Quality Assurance/Quality Control (QA/QC) Plan and Procedures

Remote Training on the Building of Sustainable National Greenhouse Gas Inventory Management Systems

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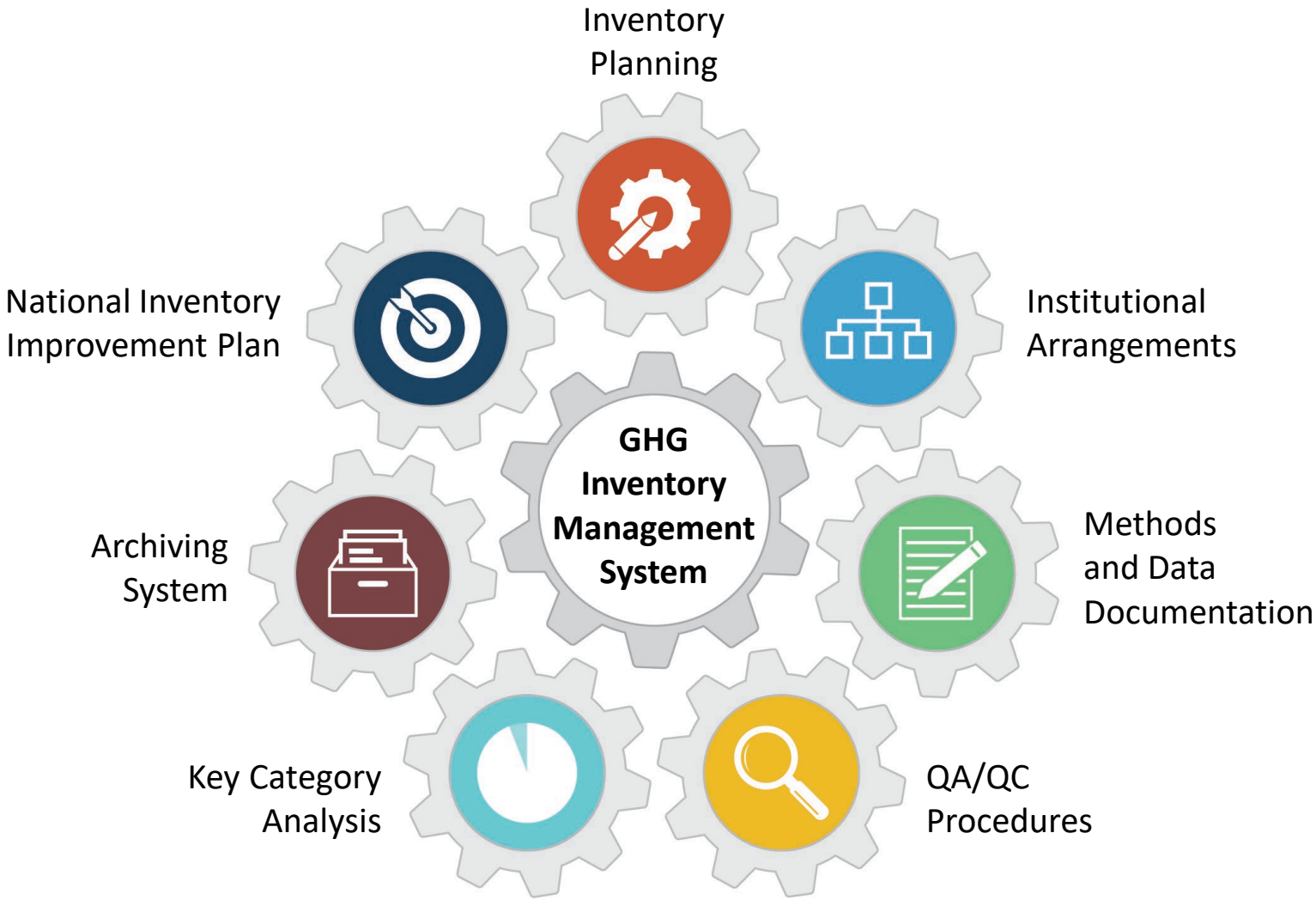
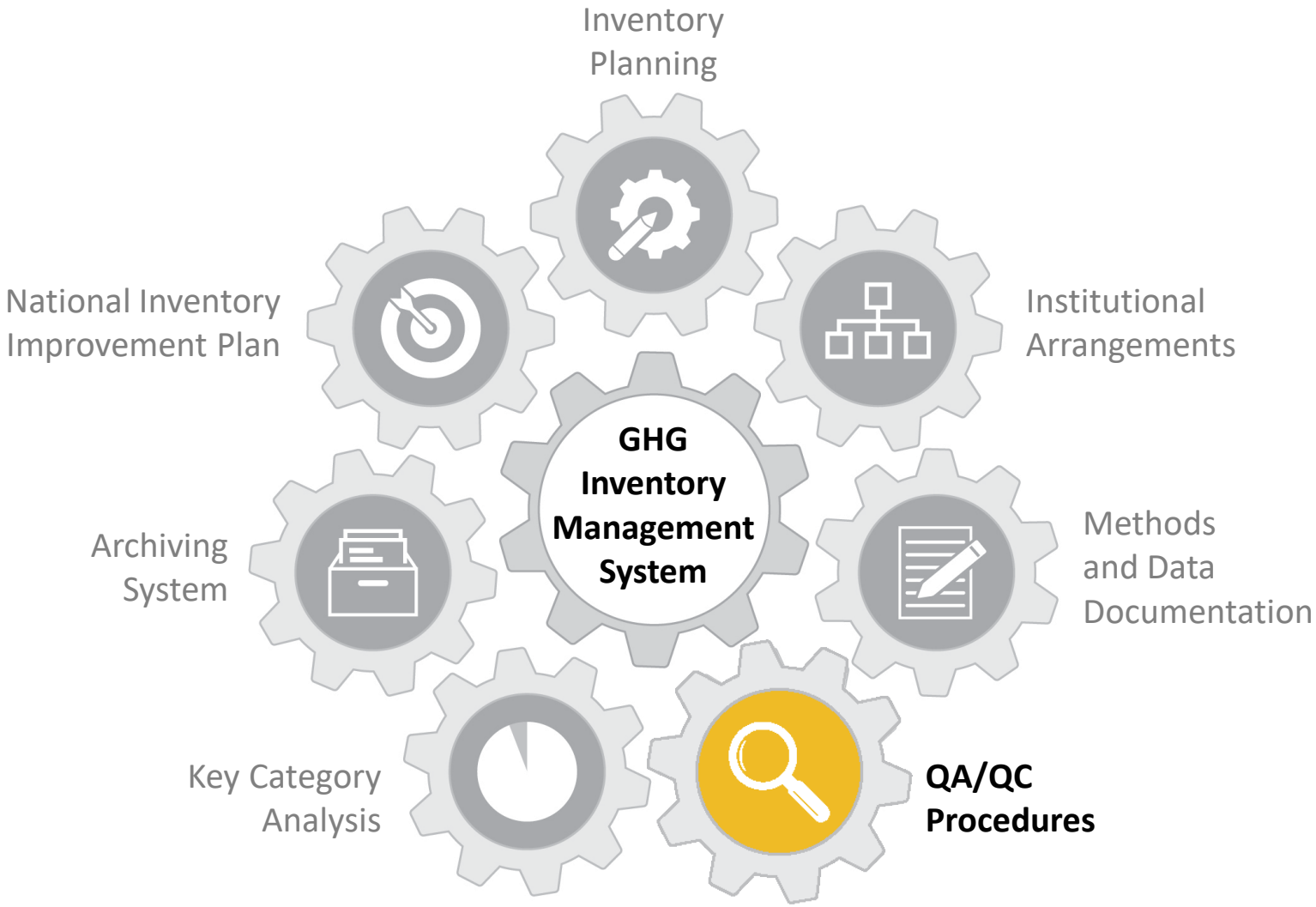
Ricardo Energy & Environment

October 27, 2022

Developing a Sustainable National GHG Inventory System



Quality Assurance and Quality Control



Overview

Introduction to Quality Assurance and Quality Control (QA/QC)

Review of the Template

QA/QC Action Plan

****If we have time – we will look at some country specific examples****

What is Quality Assurance?

A planned system of review procedures conducted by personnel **not directly involved** in the inventory compilation/development process.

- From the *2006 IPCC Guidelines*

Reviews, *preferably by independent third parties*, are performed upon a completed inventory following quality control procedure. Reviews:

- Verify the data quality objectives were met;
- Ensure that the inventory represents the best possible estimates of emissions and sinks;
- Support the quality control program.

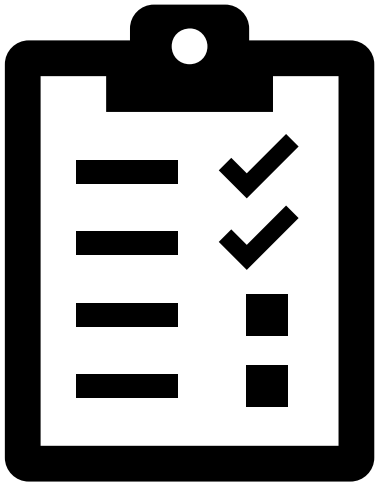
What is Quality Control?

A system of routine technical activities to assess and maintain the quality of the inventory as it is being compiled. **It is performed by personnel compiling the inventory**.

- From the *2006 IPCC Guidelines*

The 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;
- Check data acquisition, calculations, and procedures;
- Document technical reviews of data, methods, and results



Importance of QA/QC – Why bother?

Helps identify improvement options!

Builds confidence in national GHG inventories!

Verification

- 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.
- Verification activities include comparisons with emission or removal estimates prepared by other bodies and comparisons with estimates derived from fully independent assessments.

Example from 2006 IPCC Guidelines

The IPCC provides potential outside verification checks in the national level CO_2 emissions estimates compiled by the International Energy Agency (IEA)

Key Components of a QA/QC and Verification System

- Work your way round the steps in this system
- Develop an improvement plan and implement as you complete the activities – then go round the steps again – continuous improvement

QA/QC Roles and Responsibilities

Roles	Responsibilities
Agency Inventory Lead	General QA/QC
QA/QC Coordinator	Directs overall implementing of QA/QC
Emission and Removal Category Lead	Implements source specific QA/QC
Consultants (depending on institutional arrangements)	Day-to-day QC and additional QA support
Outside Experts	QA by university experts, industry groups

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The same person can have multiple roles. Not all roles are full time!

Procedures to Apply the QA/QC

Example General QC Checks

1. Check that spreadsheets use consistent units, properly labelled
2. Check that estimates are reported for all source categories and for all years
3. Cross-check spreadsheet values to publication values

Example Category-Specific QC Checks (Energy Sector)

1. Check for fuel consumption year to year trends
   - Follow up with external sources when fuel consumption inputs show unusual trends

Example QC Procedure

AG12

	A	B	C	D	E	F	AC	AD	AE	AF
1	**CO_2 EMISSIONS FROM CEMENT PRODUCTION**									
2			**1990**	**1991**	**1992**	**1993**	**2016**	**2017**	**2018**	**2019**
3	Clinker Production	(Thousand metric tons)	64,355	62,918	63,411	66,957	75,633	76,678	77,112	79,000
4	CO_2 Released	(Thousand metric tons)	32,828	32,095	32,346	34,155	38,581	39,114	39,335	40,298
5	CKD CO_2 Release*	(Thousand metric tons)	657	642	647	683	772	782	787	806
6	**Total CO_2 Release**	**(thousand metric tons CO_2 Eq.)**	33,484	32,736	32,993	34,838	39,352	39,896	40,122	41,10
7		**(million metric tons CO_2 Eq.)**	**33.5**	**32.7**	**33.0**	**34.8**	**39.4**	**39.9**	**40.1**	**41**
8										

QC Procedure #1:

Cross-check spreadsheet values to publication values ✓

CEMENT

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In 2020, U.S. portland cement production increased slightly to an estimated 87 million tons, and masonry cement production decreased slightly to 2.3 million tons. Cement was produced at 96 plants in 34 States, and at 2 plants in Puerto Rico. Texas, Missouri, California, and Florida were, in descending order of production, the four leading cement-producing States and accounted for nearly 45% of U.S. production. Overall, the U.S. cement industry's growth continued to be constrained by closed or idle plants, underutilized capacity at others, production disruptions from plant upgrades, and relatively inexpensive imports. In 2020, shipments of cement were essentially unchanged from those of 2019 and were valued at $12.7 billion. In 2020, it was estimated that 70% to 75% of sales were to ready-mixed concrete producers, 10% to concrete product manufacturers, 8% to 10% to contractors, and 5% to 12% to other customer types.

Salient Statistics—United States:[1]	**2016**	**2017**	**2018**	**2019**	**2020**[e]
Production:					
Portland and masonry cement[2]	84,695	86,356	86,368	[e]88,000	89,000
Clinker	75,633	76,678	77,112	79,000	79,000
Shipments to final customers, includes exports	95,397	97,935	99,419	103,000	103,000
Imports for consumption:					
Hydraulic cement	11,742	12,288	13,764	[illegible]	15,000
Clinker	1,496	1,209	967	1,160	1,400
Exports of hydraulic cement and clinker	1,097	1,035	919	1,002	1,000
Consumption, apparent[3]	95,150	97,160	98,500	[e]103,000	102,000
Price, average mill value, dollars per ton	111	117	121	[e]123	124
Stocks, cement, yearend	7,420	7,870	8,580	[e]7,140	7,800
Employment, mine and mill, number[e]	12,700	12,500	12,300	12,500	12,500
Net import reliance[4] as a percentage of apparent consumption	13	13	14	14	15

Recycling: Cement is not recycled, but significant quantities of concrete are recycled for use as a construction aggregate. Cement kilns can use waste fuels, recycled cement kiln dust, and recycled raw materials such as slags and fly ash. Various secondary materials can be incorporated as supplementary cementitious materials (SCMs) in blended cements and in the cement paste in concrete.

Example QC Procedure

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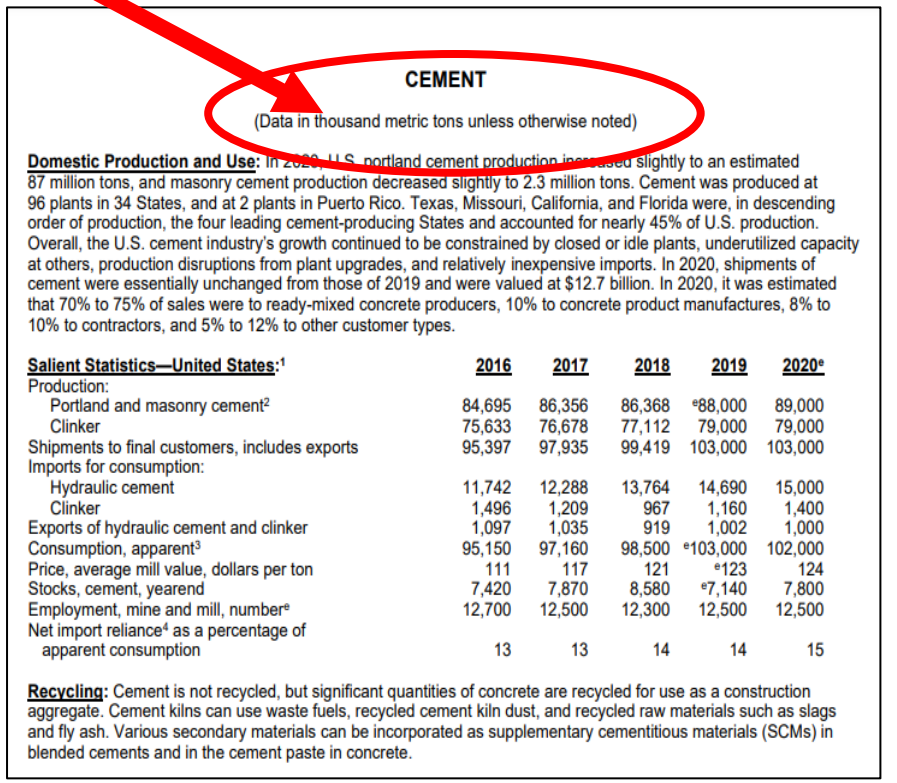
8										

QC Procedure #2:

Check that spreadsheets use consistent units and are properly labelled



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Where to Apply the QA/QC

General QC checks are applicable to **all inventory categories and all types of data**

Questions to consider for prioritizing your QC process:

1. Is the source/sink a key category?
2. Has a category's methodology or data changed?
3. Is there a high level of uncertainty for the category?
4. When was the last time this category went through the QC check?

Some categories need more QA/QC than others!

When to Apply the QA/QC

What level of QC is needed annually?

- Data updates
- A sample of data and calculations from each sector should be checked each year
- QC should be performed prior to peer review

Some QC is needed biannually, biennially, triennially.

- Not every QA/QC procedure needs to be annual, but over a couple of inventory cycles, everything should be covered

When to Apply the QA/QC

- Inventory inception meeting
- Start with previous inventory, if available
- Review and implement improvement plan
- Identify Activity Data and choose methodologies

- Collect Activity Data, Emission Factors
- QC all data

- Estimate emissions & removals
- Implement QC procedures
- Revise estimates, based on new data and QA/QC findings
- Ensure time series consistency
- Conduct uncertainty & key category analyses

- Document methodological approaches, recalculations, and references
- Write inventory report

- Conduct & document QA/QC procedures, such as basic peer review
- Address QA/QC findings

- Finalize inventory
- Develop improvement plan
- Publish/submit inventory for UNFCCC reporting on time

- Save all compilation files and references to create an inventory archive
- Backup the archive

Poll Question #1

Does your inventory team have and implement a QA/QC plan?

a) Yes
b) No
c) I do not know
d) We do not have an established compilation team

Respond using Mentimeter link in the chat!

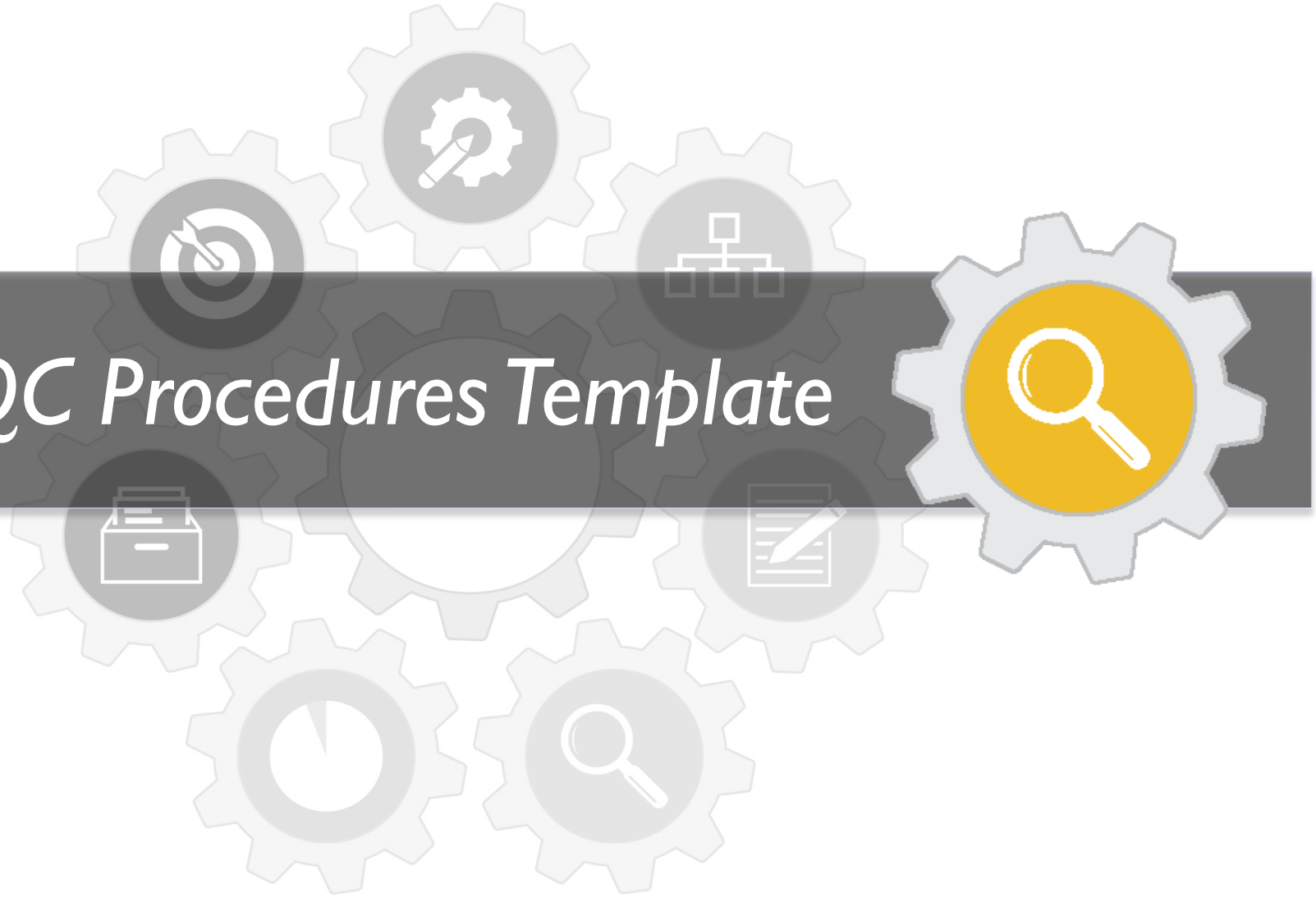
Poll Question #2

What are your Inventory team's quality control and/or quality assurance challenges?

a) QA/QC Plan is not developed
b) Roles are not assigned - It is unclear who does a particular QA/QC task
c) Limited time to conduct and document the QA/QC procedures
d) All of the above

Respond using Mentimeter link in the chat!

QA/QC Procedures Template



How This Template Will Help!

Resources in the QA/QC Template will help the inventory team:

- Define QA/QC roles and responsibilities
- Establish your official QA/QC timeline to build upon
- Establish general & category-specific QC procedures
- Establish QA procedures
- Document external reviewers
- Document improvements for the future

Step 1: Roles and Responsibilities

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

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

Who completes this table: National Inventory Coordinator (NIC) and QA/QC Coordinator

Example of Table 4-1

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

Role	QA/QC Responsibility	Name	Organization	Contact Information
National Inventory Coordinator	All aspects of the inventory program, cross-cutting QA/QC	M. Desai	EPA	Email and Phone Number
QA/QC Coordinator	Develop and implement the overall QA/QC plan	J. Steller	EPA	Email and Phone Number
Sector or Category Lead(s)	Develop and implement general, sector-specific (as appropriate) and/or category specific (as appropriate) QA/QC procedures listed in Tables 4-3 and 4-4 below. Focus on Key Categories	A. Chiu	EPA - OAP	Email and Phone Number
		T. Wirth	EPA – OAP	Email and Phone Number
		S. Roberts	EPA – OTAQ	Email and Phone Number
		G. Domke	USFS	Email and Phone Number
Outside Expert(s)	Expert review of the inventory. Ensure the role of the expert is carefully defined and agreed upon. The expert can be within the country, or an international expert	B. Jones	University of States	Email and Phone Number
		J. Doe	Cement Industry Association	Email and Phone Number
		M. Lopez	NGO expert	Email and Phone Number

Who completes this table: National Inventory Coordinator (NIC) and QA/QC Coordinator

Step 2: QA/QC Plan Timeline

Table 4-2. QA/QC plan distribution timeline

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

Who completes this table: National Inventory Coordinator (NIC) and QA/QC Coordinator

Example of Table 4-2

Table 4-2. QA/QC plan distribution timeline

Task	Timeline (when the task will occur)	Outcome (description of the results of the task)	Potential Improvements (how the task may be modified to produce a better outcome)
Create (or update) the QA/QC plan	Update plan by June 30 each year	Updates to the QC Plan was implemented with the QC check outcomes from the previous Inventory. Categories to undergo additional QC checks have been identified for the 1990-2020 Inventory	In addition to the Expert Review and Public Review QA processes, a potential improvement is to conduct an internal peer review QC process by inventory team members to focus on consistency and clarify of inventory information
Identify the best way to distribute the plan to each team member or external expert	Identify by July 14		
Distribute the QA/QC plan	No later than July 31	Plan (including timing) distributed to team	Possibly move timing forward for file distribution

Who completes this table: National Inventory Coordinator (NIC) and QA/QC Coordinator

Step 3: Establish general QC procedures

Table 4-3. General QA/QC Procedures

QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/ Initials	Date		
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 and emission factors with information on categories and ensure that these are properly recorded and archived. • Record if there are multiple sources of the same activity data, and if possible document the reasons for any differences.				
Check for transcription errors in data input and references	• Confirm that bibliographical data references are properly cited in the internal documentation (see completed Template 3, Methods and Data Documentation, if applicable). • Utilize electronic data where possible to minimize transcription errors.				

Who completes this table: QA/QC Coordinator, with NIC and Sector/Category Leads

Example of Table 4-3

Table 4-3. General QA/QC Procedures

QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/ Initials	Date		
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 and emission factors with information on categories and ensure that these are properly recorded and archived. • Record if there are multiple sources of the same activity data, and if possible document the reasons for any differences.	AA	9/18 2021	None	CementQA.xlsx
Check for transcription errors in data input and references	• Confirm that bibliographical data references are properly cited in the internal documentation (see completed Template 3, Methods and Data Documentation, if applicable). • Utilize electronic data where possible to minimize transcription errors.	AA	9/20 2021	Units were not correct. Edited metric tons to 1000 metric tons.	Cement.xlsx

Who completes this table: QA/QC Coordinator, with NIC and Sector/Category Leads

Step 4: Category-Specific QC Activities

Enter information into Table 4-4 for each category that undergoes category-specific QC checks!

Table 4-4. Category-specific QC Procedures

QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/ Initials	Date		
Data Gathering, Input, and Handling Checks					
Assess the applicability of IPCC default emission factors	• Evaluate whether national conditions are similar to those used to develop the IPCC default factors. • Compare default factors to site or plant factors. • Consider options for obtaining country factors. • Document results of this assessment.				
Review measurements	• 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 IPCC or other published default factors; document any significant discrepancies.				

Who completes this table: QA/QC Coordinator, with NIC and Sector/Category Leads

Example of Table 4-4

Table 4-4. Category-specific QC Procedures

QC Activity	Procedures	Task Completed		Corrective Measure Taken (if applicable)	Supporting Documents
		Name/ Initials	Date		
Data Gathering, Input, and Handling Checks					
Assess the applicability of IPCC default emission factors	• Evaluate whether national conditions are similar to those used to develop the IPCC default factors. • Compare default factors to site or plant factors. • Consider options for obtaining country factors. • Document results of this assessment.	BB	9/20/ 2022	Units corrected to metric tons	QA.xlsx
Review measurements	• 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 IPCC or other published default factors; document any significant discrepancies.	BB	9/20/ 2022	None	QA.xlsx

Who completes this table: QA/QC Coordinator, with NIC and Sector/Category Leads

Step 5: External Reviewers

Enter information into Table 4-5 for each category

Table 4-5. External Reviewers

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

Who completes this table: Sector/Category Leads

Example of Table 4-5

Table 4-5. External Reviewers

Name	Organization	Area of Expertise	Contact Information	Date Comments Received	Comment Summary
Jane Expert	Auto Corp	Mobile Sources	(111) 234-5678	3/18/22	A country specific emission factor is possible to calculate using…
John Expert	Univ. Of Place	Power plant models	(211) 234-5678	3/18/22	The number of iterations in the model should be increased because…

Who completes this table: Sector/Category Leads

Step 6: Improvements

Enter information into Table 4-6 for each category

Table 4-6. Potential Improvements to the GHG inventory

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

Who completes this table: Sector/Category Leads

Example of Table 4-6

Table 4-6. Potential Improvements to the GHG inventory

Topic	Category Code and Name	Issue	Relevant Inventory Quality Principle	Improvement Option
Equations	5.1 Enteric Fermentation	Implement year-specific milk fat values	Accuracy	Use Ministry of Agriculture reports to update milk fat percentage annually

Who completes this table: Sector/Category Leads

Additional Forms & Checklists

Checklists to track tasks may help the **QA/QC Coordinator** track progress of the development of the overall QA/QC plan, and QA/QC activities throughout the process

1. QA/QC Coordinator Checklist

Activities	Task Completed	
	Name	Date
1. Clarify and communicate QA/QC responsibilities to inventory team members.		
2. Develop and QA/QC checklists appropriate to roles on the inventory team. (See Table 4-2 and Table 4-3 in the "QA/QC Procedures" Template for examples)		
3. Distribute QA/QC checklist to appropriate inventory team members and set deadline for completion.		
4. Ensure the timely and accurate completion of QA/QC checklists and related activities by checking in with team members.		
5. Collect completed QA/QC checklists and forms.		
6. Review completed QA/QC checklists and forms for completeness and accuracy.		
7. Deliver documentation of QA/QC activities to the inventory lead and archive coordinator.		
8. Coordinate external reviews of the inventory document and ensure that comments are incorporated into the inventory. Steps to coordinating external reviewers include: i. Identify external reviewers (e.g. through category leads). ii. Set review schedule. iii. Establish review format (e.g., digital mark-up in Word or Excel). iv. Contact external reviewers informing them of the schedule and expectations.		

Case Study: QC of Cement Data

- **Background**: Country X uses industry reports on clinker production and an emission factor to estimate emissions for this source. Industry may submit corrected reports for prior years.

- **Issue**: While reviewing emissions estimates, the inventory compiler compares the 2018 totals from the 2018 report to the 2018 totals in the 2020 report and notices a discrepancy.

- **Resolution**: The inventory compiler reviews the raw data from both inventory years and confirms the same methodology was used for both inventories. The review reveals that a few organizations submitted updated data for 2018 in 2020, which led to the different totals.
  - Inventories will likely change not only over the time series, but a single year's totals may also change the next time emissions are estimated for that year. Documentation of the raw data and methodology supports the contractors finding of updated values from the data provider.

Action Items for QA/QC Procedures

1. Assign specific QA/QC responsibilities
2. Develop your QA/QC Plan, and include budget information
3. Communicate QA/QC Plan with the whole inventory compilation team
    1. The National Inventory Inception Memorandum Template is an effective way to document and communicate the QA/QC plan
4. Establish a process and schedule for the QA review
5. Identify potential improvements to QA/QC during the process
    - This will make the National Inventory Improvement Plan (Template 7) easier to complete

Make sure the whole inventory team understand the inventory QA/QC plan and know what their roles and responsibilities are

Country specific examples…

- Depending on time – we can look at some country specific examples…

Other Resources

- The *Managing National GHG Inventory Process* handbook is a good source:
  - Pages 27-28: QC Procedures
  - Page 47-48: Can ask peer review questions of own inventory
- Handbook on Measurement, Reporting and Verification For Developing Country Parties
- Guide For Peer Review of National GHG Inventories

Next template…

Thank You For Your Attention!

For questions & more information, email:

ghgi.transparency@epa.gov

Toolkit for Building National GHG Inventory Systems

https://www.epa.gov/ghgemissions/toolkit-building-national-ghg-inventory-systems