Capacity building on monitoring, reporting and verification of the GHG emissions and actions in developing countries

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GHG QA/QC Plan for Cement Sector

Description of Procedures

MRV Africa

Ethiopia

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Receiver:
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1 RATIONALE AND OBJECTIVES

The implementation of quality assurance, quality control (QA/QC) and verification procedures is an important part of the development of national greenhouse gas inventories, and accounting and reporting on GHG mitigation actions (hereafter commonly called 'GHG inventory'). As described in the IPCC 2006 Guidelines, an adequate QA/QC plan helps improve transparency, consistency, comparability, completeness, and confidence in national GHG inventories.

This QA/QC plan establishes procedural and technical issues while developing a GHG inventory in the cement sub-sector for a specific year y. This QA/QC plan directs activities and attention to ensure the quality of the inventory while it is being developed and compiled. An effective QA/QC plan contains the following elements, which are covered in the following chapters:

1. Roles and responsibilities;
2. Procedures (general and sub-sector specific);
3. QA review procedures;
4. Reporting, documentation, and archiving procedures.

The small blue italic text is used to provide instructions and guidance throughout the document. The blue text should be deleted from the final QA/QC plan, after including all requested sub-sector specific information.

1.1 Principles

The GHG inventory is guided by 'transparency', 'accuracy', 'consistency', 'comparability' and 'completeness' (TACCC). These are defined by IPCC 2006 Guidelines as follows:

- **Transparency -** means that the inventor complier should provide sufficient and clear documentation and report a level of disaggregation that sufficiently allows individuals or groups other than the compiler team to understand how the inventory was compiled and assure it meets *good practice* requirements for national greenhouse gas emissions inventories. The transparency of emission reporting is fundamental to the effective use, review and continuous improvement of the inventory.

- **Accuracy** - means that emissions are neither overestimated nor underestimated, as far as can be judged. This implies all endeavors to remove bias from the inventory estimates.

- **Consistency -**means that estimates for any different inventory years, gases and categories are made in such a way that differences in the results between years and source categories reflect real differences in emissions. Annual emissions, as far as possible, should be calculated using the same method, and data sources for all years, and resultant trends should reflect real fluctuations in emissions and not the changes resulting from methodological differences. Consistency also means that, as far as practicable and appropriate, the same data are reported under different international reporting obligations.

- **Comparability -** means that the national inventory is reported in such a way that allows it to be compared with national inventories of other countries. This can be achieved by following IPCC Guidelines and i.e. appropriate choice of key categories, using the reporting guidance, tables, classification and definition of categories of emissions as presented in IPCC 2006 Guidance, Volume 1, Chapter 8 on Reporting Guidance and Tables.

- **Completeness -**means that estimates are reported for all pollutants, all relevant source categories and all years and within the entire territorial boundaries of the country. Where elements are missing their absence should be clearly documented together with a justification for exclusion.

1.2 Definitions

The terms 'quality control', 'quality assurance', and 'verification' are often used in different ways.
In this document the IPCC 2006 Guidelines definitions apply, as follows:

- **Quality Assurance (QA) – a planned system of review procedures conducted by personnel not involved** in the inventory compilation process. Independent reviews verify that measurable objectives were met, ensure that the inventory represents the best possible estimates of emissions given the current state of scientific knowledge and data availability, and support the effectiveness of the QC programme.
- **Quality Control (QC)** – a system of routine technical activities implemented to measure and control the quality of the inventory as it is compiled. 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 as well as identify and address errors and omissions. QC activities include general methods such as accuracy checks on data acquisition and calculations as well as technical reviews of categories, activity data, and emission factors.
- **Verification -** 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. 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.

For further information see '*IPCC 2006 Guidelines, Volume 1, Chapter 6 on Quality Assurance/Quality Control and Verification'*.

2 QA/QC PERSONEL

The QA/QC Coordinator is the main person responsible for coordinating QA/QC activities, related roles and ensuring the implementation of the QA/QC plan. Table 1 lists persons and responsibilities for the execution of the QA/QC plan.

List persons responsible and their contact details.

Table1. Personnel Responsible for QA/QC Activities

Title	QA/QC Responsibility	Individual (initial, last name)	Institution	Contact Information
QA/QC Coordinator	▪ Clarifies and communicates QA/QC responsibilities to inventory members. ▪ Manages and provides Inventory team with documentation of QA/QC activities implementing the overall QA/QC plan. ▪ Ensures the timelines are kept. ▪ Coordinates external reviews of the inventory document and ensures that comments are incorporated into the inventory.			
Cement Sub-Sector Lead	▪ Collects Inventory data. ▪ Implementing sub-sector specific QA/QC procedures.			
External Expert(s)	▪ Expert review of the inventory			

2.1 Communicating the QA/QC Plan

It is crucial to communicate the QA/QC plan to the inventory team and external experts in order to effectively implement QA/QC procedure. The following steps are recommended:

1. Distribute the finalised QA/QC plan to all team members working on the inventory.
2. Conduct a "kick-off" meeting with all of those working on the inventory to introduce the work plan, responsibilities and required documentation.
3. Provide electronic memos to the team members to remind them of their QA/QC responsibilities and overall schedule.

3 QUALITY ASSURANCE AND CONTROL PROCEDURES

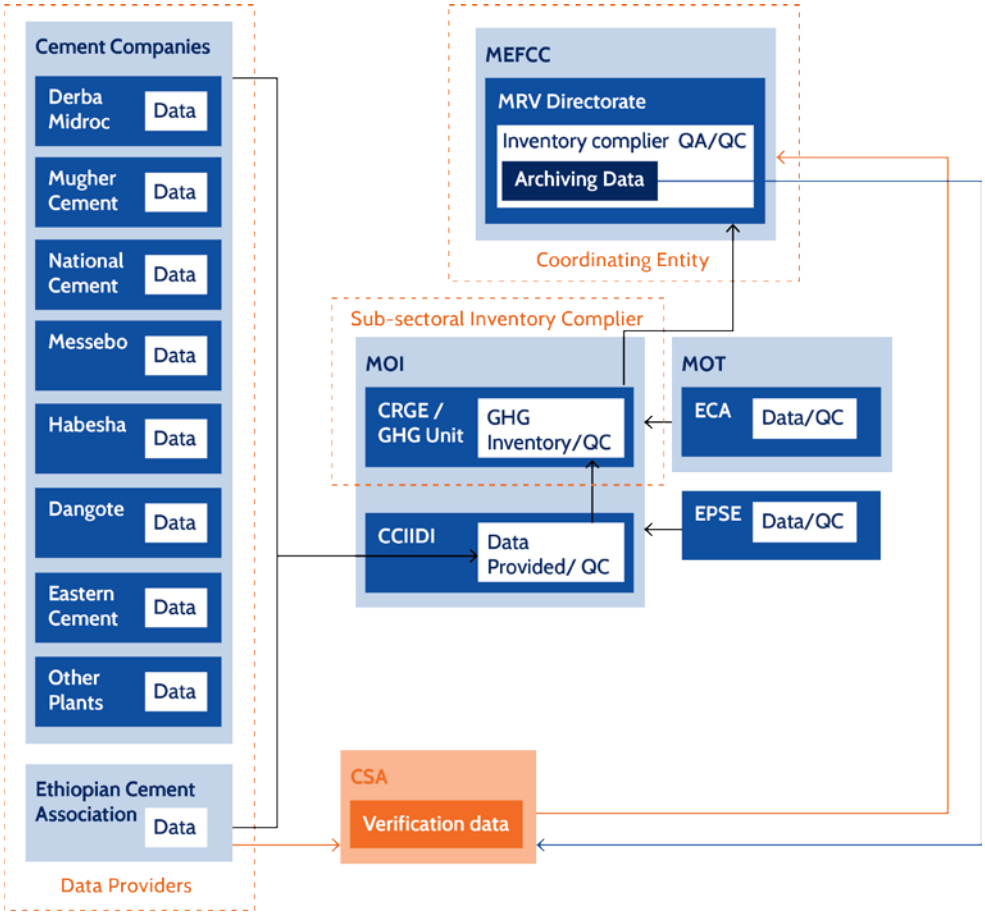
This chapter clarifies the general data flow for GHG inventory in the cement sub-sector, outlines QA/QC activities performed, the schedule for completing these activities, as well as defines the external review process and the protocols for archiving documents.

3.1 Initial Data Flow

The data collection for the GHG inventory takes place every **quarter** by using the **MRV Template_Cement Sub-Sector_Final**. The plant specific information reported quarterly should be summarised annually by using the **MRV Template_Cement Sub-Sector_ALL PLANTS**. The majority of the cells in the templates have been protected to minimise errors. To unprotect the sheets use password ghg987. This will allow the inventory complier to make changes. It is however recommended that the cells are kept protected to avoid typing errors and errors in formulas.

The MRV information flow diagram is presented in figure 1. Table 2 lists persons/institutions responsible for data flow.

Figure 1. MRV Information Flow.



List persons responsible for data collection (Who (plant manager, CCIIDI, CRGE Unit/MoI, MEFCC) is responsible for what data?)

Table 2. Data Flow Table

Data Type	Institution	Individual (initial, last name)	Contact Information
Plant Details (incl. Technical)			
Production Details			
Fuel Details			
Emission Factor			
GHG Emissions			

3.2 QC Procedures for the Cement Sub-Sector Lead

This chapter lists the QC checks a GHG inventory compiler should use routinely throughout the preparation of the GHG inventory. The procedures set out below focus on the processing, handling and documenting of sub-sector specific information. The procedures are provided in tabular format in Tables 3 and 4.

Define timelines for each task. Enter the name of the person completing the item and the date the item was completed.

Table 3. Checklist for General QC Activities

QC Activity	Procedures	Task Completed				Corrective Measure Taken		Supporting Documents (List Names)
		Date Due	**Date**	**Individual (initial, last name)**	**Errors (Y/N)**	**Date**	**Individual (initial, last name)**	
Data Gathering, Input, and Handling Checks								
Check that assumptions and criteria for the selection of activity data, emission factors, and other estimation parameters are documented.	▪ Cross-check descriptions of activity data (cement, clinker, fuel, NVC data), emission factors and other estimated parameters with information on categories and ensure that these are properly recorded and archived.							
Check for transcription errors in data input and reference.	▪ Confirm that bibliographical data references are properly cited in the internal documentation ▪ Cross-check a sample of input data from each category (either measurements or parameters used in calculations) for transcription errors.							
Check that emissions are calculated correctly.	▪ Reproduce a representative sample of emissions calculations.							
Check that parameter and emission units are correctly recorded and that appropriate conversion factors are used.	▪ Check that units are properly labeled in calculation sheets. ▪ Check that units are correctly carried through from beginning to end of calculations. ▪ Check that conversion factors are correct.							
Check for consistency in data between categories.	▪ Identify parameters (e.g. fuel names, units, NCVs and emission factors) that are common to multiple categories and confirm that there is consistency in the values used for these parameters in the emissions calculations.							
Data Documentation								
Review of internal documentation and	▪ Check that there is detailed internal documentation to support the estimates and							

archiving.	enable duplication of calculations. ▪ Check that every primary data element has a reference for the source of the data. ▪ Check that inventory data, supporting data, and inventory records are archived and stored to facilitate detailed review. ▪ Check that the archive is closed and retained in secure place following completion of the inventory ▪ Check integrity of any data archiving arrangements of outside organizations involved in inventory preparation.							
Emission Calculation Checks								
Check time series consistency	▪ Check for temporal consistency in time series input data for each category. ▪ Check methodological and data changes resulting in recalculations. ▪ Check that the effects of mitigation activities have been appropriately reflected in time series calculations.							
Check completeness	▪ Confirm that estimates are reported for all quarters and all years from the appropriate base year over the period of the current inventory. ▪ Confirm that the entire Cement sector .e. all plants is being covered. ▪ Check that information is reported in the correct units as labeled. ▪ Check that conversion factors are correct.							
Trend checks	▪ Compare current inventory estimates to previous estimates, if available. If there are significant changes or departures from expected trends, re-check estimates and explain any difference. Significant changes in emissions from previous years may indicate possible input or calculation errors. ▪ Check value of implied emission factors for							

	cement and clinker (t CO2/t production) across time series. Are changes in emissions being captured? ▪ Check if there any unusual or unexplained trends noticed for cement or clinker production or fuel use across the time series.							

Table 4. Checklist for Category Specific QC Activities

QC Activity	Procedures	Task Completed			Corrective Measure Taken		Supporting Documents (List Names)
		Date	Individual (initial, last name)	Errors (Y/N)	Date	Individual (initial, last name)	
Emission Factor Quality Checks							
Assess representativeness of IPCC emission factors for fuel and carbonates , given national circumstances	▪ Evaluate whether national conditions are similar to those used to develop the IPCC default factors for fuel or CO2 emission factor of carbonates. ▪ Compare default factors to site or plant-level factors (see sheet "QC Check from MRV Template). If the aggregated top-down approach is used, but some limited plant-specific data are available, inventory compilers should compare the site or plant level factors with the aggregated factor used for the national estimate. This will provide an indication of the reasonableness and the representatively of the data. ▪ Consider options for obtaining country-specific factors. Differences between national factors and default factors should be explained and, particularly if they are representative of different circumstances. ▪ Document results of this assessment.						
Compare country-specific factors to alternative factors (e.g., IPCC default, cross country,	▪ QC the data used to develop the country-specific factor. ▪ Assess whether secondary studies used to develop country-specific factors used QC activities.						

literature)	▪ Compare country-specific factors to IPCC defaults; document any significant discrepancies. ▪ Compare country-specific factors to site or plant-level factors. ▪ Compare to factors from other countries (using IPCC Emission Factor Database). ▪ Document results of this assessment.						
Search for options for more representative measurements	▪ Monitoring systems at the plants may be used to check the emission and oxidation factors in use at the plant. ▪ Some countries estimate emissions from fuel consumed and the carbon contents of those fuels. In this case, the carbon contents of the fuels should be regularly reviewed. ▪ Determine if national or international (e.g., ISO) standards were used in measurements. ▪ Ensure measurement equipment is calibrated and maintained properly. ▪ Compare direct measurements with CO2 estimates (exhaust gas measurements against CO2 calculation) document any significant discrepancies.						
Activity Data Quality Check: National Level Data							
Review national level activity data	▪ Check applicability of data. Determine the level of QC performed by the CRGE Unit. If inadequate, consider alternative data sources such as IPCC defaults and international data sets. Adjust the relevant uncertainty accordingly. ▪ Compare clinker and cement production data from multiple						

	reference sources. The Central Statistics Agency, if resources permit, should have information available on clinker and cement production as well as energy usage at industrial level. ▪ Check methodology for filling in time series for data that are not available annually. ▪ Provide observations on the completeness of the data set.						
Activity Data Quality Check: Site-specific Data							
Assess site-specific activity data	▪ Determine if national or international (e.g., ISO) standards were used in estimates. If not then the use of these emissions or activity data should be carefully evaluated, uncertainty estimates reconsidered. ▪ Compare aggregated site-specific data (e.g. production of clinker and cement as well as fuel use) to national statistics/data. ▪ Compare reported and calculated clinker fractions (See sheet "QC Checks" in the MRV Template; ▪ Provide observations on the completeness of the data set. ▪ Check for inconsistencies across similar sites to establish whether they reflect errors, different measurement techniques, or result from real differences in emissions, operational conditions or technology. ▪ Compare top-down and bottom-up estimates for similar orders of magnitude. ▪ For cement production, inventory compilers should compare plant data						

	(content of CaO in clinker, content of clinker in cement) with other plants in the country. ▪ Tier 2 documentation should include a description of how clinker production was estimated by the reporting entity (i.e., directly weighed, weight determined by volume of clinker pile, calculated from raw material inputs, etc.) and at what level the activity data were collected (i.e., plant level or national level). The method (e.g., country specific or IPCC default) for determining the CaO content of clinker should be documented along with any plant-specific information regarding the quantity and type of non-carbonate feeds to the kiln, such as slags or fly ash. All procedures used to quantify and determine the degree of calcination of CKD should be documented. Where the assumption that emissions of CKD are equal to 2 percent of emissions from clinker production is made, this should be transparently reported.						
Calculation Related Quality Check							
Emission comparisons	▪ Compare historical data: Check for changes in year-over-year estimates (> 10%). ▪ Checks against independent estimates or estimates based on alternative methods. Comparisons could be made between emissions estimated using different tiers. For example, if a bottom-up approach is used to collect activity data (i.e.,						

	collection of plant-specific data), then inventory compilers should compare the emissions estimates to the estimates calculated using national production data for cement or clinker(top-down approach). ▪ In cases where a hybrid Tier 1/2 approach is used during a transition period, it is considered good practice also to estimate emissions for all facilities using the lower Tier in order to compare the results of the analysis to the results derived using the hybrid approach. The results of such comparisons should be recorded for internal documentation, including explanations for any discrepancies. ▪ For tier 1 approach makes sure that cement imports have not be double counted. Use either data reported by plants (if comprehensive) against import data from MoT. Use only on set of data, whichever is more reliable.						
Check spreadsheets	▪ Clearly reference to the data source of any numbers typed into the spreadsheet. ▪ Document the spreadsheet itself specifying its name, version, authors, updates, intended use and checking procedures so that it can be used as a data source of the derived results and referenced further on in the inventory process.						
Uncertainty Related Quality Check							
QC uncertainty estimates	Apply QC techniques to uncertainty estimates	.					

	▪ Review uncertainty calculations and make sure they are well documented (see sheet “QC Checks” from MRV Template). ▪ Document uncertainty assumptions. ▪ For uncertainty estimates involving expert judgment, the qualifications of experts should also and qualifications of any experts consulted						

3.3 QA Procedures

It is good practice to carry out a **review involving national experts** and stakeholders in the different fields related to emissions from cement sub-sector, for example, production statistics, fuel use, and combustion efficiencies for different kilns/equipment types. The objective of QA implementation is to involve reviewers who can conduct an **unbiased review of the inventory** and who may have a different technical perspective. This review will identify potential problems and make corrections where possible. The review should contain a review of calculations and assumptions by experts in relevant technical fields and is typically accomplished by reviewing the documentation associated with the GHG inventory.

List external experts who have reviewed the cement sub-sector. Adjust the table in terms of expertise, as required.

Table. 5 : Data Flow Table

Individual (initial, last name)	Institution	Area of Expertise	Contact Information
		[Production Details]	
		[Fuel Details]	
		[Emission Factor]	
		[GHG Emissions]	

After the identification of the external reviewers, set and agree on review schedule. Provide the reviewers with table 6 in electronic format to collect their findings.

Define timelines for each task. Enter the name of the person completing the review and provide summary of findings and corrective measures proposed. Add rows in the table, if required.

Table. 6 : Review table.

Individual Area of Expertise		
Finding #1	Date	Corrective measure proposed
Finding #2	Date	Corrective measure proposed
Finding #3	Date	Corrective measure proposed

After collecting and compiling review comments, deliver the compiled comments to inventory coordinator in order to update inventory, as appropriate based on comments.

3.4 Verification

Verification activities provide information to improve the GHG inventory and are part of the overall QA/QC process. **Comparison between the GHG inventory and independent estimates** increases the confidence and reliability of the GHG inventory estimates by confirming the results. Significant differences may indicate weaknesses in either or both sets of data.

An ideal condition for verification is the use of **fully independent data** as a basis for comparison. It is good practice to reflect the results of the verification in the QA/QC report and incorporate recommendations for inventory improvement into the QA/QC plan. Table 7 provides a data comparison table.

Compare data and estimates to other national (or international) estimate and summaries findings and recommendations. Adjust the table in terms of data type, as required.

Table. 7 : Data Comparison Table

Data Type	Initial source of information (institution name)	Verification source (institution name)	Summary of Findings	Recommendations
Installation Details (incl. Technical)				
Production Details				
Fuel Details				
Emission Factor				
GHG Emissions				

After finalising the verification, send the compiled comments to inventory coordinator in order to update inventory, as appropriate based on comments.

3.5 Archiving

It is *good practice* to document and **archive all information** relating to the planning, preparation, and management of inventory activities. This includes, among others:

Method:
- Methods used, including those used to estimate uncertainty and those used for recalculations.
- Rationale for choice of methods.
- Assumptions and criteria for the selection of activity data and emission factors.
- Changes in data inputs or methods from previous inventories (recalculations);

Data:
- Emission factors and other estimation parameters used, including references to IPCC or published papers/ other documentation for other emission factors used in higher tiers.

QA/QC plans:
- Records of QA/QC plan and procedures.
- Final inventory report and any analysis of trends from previous years.

To establish an archiving system at minimum the questions in table 8 should be answered.

Table 8. Questions to define a Basic Archiving System

Question	Archiving System
How is the data stored?	
Where is the data stored?	Create official archive located in: *insert location of master versions of hard copy and electronic files.*
Are they stored electronically or in hardcopy? In both formats?	
How are the files named?	*For example save files with IPCC category name, inventory year, type of file, file version i.e. date the file was last save (IPPU_ Mineral Industry_Cement Production_ 2016 GHG Calculation 18_07_2017.xls)*
How are the names/files changed to reflect updates?	
What is the storage mechanism?	Duplicate copies of the archive files are stored in: *insert location, address, etc.*
How to communicate the archiving system to the GHG inventory team?	
Who is the Archiving Coordinator?	*(S)he is responsible for ensuring that all archiving procedures are performed for the inventory and all supporting documents and spreadsheets are retained appropriately.*

For more information see: “U.S. Environmental Protection Agency. Developing a National Greenhouse Gas Inventory System. Template Workbook. Template 4 : Description of Archiving System”.

4 REFERENCES

This QA/QC plan bases on the below documentation:

- EMEP/EEA Emission Inventory Guidebook 2009. Inventory management, improvement and QA/QC. Goodwin J. and Pulles T. EMEP/EEA.

- IPCC 2006. Guidelines for National Greenhouse Gas Inventories, Volume 1 General Guidance and Reporting. Prepared by the NationalGreenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). IGES, Japan.

- U.S. Environmental Protection Agency. Developing a National Greenhouse Gas Inventory System. Template Workbook. Template 3: Description of QA/QC Procedures. US EPA.

- U.S. Environmental Protection Agency. Developing a National Greenhouse Gas Inventory System. Template Workbook. Template 4 : Description of Archiving System