

## U.S. EPA Templates for Creating a National GHG Inventory System Manual

### 4. QA/QC Procedures



1: How to Use the Templates



2: Institutional Arrangements



3: Methods and Data Documentation



4: QA/QC Procedures



5: Key Category Analysis



6: Archiving System



7: National Inventory Improvement Plan

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## **Introduction to Template 4. QA/QC Procedures**

In the U.S. EPA's *Templates for Creating a National GHG Inventory System Manual*, this is Template 4. Its purpose is to help countries develop a quality assurance and quality control (QA/QC) plan for current reporting under the United Nations Framework Convention on Climate Change (UNFCCC) (i.e., Biennial Update Reports) and future required reporting under the Enhanced Transparency Framework<sup>1</sup> (ETF) for National GHG Inventories. It includes a series of tables in which you may record country-specific information about QA/QC activities in order to create a QA/QC plan. It also includes three QA/QC checklists you may use to track progress of the QA/QC work done.

The planning and implementation of QA/QC procedures are important parts of the development of national greenhouse gas inventories. A QA/QC plan helps identify improvement options to enhance transparency, accuracy, consistency, comparability, completeness in national GHG inventories. A QA/QC plan also builds confidence in national GHG inventories. The template can help improve countries' understanding of elements of a QA/QC plan to improve inventory management and reporting over time.

The 2006 IPCC Guidelines have a clear and informative section on QA/QC.<sup>2</sup> You may find it useful to read this section of the guidelines before beginning to develop the QA/QC plan. Additional useful guidance and good practices in developing inventory arrangements and applying QA/QC that complement this Toolkit are also provided in the 2019 Refinement to the 2006 IPCC Guidelines.<sup>3</sup>

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<sup>1</sup> See 18/CMA.1, Modalities, Procedures and Guidelines (MPGs), Annex Chapter II, [Section A. Definitions](#), [Section C.6 Methods](#), and [Section E.1 Reporting guidance](#) for National Greenhouse Gas Inventory Report (available at <http://unfccc.int/decisions>). If you have capacity constraints related to developing a QA/QC plan, this template may help address constraints and facilitate steps towards preparing a QA/QC plan consistent with future reporting requirements and the 2006 IPCC guidelines.

<sup>2</sup> See [https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1\\_Volume1/V1\\_6\\_Ch6\\_QA\\_QC.pdf](https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_6_Ch6_QA_QC.pdf)

<sup>3</sup> See <https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol1.html>, particularly Chapter 1: Introduction to National GHG Inventories



To complete this template, the National Inventory Coordinator (NIC) and QA/QC Coordinator should carry out the steps enumerated below by following the instructions above each table in this template, with support from other key inventory team members as required.

***When the tables are complete, delete the green text throughout this template. You may use the remaining text or tables for reporting or for your National GHG Inventory System Manual.***

Step	Purpose
1. Convene a QA/QC Plan launch meeting and identify QA/QC personnel	It is important to assign roles and responsibilities, so people understand their duties. For countries with small inventory teams, one or more people may have multiple roles.
2. Develop a timeline for distributing the QA/QC plan amongst the inventory team and external experts, considering the overall inventory schedule created in Template 1. How to Use the Templates	All stakeholders need to understand the importance of the QA/QC Plan and how it links to the inventory improvement plan. This will help maximize engagement.
3. Establish general QC procedures for source/sink category leads to follow,	These are crosscutting procedures that apply to the whole of the GHG inventory and aim to improve general quality.
4. Establish category-specific QC procedures for source/sink category leads to follow	These are category or sector specific procedures that focus on improving quality for specific categories, starting with key categories.
5. Document recommendations received as a result of experts' QA activities	QA procedures are carried out by experts who are not part of the core GHG inventory team but who have considerable inventory expertise. Their experience and insight should help improve the quality of the inventory.
6. Propose GHG inventory improvements as a result of QA/QC activities	<b>This is a vital step.</b> The areas of inventory improvement that are identified throughout the implementation of QA/QC activities should be added the GHG inventory improvement plan. Prioritizing the improvement activities should thus result in incremental improvements to the GHG inventory.
7. QA/QC Checklists	These checklists can help keep track of the QA/QC work done, and the work which remains to be done.



## Quality Assurance/Quality Control (QA/QC) Procedures

This section explains how to compile an effective QA/QC plan. It is important to understand the basic principles before developing and implementing a QA/QC plan.

### Background

Quality control and quality assurance measures are two distinct types of activities. The IPCC defines them as follows:

- **Quality Control (QC)** – A system of routine technical activities implemented by the inventory compilers to measure and control the quality of the inventory as it is prepared.
- **Quality Assurance (QA)** – A planned system of review procedures conducted by personnel not involved in the inventory development process. QA procedures are performed upon a completed inventory following the implementation of QC procedures and preferably by independent third parties. A basic expert peer review is part of this process.
- **Verification** - The activities and procedures conducted during the planning and development, or after completion of an inventory that can help to establish its reliability for the intended applications of the inventory. For inventories, verification refers specifically to those methods that are external to the inventory and apply independent data, including comparisons with inventory estimates made by other bodies or through alternative methods.

This means that QC is part of the inventory compiler's day-to-day work. In contrast, external staff who are not involved in the inventory compilation perform QA as an additional quality check. Verification activities may be constituents of both QA and QC, depending on the methods used and the stage at which independent information is used.

QC is further divided into general and category-specific QC procedures. General QC procedures include generic quality checks related to calculations, data processing, completeness, and documentation that are applicable to all inventory source and sink categories. Category-specific QC procedures complement general inventory QC procedures. Category-specific QC is directed at specific types of data used in the methods for individual source or sink categories. These procedures require knowledge of the specific category, the types of data available, and the parameters associated with emissions or removals, and are performed in addition to the general QC checks.



QA and QC are critical components of an inventory management system because when they are implemented effectively, they drive inventory improvement. Therefore, a fundamental element of the inventory management system is a written QA/QC plan. This plan outlines QA/QC activities to be performed, the personnel responsible for these activities, the schedule for completing these activities, and a list of future planned QA/QC improvements. An effective QA/QC plan includes the following elements:

- Personnel responsible for coordinating QA/QC activities;
- General QC procedures;
- Category-specific QC procedures;
- QA review procedures;
- Reporting, documentation, and archiving procedures; and,
- A prioritized QA/QC improvement list, which should be reviewed regularly and used to guide improvements.

An initial step towards developing a QA/QC Plan is to appoint one person to be the QA/QC coordinator. This is the main person responsible for developing, maintaining and implementing the QA/QC plan. Ideally, this person will be knowledgeable about each sector of the GHG inventory in order to understand the implications of ensuring quality in each of the sectors. If the inventory team is small, it is possible for one or more people to may have multiple roles. A large QA/QC team is not a necessity – the key is to ensure that the QA/QC system is efficient and effective and helps drive inventory improvement.

The QA/QC Coordinator should develop the QA/QC plan with input from each of the sector leads and ensure each receives the final plan. The QA/QC Coordinator should also regularly review the plan and modify it to reflect new processes, implement recommended improvements, or support the objectives of the National Inventory Improvement Plan. This is particularly important to do at the start of each GHG inventory compilation cycle. Related to this, the QA/QC Coordinator should keep records about how improvements have been implemented, and what their effects have been.

### **STEP 1. Convene a QA/QC Plan launch meeting and identify QA/QC personnel**

- *Convene a meeting with all team members to initiate the development of the QA/QC plan. Identify the people that could be involved in the plan. The plan should apply to the whole team (including consultants, universities, etc.) that is involved in the estimation and reporting of the GHG inventory.*



- *Identify the QA/QC coordinator. This is the main person responsible for developing, maintaining, and implementing the QA/QC plan. In this role, the QA/QC coordinator:*
  - *Clarifies and communicates QA/QC responsibilities to inventory members.*
  - *Develops and periodically reviews and updates the QA/QC checklists appropriate to various inventory team member roles (or ensures that these tasks are accomplished). (See Table 4-3 and Table 4-4 for examples).*
  - *Determines an overall QA/QC timeline and when external reviews will occur, and ensures the timely and accurate completion of QA/QC checklists and related activities.*
  - *Manages and delivers documentation of QA/QC activities to the NIC and archive coordinator.*
  - *Coordinates external reviews of the inventory document and ensures that comments are incorporated into the inventory.*
- *Identify key QA/QC personnel and any additional country-specific QA/QC responsibilities.*
- *Complete Table 4-1 below with the names and contact information of the appropriate staff.*
  - *Insert as many rows within the table as necessary to include all personnel who will be responsible for QA/QC activities, and all QA/QC responsibilities.*
  - *The responsibilities associated with each of the roles are suggested in the “QA/QC responsibility” field. You may modify them as needed.*
  - *Note that the roles are flexible and may overlap. Therefore, one staff member might cover a large number of categories or even cover a whole sector. Inventory staff may have a joint inventory compilation-QA/QC role. It is unnecessary to limit one person’s role to coordinating inventory QA/QC.*
  - *It is important that QA/QC efforts be focused on key categories but are applied to the whole GHG inventory; Template 5 explains how to identify key categories.*

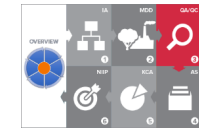


**Table 4-1. Personnel Responsible for QA/QC Activities**

Role	QA/QC Responsibility	Name	Organization	Contact Information
National Inventory Coordinator	All aspects of the inventory program, cross-cutting QA/QC			
QA/QC Coordinator	Develop and implement the overall QA/QC plan			
Sector or Category Lead(s)	Develop and implement general, sector-specific (as appropriate) and/or category specific (as appropriate) QA/QC procedures listed in Tables 4-2 and 4-3 below. Focus on Key Categories			
Outside Expert(s)	Expert review of the inventory. Ensure the role of the expert is carefully defined and agreed upon. The expert can be within the country, or an international expert			

**STEP 2. Develop a timeline for distributing the QA/QC plan amongst the inventory team and external experts**

- *It is essential to communicate the contents of the QA/QC plan to inventory team members and outside experts involved in quality assurance of the GHG inventory so that the procedures can be effectively implemented, evaluated, and improved. The QA/QC coordinator should develop a timeline for taking the following actions:*
  - *Creating or updating the QA/QC plan*
  - *Participating in an inventory inception meeting with all of those working on the inventory (including consultants, universities, etc.), and at the meeting, introducing the plan to all team members required to perform QA/QC, and distributing QC checklists (see [National GHG Inventory Inception Memorandum](#) supporting template)*
  - *Checking that members of the inventory team understand the purpose and outcomes of the QA/QC plan, and updating the plan to address any questions*



- Periodically reminding team members of their QA/QC responsibilities and the overall QA/QC schedule
- Use Table 4-2 below to develop a QA/QC plan distribution timeline. Add rows as needed to accommodate additional tasks.

**Table 4-2. QA/QC plan distribution timeline**

Task	Timeline (when the task will occur)	Outcome (description of the results of the task)	Potential Improvements (how the task may be modified to produce a better outcome)
Create (or update) the QA/QC plan			
Identify the best way to distribute the plan to each team member or external expert			
Distribute the QA/QC plan			

**STEP 3. Establish general QC procedures for source/sink category leads to follow**

- To develop the QA/QC plan, gather existing QA/QC procedures. Include QA/QC procedures used by data providers. These procedures can then be strengthened if necessary.
- The first part of developing the QA/QC Plan is to establish general QC procedures. These include generic quality checks related to calculations, data processing, completeness, and documentation that are applicable to all inventory source and sink categories and should be implemented each year. A minimum set of QC procedures should be followed each year for all categories to ensure that basic standards of quality are met. These standards generally focus on the processing, handling, documenting, archiving, and reporting procedures common to all categories.
- Table 4-3, below, lists the QC activities that should be performed at the category or subcategory level by staff compiling these estimates.
  - The Procedures column includes a description of tasks that could be done as part of each QC activity. It is not necessary to complete all of these tasks, but you are encouraged to ensure that as many of them as possible are completed. Volume 1, Chapter 6.6 of the 2006 IPCC Guidelines provides further useful guidance.





- *Modify these activities and their associated procedures as needed, and add as many rows as necessary.*
- *For each procedure, record the name of the person responsible for the item and the date of completion.<sup>4</sup>*

According to the 2006 IPCC Guidelines, though general QC procedures are designed to be implemented routinely for all categories, it may not be necessary or possible to check all aspects of inventory input data, parameters, or calculations every year. Instead, you may apply general QC procedures to a representative sample of data and calculations each year. In establishing criteria and processes for selecting sample data sets and processes, it is good practice for the inventory compiler to undertake QC checks on all parts of the inventory over an appropriate period as determined in the QA/QC plan.

**Table 4-3: General QC Activities**

QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/ Initials	Date		
<b>Data Gathering, Input, and Handling Checks</b>					
Check that assumptions and criteria for the selection of activity data, emission factors, and other estimation parameters are documented.	<ul style="list-style-type: none"> <li>• Cross check descriptions of activity data and emission factors with information on categories and ensure that these are properly recorded and archived.</li> <li>• Record if there are multiple sources of the same activity data, and if possible document the reasons for any differences.</li> </ul>				

<sup>4</sup> The UK government has issued a series of tools and guidance to help people improve the quality assurance of analytical models. The UK GHG inventory team uses elements of these. Other countries might like to consider if they could use these tools and guidance. They are available at <https://www.gov.uk/government/collections/quality-assurance-tools-and-guidance-in-decc>.



QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/Initials	Date		
Check for transcription errors in data input and references	<ul style="list-style-type: none"> <li>• Confirm that bibliographical data references are properly cited in the internal documentation (see completed Template 3, Methods and Data Documentation, if applicable).</li> <li>• Cross check a sample of input data from each category (either measurements or parameters used in calculations) for transcription errors. Record the findings of these cross checks. Pay particular attention to systematic differences. Identify steps to reduce the error rate in the future. Add these improvement steps to the QA/QC development plan.</li> <li>• Utilize electronic data where possible to minimize transcription errors.</li> <li>• Check that spreadsheet features are used to minimize user/entry error:<sup>5</sup> <ul style="list-style-type: none"> <li>○ Do not “hardwire” factors into formulas.</li> <li>○ Create automatic look-up tables for common values used throughout calculations.</li> <li>○ Use cell protection so fixed data cannot accidentally be changed.</li> <li>○ Build in automated checks, such as computational checks for calculations, or range checks for input data, mass balance</li> </ul> </li> </ul>				

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<sup>5</sup> The guidance at <https://www.gov.uk/government/collections/quality-assurance-tools-and-guidance-in-decc> may prove useful



QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/Initials	Date		
	<p>checks, internal consistency checks within and between spreadsheets.</p> <ul style="list-style-type: none"> <li>○ Ensure spreadsheets have clear instructions for updating and a description of how the spreadsheet works.</li> <li>○ Ensure spreadsheets include a record of how they have been implemented and checked.</li> </ul>				
Check that emissions/removals are calculated correctly	<ul style="list-style-type: none"> <li>● Reproduce a representative sample of emissions/removals calculations.</li> <li>● If higher-tier methods or models are used, selectively reproduce complex model calculations with abbreviated calculations to judge relative accuracy. This could be done using IPCC Tier 1 methods.</li> <li>● In all cases, record the work done and the findings. Record any improvements identified (in the appropriate Templates, if applicable).</li> </ul>				
Check that parameter and emission/removal units are correctly recorded and that appropriate conversion factors are used	<ul style="list-style-type: none"> <li>● Check that units are properly labeled in calculation sheets and the completed Template 3, Methods and Data Documentation, if applicable.</li> <li>● Check that units are correctly carried through from beginning to end of calculations.</li> <li>● Check that conversion factors are correct.</li> <li>● Check that temporal and spatial adjustment factors are used correctly.</li> </ul>				
Check the integrity of database files	<ul style="list-style-type: none"> <li>● Confirm that the appropriate data processing steps are correctly represented in the database.</li> <li>● Confirm that data relationships are correctly represented in the database.</li> </ul>				



QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/ Initials	Date		
	<ul style="list-style-type: none"> <li>Ensure that data fields are properly labeled and have the correct design specifications.</li> <li>Ensure that adequate documentation of database and model structure and operation are archived.</li> </ul>				
Check for consistency in data between categories	<ul style="list-style-type: none"> <li>Identify parameters (e.g., activity data, constants) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emissions/removals calculations.</li> <li>If using Excel, establish a “master set” of constants that all spreadsheets refer to rather than a set of constants in each spreadsheet.</li> </ul>				
Check that the movement of inventory data among processing steps is correct	<ul style="list-style-type: none"> <li>Check that emissions/removals data are correctly aggregated from lower reporting levels to higher reporting levels when preparing summaries.</li> <li>Check that emissions/removals data are correctly transcribed between different intermediate products.</li> </ul>				
Check that confidential data are appropriately protected	<ul style="list-style-type: none"> <li>Check that only the GHG inventory compilation team can handle/access confidential data.</li> <li>Check that such data are reported in compliance with requirements agreed on with the data source (if applicable).</li> </ul>				
Check that uncertainties in emissions and removals are estimated and calculated correctly.	<ul style="list-style-type: none"> <li>If using expert judgement, check that qualifications of individuals providing expert judgement for uncertainty estimates are appropriate.</li> <li>Check that qualifications, assumptions and expert judgements are recorded.</li> <li>Check that calculated uncertainties are complete and calculated correctly.</li> </ul>				



QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/Initials	Date		
	<ul style="list-style-type: none"> <li>If necessary, duplicate uncertainty calculations on a small sample of the probability distributions used by Monte Carlo analyses (for example, using uncertainty calculations according to Approach 1).</li> </ul>				
<b>Data Documentation</b>					
Review internal documentation and archiving	<ul style="list-style-type: none"> <li>Check that there is detailed internal documentation to support the estimates and enable duplication of calculations, using completed Template 3, Methods and Data Documentation, if applicable.</li> <li>Check that every primary data element has a reference for the source of the data (via cell comments or another system of notation).</li> <li>Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review.</li> <li>Check that the archive is closed and retained securely following completion of the inventory.</li> <li>Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation.</li> </ul>				
<b>Calculation Checks</b>					
Check methodological and data changes resulting in recalculations	<ul style="list-style-type: none"> <li>Check for temporal consistency in time series input data for each category.</li> <li>Check for consistency in the algorithm/method used for calculations throughout the time series.</li> <li>Reproduce a representative sample of emission/removal calculations to ensure mathematical correctness.</li> </ul>				



QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/Initials	Date		
Check time series consistency	<ul style="list-style-type: none"> <li>• Check for temporal consistency in time series input data for each category.</li> <li>• Check for consistency in the algorithm/method used for calculations throughout the time series.</li> <li>• Check methodological and data changes resulting in recalculations.</li> <li>• Check that the effects of mitigation activities have been appropriately reflected in time series calculations. Higher IPCC methodologies might be needed to accurately capture the effects of mitigation activities</li> </ul>				
Check completeness	<ul style="list-style-type: none"> <li>• Confirm that estimates are reported for all categories and for all years from the appropriate base year over the period of the current inventory.</li> <li>• For subcategories, confirm that the entire category is being covered.</li> <li>• Confirm that if an emissions or removal estimate is omitted for any given category, documentation to explain or clarify the omission is included, and notation keys are used for that category. (This may include categories that were also omitted from the previous inventory.)</li> <li>• Provide clear definitions of “Other” type categories.</li> <li>• Check that known data gaps that result in incomplete category emissions/removals estimates are documented, including qualitative evaluation of the importance of the estimate in relation to total net emissions (e.g., subcategories classified as “not estimated”).</li> </ul>				



QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/Initials	Date		
Trend checks	<ul style="list-style-type: none"> <li>For each category, compare current inventory estimates to previous estimates, if available (e.g., archived Template 2). If there are significant changes or departures from expected trends, re-check estimates and explain any differences. Significant changes in emissions or removals from previous years may indicate possible input or calculation errors.</li> <li>Check value of implied emission factors (aggregate emissions/removals divided by activity data) across time series to confirm that changes in emissions or removals are being reported.</li> <li>Check if there are any unusual or unexplained trends in activity data or other parameters across the time series.</li> </ul>				
Source: The checks identified are from the 2006 IPCC Guidelines for National GHG Inventories.					

**STEP 4. Category-specific QC procedures for source/sink category leads to follow**

*Category-specific QC complements general inventory QC procedures. Category-specific QC focuses on specific types of data used in the methods for individual source or sink categories. These procedures require category-specific knowledge, and knowledge of the types of data available and parameters associated with emissions or removals. For future UNFCCC reporting, countries should apply category-specific QC procedures for key categories (See Template 5. Key Category Analysis) and for those individual categories in which significant methodological changes and/or data revisions have occurred in accordance with the 2006 IPCC guidelines and as resources allow.*

- Table 4-4, below, lists the category-specific QC procedures that should be performed.*



- *The Procedures column includes a description of activities that could be done as part of each QC activity. It is not necessary to complete all of these tasks, but you are encouraged to ensure that as many of them as possible are completed. Volume 1, Chapter 6.6 of the 2006 IPCC Guidelines provides further useful guidance.*
- *Modify these activities and their associated procedures as needed, and add as many rows as necessary.*
- *Replicate the table for as many categories as required.*
- *For each procedure, record the name of the person responsible for the item and the date of completion.*

**Table 4-4: Category-specific QC Procedures**

Category code and name: Note "KC" if it is a key category					
QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/ Initials	Date		
<b>Emission Factor QC</b>					
Assess the applicability of IPCC default emission factors	<ul style="list-style-type: none"> <li>• Evaluate whether national conditions are similar to those used to develop the IPCC default factors.</li> <li>• Compare default factors to site or plant-level factors.</li> <li>• Consider options for obtaining country-specific factors.</li> <li>• Document results of this assessment.</li> </ul>				





<p>Review country-specific emission factors</p>	<ul style="list-style-type: none"> <li>• QC the background data used to develop the country-specific factor to assess adequacy of the emission factors and the QA/QC performed during their development             <ul style="list-style-type: none"> <li>○ E.g., if based on measurement studies, did measurement program included QC procedures</li> <li>○ E.g., understand characteristics of data (e.g. completeness, etc.)</li> </ul> </li> <li>• Assess whether secondary studies used to develop country-specific factors used (at a minimum) general QC activities.</li> <li>• Compare country-specific factors to IPCC defaults; document any significant discrepancies.</li> <li>• Compare country-specific factors to site or plant-level factors.</li> <li>• Compare to factors from other countries (using UNFCCC review tools, reported factors in inventory submissions, and/or IPCC Emission Factor Database).</li> <li>• Conduct reference calculations that use stoichiometric ratios and conservation of mass and land.</li> <li>• Document results of this assessment.</li> </ul>				
<p>Review measurements</p>	<ul style="list-style-type: none"> <li>• Determine if national or international (e.g., ISO) standards were used in measurements.</li> <li>• Ensure measurement equipment is calibrated and maintained properly.</li> <li>• Compare direct measurements with IPCC or other published default factors; document any significant discrepancies.</li> </ul>				
<p><b>Activity Data QC</b></p>					



Review national-level activity data	<ul style="list-style-type: none"> <li>• Determine the level of QC performed by the data collection agency. If inadequate, consider alternative data sources such as IPCC defaults and international activity data sets (e.g., IEA, FAO). Adjust the relevant uncertainty accordingly.</li> <li>• Compare activity data from multiple references (e.g., other independently compiled data) if possible (e.g., IEA, FAO, etc.), including data time series</li> </ul>				
Review site-specific activity data	<ul style="list-style-type: none"> <li>• Determine if national or international (e.g., ISO) standards were used in collecting or generating data.</li> <li>• Compare aggregated site-specific data (e.g., production) to national statistics/data.</li> <li>• Compare data across similar sites.</li> <li>• Compare top-down and bottom-up estimates for similar orders of magnitude.</li> </ul>				
Trend checks of activity data	<ul style="list-style-type: none"> <li>• Compare data to previous year’s data and review any sharp increases or decreases.             <ul style="list-style-type: none"> <li>○ If national activity data for any year diverge greatly from the historical trend, they should be checked for errors.</li> <li>○ If a calculation error is not detected, the reason for the sharp change in activity should be confirmed and documented.</li> </ul> </li> </ul>				
QC uncertainty estimates	<ul style="list-style-type: none"> <li>• Apply QC techniques to uncertainty estimates.</li> <li>• Review uncertainty calculations.</li> <li>• Document uncertainty assumptions and qualifications of any experts consulted.</li> </ul>				

**GHG Estimate QC/Verification**



Verify GHG estimates	<ul style="list-style-type: none"> <li>• Compare estimates to other independently compiled national estimates as available.</li> <li>• If using higher-tier methods or models, apply lower-tier methods (e.g., Energy sector comparison of reference and sectoral approach).</li> <li>• Compare intensity indicators between countries</li> <li>• Document, report, and archive verification findings and any further actions (e.g., additional QC, improvement plans).</li> </ul>				
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### STEP 5. Document recommendations received as a result of experts' QA activities

- *Quality Assurance involves expert reviewers not involved in preparing the inventory, and a basic peer review process. QA activities follow QC activities and complement QC activities.*
- *Expert review offers the opportunity to uncover technical issues related to the application of methodologies, selection of activity data, and development and choice of emission factors. The comments of the expert reviewers should be reviewed and addressed, as appropriate, prior to the submission of the Inventory, and documented/archived appropriately to ensure transparency and for reference of future compilation teams.*
- *Experts should be independent of the inventory agency, and affiliated with other national agencies, research facilities, international organizations, or other organizations with relevant expertise in GHG emission estimation methodologies, activity data, or other parameters. If third party reviewers are unavailable, staff from another part of the inventory agency not involved in the portion of the inventory under review can fulfill this role.*
- *Key categories (as outlined in Template 5) should be given priority for review, as well as source categories where significant changes in methodology or data have been made.*
- *The annex to this template provides a template you may use to instruct external reviewers (i.e., for expert elicitation).*
- *Using Table 4-5, below, identify the experts who are reviewing the GHG inventory. In the Comment Summary column, summarize experts' recommendations regarding specific improvements that could be made to the GHG inventory as a result*



*of experts' QA activities. Add major improvements identified by expert reviewers to the GHG inventory improvement plan in Template 7.*

**Table 4-5: External Reviewers**

Name	Organization	Area of Expertise	Contact Information	Date Comments Received	Comment Summary

**STEP 6. Propose GHG inventory improvements as a result of QA/QC activities**

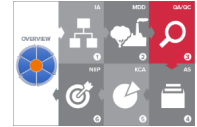
- *An important part of QA/QC activities is to use the results of these activities to identify how to improve the quality of the GHG inventory.*
- *In Table 4-6, below, describe all such potential improvements to the inventory.*
  - *Add as many rows as necessary to accommodate all potential improvements.*
  - *Instructions by column follow:*
    - *Topic: Describe the topic this improvement relates to (e.g., Institutional Arrangements, Methodology/Data, QA/QC, Communication and awareness, Other - please specify).*
    - *Category Code and Name: If the topic is "Methodology and data," please state the code and name of the category to which this improvement relates.*
    - *Issue: Concisely describe why an improvement is needed.*
    - *Relevant Inventory Quality Principle: State the relevant inventory quality principle (e.g., transparency, accuracy, completeness, consistency, or comparability).*
    - *Improvement Option: Describe the action to be taken, and how it should resolve the issue.*



- *When this table is complete, copy its contents into Template 6, National Inventory Improvement Plan.*

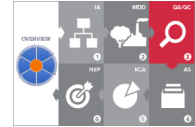
**Table 4-6: Potential Improvements to the GHG inventory**

Topic	Category Code and Name	Issue	Relevant Inventory Quality Principle	Improvement Option



### 3.1. STEP 7. QA/QC Checklists

- *This section includes three additional checklists that may help the NIC and QA/QC Coordinator track progress of the development of the overall QA/QC plan, and QA/QC activities. The checklists may be modified to suit county-specific circumstances.*
- *The checklists are:*
  1. *QA/QC Coordinator Checklist*
  2. *National Inventory Coordinator Checklist: Cross-Cutting Checks for Overall Inventory Quality*
  3. *National Inventory Coordinator Checklist: Detailed Checklist for Inventory Document*



## 1. QA/QC Coordinator Checklist

Activities	Task Completed	
	Name	Date
1. Clarify and communicate QA/QC responsibilities to inventory team members.		
2. Develop and QA/QC checklists appropriate to roles on the inventory team. (See Table 4-2 and Table 4-3 in the “QA/QC Procedures” Template for examples)		
3. Distribute QA/QC checklist to appropriate inventory team members and set deadline for completion.		
4. Ensure the timely and accurate completion of QA/QC checklists and related activities by checking in with team members.		
5. Collect completed QA/QC checklists and forms.		
6. Review completed QA/QC checklists and forms for completeness and accuracy.		
7. Deliver documentation of QA/QC activities to the inventory lead and archive coordinator.		
8. Coordinate external reviews of the inventory document and ensure that comments are incorporated into the inventory. Steps to coordinating external reviewers include: <ul style="list-style-type: none"> <li>i. Identify external reviewers (e.g. through category leads).</li> <li>ii. Set review schedule.</li> <li>iii. Establish review format (e.g., digital mark-up in Word or Excel).</li> <li>iv. Contact external reviewers informing them of the schedule and expectations.</li> <li>v. Work with NIC to distribute Inventory draft for review.</li> <li>vi. Collect and compile review comments.</li> <li>vii. Deliver compiled comments to national inventory and sector leads to address.</li> <li>viii. Update inventory, as appropriate based on comments.</li> <li>ix. Deliver compiled comments and responses to archive coordinator, to retain for reference.</li> </ul>		



## 2. National Inventory Coordinator (NIC) Checklist: Crosscutting Checks for Overall Inventory Quality

Activities	Task Completed	
	Name	Date
<b>Emission Calculations Across GHG Emission and Removal Categories</b>		
1. Identify parameters that are common across categories (e.g. conversion factors, carbon content coefficients, etc.) and check for consistency		
2. Check that calculations using same data inputs (e.g. animal population data) report comparable values (i.e., analogous in magnitude)		
3. Check across categories to ensure that same electronic data set is used for common data (e.g., linking animal population data to both enteric fermentation and manure management calculations)		
4. Check that the number of significant digits or decimal places for common parameters, conversion factors, emission factors, or activity data is consistent across categories		
5. Check that total emissions are reported consistently (in terms of significant digits or decimal places) across categories		
6. Check that emissions data are correctly aggregated from lower reporting levels to higher reporting levels		
7. Other (specify):		
<b>Documentation</b>		
8. Check if internal documentation practices are consistent across categories		
9. Other (specify):		
<b>Completeness</b>		
10. Check for completeness across categories and years		
11. Check that data gaps are identified and reported as required		
12. Compare current national inventory estimates with previous years'		
13. Other (specify):		
<b>Maintaining Master Inventory File: Spreadsheets and Inventory Document</b>		
14. Follow file control procedures		
15. Other (specify):		





### 3. National Inventory Coordinator (NIC) Checklist: Detailed Checklist for Inventory Document

Activities	Task Completed	
	Name	Date
<b>Front Section</b>		
1. Cover page has correct date, title, and contact address		
2. Tables of contents, tables, and figures are accurate: titles match document, page numbers match; numbers run consecutively and have correct punctuation		
3. The Executive Summary and Introduction are updated with appropriate years and discussion of trends		
4. Other (specify):		
<b>Tables and Figures</b>		
5. All numbers in tables match numbers in spreadsheets		
6. Check that all tables have correct number of significant digits		
7. Check alignment in columns and labels		
8. Check that table formatting is consistent		
9. Check that all figures are updated with new data and referenced in the text		
10. Check table and figure titles for accuracy and consistency with content		
11. Other (specify):		
<b>Equations</b>		
12. Check for consistency in equations		
13. Check that variables used in equations are defined following the equation		
14. Other (specify):		
<b>References</b>		
15. Check consistency of references, and that citations in text and references match		
16. Other (specify):		
<b>General Format</b>		
17. All acronyms are spelled out first time and not subsequent times throughout each chapter		
18. All fonts in text, headings, titles, and subheadings are consistent		
19. All highlighting, notes, and comments are removed from document		
20. Size, style, and indenting of bullets are consistent		
21. Spell check is complete		
22. Other (specify):		
<b>Other Issues</b>		
23. Check that each section is updated with current year (or most recent year that inventory report includes)		
24. Other (specify):		



## Annex – Expert Review Elicitation Template

The text below can be used to instruct external experts to ensure a focused review. This complements guidance in 2006 IPCC Guidelines, Volume 1, Chapter 2: Data Collection.

DATE: [insert]

TO: [insert]

FROM: [insert]

SUBJECT: Expert Review Process for [insert starting year of time series] – [insert last year of time series] Draft Inventory of [insert the name of your country]'s Greenhouse Gas Emissions and Removals

### Introduction

Thank you for your interest in providing input during the expert review process of the [insert starting year of time series] – [insert last year of time series] Draft Inventory of [insert the name of your country]'s Greenhouse Gas Emissions and Removals. Per the email [insert email address used or name of staff member who sent the email] previously sent you on [insert date of email] regarding the targeted approach for this year's expert review process, you have been identified as an expert who may wish to submit comments on this early draft of the [insert sector(s) or categories to be reviewed]. Please note that the deadline for submitting comments is [insert the deadline by which review comments should be submitted].

To facilitate your review and indicate where input would be helpful, this year's expert review includes charge questions. While these charge questions are designed to assist both reviewers and the inventory team in conducting a more targeted expert review, comments outside of the charge questions are also welcome.

### Categories to be reviewed

[In case not all categories included in the report are ready for review, clarify which categories are to be reviewed, ideally in the form of a bulleted list or table]

### Relevant Updates

[Where relevant methodological updates have been applied to any categories to be reviewed, list these and clarify what the main updates are in the following format:

- Category Code – Category Name – Change (e.g. new category included, moved to tier 2 approach for activity data)
- Example: 2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production – New source category included in draft 1990-2016 Inventory (emissions from this category range from 1.6 to 2.2 MMT CO<sub>2</sub>e across the time-series). ]

**Request for Expert Feedback for the [insert starting year of time series] – [insert last year of time series] [insert the sector to be reviewed] Chapter**

### General



1. Please provide your overall impressions of the transparency of [insert relevant sector(s) or categories].
2. Please provide any recommendations of improvements that [insert national GHG inventory agency] can consider to improve the completeness and/or accuracy of [insert relevant sector(s) or categories].
3. For the source categories included in the expert review draft, is the state of [insert relevant sector(s) or categories] current and accurately described? Are there technologies, practices, or trends that [insert national GHG inventory agency] should consider?

### **Source/Sink-Specific**

*[List category specific questions. Some potentially relevant examples are below.]*

1. With the inclusion of a new IPPU source category, we request feedback on the overall chapter text, assumptions, and information on the state of the industry for the following category:
  - o Caprolactam, Glyoxal and Glyoxylic Acid Production
2. Please provide input on:
  - o Data sources and industry information on production of calcium carbide.
  - o Data on carbonate use in non-metallurgical magnesium production.
  - o Data on carbonate use in the production of ceramics.
  - o Recent/alternative production statistics for various N<sub>2</sub>O product use subcategories listed within the Nitrous Oxide from Product Uses source chapter
3. We seek comments on assumptions applied to determine the split between primary and secondary aluminium production based on information published by the national statistical offices. Are other options/data sources available to distinguish between process production totals? ]

### **Submitting Feedback**

We look forward to receiving your feedback. Please send comments and feedback to [insert staff member and/or email-address] by [insert due date].

Please do not submit by email any information that may be confidential business information (CBI), proprietary information, or information that may otherwise be protected. If you wish to provide this type of information, please contact [insert staff member name and email-address] prior to providing protected information.

Please note that [insert national GHG inventory agency] may post submitted expert review comments without change and make expert reviewer names and credentials available online; however, individual names will not be attributed to their comments.