QA/QC and verification reporting requirements and their application in review of national greenhouse gas inventories

This paper has been commissioned by the secretariat of the United Nations Framework Convention on Climate Change and was prepared by Ms. Olia Glade for the "Refresher seminar for experienced GHG inventory reviewers" held on 13 March 2019 in Bonn, Germany. The information contained in this paper was prepared by the author, although in some instances the secretariat introduced modifications.

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I. Purpose and scope

1. The objective of this paper is to provide an analysis of the review issues on QA/QC and verification on the basis of experience gained during the reviews that have applied the UNFCCC Annex I inventory reporting guidelines[1] and 2006 IPCC Guidelines. Using that analysis, the paper identifies potential improvements to the process of reviewing QA/QC and verification in terms of:
    - Consistency between ERTs in assessing potential issues;
    - Transparency of recommendations and their usefulness to the reviewed Parties;
    - Understanding when QA/QC and verification issues may lead to Saturday papers.
2. This paper serves primarily as an analytical input to the "Refresher seminar for experienced reviewers for the greenhouse gas inventories submission by Annex I Parties" to be held on 13 March 2019 in Bonn, Germany. It aims to share the understanding by lead reviewers and experienced reviewers of the challenges of and approaches for consistency and transparency when assessing QA/QC and verification reported in Parties' GHG inventories.
3. The analysis covers ten paragraphs of the UNFCCC Annex I inventory reporting guidelines which, in some cases, contain multiple mandatory and non-mandatory reporting requirements in a single paragraph, namely:
    - paragraph 19, on elaboration and implementation of the QA/QC plan;
    - paragraph 21(b) on national inventory arrangements, including QA/QC and verification activities;
    - paragraph 23(a–c) on allocating specific QA/QC responsibilities and incorporating them in the QA/QC plan;
    - paragraph 24 on the use of information from the implementation of the QA/QC programme when developing or revising the QA/QC plan and quality objectives;
    - paragraph 25(f) on implementing general QC procedures in accordance with the QA/QC plan;
    - paragraph 26(a-d) on applying category-specific QC procedures for key categories;
    - paragraph 27(a) on internal documentation of QA/QC procedures;
    - paragraph 46 on reporting the QA/QC plan in the NIR;
    - paragraph 50(j) on the inclusion of information on the national inventory arrangements and changes to the national inventory arrangements, including information on QA/QC;
    - paragraph 58 on archiving relevant inventory information, including documentation related to QA/QC implementation.
4. The analysis also covers ten paragraphs of the reporting guidelines on greenhouse gas inventories under the Kyoto Protocol (decision 19/CMP.1) that contain mandatory and non-mandatory reporting requirements related to the QA/QC and verification in the context of national systems, namely:
    - paragraph 7, on national system characteristics;

[1] "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories". Decision 24/CP.19. FCCC/CP/2013/10/Add.3.

- paragraph 12(c) on defining specific responsibilities in relation to the QA/QC plan;
- paragraph 12(d) on elaborating a QA/QC plan;
- paragraph 12(e) on establishing a process for the official consideration and approval of the inventory;
- paragraph 13 on improving inventory quality through implementation of the QA/QC programme;
- paragraph 14(g) in conjunction with decision 4/CMP.11, paragraph 3(b) on implementing general QC procedures (tier 1) in accordance with the 2006 IPCC Guidelines;
- paragraph 15(a) in conjunction with decision 4/CMP.11, paragraph 3(b) on applying category specific QC procedures (tier 2) in accordance with the 2006 IPCC Guidelines
- paragraph 15(b) on basic review of the inventory by personnel not involved in inventory development;
- paragraph 15(c) on providing a more extensive review of the inventory key categories;
- paragraph 15(d) on periodic internal evaluations of the inventory preparation process;
- paragraph 16(a) on archiving inventory information.

5. In addition, some paragraphs from decision 13/CP.20 were used in of the development of this paper. In particular, paragraphs 74–76 that state the ERT tasks for the different forms of reviews and paragraph 95(d) regarding a mandatory requirement to include in the ARR "An assessment of the overall organization of the national inventory arrangements, including a discussion on the effectiveness and reliability of the institutional, procedural and legal arrangements for estimating GHG emissions".

6. The paper includes analysis of the good practices suggested in the 2006 IPCC Guidelines related to reporting QA/QC and verification (vol. 1, chapter 6) in conjunction with the reporting requirements under the Convention and the Kyoto Protocol, and includes some QA/QC review statistics based on the ARRs from the 2017 inventory review cycle.

7. Chapter I of this paper introduces its background, purpose and scope. Chapter II provides the definitions of quality assurance, quality control and verification issues, describes the approach to their assessment during the review process and discusses the results of the 2017 inventory review cycle in relation to QA/QC and verification issues. All examples of recommendations made by ERTs in ARRs during the 2017 inventory review cycle relevant to this analysis are provided without explicitly mentioning Parties' names. Chapter III provides information on mandatory and non-mandatory requirements associated with reviewing QA/QC and verification under the Convention and its Kyoto Protocol and describes how the good practices for QA/QC and verification included in the 2006 IPCC Guidelines relate to those modalities, including those for general QA/QC and verification procedures and those associated with higher-tier methods. Chapter IV outlines the conclusions of the analysis and presents some points for consideration by lead reviewers.

II. Definitions of QA/QC issues and verification, and the approach to their assessment during the review

Box 2-1: Definitions for quality control, quality assurance and verification[2]

DEFINITIONS

Quality Control (QC) is a system of routine technical activities to assess and maintain the quality of the inventory during its compilation. It is performed by personnel compiling the inventory. 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 and removal calculations, measurements, estimating uncertainties, archiving information and reporting. QC activities also include technical reviews of categories, activity data, emission factors, other estimation parameters, and methods.

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

Verification refers to the collection of 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 the purposes of this guidance, 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. Verification activities may be constituents of both QA and QC, depending on the methods used and the stage at which independent information is used.

8. According to the IPCC definition, QC is a process that addressed designing, planning, and implementing multiple procedures that help the Parties to ensure the quality of their inventories in terms of transparency, accuracy, comparability, consistency and completeness (TACCC):
   - the Party elaborated a QA/QC plan;
   - the Party made relevant arrangements for the QA/QC and verification process to work;
   - the QA/QC and verification process worked as intended;
   - the Party documented information associated with its QA/QC and verification system and included that information in the NIR, as required by the UNFCCC Annex I inventory reporting guidelines.
9. Further assessment of QA/QC and verification is conducted on the basis of the analysis of the effectiveness of the QA/QC and verification processes and procedures, and identification of

[2] 2006 IPCC Guidelines (vol. 1, chapter 6). Available at https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_6_Ch6_QA_QC.pdf.

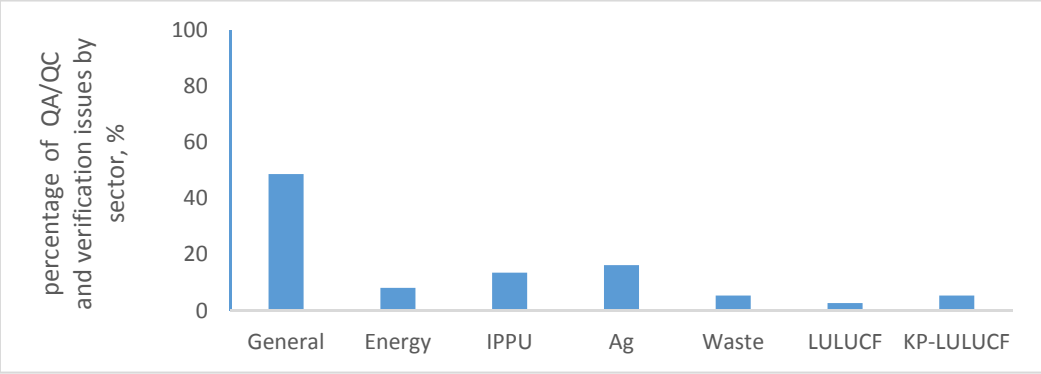
whether the faults in the design and implementation of the QA/QC and verification process are associated with problems in the national system.

10. In keeping with the outline and general structure of the NIR presented in the UNFCCC Annex I inventory reporting guidelines, most Annex I Parties include the description of their QA/QC and verification process and relevant arrangements in chapter 1 of the NIR and the category-specific QA/QC arrangements in the relevant sectoral chapters of the NIR. In addition, in the 2017 review cycle some Parties (e.g. New Zealand and Monaco) also included supplementary information on their QA/QC plan and arrangements in annexes to their NIRs.

Current status of QA/QC and verification issues identified by the ERT

11. The analysis of published ARRs from the 2017 inventory review cycle found that there are still a large number of QA/QC and verification issues present in the inventories of Annex I Parties. The ERTs identified 97 QA/QC and verification issues across the 21 ARRs reviewed. Only one Party did not have QA/QC and verification issues in 2017; 57 per cent of the Parties had the same QA/QC and verification issues reappearing in three or more consecutive years (as noted in table 4 of the ARRs). A large number of the QA/QC and verification issues (45 per cent) were assessed to be "not resolved" or in a state of "addressing" from the previous review cycles (as noted in ARRs, table 3). An additional 21 per cent of QA/QC and verification issues were among the new ERT findings. Most of the newly found issues (49 per cent) were reported as cross-sectoral; among different sectors, the most QA/QC issues were found in the agriculture sector (16 per cent) followed by the IPPU sector (14 per cent) (see figure 1.1 below).

Figure 1.1: Distribution of QA/QC and verification issues, by sector, in the 2017 review cycle



12. Analysis of tables 2–6 of the ARRs from the 2017 review cycle also found that the ARR template was not used consistently by ERTs, and many individual ARRs lacked internal inconsistency in presenting QA/QC and verification issues. Among the 21 ARRs that were used for this analysis, 81 per cent showed possible inconsistencies between table 2 and tables 3–6. Typically, paragraph 1(h) "QA/QC" in table 2 of an ARR stated, "QA/QC procedures were assessed in the context of the national system, see paragraph 2 of table 2". However, based on the review of the 2017 ARRs, many ERTs considered QA/QC issues as not related to the national system, because they were rarely referred to in paragraph 2(a) and (b) in table 2 of the ARR template.

QA/QC and verification assessment under the different review forms: desk, centralized and in-country reviews

13. According to the UNFCCC review guidelines, examining QA/QC and verification procedures is in the scope of all review types under the Convention,[3] (centralized, in-country and desk reviews:

[3] "Guidelines for the technical review of information reported under the Convention related to greenhouse gas inventories, biennial reports and national communications by Parties included in Annex I to the Convention", decision 13/CP.20, FCCC/CP/2014/10/Add.3.

decision 13/CP.20, paragraphs 74–76). The UNFCCC review guidelines also emphasize that ERTs conducting in-country reviews will consider the 'paper trail' of the inventory from the collection of data to the reported emission estimates and will examine procedures and institutional arrangements for inventory development and management, including QA and QC, record-keeping and documentation procedures (paragraph 74). Although only some paragraphs (e.g. paragraphs 74 and 75(b)) provide a direct reference to assessing QA/QC, the entire contents of paragraphs 74–76 can be used by ERTs as guidance when assessing different aspects of QA/QC and verification. In addition, paragraph 95(d) provides guidance on recording the relevant findings in the ARR. Table 2.0 below shows the differences in relation to assessment of QA/QC and verification for the different review formats and indicates the relevance of each included paragraph to assessing QA/QC and verification.

Table 2.0 Approaches to reviewing QA/QC and verification for different review formats

Ref	***Review tasks: decision 13/CP.20***	***Review formats and relevance to potential QA/QC and verification issues:***		
		Desk review	***Centralized review***	***In-country review***
75a	Examine application of the requirements of the UNFCCC Annex I inventory reporting guidelines and any further guidance adopted by the COP, and, if applied, the Wetlands Supplement, and identify any departure from these requirements	For key categories; addressing the previous recommendations	For all categories For the relevant QA/QC and verification requirements ref to tables 3.1 and 3.2 below	
75b	Examine whether the 2006 IPCC Guidelines as implemented through the UNFCCC Annex I inventory reporting guidelines and any supplementary methodologies adopted by the COP and, if applied, the Wetlands Supplement was applied and documented, in particular noting the identification of key categories, selection and use of methodologies and assumptions, development and selection of emission factors, collection and selection of activity data, reporting of recalculations and consistent time series, reporting of uncertainties related to inventory estimates, methodologies used for estimating those uncertainties and QA/QC procedures, and identify any inconsistencies	For key categories; addressing the previous recommendations	For all categories For the list of the relevant IPCC good practice see table 3.5 below	
75c	Compare emission or removal estimates, activity data, implied emission factors and any recalculations with data from previous submissions of the Annex I Party to identify any irregularities or inconsistencies	For key categories; addressing the previous recommendations	For all categories Analysis of potential QA/QC issues associated with the TACCC and adherence to the UNFCCC Annex I inventory reporting guidelines	
75d	Identify any missing categories and examine any explanatory information relating to their exclusion from the GHG inventory	For key categories; addressing the previous recommendations	For all categories Analysis of potential TACCC-associated QA/QC issues	
75e	Assess the consistency of information in the CRF tables with that in the NIR	For key categories; addressing the previous recommendations	For all categories Analysis of potential TACCC-associated QA/QC issues	
75f, 76a	Assess the extent to which issues raised in the initial assessment of annual inventories, and issues and questions raised by ERTs in previous reports, have been addressed and resolved. The ERT shall assess information on changes in response to recommendations from the previous ERT, which may include the progress made in implementing improvements taking into consideration the publication date of the previous review report and national circumstances	For all categories Analysis of potential QA/QC issues associated with the TACCC and adherence to the UNFCCC Annex I inventory reporting guidelines Assess whether potential QA/QC issues have occurred in the previous submissions Assess progress made by the Party in resolving previously noted QA/QC and verification issues		
75g	Where applicable, identify areas for further improvement of the inventories taking into account, inter alia, paragraph 73 above and note possible ways for improving the estimation and the reporting of inventory information	For key categories; addressing the previous recommendations*	For all categories Identify the issues associated with the design and implementation of the QA/QC plan and the inventory	

			documentation associated with QA/QC and verification	
75h	Assess whether the national inventory arrangements for the estimation of anthropogenic GHG emissions by sources and removals by sinks are performing the required functions and facilitating the continuous improvement of the GHG inventory	For key categories; addressing the previous recommendations*	For all categories Consider if the QA/QC findings point at the problems with the national system (see tables 3.2 and 3.3 below)	
75i	Whether all emissions are reported without corrections relating, for example, to climate variations or trade of electricity	For key categories; addressing the previous recommendations	For all categories Analysis of potential TACCC-associated QA/QC issues	
74	In addition to the tasks mentioned in paragraph 75, ERTs conducting in-country reviews will consider the 'paper trail' of the inventory from the collection of data to the reported emission estimates and will examine procedures and institutional arrangements for inventory development and management, including QA and QC, record-keeping and documentation procedures.	No	No	For all categories In-depth analysis of Party's QA/QC documentation associated with all types of QA/QC and verification issues
76b	Analyse any recalculations that have changed the emission/removal estimate for a category by more than 2 per cent and/or national total emissions by more than 0.5 per cent as provided in the CRF tables for any of the recalculated years and assess the reasons provided by the Annex I Party for the recalculations and improvements performed as well as the consistency of the revised estimates with the 2006 IPCC Guidelines as implemented through the UNFCCC Annex I inventory reporting guidelines	For all categories	as for paragraphs 75(b) and (c)	
95d	An assessment of the overall organization of the national inventory arrangements, including a discussion on the effectiveness and reliability of the institutional, procedural and legal arrangements for estimating GHG emissions shall be included in the individual review report	Consider whether the QA/QC findings point at the problems with the national system (see tables 3.2 and 3.3 below)		

*Although the review of these elements is not a priority in desk reviews, in accordance with paragraph 76, they should be addressed for key categories.

QA/QC and verification issues identified by the ERTs

14. The analysis of ARRs from the 2017 review cycle found that QA/QC and verification issues mostly result from one or more of the following key underpinning problems:

    - missing key elements in the QA/QC plan;
    - the QA/QC plan is established, but only partially implemented;
    - the QA/QC plan is designed and implemented, but not documented appropriately and not transparently described in the inventory.

15. Section 6.5 of the 2006 IPCC Guidelines describes key elements of the QA/QC plan[4] (box 2-1 below).

[4] Please note the difference in meaning of "should" between IPCC guidance and UNFCCC guidelines. In IPCC guidance, "should" means that the item is important for the inventory and, therefore, needs to be addressed (or included). In UNFCCC guidelines, "should" signifies a non-mandatory requirement.

Box 2-1: key elements of the QA/QC and verification plan

According to the 2006 IPCC Guidelines, the key elements of the plan should include:

- an outline of QA/QC and verification activities that will be implemented
- institutional arrangements
- roles and responsibilities for implementing the activities
- a scheduled time frame for the QA/QC activities that follows the inventory preparation from its initial development through to final reporting in any year
- data quality objectives (concrete targets to be achieved in the inventory preparation)

16. For a reviewer, having a clear understanding of the underpinning problems of the potential QA/QC and verification issues (i.e. whether they relate to design, implementation of the QA/QC plan, or documentation associated with the QA/QC and verification process) will mean that the associated recommendation or encouragement will be described correctly and will be fit for purpose. For a Party, being aware of fundamental barriers for conducting effective and efficient QA/QC measures makes it easier to identify the underlying problems and apply the most efficient and effective course of action in order to resolve the issue or problem, or implement an encouragement, and adjust the national system accordingly.

17. When a QA/QC and verification system is not well designed, a Party's QA/QC plan may miss some important checks and tests; QC process deliverables may not be identified (or missing); lines of responsibility and approvals for the QA/QC process may not be clearly defined and, therefore, the relevant procedures may not be adequately resourced. It means that even if the Party implemented its QA/QC plan, the inventory will manifest a number of systemic issues because the problem lies in the plan itself. Furthermore, itis likely that the resulting quality issues will manifest in several consecutive submissions.

18. The ERT can identify an issue related to the QA/QC process design through:

    - a review of the QA/QC plan description in the NIR (usually, in chapter 1, but it also can be in annexes);
    - questions to the Party related to specific elements of the QA/QC plan and analysis of the Party's documentation that is not included in the NIR, but provided by the Party during the review (e.g. the Party may be asked to provide a copy of its QA/QC plan or documentation of implemented QC checklists for consideration by the ERT);
    - analysis of QA/QC-related recommendations in tables 3 and 4 of the previous ARR because associated issues may be systemic and therefore are likely to appear in consecutive NIR submissions;
    - analysis of the new issues in the inventory based on any systemic manifestation across inventory sectors and relationships to the same element of the QA/QC plan (e.g. a check or an approval procedure).

    If an ERT's finding is associated with an omission in the QA/QC plan and/or problems with its design, the ARR could include a relevant recommendation or an encouragement to include the missing element in the QA/QC plan. The associated issue type could be described as 'adherence to the UNFCCC Annex I inventory reporting guidelines'.

19. If a Party is reviewed under the Kyoto Protocol and a QA/QC and verification design issue is related to provision of a description of the relevant inventory arrangements, the ERT could describe the

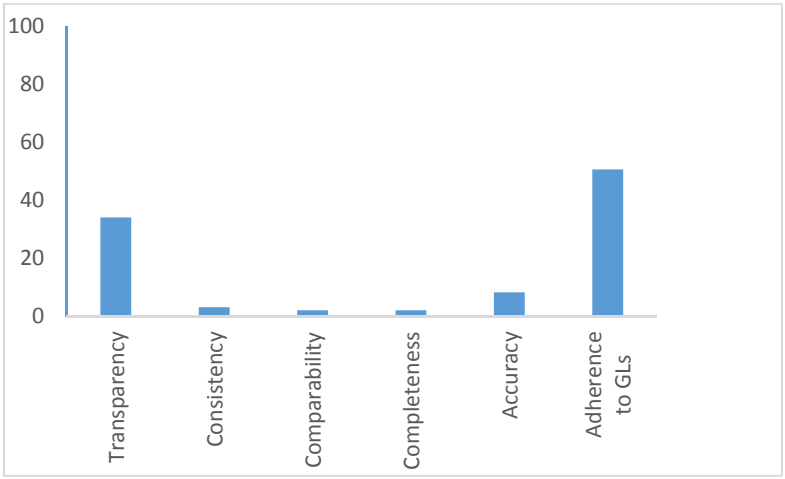
finding in the ARR as being related to the national system and the issue type as 'adherence to reporting guidelines under Article 7, paragraph 1'. In the review under the Kyoto Protocol, a finding on lack of transparency associated with roles and responsibilities for the inventory in relation to QA/QC and verification should be described as being related to the national system and classified as a transparency issue in the ARR.

20. The third source of QA/QC issues are those related to lack of documentation of QA/QC processes and procedures and lack of details on the QA/QC plan in the NIR. The ERT can identify this type of QA/QC issue through analysis of the NIR and clarifying questions to the Party. In case of an in-country review, the ERT can also request to view the records, forms and reports associated with the details of the QA/QC plan. The resulting recommendations and encouragements in relation to this type of QA/QC finding should reflect the importance of archiving and documentation of the inventory data and information, and should recommend including the relevant materials (or the references) in the inventory submission.

21. The issues that result from the partial implementation of the QA/QC plan could be very similar to those resulting from omission of the plan's element(s) in a sense that such an issue will be systemic and, most likely, repeated in consecutive submissions. The difference between these issues and those associated with design and implementation is that, in case of an implementation problem, the specific element (or elements) of the QA/QC plan does not function as expected because it is not fully implemented in the inventory. This usually results in associated TACCC issues that would not have occurred if the QA/QC plan had been fully implemented. The actions taken by the ERT in order to identify the source of the problem would be similar to those described in paragraph 15–17 above; however, the final recommendation should reflect that the relevant procedure is already included in the QA/QC plan, but it needs to be implemented in the inventory.

22. As shown in figure 1.2 below, the analysis of ARRs for 2017 review cycle found that QA/QC issues can be linked with any of the TACCC issue types, as well as being associated with adherence to the UNFCCC Annex I inventory reporting guidelines. However, the analysis suggests that it is most likely that QA/QC and verification issues (51 per cent) are associated with adherence to the applicable reporting guidelines. A significant portion of the QA/QC and verification issues are associates with transparency of the inventory (34 per cent) followed by accuracy (8 per cent). Other QA/QC issues were evenly spread between comparability, consistency and completeness (2–3 per cent each).

Figure 1.2. How QA/QC and verification issues were classified in the ARRs in relation to TACCC and adherence to the applicable reporting guidelines



23. Tables 2.1–2.5 below provide examples of the sources for TACCC-related issues with the QA/QC component from the ARRs analysed, relevant statements from the Parties and associated recommendation statements. The first column (Issue manifestation) briefly outlines the ERT finding, the second column (Party's response) provides the essence of what that Party provided in response to the ERT questions during the review, and the last column (Recommendation component) shows what the ERT recommended. In tables 2.1 – 2.5, Parties' names are not included; sector-specific technical details that do not relate to QA/QC and verification are also not included. For each issue group in tables 2.1–2.5, the issue manifestation is primarily one of TACCC. However, the ERT recommendation also suggests that if a Party applies or strengthens relevant QA/QC procedures, the associated underpinning problem could be resolved during inventory preparation, so the issue may not occur. The appropriateness of those recommendations on QA/QC and verification, in light of the UNFCCC Annex I inventory reporting guidelines and the 2006 IPCC Guidelines is discussed below (paragraphs 24–28).

24. According to the 2006 IPCC Guidelines, a QA/QC and verification system contributes to the objectives of good practice in inventory development, namely to improve transparency, consistency, comparability, completeness and accuracy of national greenhouse gas inventories. During the review, the ERT should take special care to find out if a Party can improve on the TACCC of its inventory through applying relevant QA/QC and verification procedures by updating the QA/QC plan accordingly. If this is the case, ERTs often include a QA/QC and verification component in the recommendation associated with the TACCC-related issues in the sector-specific parts of the ARR. For example, if a Party's inventory manifested entry errors for its activity data in a particular sector, following the issue description, the ARR may include a recommendation that the Party "correct the AD for <category> in the CRF tables and strengthen the QA/QC procedures to avoid similar data entry errors".

25. Although combining TACCC and QA/QC components in one recommendation could make Parties aware of the need to improve their QA/QC processes and procedures, it would also increase the number of repetitive QA/QC recommendations and encouragements without pointing at the underpinning QA/QC problems. This may diminish the impact of the QA/QC component of the recommendation and increase the risk of the QA/QC component being overlooked by the Party, because recommendations worded in that way do not make clear how deep the QA/QC issues lie and whether they are incidental or systemic. Furthermore, this approach can create inconsistencies between the reports produced by different ERTs. To make recommendations more meaningful to the Party and more consistent across the review teams, when assessing the TACCC-associated QA/QC issues, the ERT should consider both the type and the depth of the issue – that is, whether the QA/QC issues associated with the TACCC are incidental or systemic. For systemic issues, the ERT should also assess whether the issues occur at the sectoral level or across several sectors (the inventory level).

26. If the ERT concluded that a potential TACCC-associated QA/QC issue (e.g. an incorrect reference or use of in appropriate default emission factor) is not systemic, the relevant recommendation could be focused on correcting the erroneous entries without including a specific QA/QC component such as "to improve the QA/QC procedure" in the ARR.

27. If a TACCC-associated QA/QC issue occurs at the sectoral level, the ERT may consider including one overarching QA/QC recommendation addressing QA/QC as a theme that manifested in multiple TACCC-related issues, rather than including a repetitive QA/QC component in multiple TACCC recommendations. The overarching recommendation at a sectoral level should use "general" as a finding classification. The issue description should include references to particular issue ID#s within the sector in order to give examples of the issue manifestation and its effect on the inventory quality. The ERT should also apply the relevant TACCC classifier describing the impact of the issue. QA/QC issues that affect transparency should be classified as "transparency", those affecting accuracy of the reported emissions and removals as the "accuracy" and so on; for

example, “The ERT noted multiple inconsistencies in references to the tables and figures or/and incorrect references to the equations in the 2006 IPCC Guidelines in sectoral chapter X of the NIR. There were also multiple inconsistencies between the data and information presented in the NIR and CRF tables for the sector. The ERT also noted that the main impact of the issue was causing confusion regarding the location of the referenced data and information, while the actual data were used correctly and associated emissions estimates were not affected. The issues were within sector X only; other sectors were not affected to the same degree. During the review, the Party explained that the checks for internal chapter consistency and consistency between the NIR and the CRF tables were included in its QA/QC plan, but not fully implemented owing to resource constraints. The Party also explained that it is planning to implement the QC procedures in sector X for the next inventory submission. The ERT concluded that the implementation of the check for consistency between different elements of the chapter would significantly improve the transparency of the chapter and the overall inventory quality.” In this case, the ERT could write one recommendation for sector X, that the Party strengthen its QA/QC procedures to reduce the number of such inconsistencies and improve the transparency of the chapter. The recommendation should also refer to specific issue identifiers in the sector as examples of the issue manifestation.

28. Systemic TACCC-associated QA/QC issues that manifested multiple times across several inventory sectors would require an overarching recommendation at the inventory level under the “General” section of the ARR. Usually, the finding could be classified as QA/QC and verification. To emphasize the cross-sectoral manifestation of the issue, the references to the associated issue ID#s in different sectors could also be included. The ERT should also consider whether this issue points to a problem of the national system. If it does, the finding type should be adjusted accordingly.

29. It is possible that a sector-level issue may also point to a problem of the national system, especially if different parts of the inventory are prepared by different agencies and the relevant cross-sectoral arrangements associated with the QA/QC and verification process and responsibilities are not put in place or only partially implemented.

Table 2.1 Examples of transparency and QA/QC and verification issues from the analysed ARRs

Transparency issues with additional QA/QC component		
Issue manifestation	*Party’s response to the ERT*	*Recommendation component*
Inconsistencies in the NIR narrative, but the method and emission factors applied to emission estimates were correct and the emissions estimated correctly	The Party confirms that the methods and emission factors are used correctly for estimating emissions, but an erroneous number was entered in the narrative without any effect on emissions estimates	The ERT recommends that the Party report the correct value for DOC_f in CRF table 5.A and implement QC measures so as to avoid such errors in future inventory submissions
Sector-specific information (e.g. an explanation to the fact/event/noted pattern in the inventory sector) is missing	The Party explained that this occurred owing to lack of relevant information, although the corresponding emissions were reported correctly. The Party already requested (or planned to request) the additional information to the fact/event/noted pattern	The ERT recommends that the Party collect information on incidents that may lead to spikes in emissions and report on them in the NIR. The ERT also recommends that <Party> include checks (e.g. with the data suppliers) in its QC procedures in case of variations and outliers, and report on the outcome of those checks in the NIR
	The Party explained variations in the implied emission factor for the noted years during the review week	The ERT welcomes the explanation provided by <Party> and recommends that the Part> include the explanation in the next submission and improve QC procedures to identify time series break before the inventory is published
Issues related to QA/QC plan and inventory improvements [missing information]		
Description of essential elements of QA/QC plan (or planned improvements) are not included in the NIR	The Party confirmed that the missing element is part of the QA/QC plan (or an improvement plan) and provided the relevant information to the ERT during the review week	The ERT commends <Party> for the improvements to date and recommends that, in order to assist ERTs’ understanding, when <Party> intends to implement each planned improvement, provide detailed information on all the planned improvements in section X–Z of

		the NIR indicating the expected time frames for implementing the improvements .
		The ERT recommends that <Party> improve the transparency of the NIR by including information on how external QA results are taken into consideration in the national inventory development plan (e.g. what measures are included in the review and how its results relating to <Party> are used to improve the inventory) and information on current as well as planned regional QA activities (expert peer review)
Adapting higher-tier methods and verification		
A category-specific QA/QC and verification measure is implemented, but not described for the key category	The Party provided information about the regulatory bodies responsible for QC procedures for the category, and clarified that a system of QC measures has been used to ensure completeness of the inventory	The ERT recommends that <Party> describe in more detail the QC measures in place to verify the completeness of the onshore exploration and production
The NIR does not transparently explain how particular equations from the 2006 IPCC Guidelines are adapted for use in the higher-tier country-specific model for estimating emissions	The Party confirmed that a country-specific method is used and provided relevant documentation on method verification during the review	The ERT recommends that <Party> include in section X of the NIR how equations Y to Z from the 2006 IPCC Guidelines are adapted for use in the country-specific model (i.e. provide more information on equation parameters removed or added) and how the Party conducts model verification in line with paragraph 41 of the UNFCCC Annex I inventory reporting guidelines on the verification of higher-tier methods and models

Table 2.2 Examples of accuracy and QA/QC and verification issues in the analysed ARRs

Accuracy issues with additional QA/QC component		
Issue manifestation	*Party's response to the ERT*	*Recommendation component*
Correct errors that lead to **erroneous estimates** in the inventory, such as: – errors in attribution to forest management area or area of land conversions – errors in collecting, processing/use or documenting activity data – use of incorrect default emission factors	The Party confirmed that the references were incorrect, but the relevant equations and data sources were appropriately used	The ERT recommends that <Party> use the correct table numbers in the descriptions of various parameters in equation X (section Y, p.Z) in the NIR and improve QA/QC procedures to prevent the occurrence of such errors
Verification issues affecting accuracy		
Owing to potential issues with the country-specific model/method there are errors in estimating emissions. Verifying the method/model through a third-party review, comparison with a tier 1 method results or by other means would help to identify the problem with the method/model and prevent erroneous estimates	The Party explained that the method/model was only partially verified (or not verified)	The ERT recommends that <Party> conduct QA/QC and verification of the method used to estimate emissions from refrigeration and air conditioning, in accordance with paragraph 41 of the UNFCCC Annex I inventory reporting guidelines, and report on the outcomes thereof

Table 2.3 Examples of comparability and QA/QC and verification issues in the analysed ARRs

Comparability issues with additional QA/QC component		
Correct errors that create difficulty in comparisons/synthesis/analysis of the inventory data or information with inventories submitted by other Parties, although they do not lead to **erroneous**	The Party confirmed incorrect allocations with the ERT findings	The ERT recommends that <Party> use mass for all fuels in CRF table 1.A(b) and implement relevant QC procedures to ensure that correct units were used for activity data in the CRF table

estimates in the inventory: – errors in allocation of emissions, but correct emissions estimates – incorrect units of mass, but correct emissions estimates		The ERT recommends that <Party> correct the CO_2 and CH_4 emission estimates for <year> to remove the combustion-related CO_2 and CH_4 emissions and enhance QA/QC procedures to ensure correct reporting

Table 2.4 Examples of completeness and QA/QC and verification issues in the analysed ARRs

Completeness issues with additional QA/QC component		
Issue manifestation	*Party's response to the ERT*	*Recommendation component*
Correct errors that lead to **incomplete estimates** in the inventory, such as: – missing actual CO_2 emissions from some fuels in the reference approach – missing carbon stock change data in the CRF tables – use of incorrect default emission factors	The Party confirmed that the missing data and information are available from the national statistics or other sources, but were not included in the inventory by mistake	The ERT recommends that <Party> strengthen the QC procedures and report the correct total amount of CO_2 emissions from the reference approach by including values for actual CO_2 emissions from all relevant fuels and the corresponding fraction of carbon oxidized
		The ERT recommends that <Party> provide in the NIR and CRF tables estimates of carbon stock changes and emissions for all mandatory categories, provide a consistent uncertainty analysis for each estimated category, enhance the QA/QC procedures that are used for the LULUCF sector and, as a minimum, undertake an internal technical review to ensure consistency between the NIR and the CRF tables

Table 2.5 Examples of consistency and QA/QC and verification issues in the analysed ARRs

Consistency issues and verification		
Inconsistencies in time series due to potential issues with the application of a higher-tier method or a country-specific model/method used for the emission estimates or changes in country-specific/plant-specific emission factors. Verifying the method/model through a third-party review, comparison with a tier 1 method results or by other means would help to identify the problem with the method/model and explain or justify observed variations in the implied emission factor	The Party explained that the method/ model was only partially verified (or not verified)	To maintain time series consistency, the ERT recommends that <Party> verify the higher tier methodology/country specific models used to estimate emissions from <category>, in accordance with paragraph 41 of the UNFCCC Annex I inventory reporting guidelines, and report on the outcomes thereof
Lack of information on QA/QC activities prevents identifying reasons for inconsistencies		
Notable inconsistencies between national statistics and the data reported by individual facilities occurred for several years	The Party could not explain the inconsistencies during the review and did not provide the information on QA/QC activities in relation to facility level data	The ERT recommends that <Party> investigate why there is an inconsistency between the statistical data (showing decreasing nitric acid production in the period 2007–2008) and the data reported by facilities (showing increasing production in the period 2007–2008) and whether there could be any errors in the data reported by the facilities, and report on the results of the investigation in the NIR, including information on the QA/QC activities undertaken in relation to the facility-level data received
Notable inconsistencies in the time series potentially associated with the data coherence between source categories	The Party explained that the sector-specific QC procedures to check time-series consistency were not implemented	The ERT recommends that <Party> revise the estimates of DOM and establish sector-specific QC procedures to check the time-series consistency of the estimates and coherence of the estimates among carbon pools and categories

III. Modalities associated with QA/QC and verification

Reviewing QA/QC and verification under the Convention

30. According to the UNFCCC Annex I inventory reporting guidelines under the Convention, there are 5 "shall" requirements and 12 "should" requirements relevant to QC, QA and verification focused in the following areas:

- QA/QC, under section E. Methods (QA/QC, para. 19);
- section F. National inventory arrangements:
  - general guidance on national inventory arrangements (para. 21(b)),
  - inventory planning (paras. 23–24),
  - inventory preparation (paras. 25(f) and 26),
  - inventory management (para. 27(a)), on archiving QA/QC documentation;
- general guidance under section G. Reporting (paras. 46 and 50(j));
- section H. Record-keeping (para. 58).

Table 3.1 presents the QA/QC-related mandatory ("shall" requirements) and non-mandatory ("should" requirements) requirements for national GHG inventories.

Table 3.1. QC-related reporting requirements for GHG inventories of Annex I Parties

Quality assurance/quality control (QA/QC, para. 19)		Item number in table 3.3
Shall	Elaborate an inventory quality assurance/quality control (QA/QC) plan	3
Shall	Implement general inventory QC procedures in accordance with its QA/QC plan following the 2006 IPCC Guidelines	10
Should	Apply category-specific QC procedures in accordance with the 2006 IPCC Guidelines for: • key categories • those individual categories in which significant methodological changes and/or data revisions have occurred	13
Should	Implement QA procedures by conducting a basic expert peer review of their inventories in accordance with the 2006 IPCC Guidelines	14
National inventory arrangements (para. 21(b))		
Should	National inventory arrangements should be designed and operated to ensure the quality of inventories through the planning, preparation and management of inventory activities. These include, among others, QA/QC activities, and carrying out procedures for the verification of the inventory data at the national level, as described in these reporting guidelines	1
Inventory planning (paras. 23–24)		
Should	As part of its inventory planning, each Annex I Party should: (a) define and allocate specific responsibilities in the inventory development process, including those related to QA/QC	2
	(b) elaborate an inventory QA/QC plan as in para. 19	3
	(c) establish processes for the official consideration and approval of the inventory, including any recalculations, prior to its submission, and for responding to any issues raised in the inventory review process	7
Should	Information obtained from the implementation of the QA/QC programme, the inventory review process and other verification activities should be considered in the development and/or revision of the QA/QC plan and the quality objectives	8
Inventory preparation (paras. 25(f) and 26(a))		

Should (para. 25(f))	As part of its inventory preparation, each Annex I Party should implement general inventory QC procedures in accordance with its QA/QC plan, following the 2006 IPCC Guidelines	10
Should (para. 26(a))	Apply category-specific QC procedures for key categories and for those individual categories in which significant methodological and/or data revisions have occurred, in accordance with the 2006 IPCC Guidelines	13
Inventory management (para. 27(a))		
Should (para. 27(a))	As part of its inventory management achieve all relevant inventory information for the reported time series, including all disaggregated emission factors and activity data, documentation on how these factors and data have been generated and aggregated for the preparation of the inventory, internal documentation on QA/QC procedures, external and internal reviews, and documentation on annual key categories and key category identification and planned inventory improvements	15
General reporting (paras. 40, 41, 46 and 50(j))		
Should (para. 40)	For the purposes of verification, Annex I Parties should compare their national estimates of CO_2 emissions from fuel combustion with those estimates obtained using the IPCC reference approach, as contained in the 2006 IPCC Guidelines, and report the results of this comparison in the NIR	11
Shall (para. 41)	Annex I Parties that prepare their estimates of emissions and/or removals using higher-tier (tier 3) methods and/or models shall provide in the NIR verification information consistent with the 2006 IPCC Guidelines	6
Shall (para. 46)	Annex I Parties shall report in the NIR on their QA/QC plan and give information on QA/QC procedures already implemented or to be implemented in the future	5
Encouraged (para. 46)	Report on any peer review of their inventory, apart from the UNFCCC review	14
Shall (para. 50(j))	The NIR shall include information on the national inventory arrangements and changes to the national inventory arrangements, including a description of the institutional arrangements for inventory preparation, as well as information on verification as requested in paragraphs 40 and 41 above and on QA/QC as requested in paragraph 46	4
Record-keeping (para. 58)		
Should (para. 58)	Relevant supporting documentation related to QA/QC implementation, uncertainty evaluation or key category analyses should be kept on file	15

31. Parties without a commitment under the Kyoto Protocol in the second commitment period are reviewed under the Convention. If a Party reviewed under the Convention does not comply with a mandatory requirement (those are marked as "shall" in table 3.1), the ERT needs to include the relevant recommendation in the ARR. If a Party does not comply with the requirements that are not mandatory (i.e. do not contain "shall"), the ERT may include a relevant encouragement in the ARR.

Reviewing QA/QC and verification under the Kyoto Protocol

32. Under the Kyoto Protocol, the provisions for QA/QC are included within the provisions for national systems, under Article 5, paragraph 1, of the Kyoto Protocol, which are covered by decision 19/CMP.1. For Parties reviewed under the Kyoto Protocol, these provisions supersede those included in table 3.1 above and where there is a difference, the Kyoto Protocol provisions prevail.

33. Although decision 19/CMP.1 is a key reference when reviewing QA/QC and verification of the inventories under the Kyoto Protocol, the ERT should refer to decision 19/CMP.1 in conjunction with decision 4/CMP.11. This is because decision 19/CMP.1 refers to the Revised 1996 IPCC Guidelines and the IPCC good practice guidance, which, for the second commitment period, were replaced by the 2006 IPCC Guidelines. Decision 4/CMP.11, paragraph 3(b), provides the relevant guidance (box 3-1).

Box 3-1: GUIDANCE FOR REFERRING TO IPCC GUIDELINES AS IN THE DECISION 4/CMP.11, PARAGRAPH 3(b)

"All references to the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines) as elaborated by the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance), the IPCC Guidelines as elaborated by the IPCC good practice guidance, the IPCC Guidelines and any good practice guidance or the IPCC good practice guidance, shall be read as references to the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines) as implemented through the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories" and the 2013 *Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol* and the 2013 *Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*, as implemented in accordance with decisions 24/CP.19 and 6/CMP.9, except references in paragraph 1 of decision 20/CMP.1".

34. Table 3.2 presents the QA/QC-related mandatory ("shall" requirements) and non-mandatory ("should" requirements) requirements for national GHG inventories in accordance with decision 19/CMP.1 in conjunction with decision 4/CMP.11 for reviewing QA/QC and verification within the context of national systems under the Kyoto Protocol.

Table 3.2 QA/QC and verification related reporting requirements for GHG inventories of Annex I Parties in accordance with decision 19/CMP.1 in conjunction with 4/CMP.11

IV. Characteristics, para. 7		Item number in table 3.3
Should	National systems should be designed and operated to ensure the quality of the inventory through planning, preparation and management of inventory activities. Inventory activities include <…> quality assurance/quality control (QA/QC) activities, and carrying out procedures for the verification of the inventory data at the national level, as described in these guidelines for national systems	1
VI. Specific functions: A. Inventory planning (paras. 12 and 13)		
Shall (para. 12(c))	As part of its inventory planning, each Party included in Annex I **shall define and allocate specific responsibilities** in the inventory development process, including those relating to <…> QC and QA. This definition shall specify the roles of, and cooperation between, government agencies and other entities involved in the preparation of the inventory, as well as the institutional, legal and procedural arrangements made to prepare the inventory	2
Shall (para. 12(d))	As part of its inventory planning, each Party included in Annex I **shall elaborate an inventory QA/QC plan** that describes specific QC procedures to be implemented during the inventory development process, facilitate the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establish quality objectives	3
Shall (para. 12(e))	As part of its inventory planning, each Party included in Annex I **shall establish processes for the official consideration and approval** of the inventory, including any recalculations, prior to its submission and to respond to any issues raised by the inventory review process under Article 8	7
Should (para. 13)	As part of its inventory planning, each Party included in Annex I should consider ways to improve the quality of activity data, emission factors, methods and other relevant technical elements of inventories. Information obtained from the implementation of the QA/QC programme, the review process under Article 8 and other reviews should be considered in the development and/or revision of the QA/QC plan and the quality objectives	8
B. Inventory preparation (paras. 14 and 15)		

Shall (para. 14(g)) + decision 4/CMP.11 (para. 3(b))	As part of its inventory preparation, each Party included in Annex I **shall implement general inventory QC procedures (tier 1)** in accordance with its QA/QC plan following the *relevant Guidelines*	10
Should (para. 15(a)) + decision 4/CMP.11 (para. 3(b))	As part of its inventory preparation, each Party included in Annex I should apply category-specific QC procedures (tier 2) for key source categories and for those individual categories in which significant methodological and/or data revisions have occurred, in accordance with *relevant Guidelines*	13
Should (para. 15(b))	Provide for a basic review of the inventory by personnel that have not been involved in the inventory development, preferably an independent third party, before the submission of the inventory, in accordance with the planned QA procedures referred to in paragraph 12(d) above	14
Should (para. 15(c))	Provide for a more extensive review of the inventory for key categories, as well as source categories where significant changes in methods or data have been made	11
Should (para. 15(d))	Based on the reviews described in paragraph 15(b) and (c) above and periodic internal evaluations of the inventory preparation process, re-evaluate the inventory planning process in order to meet the established quality objectives referred to in paragraph 12(d)	9
C. Inventory management (para. 16)		
Shall (para. 16(a))	As part of its inventory management, each Party included in Annex I **shall archive inventory information** for each year in accordance with relevant decisions of the COP and/or COP/MOP <…>. This information **shall also include internal documentation** on QA/QC procedures, external and internal reviews, documentation on annual key categories and key category identification and planned inventory improvements	15

35. Reviewing the QA/QC and verification under the Convention and the Kyoto Protocol differ by approach to modality of requirements, review format and the outcome of the assessment and its impact on the Party under the review. Table 3.3 compares the reporting requirements under the Convention and the Kyoto Protocol in relation to QA/QC and verification, and provides an overview of the differences grouped by the themes of QA/QC and verification requirements. The table also provides references to the relevant paragraphs in the reporting guidelines.

Table 3.3 Comparison of reviewing QA/QC and verification under the Convention and the Kyoto Protocol

Item	Requirement (theme)	Modality under the Convention	Para(s) in UNFCCC Annex I inventory reporting guidelines	Modality under the Kyoto Protocol	Para(s) in decisions 19/CMP.1 + 4/CMP.11
	National system and QA/QC plan				
1	National system design includes inventory activities related to QA/QC and verification	should	21(b)	should	7
2	Allocate roles and responsibilities in relation to QA/QC activities and verification procedures	should	23(a)	shall	12(c)
3	**Elaborate QA/QC plan**	**shall**	19, 23(b)*	**shall**	12(d)
	Inclusion of QA/QC information in the NIR				
4	Include in the NIR information on the inventory arrangements and changes to inventory arrangements related to QA/QC and verification	shall	50(j)	No provision***	NA
5	Include in the NIR information on QA/QC and verification activities	shall	46	No provision	NA
6**	Include verification for higher-tier (tier 3) methods in the NIR	shall	41	No provision	NA

	Inventory approval process				
7	Establish inventory approval process	should	23(c)	shall	12(e)
	QA/QC plan improvement				
8	Consider improvement of the inventory quality and revise QA/QC plan and quality objectives based on information from implemented QA/QC programme and inventory reviews	should	24	should	13
9	Periodically re-evaluate the inventory planning process in order to meet the established quality objectives	No provision	NA	should	15(d)
	General (T1) QC procedures				
10	**Implement general (T1) QC procedures**	**shall**	19, 25(f)*	**shall**	14(g) + 4/CMP.11, 3(b)
11	Verification in relation to estimating emissions from the energy sector (reference vs sectoral approach)	should	40	No provision	NA
	Higher-tier methods, key categories and categories with significant method or data changes key categories				
12	Provide a more extensive review of key categories and categories where significant changes in methods/data occurred	No provision	NA	should	15(c)
13	Apply source category-specific QC procedures (T2) for key categories and categories where significant changes in methods/data occurred	should	19, 26(a)	should	15(a) + 4/CMP.11 3(b)
6**	Include verification for higher-tier (T3) methods in the NIR	shall	41	No provision	NA
	Quality assurance				
14	Provide a basic review of the inventory by the third party (QA)	should	19, 46	should	15(b)
	Archiving (different from inclusion in the NIR)				
15	Include documentation on QA/QC procedures, external and internal reviews in the inventory archives	should	27(a), 58	shall	16(a)

Notes:

**Paragraphs 23(b) and 25(f) of the UNFCCC Annex I inventory reporting guidelines under the Convention includes a non-mandatory requirement of elaborating the QA/QC plan at the inventory planning stage, and implementing general inventory QC procedures during the inventory preparation stage. This does not imply that elaborating the plan or implementing general QC procedures are not mandatory, just that performing these actions during a particular phase in the inventory cycle (planning and preparation) is not mandatory. For example, a Party could elaborate its QA/QC plan or implement general QC procedures during a different stage of the inventory cycle or in previous inventory cycles.*

***Item 6 is included twice because it relates both to a group of requirements about including information on QA/QC and verification in the NIR and to a group of requirements related to higher-tier methods.*

**** There is a requirement to report on changes to any provisions under decision 15/CMP.1, annex, paragraph 21.*

36. There are two requirements that are mandatory under both the Convention and the Kyoto Protocol. These are elaborating a QA/QC plan and implementing general (tier 1) QC procedures.

37. Other mandatory requirements under the Convention relate to including QA/QC and verification information in the NIR. So ERTs also need to check whether the NIR of the Party reviewed under the Convention includes:

    - information on QA/QC and verification activities;
    - information on the inventory arrangements and changes to inventory arrangements related verification for higher-tier (T3) methods.

38. In the reporting guidelines under the Kyoto Protocol, requirements associated with reporting higher-tier inventory methodologies, key categories and categories with significant methods or data changes (items 12 and 13 in table 3) are non-mandatory. Compared with the reporting guidelines under the Convention, there are no additional provisions for verification. Therefore ERTs should include a recommendation in the ARR if a Party does not apply verification whenever tier 3 methods are used (para. 41 of the reporting guidelines under the Convention), regardless of whether the review is under the Convention or under the Kyoto Protocol. An encouragement can be included if category-specific QC procedures (tier 2) or a more extensive review are not applied to key categories, and categories with significant method or data changes.

39. Reporting guidelines under the Kyoto Protocol include three other mandatory requirements in relation to QA/QC and verification in addition to those described in paragraphs 27 and 29 above:

    - allocate roles and responsibilities in relation to QA/QC activities and verification procedures;
    - establish an inventory approval process;
    - include documentation on QA/QC procedures, external and internal reviews in the inventory archives.

    For Parties that are reviewed under the Convention, non-compliance with these requirements may result in encouragement in the ARR, but not a recommendation. There are six non-mandatory requirements under the Kyoto Protocol associated with QA/QC and verification (items 1, 8, 9, 12, 13 and 14 in table 3.3). Although there is no provision under the Kyoto Protocol for verification in relation to estimating emissions from the energy sector (reference versus sectoral approach), the reporting guidelines under the Convention include a relevant non-mandatory requirement (item 11 in table 3.3 above) and the review of Parties under the Kyoto Protocol should also encompass any review under the Convention. If a Party reviewed under the Kyoto Protocol does not comply with any of these requirements, the ERT should also issue a relevant encouragement.

40. There is a difference in the outcomes of the non-compliance with mandatory requirements between reviews under the Convention and the Kyoto Protocol. If Parties reviewed under the Convention do not comply with a mandatory reporting requirement, the ERT should write a relevant recommendation in the ARR. However, a non-compliance with a mandatory requirement that is within the context of national systems under the Kyoto Protocol may result in a Saturday Paper and a Question of Implementation. Table 3.4 provides a list of such requirements associated with assessing QA/QC and verification. The ERT should be most careful when assessing Party's inventories against these requirements.

Table 3.4. Mandatory requirements on QA/QC and verification within the context of national systems under the Kyoto Protocol

VI. Specific functions: A. Inventory planning (para. 12) (technically, para. 12(a) and (b) are also "shalls")		Item number in table 3.3
Shall (para. 12(c))	As part of its inventory planning, each Party included in Annex I **shall define and allocate specific responsibilities** in the inventory development process, including those relating to <…> QC and QA. This definition shall specify the roles of, and cooperation between, government agencies and other entities involved in the preparation of the inventory, as well as the institutional, legal and procedural arrangements made to prepare the inventory	2
Shall (para. 12(d))	As part of its inventory planning, each Party included in Annex I **shall elaborate an inventory QA/QC plan** that describes specific QC procedures to be implemented during the inventory development process, facilitate the overall QA procedures to be conducted, to the extent possible, on the entire inventory and establish quality objectives	3
Shall (para. 12(e))	As part of its inventory planning, each Party included in Annex I **shall establish processes for the official consideration and approval** of the inventory, including any recalculations, prior to its submission and to respond to any issues raised by the inventory review process under Article 8	7
B. Inventory preparation (para. 14) (technically, para. 14(a–f) are also "shalls")		

Shall (para. 14(g)) + decision 4/CMP.11 (para. 3(b))	As part of its inventory preparation, each Party included in Annex I **shall implement general inventory QC procedures (tier 1)** in accordance with its QA/QC plan following the *relevant Guidelines*	10
C. Inventory management (para. 16) (technically, para. 16(b) and (c) are also ”shalls”)		
Shall (para. 16(a))	As part of its inventory management, each Party included in Annex I **shall archive inventory information** for each year in accordance with relevant decisions of the COP and/or COP/MOP <…>. This information **shall also include internal documentation** on QA/QC procedures, external and internal reviews, documentation on annual key sources and key source identification and planned inventory improvements	15

41. To ensure consistency between ERTs in relation to Saturday papers associated with QA/QC and verification, the ERTs may wish to take into account, among other considerations, the following points:

    - whether there were significant gaps in the implementation of decision 19/CMP.1 regarding QA/QC and verification that strongly affected the performance of the national system and overall inventory quality;
    - if the findings that included those of QA/QC and verification type are ongoing, whether a Party was able to demonstrate the implementation of the work plan prepared in response to the previous review;
    - whether there were any problems associated with QA/QC and verification and related to key functions of the inventory system;
    - generally, whether the QA/QC issue noted by the ERT fits in a bigger picture of serious problems associated with inventory arrangements and performance of the national system.

42. The analysis of ARRs from the 2017 review cycle found that not all cases of non-compliance with mandatory requirements summed up in table 3.4 above led to Saturday Papers being issued. For example, among the published ARRs analysed there were at least two Parties that did not fully comply with decision 19/CMP.1 with regard to QA/QC and verification. However, a QA/QC-related Saturday Paper was issued for one of those Parties, and in this case, the QA/QC issues noted by the ERT were actually manifestations of much deeper problems associated with the organization and performance of the national system.

2006 IPCC Guidelines and modalities of reviewing QA/QC and verification under the Convention and the Kyoto Protocol

43. Chapter 6 of volume 1 of the 2006 IPCC Guidelines provides guidance on developing QA/QC and verification systems and plans. Additional materials and guidance for developing sector-specific QA/QC and verification procedures are also included in volumes 2–5 of the 2006 IPCC Guidelines. The ERT should assess whether Parties’ QA/QC and verification systems and plan and procedures are developed and implemented in accordance with the IPCC Guidelines. This section explores the relationship between mandatory and non-mandatory requirements under the reporting guidelines under the Convention and the Kyoto Protocol, and good practices as set out in the 2006 IPCC Guidelines.

44. Table 6.1 in chapter 6, volume 1 of the 2006 IPCC Guidelines contains a list of ‘general inventory QC procedures’ (also included in the annex to this paper). The 2006 IPCC Guidelines suggest that the checks presented in table 6.1 should be applied irrespective of the type of data used to develop the inventory estimates. The checks are equally applicable to categories where default

values or national data are used as the basis for the estimates. The 2006 IPCC Guidelines also suggest that, although general QC procedures are designed to be implemented for all categories and on a routine basis, it may not be necessary or possible to check all aspects of inventory input data, parameters and calculations every year. However, it is good practice to plan to undertake QC checks on all parts of the inventory over an appropriate period, as determined in the QA/QC plan. The reporting guidelines under the Convention and the Kyoto Protocol often refer to the general inventory QC procedures in accordance with the 2006 IPCC Guidelines. The ERT should note that those references are related to the general procedures summarized in table 6.1 of the 2006 IPCC Guidelines. The ERT should also consider that, because it may not be possible to check every aspect of the inventory on a yearly basis, it is a Party's decision how frequently those checks are performed for its inventory.

45. Good practices in the 2006 IPCC Guidelines associated with QA/QC and verification comprise planning, implementation and improvement practices, as well as practices related to applying general, category-specific and higher-tier QC procedures, QA and verification. Table 3.5 below combines IPCC good practices related to QA/QC and verification (2006 IPCC Guidelines, vol. 1, chapter 6) with the appropriate paragraphs from the UNFCCC Annex I inventory reporting guidelines under the Convention and the Kyoto Protocol.

Table 3.5. IPCC good practices associated with QA/QC and verification, and relevant reporting requirements under the Convention and the Kyoto Protocol

item #	IPCC good practice	Relevant reporting requirement (mandatory requirements are shown in **bold** font)	
		Under the Convention	Under the Kyoto Protocol; decision 19/CMP.1 and decision 4/CMP.11
	Implementing QA/QC		
1	It is good practice to implement quality assurance/quality control (QA/QC) and verification procedures in the development of national greenhouse gas inventories. (page 6.5)	**Para. 19**	Paras. 12(d), **14(g) + 4/CMP.11, para. 3(b)**
	QA/QC and verification system		
2	A good practice system for QA/QC and verification seeks <...> to enable continuous improvement of inventory estimates. Judgements to select the respective parameters will need to be made on the following: • Resources allocated to QA/QC for different categories and the compilation process; • Time allocated to conduct the checks and reviews of emissions and removal estimates; • Frequency of QA/QC checks and reviews on different parts of the inventory; • The level of QA/QC appropriate for each category; • Availability and access to information on activity data, emission factors and other estimation parameters, including uncertainties and documentation; • Acquisition of additional data specifically required, e.g., alternative data sets for comparisons and checks; • Procedures to ensure confidentiality of inventory and category information, when required; • Requirements for documenting and archiving information; • Whether increased effort on QA/QC will result in improved estimates and reduced uncertainties; • Whether sufficient independent data and expertise are available to conduct verification activities.	**Paras. 19,** 21(b), 23(b), 25(f)	**Paras. 12(d)**, 7
	Roles and responsibilities		

3	(p. 6.7) It is good practice for the inventory compiler to define specific responsibilities and procedures for the planning, preparation, and management of inventory activities, including: • Data collection; • Selection of methods, emission factors, activity data and other estimation parameters; • Estimation of emissions or removals; • Uncertainty assessment; • QA/QC and verification activities; • Documentation and archiving.	Para. 23(a)	**Para. 12(c)**
4	(p. 6.8) It is good practice for the inventory compiler to designate a QA/QC coordinator as the person responsible for ensuring that the objectives of the QA/QC process as set out in the QA/QC plan (see Section 6.5) are met.	Para. 23(a)	**Para. 12(c)**
	Revision of QA/QC plan		
5	(p.6.8) As part of the QA/QC plan, it is good practice to accommodate procedural changes and a feedback of experience. Conclusions from previous reviews need to be used to improve the procedures. Such changes can also concern data quality objectives and the QA/QC plan itself. The periodic review and revision of the QA/QC plan is an important element to drive the continued inventory improvement.	Paras. 24, 23(c)	Paras. 13, 15(d)
	General QC procedures		
6	(6.9) In establishing criteria and processes for selecting sample data sets and processes, it is good practice for the inventory compiler to plan to undertake QC checks on all parts of the inventory over an appropriate period of time as determined in the QA/QC plan.	**Paras. 19**, 26(a)	**Para. 14(g) + 4/CMP.11, para. 3(b)**
7	(6.11) It is good practice for the inventory compiler to confirm that national statistical agencies have implemented QC procedures equivalent to those in table 6.1.	**Para. 19**	**Para. 14(g) + 4/CMP.11, para. 3(b)**
	Using IPCC default emission factors		
8	6.12) When using IPCC default emission factors, it is good practice for the inventory compiler to assess the applicability of these factors to national circumstances. If possible, a supplemental activity is to compare IPCC default emission factors with site or plant-level factors to determine their representativeness relative to actual sources in the country. This supplementary check is good practice even if data are only available for a small percentage of sites or plants.	**Para. 41**	**Para. 14(g) + 4/CMP.11, para. 3(b)**
	Calculation-related QC for higher tiers and uncertainties		
9	(6.16) If the original calculation and the simple approximate method disagree, it is good practice to examine both approaches to find the reason for discrepancy. Further checks on the calculation procedure will require external data (verification).	**Para. 41**	Paras. 15(a) + decision 4/CMP.11 para. 3(b)
10	(6.16) It is a prerequisite that all calculations leading to emission or removal estimates should be fully reproducible. It is good practice to discriminate between input data, the conversion algorithm of a calculation and the output. Not only does the output need to be recorded, but also the input, the conversion algorithm, and how this algorithm accesses the input.	**Paras. 19**, 25(f)	**Para. 16(a)**
11	(6.18) It is good practice to apply QC procedures to uncertainty estimation to confirm that calculations are correct and data and calculations well documented.	**Para. 19**	**Paras. 14(g) + 4/CMP.11, para. 3(b)**
	QA procedures and audits		
12	Good practice for QA procedures includes reviews and audits to assess the quality of the inventory, to determine the conformity of the procedures taken and to identify areas where improvements could be made.	Paras. 19, 27(a)	**Paras. 12(d)**, 15(b), 15(d)
13	(6.17) It is good practice for inventory compilers to conduct a basic expert peer review of all categories before completing the inventory in order to identify potential problems and make corrections where possible.	Paras. 19, 46	Para. 15(b)
14	For the purpose of good practice in inventory preparation, audits may be used to evaluate how effectively the inventory compiler complies with the minimum QC specifications outlined in the QC plan.	Para. 19	Paras. 15(b), 15(d)
15	(6.18) It is good practice for the inventory compiler to develop a schedule of audits at strategic points in the inventory development.	Para. 19	Paras. 15(b), 15 (d)
	Documentation, archiving and reporting		
16	(p. 6.14) When using national activity data from secondary data, it is good practice for the inventory compiler to evaluate and document the associated QA/QC activities.	Para. 58	**Para. 16(a)**
17	(6.21) It is good practice to document and archive all information relating to the planning, preparation, and management of inventory activities. This includes, among others, QA/QC plans and outcomes of QA/QC procedures.	**Paras. 50(j)**, 58	**Para. 16(a)**
18	(6.23) It is good practice for inventory compilers to maintain this documentation for every inventory produced and to provide it for review. It is good practice to maintain and archive this documentation in such a way that every inventory estimate can be fully documented and reproduced if necessary.	**Paras. 50(j)**, 58	**Para. 16(a)**
19	(6.23) It is good practice to maintain and archive this documentation in such a way that every inventory estimate can be fully documented and reproduced if necessary.	Para. 58	**Para. 16(a)**

20	(6.23) Records of QA/QC procedures are important information to enable continuous improvement to inventory estimates. It is good practice for records of QA/QC activities to include the checks/audits/reviews that were performed, when they were performed, who performed them, and corrections and modifications to the inventory resulting from the QA/QC activity.	Paras. 27(a), **46**, **50(j)**	**Para. 16(a)**
21	(6.23) It is good practice to report a summary of implemented QA/QC activities and key findings as a supplement to each country's national inventory. In this summary, the inventory compiler should focus on the following activities. • Reference to a QA/QC plan, its implementation schedule, and the responsibilities for its implementation should be discussed. • Describe which activities were performed internally and what external reviews were conducted for each source/sink category and on the entire inventory. • Present the key findings, describing major issues regarding quality of input data, methods, processing, or estimates for each category and show how they were addressed or plan to be addressed in the future. • Explain significant trends in the time series, particularly where trend checks point to substantial divergences. Any effect of recalculations or mitigation strategies should be included in this discussion.	**Paras. 46, 50(j)**	No specific provision for including QA/QC and verification activities in the NIR

46. Table 3.5 above shows that, to be consistent with good practice, Parties are required to undertake activities associated with elaborating and implementing QA/QC and verification system, implementing general QC procedures and verification for tier 3 methods, although verification through the reference approach in the energy sector is not a mandatory obligation. It is also mandatory to report in the NIR the information about the QA/QC plan, national arrangements for QA/QC, and QA/QC procedures already implemented and planned for the future (items 1, 2, 6–11, 17, 18, 20 and 21 in table 3.5 above). If a Party did not follow these good practices in its inventory, the ERT should include relevant recommendations in the ARR (unless otherwise specified in the relevant decisions under the Convention and its Kyoto Protocol).

47. To strengthen the recommendation and provide better guidance for resolving QA/QC and verification issues, the ERT could include a note about the relevant good practice(s) from the 2006 IPCC Guidelines in the recommendation. Referring to the relevant good practice may also strengthen an encouragement. The examples in box 3-2 show how the reference to the relevant IPCC good practice could be incorporated in the ERT's recommendations and encouragements.

Box 3-2: Examples of including references to IPCC good practices in QA/QC recommendations

Example 1. In relation to organizing QA activities during inventory planning:

A. Revise the organization of the QA activities, taking into account that, in principle and in accordance with the IPCC good practice guidance, these should not be carried out by experts involved in the preparation of the inventory.

B. The Party reported in the NIR (chapter 1.2.4.4) that it is implementing QA procedures at different levels, including basic review of the draft report, public review, external peer review, internal audit, and European Union and UNFCCC reviews. The Party also indicated in the NIR that part of the QA procedures is bilateral cooperation with <Party X>. The ERT considers that the Party did not provide a clear indication of how and in which sequence the QA was performed and did not clearly state that the QA reviewers were not involved in the preparation of the inventory. The ERT notes that providing such information represents good practice in line with the 2006 IPCC Guidelines (vol. 1, chapter 6.8). During the review the Party explained that the QA activities are in accordance with the 2006 IPCC Guidelines and involved stakeholders outside of the national inventory system since all NIR chapters and sectoral CRF tables are checked, verified and approved by experts from the Ministry of Environment (each sector has a different reviewer).

   The ERT recommends that the Party increase transparency regarding the reporting of the general QA procedures and provide in the NIR more information on the sequence of the QA procedures as well on the experts/stakeholders involved.

Example 2. In relation to QA/QC plan:

Continue updating and improving the QA/QC plan, with a view to improving the effectiveness of the QA/QC procedures given that, according to the 2006 IPCC Guidelines, it is good practice to accommodate procedural changes and feedback on the experience, and the records of QA/QC procedures are important information to enable continuous improvement to inventory estimates.

Example 3. In relation to QA/QC activities for activity data:

Improve the description in the NIR of the category-specific QA/QC activities performed on the activity data, with the objective of better understanding the links between the EU ETS, the energy balances and the data reported in the CRF tables, taking into consideration that in accordance with the 2006 IPCC Guidelines, when using national activity data from secondary data it is good practice to evaluate and document the associated QA/QC activities.

48. Example 1 uses the reference to the IPCC good practice to provide additional guidance to the Party regarding selecting the personnel who may be involved in carrying out QA procedures. The ERT included this reference in the original formulation of the recommendation in both case A and case B. Case A shows a brief example and case B shows a more detailed example of the recommendation; the two recommendations are given to different Parties, but both ERTs were not quite consistent in their assessment and recommendations. In examples 2 and 3, the original text of the recommendations did not include the reference to the IPCC good practice. In example 2, adding the reference to the 2006 IPCC Guidelines (highlighted) provides further guidance to the Party regarding possible ways of updating and improvement of the QA/QC plan in order to enable continuous inventory improvement. The recommendation used in example 3 in its original form explained the actions expected of the Party and their objectives, but did not provide the linkage between the recommended actions and the inventory guidance. Including the reference to the relevant 2006 IPCC Guidelines (highlighted) would provide the linkage.

49. Following other QA/QC and verification good practices in the IPCC guidelines, although important for maintaining the inventory quality, is not supported by mandatory requirements under the Convention and therefore is not mandatory when a Party is reviewed under the Convention only. This applies to good practice associated with allocation of roles and responsibilities in relation to QA/QC and verification, revision of the QA/QC plan, inventory audits, implementing QA procedures and archiving (items 3–5, 12–16 and 19 in table 3.5 above).

50. Mandatory requirements for Parties reviewed under the Convention and the Kyoto Protocol are more comprehensive. In addition to mandatory requirements associated with the good practices described in paragraph 36, the Kyoto Protocol requires Parties to follow good practices associated with allocating roles and responsibilities for different aspects of QA/QC and verification, conducting overall QA procedures, and documenting and archiving inventory records (items 12, 16, 19 in table 3.5 above) and report on this.

51. Good practices associated with revision of the QA/QC plan and inventory audits (items 5 and 12–15 in table 3.5) are not supported by mandatory requirements under either the Convention or the Kyoto Protocol. However, these practices would help Parties to improve their inventory standards and, therefore, the ERT may consider including relevant encouragements in the ARR if the review confirms that a Party did not follow those good practices in their inventory planning, preparation and management.

Higher tier and category-specific QC procedures

52. According to the 2006 IPCC Guidelines, category-specific QC complements general inventory QC procedures and is directed at specific types of data used in the methods for individual source or sink categories. These procedures are performed in addition to the general QC checks described in table 6.1 of the 2006 IPCC Guidelines (vol. 1, chapter 6) focusing on key categories and on categories where significant methodological and data revisions have taken place and/or when higher-tier methods are used in the inventory. According to the reporting guidelines under the Kyoto Protocol, higher-tier QC activities also include technical reviews of source categories, activity and emission factor data and methods.

53. The requirements provided in the UNFCCC Annex I inventory reporting guidelines under the Convention (para. 26(a)) and Kyoto Protocol (para. 15(a) in conjunction with paragraph 3(b) of decision 4/CMP.11) are not mandatory in relation to applying category-specific QC procedures to key source categories and for those individual categories in which significant methodological and/or data revisions have occurred. Therefore, ERTs may include a relevant encouragement in the ARR if a Party did not comply with these provisions.

54. The 2006 IPCC Guidelines (vol. 1, chapter 6.7) provide a summary of higher-tier QC procedures. Additional category-specific QC procedures can be found in the sector-specific volumes 2–5 of the 2006 IPCC Guidelines. The scope of QC procedures for categories to which higher-tier methods are applied includes a suite of checks associated with country-specific emission factors, QC checks on models, direct emission measurements, activity data QC including site-specific activity data, and calculation-related QC. Table 3.6 provides a summary and examples of higher tier QC procedures.

Table 3.6. Summary of the higher-tier and category-specific QC procedures suggested by the 2006 IPCC Guidelines

Country-specific emission factors	
Higher-tier and category-specific QC procedures	*Subject of assessment*
QC checks on the background data used to develop emission factors	Assess the adequacy of the emission factors and the QA/QC performed during their development
Uncertainty considerations	Assess the uncertainty of any emissions estimates derived from the secondary data
Comparison with IPCC default factors, plant-specific emission factors, and international comparisons	Consider if any alternative data, including IPCC default values, may provide a better estimate of emissions from this category
	Note: If source/sink category characteristics are dissimilar between countries, the effectiveness of this check is diminished
QC checks on models	

Assumptions	Appropriateness; applicability to the national circumstances
Availability of model documentation	If there are emission factors available for a few plants (but not enough to support a bottom-up approach) these plant-specific factors could be compared with the aggregated factor used in the inventory. This type of comparison provides an indication of both the reasonableness of the country-specific factor and its representativeness
Types and results of associated QA/QC procedures	These should include, for example, model validation steps. Responses to these results should be documented
Periodic model evaluation	Plans to periodically evaluate and update or replace assumptions with appropriate new measurements; sensitivity analysis in relation to different model parameters and assumptions for those analyses
Completeness in relation to inventory categories	No further explanation is provided
Direct emission measurements	
Data checks	All measurements should be checked as part of QC activities
	Supplementary QC activities are encouraged for bottom-up methods based on site-specific emission factors where significant uncertainties remain in the estimates
Activity data checks	
QC checks of reference source for national activity data	Evaluate and document the associated QA/QC activities in regards to activity data as in the relevant QA/QC plan, adequacy of the sampling protocol, potential bias in the data, documentation of uncertainties, identification and documentation of errors
Comparison with independently compiled data sets (verification)	For example, checking national data against international or other national data sets such as FAO, IEA data, ETS data etc.
Data reasonableness checks	Comparisons with samples and partial data sets at sub-national levels
Trend checks of activity data	If the national activity data for any year diverge greatly from the historical trend, they should be checked for errors. If a calculation error is not detected, the reason for the sharp change in activity should be confirmed and documented
Establishing QC checks of measurement protocol	For example, checking whether individual sites carried out measurements using recognised national or international standards and whether acceptable QC procedures in use at the site may be directly referenced
Comparisons between sites and the national data	Comparisons of activity data from different reference sources and geographic scales
Production and consumption balance	Site-specific activity data checks may also be applied to methods based on product usage
Calculation-related checks	
Checks of the calculation algorithm	Comparison of original and simplified algorithms
Calculations are fully reproducible	It is good practice to discriminate between input data, the conversion algorithm of a calculation and the output
Record keeping	Record inputs, outputs, conversion algorithm, how the algorithm accesses the input. Additional measures are suggested for spreadsheet- and database-based calculations
	The documentation should be retained with the material archived in support of the completed inventory

IV. Conclusions

55. A significant number of QA/QC and verification issues were noted by reviewers during the 2017 review cycle, implying that QA/QC and verification issues require close attention from the experts and lead reviewers during inventory reviews. The largest number of QA/QC and verification issues were of a general character, and the highest number of sector-specific QA/QC and verification issues were found in the agriculture and IPPU sectors. The majority of QA/QC and verification issues in the 2017 review cycle were associated with adherence to the UNFCCC Annex I inventory reporting guidelines and transparency, followed by accuracy.

56. According to the UNFCCC Annex I inventory review guidelines (paras. 74–76), examining QA/QC and verification procedures is within the scope of all review types (centralized, in-country and

desk). The ERTs conducting in-country reviews will consider the 'paper trail' of the inventory from the collection of data to the reported emission estimates and will examine procedures and institutional arrangements for inventory development and management, including QA and QC, record-keeping and documentation procedures (para. 74).

57. When reviewing QA/QC and verification systems, lead reviewers and the ERTs should pay special attention to the consistency of their recommendations and encouragements in the ARR, both between the different parts of the ARR and between different review teams. Important elements in this regard include:

    - identifying the source of the QA/QC and verification issue;
    - applying an issue classification consistent with its source;
    - referring to good practices and modalities under the UNFCCC and Kyoto Protocol reporting guidelines;
    - assessing mandatory and non-mandatory reporting requirements;
    - differentiating between the inventories reported under the Convention and the Kyoto Protocol;
    - identifying which QA/QC and verification issues can result in issuing Saturday Papers and Question of Implementation;
    - assessing application of higher-tier QC procedures;
    - reporting QA/QC and verification consistently in table 2 of the ARR.

58. A good way of identifying systemic issues associated with establishing and implementing QA/QC and verification plans is to analyse tables 3 and 4 of the previous ARR to identify repetitive systemic issues associated with different key elements of the QA/QC plan. The other useful procedure is to evaluate the frequency of appearance of similar QA/QC and verification issues in several inventory sectors and categories. Frequent appearance of similar issues that can be resolved if an appropriate QA/QC or verification procedure is applied, points to missing elements of the QA/QC plan or incomplete implementation of the plan. In this case, the issue can most likely be classified as adherence to the UNFCCC Annex I inventory reporting guidelines. In cases where the issue is related to missing information relating to QA/QC or verification in the NIR, the appropriate issue qualifier is transparency.

59. Non-systemic QA/QC and verification issues that are usually found in the different inventory sectors can be associated with any of the TACCC classifiers in the ARR. If the issue is not systemic (i.e. it affects only a particular sector or a category) there may not be a need for a specific QA/QC and verification recommendation in the ARR. QA/QC and verification issues that are more systemic in nature, either within a sector or across the entire inventory, may imply the need for a broader recommendation with a QA/QC or verification component (see tables 2.1–2.5 above for relevant examples).

60. Requirements related to QA/QC and verification and reporting on them under the Convention and the Kyoto Protocol are not the same. The lead reviewers and ERTs should note that the requirements associated with allocating roles and responsibilities in relation to the QA/QC plan and its implementation, establishing an inventory approval process and archiving inventory data and information are mandatory under the Kyoto Protocol, but are not mandatory under the Convention. Table 3.1 above provides a list of mandatory and non-mandatory requirements associated with QA/QC and verification under the Convention (decision 24/CMP.19). Table 3.2 above provides similar information regarding QA/QC and verification requirements under the Kyoto Protocol (decision 19/CMP.1 in conjunction with decision 4/CMP.11). Table 3.3 provides a comparison between modalities under the Convention and the Kyoto Protocol.

61. Reviewing a Party under the Kyoto Protocol may result in a Saturday Paper and questions of implementation. Both can be written in relation to the QA/QC and verification issues if the ERT concludes that such issues are within the context of national systems under the Kyoto Protocol. Table 3.4 above provides a quick reference of the relevant mandatory requirements for reviewers.

62. When including issue identifiers in table 2 of the ARR it is advisable to include references to the QA/QC and verification issues that are not within the context of national systems under the Kyoto Protocol in paragraph 1(h) of the same table. The references to issues within the context of national systems under the Kyoto Protocol (see table 3.4 above) should be included in paragraph 2 of table 2 in the ARR.

63. The 2006 IPCC Guidelines have been adopted by the UNFCCC as methodological guidance for the inventories, so it is important for reviewers to be aware of how the good practices in the guidelines relate to the mandatory and non-mandatory requirements under the Convention and the Kyoto Protocol. Table 3.5 above provides lead reviewers and experts with such references, clearly identifying mandatory and non-mandatory requirements associated with each good practice included in chapter 6 of volume 1 of the 2006 IPCC Guidelines.

64. The 2006 IPCC Guidelines contain both general and category-specific QC procedures when applying higher-tier methodologies. Implementation of general QC procedures is a mandatory requirement; however, this is not always the case for category-specific procedures applying higher-tier methods. Applying verification procedures for tier 3 methods used in the inventory is a mandatory requirement; however, other category-specific QC for the categories using higher-tier methods and procedures are not mandatory. Table 3.6 above provides a summary of category-specific QC procedures for the categories using higher-tier methods as a quick reference for reviewers.

65. Regardless of the type of the review and issue classifier, it is important that, in order to improve the quality of the inventory, all recommendations related to QA/QC and verification issues reflect the source of the issue and its nature and are fit for purpose, so that it is clear to the Party receiving those recommendations what exactly is required to resolve the issue and make an improvement to their inventory.

Appendix

Extract from the ARR table 2. Summary of review results and general assessment of the inventory of <Party> (showing paragraphs 1 and 2 only, QA/QC sections are highlighted)

Assessment			*Issue or problem ID#(s) in table 3 and/or 5[a]*
Dates of submission	Original submission Revised submission: Unless otherwise specified, the values from the latest submission are used in this report		
Review format			
Application of the requirements of the UNFCCC Annex I inventory reporting guidelines and Wetlands Supplement (if applicable)	1. Have any issues been identified in the following areas:		
	(a) Identification of key categories	Yes/No	
	(b) Selection and use of methodologies and assumptions	Yes/No	
	(c) Development and selection of emission factors	Yes/No	
	(d) Collection and selection of activity data	Yes/No	
	(e) Reporting of recalculations	Yes/No	
	(f) Reporting of a consistent time series	Yes/No	
	(g) Reporting of uncertainties, including methodologies	Yes/No	
	(h) QA/QC	*QA/QC procedures were assessed in the context of the national system (see below) OR include references to the QA/QC issues that are not considered in context of the national system*	
	(i) Missing categories/completeness	Yes/No	
	(j) Application of corrections to the inventory	Yes/No	
Significance threshold	For categories reported as insignificant, has the Party provided sufficient information showing that the likely level of emissions meets the criteria in paragraph 37(b) of the UNFCCC Annex I inventory reporting guidelines?	Yes/No	
Description of trends	Did the ERT conclude that the description in the NIR of the trends for the different gases and sectors is reasonable?	Yes/No	
Supplementary information under the Kyoto Protocol	2. Have any issues been identified related to the national system:		
	(a) The overall organization of the national system, including the effectiveness and reliability of the institutional, procedural and legal arrangements	Yes/No	*For paragraph 2(a, b), include examples of QA/QC issues considered in context of the national system here*
	(b) Performance of the national system functions	Yes/No	

Abbreviations and acronyms

2006 IPCC Guidelines	*2006 IPCC Guidelines for National Greenhouse Gas Inventories*
ARR	annual review report
CH_4	methane
CO_2	carbon dioxide
CRF	common reporting format
ERT	expert review team
EU ETS	European Union Emissions Trading System
FAO	Food and Agriculture Organization of the United Nations
GHG	greenhouse gas
ID#	issue identification number
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPPU	industrial processes and product use
KP-LULUCF activities	activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol
Kyoto Protocol Supplement	*2013 Revised Supplementary Methods and Good Practice Guidance Arising from the Kyoto Protocol*
LULUCF	land use, land-use change and forestry
NA	not applicable
NIR	national inventory report
QA/QC	quality assurance/quality control
Revised 1996 IPCC Guidelines	*Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*
TACCC	transparency, accuracy, comparability, consistency, completeness
UNFCCC	United Nations Framework Convention on Climate Change
UNFCCC Annex I inventory reporting guidelines	"Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual greenhouse gas inventories"
UNFCCC review guidelines	"Guidelines for the technical review of information reported under the Convention related to greenhouse gas inventories, biennial reports and national communications by Parties included in Annex I to the Convention"
Wetlands Supplement	*2013 Supplement to the 2006 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories: Wetlands*