendix 4) there are detailed references to appropriate individual chapters in guidance documents, governing the inventory work, for all sources.

Some of the most important guidelines for the inventory planning are:

- Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
- IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories
- IPCC Good Practice Guidance for Land Use, Land-use Change and Forestry
- 2006 IPCC Guidelines for National Greenhouse Gas Inventories
- EMEP/CORINAIR Emission Inventory Guidebook
- UNFCCC Guidelines on reporting and review FCCC/CP/2002/8
- Guidelines for Estimating and Reporting Emission Data under the Convention on Long-Range Transboundary Air Pollution.

QUALITY OBJECTIVES AND QUALITY PROGRAM

The main quality objectives relating to Iceland's air emission inventories are to,

- that deadlines are met, and
- the work is conducted as efficiently as possible.

The quality program to meet these objectives is based on follow-up and improvement as described in chapter 8. Procedures for handling of non-conformity, corrective and proactive actions are described in chapter 7.

6. INVENTORY PREPARATION (DO)

ORGANISATION AND RESPONSIBILITIES

Environment Agency of Iceland (EA)

EA, an agency under the Ministry for the Environment, has overall responsibility for the national inventory. EA compiles and maintains the greenhouse gas emission inventory, except agriculture and LULUCF which is compiled by the Agricultural University of Iceland (AUI). The QA/QC elements outlined in this document are the responsibility of the EA which is the designated Inventory Agency for the Greenhouse Gas National Inventory System. EA assigns the QA/QC coordinator, who is responsible for ensuring that QA/QC system is implemented and functioning. The EA is also responsible for designating responsibilities for implementing and documenting these or similar QA/QC procedures to other agencies or organizations who contribute data or advice to the National Inventory.

Agriculture University of Iceland (AUI)

The Agriculture University of Iceland is a major data provider (activity data, emission factors) in the agriculture sector and the sectoral expert for LULUCF. The AUI is responsible for implementing QA/QC procedures in the LULUCF sectors.

Data providers

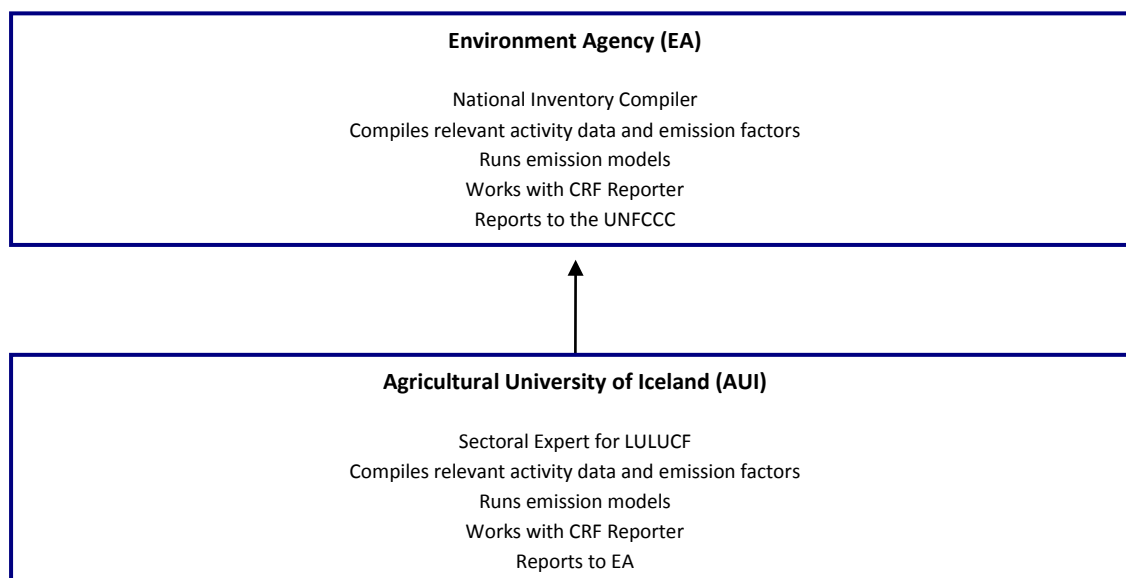
The main data providers in the Icelandic GHG Inventory are the National Energy Authority, Statistics Iceland, Iceland Forest Service and Soil Conservation of Iceland. A formal agreement has been established with these data providers, emphasizing their responsibility for the collection and timely submission of activity data to EA/AUI, applying QC procedures according to chapter 8 of the IPCC GPG, as well as evaluation of uncertainties of the initial data.

Coordinating team

The Coordinating Team, with representatives from the Ministry for the Environment, the EA and the AUI not directly involved in preparing the inventory, has the role to officially review the emission inventory before submission to UNFCCC, as well as to plan the inventory cycle and formulate proposals on further development and improvement of the national inventory system. After the Coordinating Team has reviewed the inventory and the institutions responsible for preparing the inventory responded accordingly, the greenhouse gas inventory and the NIR are submitted to UNFCCC by the Environment Agency.

The Coordinating team is responsible for identification and prioritization of categories for review, based on key category and uncertainty analysis. The team is also responsible for identification of review personnel in cooperation with EA and the Ministry for the Environment. Figure 3 shows the flow chart for the inventory system.

Figure 3. Flow chart for the inventory system



A QC team performs an annual internal audit directed toward checking that all QC-procedures in the inventory project have been performed and documented. The co-ordinator is responsible for the internal audit of the air emission inventory.

EDUCATION, AWARENESS AND COMPETENCE

It can be difficult in a small country to maintain competence within the inventory team as the workload depends on the contribution of very few people. EA is responsible for maintaining an adequate staff of experts with suitable education and competence to perform the air emission inventories according to quality requirements.

Maintaining competence and awareness in the inventory work is achieved by ensuring that more than one person is sufficiently familiar with a specific area of work to be able to perform the work in accordance with quality requirements. Standard Operating Procedures (SOPs) will describe in detail implementation of the inventory work. For the time being only short descriptions exist, in the NIR as well as in the calculation sheets.

DOCUMENTS AND DOCUMENTS CONTROL

The documentation relating to air emission inventories is rich. The most important documents are updated annually. Version and date is given, as well as information on the version of the document.

All documents are stored electronically on the EA's computer network. This includes quality system documents, reports, original data from data providers, the CRF Reporter database files, data submitted to the UNFCCC and spreadsheets of the emission inventory. Also decisions reached by the coordinating team, reviews, and results of key category and uncertainty analysis as well as inventory development is documented and archived in the data base. Geographical database used for preparing the LULUCF inventory is stored at the AUI computer network. Resulting digitized maps of land use classification are stored also at EA. After each submission to UNFCCC a complete copy is archived.

QUALITY PLAN

The annual inventory cycle and QA/QC is governed by an activity plan. The activity plan specifies when all activities (QA/QC and other activities) must take place in order to maintain timeliness and maintain high quality in delivered tables, reports etc.

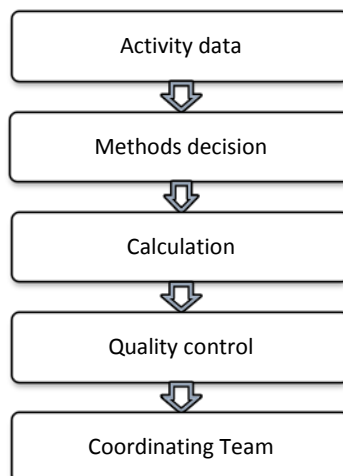


Figure 4. Quality plan

7. CHECKING (CHECK)

The objective of the quality control and quality assurance steps and procedures outlined in this and the following chapters is to ensure that the inventory is as comparable, consistent, complete, transparent and accurate as possible, given the resources and expertise available.

This chapter describes the routines for quality control and quality assurance that shall be performed during the inventory process by the inventory staff when gathering data and calculating and compiling the emission inventory.

GENERAL QC PROCEDURES

Preparation of general procedures:

- Control of documents (ISO 9001:2000, 4.2.3). Define preparations, review, etc. of documents;
- Control of all records, including those made in electronic form (ISO 9001:2000, 4.2.4). A complete and correct archiving of GHG inventory data should also be included;
- Procedure for audits with responsibilities and requirements for planning and conducting audits, and for reporting results and maintaining records (ISO 9001:2000, 8.2.2), that would be QA activities;
- The controls and related responsibilities and authorities for dealing with non-conforming product shall be defined in nonconforming product procedure (ISO 9001:2000, 8.3);
- Procedures for corrective and preventive actions (ISO 9001:2000, 8.5.2, 8.5.3).



CHECKLIST FOR GENERAL QC CHECKS:

Item	Check completed		Corrective action			Supporting Documents (provide reference)
	Date	Individual (initials)	Errors (Y/N)	Date	Individual (initials)	
1. Check a sample of input data for transcription errors						
2. Review spreadsheets with computerised checks and/or quality check reports						
3. Check project file for completeness						
4. Confirm that bibliographical data references are included for every primary data element						
5. Check that all appropriate citations from the spreadsheets appear in the inventory document						
6. Check that all citations in spreadsheets and inventory are complete (i.e., include all relevant information)						
7. Randomly check bibliographical citations for transcription errors						
8. Check that originals of new citations are in current docket submittal						
9. Randomly check that the originals of citations contain the material & content referenced						
10. Check that assumptions and criteria for selection of activity data, emission factors and other estimation parameters are documented						
11. Check that changes in data or methodology are documented						
12. Check that citations in spreadsheets and inventory document conform to acceptable style guidelines						
13. Check that all calculations are included						
14. Check whether units, parameters, and conversion factors are presented appropriately						
15. Check if units are properly labelled and correctly carried through from beginning to end of calculation						
16. Check that conversion factors are correct						
17. Check the data relationships (comparability) and data processing steps in the spreadsheets						
18. Check that spreadsheet input data and calculated data are clearly differentiated						



Item	Check completed		Corrective action			Supporting Documents (provide reference)
	Date	Individual (initials)	Errors (Y/N)	Date	Individual (initials)	
19. Check a representative sample of calculations, by hand or electronically						
20. Check the aggregation of data within a category						
21. When methods or data have changed, check consistency of time series inputs and calculations						
22. Check current year estimates against previous years (if available) and investigate unexplained departures from trend						
23. Check value of implied emission/removal factors across time series and investigate unexplained outliers						
24. Check for any unexplained or unusual trends for activity data or other calculation parameters in time series						
25. Check for consistency with IPCC inventory guidelines and good practices, particularly if changes occur						

CHECKLIST FOR SPECIFIC QC CHECKS:

Part A : Data gathering and selection

EMMISSION DATA QUALITY CHECKS

Item	Check completed			Corrective action		Supporting documents (provide reference)
	Date	Individual (initials)	Errors Y/N	Date	individual (initials)	
1. Emission comparisons: historical data for source, significant sub-source categories						
3. Reference calculations						
4. Completeness						



EMMISSION FACTOR QUALITY CHECKS

Item	Check completed			Corrective action		Supporting documents (provide reference)
	Date	Individual (initials)	Errors Y/N	Date	individual (initials)	
6. Assess representativeness of emission factors, given national circumstances and analogous emissions data						
7. Compare to alternative factors (e.g., IPCC default, cross-country, literature)						
8. Search for options for more representative data						

Activity data quality checks: National Level Activity data

Item	Check completed			Corrective action		Supporting documents (provide reference)
	Date	Individual (initials)	Errors Y/N	Date	individual (initials)	
10. Check historical trends						
11. Compare multiple reference sources						
12. Check applicability of data						
13. Check methodology for filling in time series for data that are not available annually						

Activity Data Quality Checks: Site – specific activity data

Item	Check completed			Corrective action		Supporting documents (provide reference)
	Date	Individual (initials)	Errors Y/N	Date	individual (initials)	
15. Check for inconsistencies across sites						
16. Compare aggregated and national data						

Part B: Secondary data and direct emission measurement

Item	Check completed			Corrective action		Supporting documents (provide reference)
	Date	Individual (initials)	Errors Y/N	Date	Individual (initials)	
1. Are QC activities conducted during the original preparation of the data (either as reported in published literature or as indicated by personal communications) consistent with and adequate when compared against (as a minimum), general QC activities?						
2. Does the statistical agency have a QA/QC plan that covers the preparation of the data?						
3. For surveys, what sampling protocols were used and how recently were they reviewed?						
4. For site-specific activity data, are any national or international standards applicable to the measurement of the data? If so, have they been employed?						
5. Have uncertainties in the data been estimated and documented?						
6. Have any limitations of the secondary data been identified and documented, such as biases or incomplete estimates? Have errors been found?						
7. Have the secondary data undergone peer review and, if so, of what nature?						

QA PROCEDURES

The most important external reviews of Iceland's GHG inventory have been performed by the UNFCCC ERTs, which perform extensive reviews of each year's submission. Results from these reviews are considered annually and decisions are taken on how the recommendations will be taken forward in the development and improvement of the national system.

The Coordinating team is responsible for identification and prioritization of categories for external review, as well as for identification of review personnel in cooperation with EA and the Ministry for the Environment. Quality assurance procedures involve external reviewers conducting an unbiased review of the national inventory or parts of the inventory.

8. FOLLOW-UP AND IMPROVEMENT (ACT)

At the planning meeting of the Coordinating Team the inventory work is evaluated regarding organisation, efficiency and quality. At this meeting all relevant ideas for improvement of the inventory are noted in the planning document. From the planning document issues that need to be addressed are presented for further consideration. Changes that are prioritised by the Coordinating are included in the work with the next submission if possible.