Corporate Greenhouse Gas Verification Guideline

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Prepared by
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Section A: Overview of the Corporate Verification Guideline

The *Corporate Greenhouse Gas Verification Guideline (CGVG)* was created to highlight and summarize some of the key issues associated with the verification and review of corporate greenhouse gas (GHG) emission inventories. The *CGVG* is designed to assist and support the work of experienced providers of environmental verification services by providing policy neutral information on the scope and process of corporate inventory verification. Use of the *CGVG* requires some familiarity with the process of developing and reviewing greenhouse gas emission inventories. A great deal of information related to measurement and accounting of corporate greenhouse gas emissions is available on-line, and the reader is referred to Appendix I: References and Bibliography for such information.

Need for Verification Guidelines

GHG verification is subject to divergent approaches and varied levels of technical rigor. Although many companies have arranged to have their emission inventory verified by an independent party, past verification activities have varied considerably.[1] These inconsistencies have been created largely due to case-by-case decisions made by companies and the technical service providers they employ. Even the terminology used by different parties to describe the verification results is often inconsistent and not precisely defined. This lack of comparability of results lowers the value of corporate verification efforts and causes confusion among market participants, the public, and policy makers.

By contrast, the emissions inventory community has made significant progress in developing flexible guidance documents and tools for inventory development and documentation that still provide some level of standardization. *The GHG Protocol*[2] is an example of a flexible guidance document, building on earlier guidance for national inventories, which defines and describes various "scopes" of corporate inventory work but allows companies to choose between options based on their individual needs. The field of corporate GHG inventory verification requires a similar level of standardization in order to consistently compare the various verification practices across companies and programs. Project-level validation/verification standards have also been developed for some notable organizations (e.g., Prototype Carbon Fund[3]), and validation and verification procedures have been outlined for projects under the United Nations Clean Development Mechanism,[4] but verification standards for corporate-wide inventories and protocols have not been clearly elaborated to date.

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[1] See Christopher P. Loreti, Scot A. Foster, and Jane E. Obbagy, *An Overview of Greenhouse Gas Emissions Verification Issues* (Pew Center on Global Climate Change, October 2001), at http://www.pewclimate.org/docUploads/emissions%5Fverification%2Epdf.

[2] See http://www.ghgprotocol.org for additional details on the World Resources Institute/World Business Council for Sustainable Development collaboration to develop standardized reporting procedures for GHG emission inventories.

[3] See *Preliminary Validation Manual* (Prototype Carbon Fund, November 2000), at http://prototypecarbonfund.org/docs/pvm_guidelines.ppt.

[4] See http://unfccc.int/cdm.

Clarifying standards for corporate inventory verification will help companies compare results and assess the value of their inventory development work in achieving objectives and documenting environmental performance. The *Corporate Greenhouse Gas Verification Guideline* has been defined to fill the need for a consensus standard on corporate GHG inventory verification.

The purpose of this verification guideline is not to define how a corporate inventory should be established, but rather to provide guidance on how to verify inventories once a reporting organization has established an accounting position on the subject or selected a reporting standard to apply.

Definitions

Verification is the confirmation, through provision of objective evidence by an independent party, that a reported GHG inventory reflects the actual GHG emissions of the reporting organization.[5] **Accreditation** is the official authorization of verifiers to conduct verification activities and issue verification statements as part of an official process. The verifier may or may not be accredited by an agency or licensure process. **Certification** is the process by which an accredited verifier provides written assurance that a GHG inventory conforms to requirements specified by the administrator of a particular reporting program. The administrator of the GHG reporting program to the corporate entity then issues formal, written certification of the GHG inventory results.

An **audit trail** is the historic data and supporting information that are available for examination in order to evaluate the quality of a corporate greenhouse gas inventory and which allows material misstatements to be detected. A **material misstatement** is an inaccurate assertion of a significance, relative to the entity's overall GHG emissions, that reasonably influences decisions or actions taken by other users of the corporate greenhouse gas inventory data (and of any associated verification statement), due to individual or aggregation of errors or omissions.

A **field audit** is the act of physically visiting one of the reporting organization's facilities and conducting facility-specific verification activities as discussed in this document. A **field audit list** (or audit list) is a listing of a reporting organization's facilities that have been selected for a field audit.

This document builds on existing guidance (for additional information see References) and provides practical direction on the selection and application of corporate GHG inventory verification procedures. This verification guideline is designed to be useful under a variety of reporting programs and for a variety of accrediting agencies.

Elements of Verification

A comprehensive verification effort will endeavor to cover a number of elements related to inventory design and development. The U.S. Environmental Protection Agency (EPA)

[5] See Roel Hammerschlag and Wiley Barbour, "Verification and Certification" (February 2003), at http://www.nescaum.org/greenhouse/registry.

provides information and guidance on a variety of issues related to emission inventory development and review, primarily focusing on air quality pollutants, but also addressing greenhouse gases.[6] For example, EPA's Emission Inventory Improvement Program (EIIP)[7] classifies five "audit types" that cover the full range of corporate responsibility for emission inventory data quality (see Table A.1):

Table A.1: Emission Inventory Improvement Program Audit Types

EIIP Audit Type	Objective
Management Systems	Determine the appropriateness of the management and supervision of inventory development activities and training of inventory developers.
Technical Systems	Determine the technical soundness, effectiveness, and efficiency of the procedures used to gather data and calculate emission results.
Performance Evaluation	Determine whether the equipment used to collect measurement data operates within acceptable limits.
Data/Report	Determine whether the results reported accurately reflect the emission results calculated and recorded in the supportive data.
Data Quality	Determine the accuracy and completeness of the data used to develop the emission results.

Source: Emission Inventory Improvement Program, EIIP Document Series - Volume VI, at http://www.epa.gov/ttnchie1/eiip/techreport/volume06/index.html.

Although the term 'audit' is used in the EIIP, its use with respect to emission inventories may lead to confusion due to its common association with the review of financial records and statements against specific standards.[8] This document instead employs the terms 'verification' or 'corporate inventory verification,' which are more specific to greenhouse gas inventories. The term 'corporate inventory verification,' used herein, refers to the examination of some or all of the following elements related to the quality of the inventory:

1. Inventory boundary setting procedures
2. Methodologies, algorithms, and calculations used to generate emission estimates
3. Original underlying production records, fuel receipts, materials used
4. Process information, equipment counts and operational details
5. Data management systems used for corporate energy and environmental data

[6] See http://www.epa.gov/air.

[7] See http://www.epa.gov/ttnchie1/eiip/techreport/volume06/index.html.

[8] The word 'audit' is defined as: an examination of records or financial accounts to check their accuracy; an adjustment or correction of accounts; or an examined and verified account.

6. Quality Assurance/Quality Control (QA/QC) plans, procedures, and results
7. Processes for and results from uncertainty assessments
8. The compiled emission inventory report itself
9. Supporting testimony and documentation for each of the above

Who Performs Verification?

When performed, the verification of a GHG inventory is usually conducted by someone independent of the inventory preparation process and preferably by a third party. Typically, the review of a corporate inventory by someone within the corporation is treated as part of the company's quality assurance procedures (see B.7 QA/QC Planning and Verification). Internal quality assurance activities (i.e., peer reviews) are often conducted as a learning experience or as a first step to verification activities. Verification activities undertaken directly by most reporting programs and registries have generally limited to a basic review of corporate inventory reports. Independent third parties have been called upon to perform more extensive verification of calculations, original records and GHG management systems.

Verifying a corporate inventory of greenhouse gas emissions and sinks often requires specialized skills and knowledge. The verifier will often assemble a multidisciplinary team to review the inventory, dividing the work between different specialties, such as electricity usage and indirect emission calculations, on-site energy use, wastewater, vehicle fleets, etc. The complexity and size of a company's operations will determine the appropriate makeup of the team and the level of effort required to verify the inventory. The robustness of the verification effort will depend in large measure on the ultimate end uses of the GHG inventory results reported, as well as the resources allocated and the experience and qualifications of the verifier.

It is critical to ensure that the relationship between verifiers and the company being verified is free of conflicts of interest or the appearance thereof. To minimize conflict of interest and enhance verification credibility, third-party verifiers should not be actively employed to develop the same inventory that they are then hired to verify. In all cases, the verification report should disclose any involvement of the verifier with the reporting company.

Tiers of Verification

Because companies developing emission inventories may have different objectives, there are necessarily a variety of possible objectives when conducting the verification of the inventories. For example, a company reporting emissions solely for internal information or general public recognition purposes may require a less stringent approach to verification than a company interested in emissions trading or seeking to be certified against a certain standard.

The elements of the verification activity, the accreditation status of the verifier, and the verifier's relationship to the company or project together define the rigor of the verification activity. For the purposes of this document we define three specific tiers of verification that range from the most easily implemented and least rigorous (Tier I) to the least easily

implemented but most rigorous (Tier III). A company can choose any one of these tiers, depending on the purpose of the inventory and the goals of the verification. Companies may decide to begin work at Tier I and gradually enhance the credibility of the inventory over time to support higher degrees of verification.

The goals for the different tiers of verification are summarized below:

- Tier III: Highest level of assurance and credibility to maximize compatibility with financial accounting and to meet the most rigorous standards which may include regulatory obligations and external trading requirements.
- Tier II: Intermediate level of assurance and credibility to meet needs for voluntary non-financial public reporting.
- Tier I: Review of inventory development process and management systems sufficient to meet internal planning needs and to prepare for more rigorous verification efforts.

Table A.2, below, provides a summary of the key features for each tier of verification.

Table A.2: Key Features of Verification Tiers

Feature	Tier I	Tier II	Tier III
Example of intended verification end use	Internal planning	Voluntary public reporting, (i.e., non-financial, and not for compliance purposes)	External emissions trading; compliance requirements; baseline protection; credit for early action
Typical implementation body	Internal corporate group independent of inventory team (e.g., quality control/auditing department)	Internal corporate group or third party	Third party
Verification location	Desktop, phone interviews	Desktop, phone interviews + some site visit(s)	Central office (for data system review) + facility visits

Tier I – Initial Checks and Procedures Review

The goal of Tier I verification is to review management systems and identify fundamental errors in the general methodology and overall procedures for inventory development. This level of verification attempts to review the logic and procedures used to compile the emission estimates, and to assess the validity of the inventory design itself. Methodologies are only

investigated at the corporate or business unit (BU) level. Generally, there is no effort made to investigate inventory information at lower levels of the corporate structure or individual facilities. A Tier I verification effort focuses on a review of the procedures and systems in place and identifies gaps in a company's inventory program. Some emission data may also be reviewed at a high level to detect internal inconsistencies, identify outliers and find errors in reporting, but most of the effort of a Tier I verification involves review the company's internal processes and systems.

Site visits (i.e., field audits) are not part of Tier I verification. Tier I may include a completeness check to identify obvious omissions of expected source categories and should be conducted as much as possible according to published standards and best engineering practice. Data in spreadsheets or databases may be examined and/or subjected to automated error checking procedures. Detailed calculations are not examined at this level. Verification activities in which only the inventory report is examined are generally considered as a Tier I verification effort.

Tier I verification is appropriate for basic reporting, or for those voluntary efforts where there is no expectation of fair treatment under future regulations (e.g., baseline protection) and no interest in GHG trading.

Tier II – Intermediate Verification

Tier II verification builds on the activities and checks described in Tier I. It must involve a review of calculations and methodologies used to generate the inventory report, including reviews of some disaggregated data. Documentation and data are selected for examination, and the audit trail is followed below the business unit level (i.e. some key facility-specific estimates are usually reviewed). At this tier, the verifier conducts some select field audits of a representative number of facilities, based on the procedures outlined in Figure A.2.

Tier II verification involves the systematic application of verification procedures by knowledgeable—often third party—reviewers for evaluating and reviewing a subset of reported data, calculations, and GHG data management systems.

Tier II verification is appropriate for basic voluntary reporting purposes, including stakeholder reporting and other external communications (e.g., voluntary target commitments), and to prepare for the more rigorous Tier III verification.

Tier III – Full Third Party Verification

Tier III verification represents the highest level of scrutiny and assurance. It seeks to independently corroborate the claims of the inventory report based on supporting evidence and good engineering practice. This type of verification is inherently specific to each company. The verifier will perform the activities listed under Tier I and II, and will examine the reported data, quantification methods, source data, and data management systems underlying the report in greater detail than Tier II. Additionally, a more rigorous review of corporate GHG data management systems, and existing data quality controls in place, is also performed as a unique part of Tier III verifications. This may require developing a detailed understanding of how measurement and monitoring data are collected, handled, and stored at

various levels within a company. Records that pertain to emissions quantification, such as material consumption or fuel usage, will also be examined in detail. External data and records may be employed to corroborate internal estimates.

Tier III verification requires the credibility afforded by a qualified and impartial third-party verifier.[9] This may also require a multidisciplinary team conducting in-depth site visits and interviews with company experts in the instance of a complex corporate inventory. This level of verification is particularly appropriate for inventories geared toward achieving the highest level of environmental credibility, promoting emissions trading, and demonstrating corporate performance against clearly set emission reduction targets or any compliance requirements.

Inventory Quality and Verification Efforts

Rigorous verification activities are usually only conducted on inventories that are also robust, well documented, and rigorous, but this need not be the case. Corporate inventories of any level of quality may be subjected to any level of verification. For example, a company may choose a Tier II verification despite having a very high quality inventory that would likely meet Tier III standards. One example might be a company that gathers detailed inventory data to explore opportunities for cost reduction strategies. Such company might want to make a public statement about its emission reduction achievements, but might not wish to invest in a Tier III verification if it operates in a country where GHG emissions trading is unlikely to be introduced. Conversely, an organization may have a low quality inventory and may lack internal know-how on how to improve it. A Tier II or III verification will reveal numerous gaps that can become the basis for an action plan for inventory improvement.

Selection of Data to be Verified

Regardless of the level of verification required, in nearly all cases the verifier will examine only a subset of the entire population of company data. The total amount of data available at the company-wide and/or facility-specific levels will often be too large to allow for a complete and comprehensive examination of all data. An exhaustive review of all supporting data may also be unnecessary for a successful verification effort, even when the amount of data is modest and/or readily available. In addition, a company may utilize summary data that have been aggregated together, in which case the review of data management procedures and systems may be as or more important than the examination of all of the original unprocessed data. For example, a company may aggregate data from a large number of facilities together, or may aggregate data recorded on an hourly or daily basis into a monthly or annual total. In such cases it may be appropriate for the verifier to examine only a portion of the original data to verify the data itself and confirm the accuracy of the aggregation procedure. These concerns are particularly significant in the case of activity data, which may encompass hundreds or thousands of records for a wide range of sources over multiple years.[10]

[9] Accreditation of the verifier may be required by specific greenhouse gas emission reporting programs.

[10] Guidance on verification of activity data is discussed in Chapter B.4, Activity Data.

The proper selection of the specific sample or samples of data to be examined is a crucial element in any successful verification effort. To a great extent, the amount and types of data selected for examination is at the discretion of the verifier. All verifiers will be confronted with a trade-off between time and thoroughness. The balance must be made such that sufficient information is examined that permits the verifier to make a credible statement regarding the quality of the company's data, data collection and management procedures, quantification methods and related processes. In most cases, even the most rigorous verification efforts will be confronted with this balancing act, so it is important for the verifier to prioritize and carefully select sample data and other issues to investigate. This can be done though data sampling, a process that allows the verifier to form an opinion on the data as a whole. To draw reasonable conclusions, the sample data must be representative of the total data.

The process of verifying company data will typically involve three steps: the selection of an appropriate group of facilities to undergo field audits (for Tier II and III only), the selection of an appropriate subset of issues and data to be examined during the field audit, and the selection of issues and data to examine from facilities that are not selected for a focused field audit.

The following section presents a detailed guide to the selection of the appropriate number and types of facilities for field audits. Guidance on the selection and review of the specific data from these facilities is provided in Section B: Verifying the Corporate Inventory.

Selection of Facilities for Field Audits

This section is relevant only for a Tier II and III verification effort and can be skipped for a Tier I verification, as facility level data is not examined and field audits are not conducted. In general, the selection of facilities to be visited by the verifier will consist of four main steps:

- Company profile analysis
- Facility homogeneity analysis
- Development of an initial audit list
- Field audit list refinement

During the company profile analysis, the verifier must identify the *key verification parameters* that have the potential to cause a material misstatement on the overall quality of the inventory. Differences may exist between facilities within a company related to types of emission sources or the manner in which data are handled. For instance, one type of data management system may rely on hand-entered data input, while another system within the same company may use automated processes or emissions monitoring. By understanding these company specific processes and relying on the step by step process outlined here, a verifier can maximize the effectiveness of the time spent on field audits.

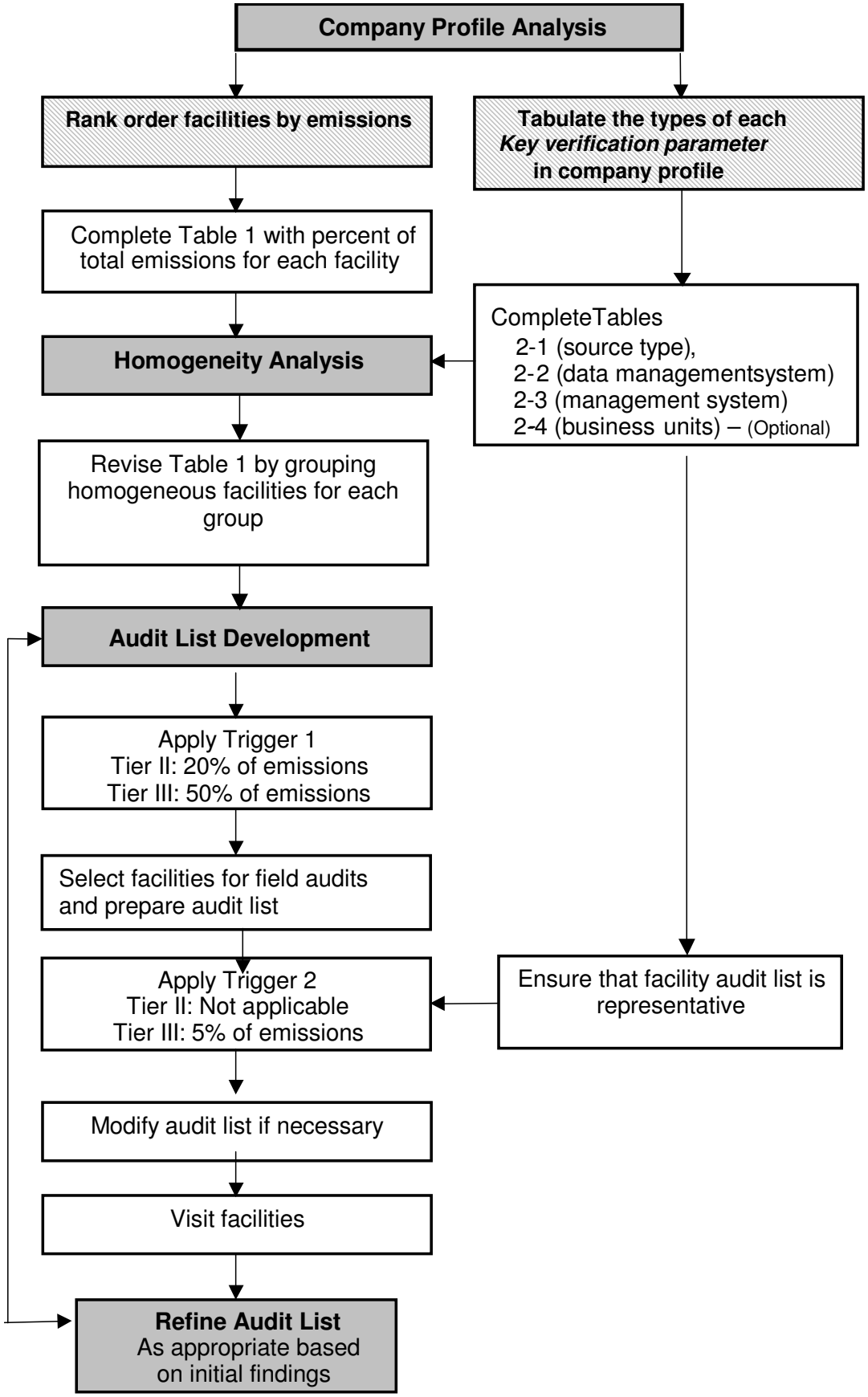
The verifier should evaluate the corporate emission inventory on the basis of the following *key verification parameters*:

- Emission source
- Data management system
- Management system
- Business units or activities. (optional)

The verifier should seek to understand what *types* of emission sources are present, what *types* of data management systems are used, and what *types* of management structures are present in the company.

These steps are discussed in detail below, and are illustrated in the accompanying flow chart (Figure A.1).

Figure A.1: Decision Tree for Developing Field Audit List



***Step 1: Company Profile Analysis*:** The purpose of the company profile analysis is to identify and characterize individual sources of emissions company-wide, and to categorize emissions at the facility level according to the *key verification parameters*. First, the verifier will rank order organization facilities by total GHG emissions (or total GHG emissions relevant to the verification activity), as illustrated in Example Table 1. The table should list both the percentage and the cumulative percent of total company-wide emissions for each individual facility, ordered from highest to lowest emissions. Homogeneous facilities may be listed separately or grouped together as a single unit with the percent of their total combined emissions (this will be discussed further in Step 2). A site visit to only one facility in a homogeneous group may be sufficient.

For large, more complex organizations with a large number and diverse array of facility types (e.g., a multi-national oil company), the company profile analysis may be more effectively conducted on a Business Unit (BU) basis. How a company defines a "facility" (e.g., geographic location, collection of equipment, industrial site, etc.), and the degree of disaggregation or "fineness" of the GHG inventory data collected and reported, will determine the optimal basis for the company profile analysis (see also Table A.4-4).

Example Table 1: Facilities Rank Ordered by Emissions

Facility	Percentage of total organization-wide emissions	Cumulative Percentage
Facility 1	15	15
Facility 2	15	30
Facility 3	10	40
Facility 4	10	50
Facility 5	10	60
Facility 6	8	68
Facility 7	8	76
Facility 8	6	82
Facility 9	7	89
Facility 10	6	95
Facility 11	5	100
Totals	**100**	**100**

In order to complete the profile for a company, in many cases a verifier must then develop a table for each *key verification parameter* that lists the number of facilities and percent of total company-wide emissions represented by each parameter *type*. (This step may not be necessary in the case of Tier II, as discussed further in Step 2: Homogeneity Analysis, below.) Example Table 2-1 lists the different types of emission sources that are likely to be encountered in a company inventory. The emission source categories and subcategories listed (e.g., stationary combustion/coal, non-combustion process, etc.) are intended to be comprehensive. Care should be taken if any additional categories are added or combined,

since the numeric thresholds discussed later reflect the degree of detail used in this table. Example Table 2-1 also displays illustrative facility data for companies in three general sectors (i.e., industrial manufacturing, industrial oil and gas, and commercial). The actual values will vary for specific companies, but broad differences are readily discernable in this example.

Example Table 2-1: Company-Wide Emissions by Source (Example)

	Industrial (Manufacturing)		**Industrial** (Oil and Gas)		**Commercial** (Banking)	
Emission Source Type	# of facilities	% of total emissions	# of facilities	% of total emissions	# of facilities	% of total emissions
Direct Emissions						
Stationary Combustion						
Coal	1	20				
Oil	1	15	1	20		
Natural Gas	3	25	1	50		
Mobile Combustion						
Highway Vehicles		5				
Other mobile						
Non-Combustion Processes	5	15				
Stationary Fugitive			1	10		
Agriculture						
Livestock						
Cropping						
Forestry						
Waste Management						
Landfill	1	8				
Wastewater	1	2				
Indirect Emissions						
Electricity		10	1	20	500	100
Heat and Steam						
Total	5	100%	1	100%	500	100%

Note: Since a single facility may contain multiple emission sources, the sum of the values in the "# of facilities" columns may not match those in the 'Total' row.

Once the emission sources and percentages have been characterized, the verifier next assesses the types of data management systems and management systems used within the company. Example Tables 2-2 and 2-3 display sample types and values for the data management system and management system, respectively. The types listed here (e.g., web-based data collection, ISO certified management) will vary from company to company, and can also vary within a large company. All three tables should be organized to account for 100% of total company-wide emissions.

Example Table 2-2: Company-Wide Emissions by Data Management System			
System Type	Data Type	# of facilities	% of total emissions
Example 1			
1. Web-based data collection	Activity/emissions		
2. Hand entered data	Activity		
Example 2			
1. Environmental Health and Safety reporting	Process flows		
2. Accounting	Fuel and electricity purchases		

Example Table 2-3: Company-Wide Emissions by Management System			
System Type	Data Type	# of facilities	% of total emissions
Example 1			
1. ISO Certified	Activity		
2. Non-Certified	Emissions		
Example 2			
1. Environmental performance indicators present in management goals (incentive structure)	Company policy		
2. No environmental indicators or performance incentives	Company policy		

In some cases, it may also be useful to understand the differences in emissions from individual business units or business activities. In such cases the verifier may wish to develop an additional table listing the number of facilities and percent of emissions by geographical location, corporate operating division or other similar organizational types. Such an organizational profile analysis is recommended for large, complex corporations, particularly those with multi-national operations. Example Table 2-4 provides an example.

Example Table 2-4: Company-Wide Emissions by Business Unit or Activity (Optional)		
System type	# of facilities	% of total emissions
Example 1: Business Units		
1. North American Operations		
2. European Operations		
3. Asian Operations		
Example 2: Business Activities		
1. Production		
2. Refining		
3. Retail		

Step 2: Homogeneity Analysis*:** The next step in the selection of facilities for field audits is to examine the facility data to determine the degree of homogeneity between facilities. Note that this step is to be conducted solely at the discretion of the verifier. In some cases it will not be needed (e.g., verification of an industrial firm with a limited number of facilities that are clearly not similar). In cases where individual facilities are virtually identical, the verifier may decide that it is not necessary to visit multiple identical facilities to verify the emissions. When developing a list of facilities for field audits similar facilities can be treated as a homogeneous group, and in such cases the verifier need conduct a site visit to only one representative facility. An example would be a commercial bank with a large number of individual retail branches, each of which has emissions only from electricity consumption and natural gas heating. The verifier should compare the data from Example Tables 1, 2-1, 2-2, 2-3 and 2-4 (optional) to determine the degree of homogeneity present. Facilities may be considered homogeneous only if **each type of the *key verification parameters is the same (the level of emissions at each facility may vary). Note that a given company can have several different groups of homogeneous facilities. For each homogeneous group identified, the verifier should add the emissions from the individual facilities and enter this sum as a group in Table 1. To facilitate the analysis it is recommended that a master table be developed using a spreadsheet with a sorting function to assist in determining the field audit triggers for the emission thresholds and each of the *key verification parameters* as illustrated in Example Table 3.

Example Table 3: Facilities Rank Ordered by Emissions With Key Verification Parameters*

Facility	Percentage of total	Cumulative Percentage	Table 2-1	Table 2-2		Table 2-3		Table 2-4
			Source Type	System	Data Type	System	Data Type	BU
Group A	28	28	Nat. Gas	Web	Activity	ISO	Activity	Europe
Group B	25	53	Coal	Web	Emissions	ISO	Activity	N. America
Facility 1	15	68	Oil	Web	Activity	Non	Activity	Africa
Facility 2	15	83	Oil	Web	Activity	ISO	Emissions	Asia
Facility 4	10	93	Nat. Gas	Manual	Activity	Non	Emissions	S. America
Facility 9	7	100	Coal	Manual	Emissions	ISO	Activity	N. America
Totals	**100**	**100**						

*In this example, Group A is comprised of Facilities 3,5,6 and Group B is comprised of Facilities 7,8,10 and 11 from Example Table 1.

In cases were the verifier determines that a homogeneity analysis is not required, for a Tier II level of verification the development of Tables 2-1, 2-2, 2-3, and 2-4 is not necessary. In such cases the verifier may simply develop Table 1 and then proceed immediately with Step 3: Audit List Development (below). A Tier III level of verification will require the completion of tables for all of the *key verification parameters*, however.

***Step 3: Field Audit List Development*:** In the last step in the Tier II and III field audit selection process, the verifier screens the facilities ordered and listed in Table 1 to determine which of them must be visited in person. To assist the verifier in making this determination, the results of the company profile and homogeneity analysis are reviewed and the emission

percentages by parameter type are tabulated. Two specific criteria with prescribed numeric threshold (trigger) values are proposed in this guideline, but verifiers should not be limited to these criteria when selecting facilities for field audits.

- Trigger 1: The first criterion requires that the facilities selected for site visits represent a minimum cumulative percentage of the total company-wide emissions. A Tier II level of verification requires a minimum of 10 to 20% of total company-wide emissions; Tier III requires a minimum of 40 to 50%. The verifier will employ a table similar to Example Table 3 to determine which facilities must be visited to satisfy Trigger 1. For a Tier II level of verification, Trigger 1 is sufficient, and the verifier may then proceed to visit the facilities on the revised field audit list.

- Trigger 2: A Tier III level of verification will require the additional application of a second criterion to the revised facility list. For each of the *key verification parameters*, the verifier will identify all types (e.g., stationary combustion/coal, web-based data collection, ISO certified management) that account for 5% or more of the total company-wide emissions. Trigger 2 then requires that the verifier visit at least one facility representing each of these types identified (some or all of the facilities selected for Trigger 1 may satisfy Trigger 2 as well).

Verifiers, however, should not be limited to these criteria when selecting facilities for field audits. Expert judgment should be excised to ensure that a representative sample of facilities is selected for field audits. Verifiers should also consider randomly selecting one facility below either of the trigger thresholds to check whether smaller facilities operate similar to the company's larger facilities.

Table A.1 provides a summary of the two criteria and the numeric values proposed for each.

Table A.1: Criteria for Selection of Facilities to be Audited

Selection Criteria	Tier I	Tier II	Tier III
Trigger 1: Select facilities from Table 1 that represent [10-20% / 40-50%] of cumulative company-wide emissions	NA	10 to 20%	40 to 50%
Trigger 2: Select sufficient facilities to ensure that each type of key verification parameter causing >5% of cumulative emissions from Tables 2-x is covered by the site visits.	NA	NA	> 5%

Recall that in Step 1, the facilities are listed in rank order, from highest to lowest emissions. It should therefore be noted that the facilities to be visited need not be selected in rank sequence. Careful selection of facilities by the verifier can simplify the effort required by minimizing the number of facilities subject to field audits. The verifier is free to select any of the facilities from Table 1, and may skip facilities higher up on the list provided that the facilities selected for field audits are sufficient to satisfy Trigger 1 and (in the case of Tier III

verification) Trigger 2. In a Tier III verification effort, in some cases the facilities chosen to satisfy Trigger 1 will also be sufficient to satisfy Trigger 2, and visits to additional facilities will not be required. In other cases Trigger 2 will require that the verifier visit facilities in addition to those required to satisfy Trigger 1. In such cases, if field audits of only the Trigger 1-related facilities are sufficient to verify at least 40 to 50% of the total company-wide emissions, for each additional facility visited to satisfy Trigger 2 the verifier need only examine data and issues related to specific *key verification parameter* type(s) in question. Examination of information pertaining to other specific parameter type(s) is therefore not required. Example Table 4 illustrates the Trigger identification.

Example Table 4: Facilities Rank Ordered by Emission and Source Type

Facility	Percentage of total	Cumulative Percentage	Table 2-1 Source Type
Group A	28	**28**	Nat. Gas
Group B	25	**53**	Coal
Facility 1	15	68	Oil
Facility 2	15	83	Oil
Facility 4	10	93	Nat. Gas
Facility 9	7	100	Coal
Totals	**100**		

Trigger 1 Tier II: ≥ 20%

Trigger 1 Tier III: ≥ 50%

Example Table 5 Facilities Ordered by Key Verification Parameter: Emission Source Type

Facility	Percentage of total	Table 2-1 Source Type	Percentage by Source Type
Group B	25	Coal	**32**
Facility 9	7	Coal	
Group A	28	Nat. Gas	**38**
Facility 4	10	Nat. Gas	
Facility 1	15	Oil	**30**
Facility 2	15	Oil	
Totals	**100**		**100**

Trigger 2 Tier III: ≥ 5%

Trigger 2 Tier III: ≥ 5%

Trigger 2 Tier III: ≥ 5%

Once Trigger 2 has been satisfied for each of the *key verification parameters*, the verifier may then proceed to visit the facilities on the new revised list.

***Step 4: Field Audit List Confirmation and Refinement*:** As the verifier conducts field audits, the preliminary findings from each facility should be considered to determine if it confirms the original selection of facilities for the field audit list. If not, the verifier should refine the list of facilities using the above procedures. Verifiers may also wish to modify their audit lists based on findings of previous verification efforts.

The following sections in this document provide detailed guidance on the steps to be followed in the verification process. In Section B: Verifying the Corporate Inventory, the key topic areas that should be addressed in the verification effort:

- Organizational boundaries
- Operational boundaries
- Quantification methods
- QA/QC planning and verification
- Base year emissions

Scope and activities, documentation, uncertainties and potential errors associated with each are detailed in individual chapters. Section C discusses the reporting of verification results, and Section D details the verification of key performance indicators (i.e., normalized rate-based indicators). A section on verification of project-level inventories is under development.

Section B: Verifying the Corporate Inventory

B1. Organizational Boundary

A GHG emissions inventory is an accounting of releases to the atmosphere that take place over a certain period of time within the defined boundaries of a company or organization. The extent of a complex organization may include a parent company, wholly owned and partially owned subsidiaries, and even facilities where the parent holds the operating license but holds no ownership interest at all. Organizational boundaries can be drawn in different ways, so it is important that the inventory and supporting information clarify exactly which facilities are included in the emission totals. Fundamentally,

- an equity share approach would have a company apportion emissions from partially owned entities proportional to equity share in that entity, or
- a control approach would have a company report 100% of emissions from controlled entities and 0% of emissions from entities not controlled, regardless of their equity share.[11]

The objective of the organizational boundary verification effort is to check that actual reporting boundaries used in the preparation of the inventory are consistent with declared organizational boundaries and any applicable reporting standards. The process of *verifying* the organizational boundaries of the inventory requires a review of the following three elements:

1. The methodology for defining organizational boundary conditions is *clearly defined*. The degree of supporting documentation provided to the verifier is adequate to support the level of rigor selected as the basis for the verification tier.
2. The methodology for apportioning emissions within organizational boundary is *accurate and appropriate*.
3. The methodology is *applied consistently* across facilities and time.

The verifier must review the overall organizational structure of a reporting organization as well as any requirements by relevant reporting programs pertaining to organizational boundaries. Documentation should include a table that shows the headquarters unit or central office with overall responsibility for compiling and reporting the corporate inventory and subsidiaries, divisions, business units, joint ventures and other entities that may be considered as organization components. The organizational boundaries of the inventory should list all facilities that are included in the inventory (often hundreds of facilities for large multinational corporations) and the basis for including (or excluding) those facilities in the inventory.

[11] 'Control' in this context is defined as the ability of a company to direct the operating policies of another entity. See World Resources Institute and World Business Council for Sustainable Development, *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (September 2001), at http://www.ghgprotocol.org/standard/ghg.pdf.

Definitions

Reporting organization: The primary reporting entity (i.e., corporation or other legally constituted body, city, county, or other government agency, non-profit organization, etc.) and its organizational components that contribute to the total emissions being reported. These components can be defined by:

(a) When accounting and/or reporting based on equity share, the reporting organization should account for all business units/divisions, and all other legally separate entities (e.g., wholly owned subsidiaries, joint ventures) for which the reporting organization holds an equity share.

(b) When accounting and/or reporting based on operational control, the reporting organization should account for all business units/divisions and all other legally separate entities (e.g., wholly owned subsidiaries, joint ventures) for which the reporting organization has the ability to determine, or has primary influence over, the operating policies.

(c) Other subsidiaries or business arrangements for which the nature and significance of their relationship with the reporting organization are such that exclusion would lead to significant risk of material misstatements. For example, a joint arrangement that is not incorporated may represent a significant emission source, and the omission of such might misrepresent the overall inventory footprint. Inclusion of such activities is dependent on the reporting organizations objectives.

Equity share: the percentage of economic interest in/benefit derived from an operation.

Facility: A physical location at which emissions are generated.

Inventory manager: Individual with primary responsibility for oversight of compiled entity-wide inventory.

Organizational Boundary: Facilities that are included in an organization's emission inventory in accordance with an organization's accounting/reporting position.

What is to be Verified

The overarching elements that must be included in verification of organizational boundaries are listed here. Details of how to verify these elements are provided below.

- Ensure that the reporting organization has a stated position defining how organizational boundaries are set.
- Ensure that the reporting organization has a stated position for how they apportion emissions within that boundary. For example, the reporting organization may state that accounting for emissions will be by equity share, therefore reporting, for instance, 40% of emissions from a 40% owned subsidiary.
- Determine if the reporting organization *intends* for its stated positions on defining and accounting for emissions within its organizational boundaries is meant to comply with a referenced standard from a specific reporting program.

- As applicable, evaluate the reporting organization's stated position to determine if it would result in *compliance* with the intended referenced standard from a specific reporting program.
- Examine available supporting evidence to confirm or contradict implementation of the stated positions. Determine if all facilities within the stated boundary are in fact included, and if emissions from those facilities are apportioned per the stated approach.

How to Verify

The purpose of this step of the verification process is to confirm organizational boundaries are clearly defined, and that apportionment of emissions within those boundaries are accounted for in the inventory in a clear and consistent manner. This objective will be met using different processes for each of the three verification tiers.

Emissions are generally accounted for based on either the percentage of equity share held by the reporting organization, or by the degree of operational control. The verification process will examine evidence of one or the other, depending on the accounting method specified by the reporting organization.

Verifying for equity share: Financial accounting records and entity incorporation legal documents (e.g., joint venture agreements) will provide verifiable data for this purpose.

Verifying for operational control: The level of control may be verified through guidelines that allow the reporting organization to introduce and implement its operational and health, safety and environment (HSE) policies at the business unit or facility level. Such documents to establish the level of control may include operating permits or licenses, contracts, joint venture agreements, lease agreements, or other legal documentation of operational control. Corporate reporting policies or practices should reflect this level of control.

In other cases, a reporting organization may not directly manage operations but may hold a controlling equity share (typically >50%) in the facility, or the facility may be considered part of a fully consolidated subsidiary for purposes of financial accounting. In these instances, the reporting organization will exert influence over financial and operating policy and will hold a long-term interest in operations. In such a case, that facility could be included within the organizational boundary based on operational control, and its inclusion and associated GHG emissions accounting and reporting should be so documented, and subsequently verified.

Table B.1-1 details the general process of organizational boundary verification for each of the three verification tiers. The requirements of each tier are inclusive of lower level tier(s). For example, Tier II requirements include not only those processes listed under Tier II, but also the processes listed previously under Tier I. Specific documentation or interview topics that may be included in the verification are detailed in Table B.1-2.

Uncertainty

Uncertainty in organizational boundaries arises when the assets being considered may be in flux during the verification timeframe. This situation may occur during an acquisition or

divestiture. Such uncertainties need to be resolved or addressed by quantifying the amount of emissions associated with the uncertainty and determining whether it leads to a material misstatement. The most likely sources of uncertainty are summarized in Table B.1-3:

Uncertainty will arise when there is an absence of documentation for the period in question. Ideally the uncertainty would be minimized through the documentation of not only the current organizational boundary, but also for periods that correlate to reported emissions that are the focus of the verification.

Errors

In establishing organizational boundaries a variety of misinterpretation can lead to errors. Such occurrences can greatly undermine the accuracy of an inventory effort. Verifiers ought therefore to carefully examine areas of potential error. Some likely sources of error are summarized in Table B.1-4:

TABLE B.1-1
ORGANIZATIONAL BOUNDARY: VERIFICATION SCOPE AND ACTIVITIES

Tier I	Tier II	Tier III
Complete interviews with inventory manager to determine: 1. How organizational boundaries were defined and emissions within the boundaries apportioned 2. If organizational boundary accounting method is meaningful and consistent with the nature of the holdings (i.e. Avoid serious omissions) 3. If organizational boundary accounting method is intended to comply with an external reporting program, and if so, whether the accounting method does comply 4. That the organizational boundary accounting method was applied uniformly 5. That a method exists to adjust the emissions inventory as organizational boundaries change (acquisitions, divestitures, etc.) Review documentation that defines policy for organizational boundary accounting method.	Tier I guidance plus the following. Interview inventory manager or other relevant decision makers regarding a representative number of facilities (see below) to confirm that inclusion, emissions apportionment, or exclusion from organizational boundaries is consistent with the stated accounting position (Tier 1 items 1-5). Some data may be obtained from site visits. Based on field audits, confirm the proper inclusion, emissions apportionment, or exclusion of facilities and sources from organizational boundaries.	Tier II guidance plus the following. Based on field audits, confirm the proper inclusion, emissions apportionment, or exclusion of said facilities and sources from organizational boundaries; Based on field audits, conduct interview to confirm that documentation reviewed is correct and accurately reflects implementation of organizational boundaries per the stated accounting position. Review documentation for roughly 10% of those facilities where the reporting organization does not have a 100% equity share (equity share approach).

TABLE B.1-2
ORGANIZATIONAL BOUNDARY: DOCUMENTATION TO BE REVIEWED FOR VERIFICATION

Accounting Position	Potential Verification Methods for Interview or Document Review of Accounting Method Application		
	Tier I	**Tier II***	**Tier III***
Equity share **(Generally report emissions proportional to ownership share)**	Confirm through interviews how equity share was determined	Identify whether documentation is consistent with financial reporting • Corporate records and representation on financial reporting, policies and ownership and control of the entity • Unanimous Shareholders Agreements • Audited financial statements • Completed and filed tax returns • SEC filings • Attestation of third party (i.e., accountants or lawyers) • Corporate ownership structure • Corporate Share Register • Confirm through interviews and documentation with facility managers/ accountants how financial information is governed • For finance / capital leases, are they recorded on the balance sheet as financial assets.	
Operational Control **(Generally report 100% of emissions from controlled facilities)**	Confirm through interviews how control was determined	Identify whether practices and documentation at facilities indicate operational control • Do contracts, ownership agreements, etc. authorize reporting organization to implement its operational and HS&E policies • Identity of applicant on operating permits and licenses • Confirm through interviews with operational managers/ staff at facility how operational and HS&E direction is provided/ supplied to the operation • What entity is responsible for operational procedures, management and operations personnel reporting and supervision, capital budget decisions, etc. • Does reporting organization own greater than 50% equity share (see above) • Contracts and joint venture agreements regarding operational control • For leases, are these operated in line with reporting organization's operational and HS&E policies.	
Other		Evaluate contracts that apportion emissions between owners.	

* In this table the difference between Tier II and Tier III is a matter of degree – the same type of material may be reviewed in each Tier, but more facilities are subject to this review in Tier III than in Tier II, as shown in Table B.1-1. Additionally, given the significantly more rigorous end use needs of Tier III verification (see Table A.2), fewer types of documentation checks and confirmation are indicated for Tier II verifications as compared to that for Tier III verifications.

TABLE B.1-3 ORGANIZATIONAL BOUNDARY: AREAS OF POTENTIAL UNCERTAINTY	
Area of Uncertainty	**Uncertainty Source Examples**
Identification of facilities	• Contract documentation not finalized • Acquisitions/divestitures taking place during verification timeframe
(Equity) Actual percentage ownership	• Equity share ownership in flux during verification timeframe or changes on a frequent basis
(Control) Degree of influence	• May be difficult in some circumstances to qualify whether influence is significant enough to qualify as control or whether it is just a strongly suggested recommendation

TABLE B.1-4 ORGANIZATIONAL BOUNDARY: AREAS OF POTENTIAL ERROR	
Area of Potential Error	**Error Source Examples**
Identification of facilities	• Facilities omitted, new acquisitions omitted • Facilities included but no longer owned/operated
(Equity) Actual percentage ownership	• Equity share not accurately identified • "True" economic value derived from component unit operation not determined appropriately; simple ownership share used instead (e.g., in Production Sharing Agreements, associated with oil production) • Equity share not accurately updated when changed
Inventorying emissions proportional to equity share	• Emissions not multiplied by percent equity share
Applying a consistent definition of operational control	• Definition of operational control varies from one facility to another
Contract assignment of emissions	• Contract assignment of percent emissions not accurately reflected in inventory
Mixing accounting approaches between equity and control	• Partial control of a facility recording only partial emissions rather than 100%

B2. Operational Boundary

Once a reporting organization's organizational boundaries have been verified, including which facilities it owns and/or controls, operational boundaries should then be examined. Operational boundaries involve the specification of which GHGs and emission sources have been included in the reporting organization's inventory.

The objective of the operational boundary verification effort is to check that actual reporting boundaries used in the preparation of the inventory are consistent with declared operational boundaries and any applicable reporting standard. The process of *verifying* the operational boundaries of the inventory requires a review of the following three elements:

1. The methodology for defining operational boundaries is *clearly defined* and the degree of supporting documentation provided to the verifier is adequate to support the level of rigor selected as the basis for the verification tier.
2. The methodology for apportioning emissions within operational boundaries is *accurate and appropriate* (i.e., is the methodology for assigning direct emissions is consistent with the specification of the organizational boundaries as discussed in Chapter B.1)
3. The methodology is *applied consistently* across facilities and time.

The verifier must review the overall definitions of operational boundaries by a reporting organization to ensure that the operational boundaries have been defined consistently within the organizational boundaries selected. This review must also assess any requirements from relevant reporting programs pertaining to operational boundaries.

Definitions

When considering how to define operational boundaries, companies will need to decide whether and what types of indirect greenhouse gas (GHG) emissions to include:

Direct GHG emissions: emissions from sources owned or controlled by the reporting organization. These sources typically include any equipment consuming fossil fuels (i.e., coal, oil, or natural gas) or processes that may emit GHGs (e.g., adipic acid production or magnesium smelting). Under the WRI/WBCSD *Greenhouse Gas Protocol*, these emissions are referred to as Scope 1 emissions.

Indirect GHG emissions: emissions that occur due to activities of the reporting organization but are not directly released to the atmosphere within the reporting organization's physical (i.e., organizational) boundaries. Indirect emissions can occur upstream or downstream from activities directly controlled by the company. Some efforts to define indirect emissions distinguish between energy purchases used for a company's production processes (i.e., electricity and process heat or steam, and other indirect sources such as employee travel, transportation of products, and life cycle

emissions, among others). For example, under the WRI/WBCSD *Greenhouse Gas Protocol*, emissions from purchased electricity, heat, or steam are referred to as Scope 2 emissions. Other emissions from upstream and downstream activities are referred to as Scope 3 emissions.

What is to be Verified

The overarching elements that must be included in verification of operational boundaries are listed here. Details of how to verify these elements are provided below.

- Ensure that the organization has a stated position defining how operational boundaries are set.
- Determine if operational boundary accounting method is appropriate and consistent with the know activities of the company (i.e., avoids serious omissions or inconsistencies).
- Determine if the reporting organization intends for its stated positions on defining and accounting for emissions within its operational boundaries is meant to comply with referenced standard from a specific reporting program.
- As applicable, evaluate the reporting organization's stated position to determine if consistent with intended referenced guidance from a specific reporting program.
- Examine available supporting evidence to confirm or contradict implementation of the stated positions. Determine if all emission sources within the stated boundary are included, and if emissions from those emission sources are consistently assessed per the stated approach.

Ensure that there is an established methodology for ensuring that all relevant sources have been identified. This methodology will need to be more rigorous as the corporate inventory moves towards including scope 2, then scope 3, emissions, since the possibility of improper specification of emission sources will increase as more emission sources upstream and/or downstream are included.

How to Verify

The purpose of this step of the verification process is to confirm that operational boundaries are clearly defined, and that estimation of emissions within those boundaries are accounted for in the inventory in a clear and consistent manner. This objective will be met using different processes for each of the three verification tiers.

The verifier must document that the direct and indirect emissions have been consistently estimated throughout the reporting organization. At a minimum, this part of the verification exercise should determine:

- Whether emissions from a particular source category are direct or indirect
- The specific greenhouse gases to be covered
- Compliance with any referenced standard
- The time period to be covered

As part of this exercise, the verifier must check that no material misstatements result due to inconsistent application of the operational boundaries or omission of key emission sources from the reporting organization's stated position.

Table B.2-1 details the general process of boundary verification for each of the three verification tiers. The requirements of each tier are inclusive of those in the tier(s) below. For example, Tier II requirements include not only those processes listed under Tier II, but also the processes listed previously under Tier I. Specific documentation or interview topics that may be included in the verification are detailed in Table B.2-2.

Uncertainty

Uncertainty in operational boundaries arises when the operational conditions being considered may be in flux during the verification timeframe. This situation may occur during periodic restructuring where activities are being in-sourced or out-sourced and the documentation is not clear or finalized at the time of the verification. Such uncertainties need to be resolved or addressed by quantifying the amount of emissions associated with the uncertainty and determining whether it has lead to a material misstatement. The most likely sources of uncertainty are summarized in Table B.2-3.

Errors

In establishing operational boundaries a variety of uncertainties can lead to errors. Such occurrences can greatly undermine the accuracy of an inventory effort. Verifiers ought therefore to carefully examine areas of potential error. Potential sources of error are summarized in Table B.2-3:

TABLE B.2-1
OPERATIONAL BOUNDARY: VERIFICATION SCOPE AND ACTIVITIES

Tier I	Tier II	Tier III
Complete interviews with inventory manager to determine: 1. How operational boundaries are defined 2. If operational boundary accounting method is meaningful and consistent with the nature of all of the reporting organization's activities (i.e., avoid serious omissions) 3. If operational boundary accounting method is intended to comply with an external reporting program, and if so, whether the accounting method does comply 4. That the operational boundary accounting method was applied uniformly 5. That a method exists to adjust the emissions inventory as operational boundaries change (addition of other gases, new indirect sources, etc.) Review documentation that defines policy for operational boundary accounting method.	Tier I guidance plus the following. Interview inventory manager or other relevant decision makers regarding a representative number of facilities (see below) to confirm that inclusion or exclusion from operational boundaries is consistent with the stated accounting position (Tier 1 items 1-5). Some data may be obtained from site visits. Review documentation for a subset (see below) of the representative number of facilities to confirm their proper inclusion or exclusion from operational boundaries per the stated accounting position. Based on field audits, confirm the proper inclusion or exclusion of emissions from operational boundaries.	Tier II guidance plus the following. On-site evaluations at selected facilities to determine if operational boundaries consistently applied and no serious omissions or misstatements have occurred. Based on field audits, confirm the proper inclusion or exclusion of emissions from operational boundaries; During site visit conduct interview to confirm that documentation reviewed is correct and accurately reflects implementation of organizational boundaries per the stated accounting position;

TABLE B.2 -2
OPERATIONAL BOUNDARY: DOCUMENTATION TO BE REVIEWED FOR VERIFICATION

Accounting Position	Potential Verification Methods for Interview or Document Review of Operational Boundaries Application		
	Tier I	**Tier II***	**Tier III***
Emission Sources Included	Confirm through interviews which emission sources were included and how the determination was made	Identify whether documentation is consistent with operational boundaries definition and inventory implementation.. • Corporate records and representation on financial reporting, policies and ownership and control of the entity • GHG emissions inventory accounting and reporting protocol • Facility construction and operating permits and licenses • Annual emissions inventory statements • Annual operating permit and other compliance reports • Attestation of third party (i.e., accountants or lawyers) • Confirm through interviews and documentation with facility managers/ accountants how operational, environmental, and compliance information is governed	
Energy Indirect Sources	Confirm through interviews which emission sources were included and how the determination was made	• Utility meters • Utility invoices	
Other Indirect sources	Confirm through interviews which emission sources were included and how the determination was made		
GHG Gases		• Emissions inventory • Material safety data sheets (MSDS) • Proprietary formulation/composition data • Published emission source reference materials (e.g. AP-42) • Sector guidance documentation	

* In this table the difference between Tier II and Tier III is a matter of degree – the same type of material may be reviewed in each Tier, but more facilities are subject to this review in Tier III than in Tier II, as shown in Table B.2-1. Additionally, given the significantly more rigorous end use needs of Tier III verification (see Table A.2), fewer types of documentation checks and confirmation are indicated for Tier II as compared to that for Tier III

TABLE B.2-3 OPERATIONAL BOUNDARY: AREAS OF POTENTIAL ERROR AND UNCERTAINTY	
Areas	**Examples**
Different reporting conventions among facilities, business units, etc.	• Different definitions of direct vs. indirect emissions • Inclusion of different greenhouse gases
Inconsistent reporting of key emission sources	• Different interpretations of materiality at a particular facility, site, business unit, etc.
GHG gases	• Where a definitive statement of which GHGs are being considered is in question or under review
Reference Standard	• Standard may be in draft and subject to final changes

B.3 Quantification Methods

This section of the corporate GHG verification guideline addresses verification issues associated with GHG quantification methods for estimating emissions. Included are brief summary descriptions of commonly used quantification methods, along with specific examples of their applicability and use for various source types. Various types of data require some attention to establish whether the verified inventory has any comparative value to other inventories or programs. The verification of quantification methods applies to the following *data types*:

- Emissions data
- Activity data,
- Emission factors

Also presented is a summary of different tiers of verification rigor and associated verification activities with the key elements and selection of quantification methods.

When verifying quantification methods, the objective is to assess and collect sufficient evidence to ensure that quantification methods are appropriately selected and applied to develop accurate emission estimates. Verification of QA/QC activities is covered in Section B.4, however examination of QA/QC documentation to support the quantification methods is relevant to this chapter. The process of verifying the quantification methods in the inventory requires a review of the following three (3) elements:

- Quantification method for each data type is clearly defined, and the degree of supporting documentation provided to the verifier is adequate to support the level of rigor selected as the basis for the verification project.
- Defined quantification methods are appropriate for accurately quantifying each data type based on the level of rigor required of the inventory.
- Defined quantification methods are applied consistently to develop the emission inventory.

Definitions

Emission data: The measurement of emissions from a source. Can also mean the calculated result of an algorithm based on activity data, and emission factors.

Activity data: A proxy measure of the magnitude of an activity that causes emissions.

Emission factor: An emission factor is a coefficient that relates an activity data to the amount of pollutant that is released to the environment. Emission factors are often based on a sample of measured emission data and then averaged to develop a representative rate of emission for a given activity level under a given set of operating conditions.[12]

[12] Intergovernmental Panel on Climate Change, *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm.

Method Descriptions

There are several different methods that are utilized to estimate GHG emissions in support of corporate GHG inventory development and reporting. A brief overview and description of different quantification methods and related verification issues is provided in Table B.3-1.

TABLE B.3-1
DESCRIPTION OF QUANTIFICATION METHODS

Data Type	Method	Verification Focus
All Quantified Data	Data gathering, propagation and transfer methodologies	• Appropriate selection of methodological approach based on organization-specific situation and data quality objectives • Review of algorithms based on reference methodology or best engineering practice • Appropriate data management systems and controls for identifying, collecting, recording, reporting and safeguarding emissions data.
Emission Data	**Direct Emissions Monitoring** Continuous emissions monitoring (CEM) systems (typical for CO_2 from stationary combustion)	• Operation and calibration of equipment • Existence and appropriateness of operation and maintenance SOPs[13] • Consistent and accurate data management
All Quantified Data	**Process Monitoring** Key process operating parameters used to estimate GHG emissions, including: • Process operating temperatures, pressures, and compositional data • Direct flow measurements of process streams and point source vent streams • Process parameters used as "surrogate" indicators (e.g. for stack/vent emission rates) • Material and energy balances	• Representativeness of sampling for operating parameters • Robustness of test data to substantiate use of process parameters as "surrogates" or to substantiate use of predictive algorithms • Accuracy of material and energy input and output estimates • Appropriate operation and maintenance of instrumentation • Review of calibration records, OEM documentation, service records

[13] While CEM systems operated with appropriate quality assurance procedures should produce accurate and reliable data, there may be uncertainties associated with their flue gas flow rate or concentration data. In such cases, particularly for Tier III-level verification programs applied to such systems, crosschecking CEM data with fuel flow and fuel composition data is recommended.

TABLE B.3-1
DESCRIPTION OF QUANTIFICATION METHODS (cont.)

Emission Factors	**Site-Specific and Equipment-Specific Emission Factors** • Emission Factors (EF) derived from on-site emissions sampling programs under representative conditions • Site-specific EF based on collected data such as fuel quantity and composition, and stack gas measurements • Installed equipment-specific EF based on manufacturers' test data • Combustion sources: Measured fuel usage and actual composition data (C content) used to estimate CO_2 emissions	• Variability in fuel or other input material composition • Appropriateness of assumed combustion efficiency • Representativeness of sampling technique and QA/QC documentation associated with stack gas measurement data used to determine average emission factor • Appropriate application of equipment and fuel type emission factors to specific equipment and fuels
Emission Factors	**Default Emission Factors** Based on a generic source type or average composition of fuel, electricity source, or other parameter. When available, equipment or site-specific emission factors will be more accurate. Examples include: • Stationary combustion sources: equipment-type factors typically used for CH_4 and N_2O. • Mobile source emissions computed with freight tonnage, vehicle miles data, vehicle classification, and average fuel composition and economy factors. • Non-point fugitive emissions, such as pipeline leaks based on equipment, demographics, and average gas composition • Indirect emissions from electricity purchase computed from MW-hr, combined with a default emission factor based on the method of generation. Example: Statewide or regional grid-average emission factor.	• Applicability of default emission factor to specific condition • Availability of alternative emission factors • Reference citation documenting original source of emission factor to support data quality assessment

For large organizations, the optimal strategy to develop an entity-wide GHG emission inventory will likely involve some combination of the above quantification methods. The entity's existing monitoring systems, and the intended end use for reporting of the inventory results, will largely determine the estimation methods employed. Initial guidelines for verification of quantification methods are presented in the following section.

Verification Elements

This section presents initial guidelines for verification activities associated with different levels of rigor, primarily focused on quantification methods. Some key related GHG inventory verification program elements are also included here, along with references to other sections of the document containing more detailed information.

The quantification methods purpose and objectives for each of the three levels of verification rigor are summarized below.

Tier I

- Identify quantification errors in overall entity roll-up reporting, identify outliers in business unit/division level results, and detect methodology inconsistencies.
- Ensure the appropriateness of the estimation methodology applied to the organization-specific situation (based on size of the source, data availability and acceptable level of uncertainty).

Tier II

- Perform detailed review of calculations and quantification methods used to develop corporate inventory report, and determine if results reported reflect emission estimation approach and supporting data.
- Examine quantification method documentation at the facility level, reviewing key facility-specific results, calculations, emission factors, and assumptions to determine validity of the methodology.
- Examine the reported levels of accuracy and uncertainty of the emission estimates.

Tier III

- Verify application of quantification methodology to derive the data types by examination of supporting evidence for key facilities and major sources.
- In-depth quantification review of all methods, underlying data/assumptions, reference citations, and data management systems, from corporate roll-up to individual source root data, with field audits and use of external data and third party records to confirm corporate reports.
- Determine accuracy of quantification data, and if key metering and monitoring equipment operate in acceptable limits.

- Conduct desk audits of data and calculations for a select number of facilities not included in audit list.

Table B.3-3 presents the quantification method verification scope and activities for each tier. Table B.3-4 presents the quantification methodology documentation to be reviewed as part of the verification evidence gathering process. Uncertainty and error issues are reviewed in Table B.3-5 and B3-6 respectively.

What is to be Verified

The following elements should be included in the verification of each of the *data types* (emissions data, activity data, and emission factors) at a level of effort appropriate to the verification tier being applied:

- Determine whether the data used are appropriate and sufficient to allow for the accurate calculation or application of the reported emissions
- Determine whether the data is appropriate for the relevant voluntary or regulatory emissions inventory reporting program standards.
- Confirm that the data stated in the emission inventory report are consistent with the original data sources.
- Determine whether the most appropriate data readily available was used for each source and data type (Tier III).
- Ensure that notable outlier values have been explained (Tier III).

Table B.3-3, below, details the scope and activities of data verification for each verification tier.

How to Verify

The verification of the correct use of the quantified data will be based primarily upon examination of the emission inventory report. Tier II and Tier III verification will also require checking the original documentation from which the data was obtained.

The calculation of emissions will often be complex, particularly when the number of sources or source types is large, or multiple data parameters are required for a single source type. These factors may give rise to significant uncertainties in the emission estimates, and may also increase the likelihood of calculation errors. Tier II and Tier III verification efforts should pay particular attention to the use of activity data, normalization data and emission factors in emission calculations in such cases.[14]

Table B.3-3 details the general process of verification for each of the three verification tiers. The requirements of each tier are inclusive of those in the tier(s) below. For example, Tier II requirements include not only those processes listed under Tier II, but also the processes listed previously under Tier I. Specific documentation or interview topics that may be included in the verification are detailed in Table B.3-4.

[14] Guidance on verification of the methodology and calculations used to estimate emissions is discussed in Chapter B.3, Quantification Methods.

Uncertainty

In calculating emissions, a wide range of uncertainties and inconsistencies may lead to inaccurate or biased results. It is important to evaluate the degree of uncertainty to ensure that within a given confidence level the quality of the inventory is not compromised. A list of the some of the most likely sources of uncertainty is provided below in Table B.3-4. The issue of quantification of uncertainty is discussed further in section B.4 QA/QC Planning and Verification.

Errors

When emissions are not directly monitored or metered, their estimation depends upon activity data, normalization data or emission factors. The use of inappropriate or inaccurate data types will therefore produce inaccurate results. It is important that verifiers examine all data closely to identify potential errors and problems and determine whether they have lead to a material misstatement. A detailed list of the most likely sources of error is provided for each source category in Table B.3-5.

B.3.1 Emissions Data

Emissions data can be directly measured such as with emissions monitoring equipment, or may be derived from activity data and emission factors, both of which are described below in subsections B.3.2 and B.3.4 respectively.

B.3.2 Activity Data

The accurate estimation of GHG emissions is the key goal of corporate emission inventory development. Inventory managers will often estimate emissions based on activity data, information that provides the magnitude of the activities that cause the emissions during the GHG accounting and reporting time period.

There are many different types of activity data that can be used to estimate emissions. Examples include:

TABLE B.3-2 ACTIVITY DATA CATEGORIES

Emission Category	Examples of Activity Data Required Depending on Quantification Method
Stationary Combustion	Fuel consumption, equipment type
Indirect Emissions from Electricity Use	Electricity purchased
Mobile Sources	Fuel consumption, total vehicle miles traveled, vehicle fuel economy, etc.
Industrial Process Emissions	Raw material purchased, total production, etc.
Fugitive Emissions	Pipeline components, total fuel delivered, gas flow rates, gas composition, etc.

Agriculture	Fertilizer quantity/type applied, animal type and feed, etc.
Waste	Waste volume, density or proportion of biogenic material, age and volume of landfill, etc.

The objective of activity data verification is to confirm that the activity data used in the emission calculations (1) matches the data stated in the corporate emission inventory report or protocol and is appropriate for the emission sources, (2) that the activity data has been correctly applied from the original documentation, and (3) that the most accurate activity data readily available have been used in the inventory.[15] The extent to which the verifier must confirm these attributes will depend on the desired level of verification.

The verifier should confirm that the methodology accounts for all variations in the activity data over the time period of the inventory.

In cases where activity data has been reported to or is available from an external source (e.g., utility fuel consumption data reported to the U.S. Energy Information Administration), corporate activity data should be matched against external data as well (Tier III).

B.3.4 Emission Factors

As noted previously in section B.3.1, emissions are often estimated through the use of activity data. This estimation methodology involves the application of an emission factor to the activity data (typically the fuel combusted or material consumed as input). An emission factor is a tool that is used to estimate air pollutant emissions to the atmosphere. It relates the quantity of pollutants released from a source to some activity associated with those emissions. Emission factors are usually expressed as the ratio of the mass of pollutant emitted to the unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., pounds of carbon dioxide emitted per ton of coal burned).[16,17]

In general, emission factors are either default values taken from publicly available sources such as the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, or are calculated based on equipment and/or conditions specific to the particular site:[18]

- **Default emission factors** are taken from an external source such as the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*[19] and specific to a given

[15] The evaluation of accuracy in this context will depend upon several factors, including the importance of the emission source (i.e., based on the magnitude of its emissions, and the uncertainty associated with its measurements or estimations), the availability of more accurate data, and the ease and expense of obtaining it.

[16] US Environmental Protection Agency, *EPA-454/R-95-015 Revised: Procedures for Preparing Emission Factor Documents* (November 1997), at http://www.epa.gov/ttn/chief/efdocs/procedur.pdf.

[17] The discussion of emission factors in this chapter covers carbon content factors (mass of carbon per unit mass or volume of fuel), emission rates (quantity of emissions per unit of activity, such as kWh generated or miles driven), and combustion efficiency. The latter is sometimes covered under quantification methods or other areas, but if not the inventory should incorporate it into calculations which use emission factors.

[18] The IPCC is currently developing a master database that will include the official IPCC default emission factor values, as well as a range of emission factors submitted by third parties and approved by the IPCC. The Emission Factor Database is available at http://www.ipcc-nggip.iges.or.jp/EFDB/main.php.

parameter, such as fuel type, electricity prime mover, production method, and/or geographic area. Default emission factors are readily available for many sources, and their use may reduce the time and cost of estimating emissions. However, because they are not based on the emission characteristics of specific facilities, they may sometimes produce less accurate results than site-specific factors.

- **Site-specific emission factors**, which are specific to a facility, plant or unit. Site-specific factors will in general be developed by the facility itself or by a hired contractor, and are based on historical data. They will therefore tend to provide more equipment specific or operationally appropriate emission estimates, but their derivation and use will be more complex than the use of default factors. The use of site-specific factors warrants particular attention. They can be more accurate than default factors. Site-specific factors may therefore be useful when a higher level of accuracy is required (e.g., when a company must meet an external regulatory compliance standard). They may also be used in cases where specialized equipment has been developed to fit the specific needs of the facility; where the pattern of use of equipment varies significantly from the manufacturer's specifications; or where operating conditions (e.g., frequent and significant variability in temperature or pressure) may reduce the accuracy of default factors. Site-specific factors are developed by the facility based on historical emission and activity data, which are often subject to significant uncertainties.

The objective of emission factor verification is to:

- Confirm that the emission factors used match those listed in the corporate emission inventory report or protocol and are appropriate to the respective activities,
- Confirm that the emission factors have been correctly applied from the original documentation to the relevant activity data, and that the most appropriate factors readily available[20] have been selected.
- Confirm that all site-specific emission factors have been calculated correctly, and that their values appear reasonable when compared to known factors of the same type, where they exist Both the source data and the methodology used to derive site-specific emission factors must be carefully checked and evaluated by the verifier. (Tier III).
- Where site-specific emission factors have been used, the sampling and calculations used to derive them should be examined. Site-specific factors should also be compared to known and accepted factors (when available) from independent sources to assess accuracy. In cases where emission estimates from continuous monitoring or metering of emissions are available (e.g., from CEM data), it is good practice to

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19 The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* prescribes default estimation methodologies and emission factors for a range of sectors, industries, and production methods. The use of the term "default emission factor" is therefore often assumed to refer to the IPCC values. In this paper, however, the term is used in its most general sense, and refers to a factor taken from any external official source, including but not limited to the EPA Emissions & Generation Resource Integrated Database (EGRID), the EPA AP-42 database, and the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*.

20 Although site-specific emission factors will generally be more accurate, corporate inventory verification does not require their use because they are significantly more difficult and expensive to obtain.

compare them with emissions calculated from emission factors to check the latter for accuracy. It may be appropriate to do so when the number of sources using monitoring or metering is large (Tier III).

The extent to which the verifier must confirm these attributes will depend on the verification tier. In general, default factors will be sufficient in cases where uncertainties in other parameters such as activity data are expected to introduce greater levels of uncertainty, while in other cases demand for greater accuracy will require the use of site-specific emission factors. In cases where in the verifier's judgment the use of default emission factors may be inapplicable due to operating or location-specific conditions, the use of site-specific factors may be required for the inventory to be verified above the Tier I verification level.[21]

[21] It is considered good practice to use locally derived emission factors whenever possible, as suggested in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* and the IPCC *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*.

TABLE B.3-3 QUANTIFICATION METHODS: VERIFICATION SCOPE AND ACTIVITIES		
Tier I	**Tier II**	**Tier III**
Quantification method review typically only at the reporting organization or business unit level; data on individual facilities and sources, methodology assumptions, and detailed calculations not evaluated. General assessment of data types for completeness and consistency. Limited review of spreadsheets and tabular data of aggregate emissions calculated at or rolled-up to reporting organization or business unit level, and of their aggregation to create corporate inventory. Review activity data and emission factors to evaluate whether the data used is appropriate for the associated activities, and sufficient to provide a reasonable estimate of the emissions from the source category.	Includes Tier I guidance plus the following: Based on field audits, identify any missing or incomplete data. In cases where a large number of *data type* records exist and have been aggregated together, verifier will review data management practices used to compile final rolled-up data. Evaluate trends in calculated GHG emissions over multiple reporting periods, including comparison against relevant production data at the facility level. Preliminary evaluation of how data are collected and aggregated, including desktop data reviews of some key individual source data at select facilities, comparing against aggregated totals. Tier II requires that verifier has access to the original sources for each *data type*. Data listed in corporate emission inventory report should be compared against that in the original source.	Includes Tier II guidance plus the following: Consolidation of data at the reporting organization and business unit level, while assessing how data are collected, handled, and stored at all levels in the organization. Field audit verification activities include: • Key personnel interviews (data management specialists, process engineers, monitoring maintenance personnel, etc.). • Raw data recording, daily/monthly rollups, and data transfer examined. • Meter calibration and maintenance records and frequency documented. • Evaluation of root data, quantification methods, and analytical results. Key meter/instrument calibration and maintenance logs should be reviewed, and adherence to QA/QC plan (Section B.4). More detailed review of quantification methods than Tier II, based on engineering best practices, including: • Re-computation checks for accuracy of calculations and algorithms. • Check validity of detailed calculations, assumptions, and emission factors. • Verify spreadsheet and database calculations. Cross check all monitoring data with site-specific emission factors, fuel use data, and material/energy balance engineering calculations. Databases, reports, and other information systems are checked; manually recorded data logs, hand calculations, and spreadsheets are checked in the field and compared against inventory data. Review original data records & audit trail to raw data, identify errors & omissions in reported GHG data and ensure accurate reporting (e.g., energy use verified by energy supplier data such as fuel shipment bills of lading, invoices, utility bills, fuel analysis reports). Thorough review of alternative quantification methods, and benchmark analytical results to those of similar sources, facilities, and sector entities.

TABLE B.3-3 QUANTIFICATION METHODS: VERIFICATION SCOPE AND ACTIVITIES (Con't)		
Tier I	**Tier II**	**Tier III**
Interviews with corporate inventory manager to determine: 1. How each of the applicable data types were determined and collected 2. Whether data collection/estimation methodology or technology have changed, and whether the data types were adjusted per this or other structural changes 3. If the data selection, calculation methodologies, and associated adjustment methods are intended to comply with an external reporting program, and if so, whether they comply	In cases where data values can be expected to vary or be updated over the time period of the inventory the verifier will confirm that data has been adjusted accordingly. (e.g., for activity data: impact of a change in vehicle routes on average fuel economy, variations in purity of raw material inputs; emission factors are updated periodically. In cases where a single category of a *data type* has been estimated using several different sources (e.g., a portion of the total coal consumed may be weighed, with the rest estimated through delivery records), verifier should confirm through interview that double-counting or omission has been avoided. When data type calculations incorporate several interrelated parameters (e.g., for activity data: mobile source emission calculations employing number and type of vehicles, age of vehicles, vehicle miles traveled, average fuel economy, etc.), verifier should review them to ensure that they have been calculated appropriately.	Verifier will evaluate whether the most accurate and appropriate *data types* readily available were used in the inventory which may be affected by local factors such as the facility's geography/location, ambient operating conditions, or choice of measure (e.g. default vs. specific factors), etc. Verifier should also identify and evaluate notable outlier data. For example for emission factors, confirm that the actual emission factors used are appropriate for the assumed fuels, production/farming methods, technologies, equipment manufacturers, emission control devices, ambient operating conditions, etc. Data should also be compared to known and accepted external sources to assess accuracy and appropriateness.

TABLE B.3-4 QUANTIFICATION METHODS: DOCUMENTATION TO BE REVIEWED FOR VERIFICATION		
Tier I	**Tier II**	**Tier III**
Minimal documentation required for review, typically the reporting organization's data management system or a set of spreadsheets and the emission inventory internal report. Overall quantification methodology documentation such as equations embedded in spreadsheets, or may include more formal documentation such as a protocol specifying the data to be used for emissions, activity data, and emission factors Check, based on available documentation, that quantification methods used in corporate inventory report have been consistently applied across business units.	Some "intermediate" level of written documentation is necessary to support Tier II objectives; more detailed than Tier I spreadsheet notes, but less rigorous than the formal Tier III protocol document. Focus of Tier II verification is the validity of calculations and assumptions made in estimating entity's corporate emissions. Is sufficient documentation available to track the inventory quantification methods used over time? Are data assessment trails complete/transparent? Are emission estimates, activity data, and emission factors consistent over the reporting period? If methods changed over time, have the changes been noted and/or updated for the previous year(s)?	An existing detailed emission inventory protocol is necessary to support Tier III verification of quantification methods. Supporting evidence, reference citations, justification of key quantification assumptions, and identification of primary uncertainty sources are focus in Tier III. Some examples of the types of documentation to be reviewed in Tier III include: • Standard operating procedures • Manufacturer's operating manuals and calibration procedures • Metering and calibration records • Maintenance logs • Fuel/energy supplier invoices, analytical results • Justification of quantification method and emission factors used • Reference for quantification method and emission factor • Explanation of GHG trends • Documentation of key assumptions and uncertainties with GHG estimates and reporting In addition to Tier II activities, separate reviews of input data (e.g., verification of activity data and justification of emission factors are also conducted in Tier III. Quantification method review should include any plans for changes to the approach for future baseline emissions, and their associated impacts. Documentation of data management system that describes the process of data collection, entry, calculation, and management, and allows evaluation and crosschecking of factors, calculations, and estimates in data system. Trace data or references back to root generation to assess the appropriateness of its application.

TABLE B.3-4 QUANTIFICATION METHODS: DOCUMENTATION TO BE REVIEWED FOR VERIFICATION OF DATA TYPES		
Tier I	**Tier II**	**Tier III**
	In general, the following data types to be reviewed will be the same as in Tier II, but Tier III will require a greater volume of documentation. ***Activity Data*** Documentation consists of the original materials from which the activity data were obtained. Examples to be reviewed may include: • Fuel delivery, purchase and/or weight records • Reports detailing fuel purity and composition • Plant/BU reports • Sample surveys • Electric bills • Metering records • Vehicle manufacturer specifications • Mileage reports • Raw material purchase records and composition reports • Records of industrial output • Inventories of vehicles, livestock populations, etc. • Records of activity data reported to and obtained from an external source ***Emission Factors*** Review reference materials or manuals listing original emission factors or for site-specific emission factors (when used) review corporate reports summarizing their development. For facility-specific emission factor data other documentation may include: • Company operating records • Monitoring reports • Engineering or independent consultant analyses • Manufacturer's operating manuals, equipment/nameplate standards and specifications • Internal records of ambient operating conditions • Reports detailing the characteristics of the local electricity generation system, specifically the average fuel mix and degree of interstate or interregional electricity transmission (in the case of indirect emissions) • External records/references from similar organizations or sector groups (Tier III)	

TABLE B.3.5 QUANTIFICATION METHODS: UNCERTAINTY ISSUES		
Tier I	**Tier II**	**Tier III**
Uncertainty and accuracy assessment of inventory internal report limited to "qualitative" basis of identifying relative areas of uncertainty, consistent with scope and level of analysis of Tier I program.	Uncertainty and accuracy Tier II assessment dependent on objectives and end use of inventory reporting data. Reliance on expert judgment and ordinal ranking of uncertainty in estimates, not by statistically valid confidence intervals.	Review of reporting organization's quantitative/statistical inventory uncertainty assessment (including monitoring, analytical, calculations, and emission factors), and discussion of the likely causes of the uncertainties. Quality assessment of physical measurements and analysis of source data (e.g., stack gas composition, fuel composition, flow rates, etc.), supported by appropriate monitoring, calibration, and maintenance regimes (see QA/QC discussion in Section B.8). Identify methods employed to reduce uncertainty, and variability between reported and actual emissions data.

TABLE B.3-6
QUANTIFICATION DATA: AREAS OF POTENTIAL ERROR

Data Type	Potential Errors	Error Examples
All Quantified Data		
All	General	• Transcription errors • Failure to make adjustments to the inventory for changes in data source • Applying the protocol guidance inconsistently and without the required rigor for determining various data (e.g., no detailed written documentation available to explain how specific data was obtained such as calculation and estimate methodologies used)
Activity Data		
Fuel Consumption	General	• Fuel qualities, purity levels, or heating values incorrect or differences not accounted for • Plant reports or sample surveys incomplete • Fuel losses during shipment from main facility to subsidiary units (e.g., emissions from gas leaks) not accounted for • Materials or fuels carried over from previous year or into next year as a result of changes in stocks have caused time series errors • Data for unconventional fuels or seldom used equipment (e.g. backup generators) omitted
	Delivery data	• Delivery records incomplete • Deliveries not visually inspected or checked against periodic weighing to ensure accuracy
	Measurement data	• Weighing scales or natural gas flow meters not calibrated properly • Net weight not estimated accurately from gross weight
	Missing or incomplete time series data	• Historical purchase or consumption records incomplete • Data averaged over period of time insufficient to reflect variability in consumption
	Electricity consumption	• Electric bill records incomplete • Self-metering equipment not calibrated properly
Mobile Sources	General	• Data on some vehicles or vehicle types omitted from inventory • Fuel type/composition and other parameters (vehicle miles traveled, average fuel economy, etc.) not matched correctly to vehicle types • Fuel consumption from on-site transport omitted
	Data calculations	• Incompatible units used (e.g., calculating fuel consumption by dividing kilometers traveled by miles per gallon), or adjustments not made for orders of magnitude • Necessary adjustments to key parameters omitted (e.g., impact of vehicle vintage and/or use of air conditioning on fuel economy) • Impact of emission control systems omitted or efficiency of emission control devices not taken into account
	Non-CO_2 GHG emissions	• Required data omitted (estimates of N_2O and CH_4 emissions from mobile sources requires detailed activity data beyond the requirements of CO_2 calculations) • Air conditioning leaks (a source of HFC emissions) omitted
	External conditions	• Impact of seasonal variability, weather and/or geography on vehicle performance not taken into account

TABLE B.3-6 QUANTIFICATION DATA: AREAS OF POTENTIAL ERROR		
Data Type	**Potential Errors**	**Error Examples**
Industrial Sources	General	• Estimates of production volumes inaccurate • Material composition/purity data inaccurate or not adjusted to account for variability (e.g., percent lime content of clinker in cement production, purity of limestone and dolomite).
	Cement Production	• Cement kiln dust (a source of additional CO_2 emissions) omitted
	Industrial use of SF_6, N_2O, and ozone-depleting substance (ODS) substitutes	• Purchasing records incomplete • Vintage of equipment inaccurate • Estimated leak rates inaccurate
Fugitive Emissions	Oil or natural gas transport	• Estimated length of pipelines inaccurate • Average gas composition not estimated accurately • Gas flow rates not measured accurately, or measurements not taken over period of time sufficient to reflect variability • Vintage of pipelines and equipment not accounted for • Venting operation and maintenance not properly accounted for
Agriculture	Livestock	• Animal populations, proportions of different animal types and other parameters (e.g., average weight) not estimated accurately • Feed type not matched correctly to animal type
Waste	Land disposal or incineration of solid waste	• Proportions of biogenic and non-biogenic waste not estimated accurately
	Landfills	• Landfill volume, age not estimated accurately
Emission Factors		
All	Application of emission factors to activity data	• Emission factors not accurately matched to activity data, including emission type, fuel type or grade, crop type, production or farming (i.e. livestock) method, and/or equipment or technology • Incompatible units used, or adjustments not made for orders of magnitude
	Fuel characteristics	• Composition or quality of fuels varies over time • Incompatible heating values used, e.g., emission factors for some sources use low heating value (LHV) while others at same facility use high heating values, etc. • Emission factors for sources fueled by biomass not adjusted to reflect the carbon neutral portion of fuel input
	Combustion assumptions	• Assumed combustion efficiency inaccurate • Emission factor not adjusted to account for unoxidized carbon • Emission factors not adjusted to account for co-firing or mixing of fuels • CO_2 from disposal or incineration of biogenic waste included in totals

TABLE B.3-6 QUANTIFICATION DATA: AREAS OF POTENTIAL ERROR		
Data Type	**Potential Errors**	**Error Examples**
	Operating conditions	• Different emission factors not used for start-up or shut-down periods
	Post-combustion emissions	• Impact of emission control systems omitted or efficiency of emission control devices not taken into account • Conversion of other emissions (e.g., CO, NMVOCs) into GHGs in atmosphere not accounted for in emission factors • Emissions of non-CO_2 GHGs excluded
	Location	• Identical emission factors used at separate facilities with different operating conditions
Default	Operating conditions	• Emission factors used not appropriate for actual operating conditions
	Geography	• Use of higher-level (e.g., national or international) emission factors in areas where locally derived (e.g., regional or state) defaults are available • Agriculture emission factors not adjusted for different climatic regions
	Indirect emissions from purchase of grid-generated electricity	• Application of average grid emission factor or fossil fuel grid emission factor without consideration of local grid fuel mix and dispatch profile • Use of local instead of state-level (or state-level instead of regional) factors in areas with significant interlocal (or interstate) transmission
Site-Specific	Calculation of site-specific emission factors	• Sampling techniques or measurement of stack gas not conducted accurately • Measurements not taken over period of time sufficient to reflect variability in emissions • Inconsistent data aggregated and included in calculations

B.4 QA/QC Planning and Verification

Quality assurance (QA) and quality control (QC) planning activities are an integral and critical part of the development of a verifiable corporate GHG emissions inventory. The nature and extent of QA/QC activities, and the development and implementation of a formal QA/QC plan by the responsible party for the entity, will vary greatly according to the end uses of the reported GHG data (see Section A). The verifier's role is not to develop a GHG inventory QA/QC plan as part of the verification; rather, it is to verify:

- That QA/QC procedures exist for each of the major data gathering and processing steps, and identify general areas of conformance and non-conformance with said QA/QC procedures by the entity.
- The appropriateness of the QA/QC procedures (and/or plan), with respect to its design and elements, and their relationship to the reporting organizations applications for the reported GHG emissions data.
- The existence of a written QA/QC plan and/or documented QA/QC procedures (potentially beginning with Tier II, and a recommended requirement for supporting Tier III), either developed specifically for the reporting organization's GHG inventory program, or for more general environmental or financial programs and then applied in some fashion to the GHG inventory.
- The applicable QA/QC procedures referenced by the responsible party were actually implemented as part of the entity GHG inventory development activities, and QA/QC results are available for review by the verifier.

A primary objective of QA/QC procedures is to identify the sources of error or uncertainty in both the data and data management system(s), and to reduce uncertainty and improve data quality. Verification activities in this area should take full advantage of any available results from the organization's ongoing QA/QC program, as it relates to their emissions inventory. QA/QC activities performed by the organization should provide valuable reference data against which the verifier can check results of the verification, and to use as input to help plan for and guide execution of the verification activities outlined in Section B.3.

QA/QC activities should be designed to address emissions estimation uncertainty and data quality. For GHG emissions inventory verification, uncertainty describes the level of verifier knowledge of the GHG data, and risk of a material misstatement of reported results. The uncertainty associated with the verifier's assessment of risk is reflected in the degree of confidence stated in their assertion: the greater the uncertainty, the lower degree of confidence in the reported results and, hence, a higher concern about risk. As part of their QA/QC planning activities, the verifier should ensure that the verification is conducted in accordance with any applicable guidelines.

Definitions

Quality Assurance is a planned system of review procedures conducted by personnel not directly involved in GHG inventory development. This review is to determine the quality of

the inventory data; reduce or eliminate any inherent error or bias in the inventory process; and assess the effectiveness of the internal QC program.

Quality Control is a system of routine technical activities to determine and control the quality of the GHG inventory development. The QC system is designed to identify and reduce errors and omissions; provide routine checks to maximize consistency in the inventory process; and facilitate internal and external inventory review and verification.

Data Quality Objectives are statements of acceptable uncertainty in reported data, to ensure that it is sufficient for its end use. They are based on the specified data collection and quantification methodology and the quality of available data. Data quality objectives identify the end use of the data and the level of uncertainty anticipated in GHG estimates.

Data Quality Indicators are used to measure data quality objectives. Data quality indicators can include quantitative measures (e.g., statistical measures of bias and precision, confidence limits, numerical ranking systems, etc.) and qualitative indicators (letter grading, summaries of inventory strengths and limitations, etc.).

Uncertainty
Statistical definition: A parameter associated with the result of a measurement that characterizes the dispersion of the values that could be reasonably attributed to the measured quantity. (e.g., the sample variance or coefficient of variation).

Inventory definition: A general and imprecise term which refers to the lack of certainty in emissions related data resulting from any causal factor, such as the application of non-representative factors or methods, incomplete data on sources and sinks, lack of transparency etc. Reported uncertainty information typically specifies a quantitative estimates of the likely or perceived difference between a reported value and a qualitative description of the likely causes of the difference.

Confidence in an emissions estimate is often expressed as a confidence interval, or the probability that the true value will fall within a certain range about the estimate.

What to Verify

QA/QC procedures for inventory development will vary depending on the end use of the data, ranging from institutional knowledge of the inventory manager, to documented general QA/QC procedures, to a formal written inventory QA/QC plan. A formal written QA/QC plan for the GHG emissions inventory and reporting program may not exist. Regardless, elements of a reporting organization's QA/QC program that should be assessed as part of an emission inventory verification effort are listed below.

- Identify whether definitions of data quality objectives exist, whether they are consistent with end uses of the reported GHG data, and whether the verification level of rigor is appropriate.

- Determine if major sources of uncertainty have been identified, and whether an approach to reduce uncertainty and improve the quality of reported results has been developed and implemented.
- Confirm that applicable QC and independent QA activities have been performed.
- Confirm that data collection and management processes, and QA/QC procedures have been properly implemented.
- Confirm that QA/QC results and resolution of problems have been adequately documented, and results communicated to the inventory development team.
- Determine the degree to which any existing data quality objectives of the inventory have been met, including assessments of accuracy (or uncertainty) of estimates; data completeness (e.g., materiality—see Section B.2); representativeness; aggregation/disaggregation; comparability/consistency; and documentation.
- Ensure the following:
  - Reasonableness of data and emissions estimates.
  - Validity of assumptions, methodology, and data used.
  - Algorithmic correctness.

The scope and activities of QA/QC planning and procedures verification are detailed for each level of verification in Table B.4-1 below.

How to Verify

The process of verifying the implementation of QA/QC activities for GHG inventories will involve evaluation of the entity's QA/QC plan and procedures, as well as a review of any information that may be contained in a QA report, and in any previous verification activities. Table B.4-2 below lists the types of documentation that may be required for review associated with each level of verification.

QA/QC methods and their results that are to be assessed by the verifier could include:

- Reality checks: compare data or estimate to a standard reference value, estimates for similar sources, expert judgment on reasonableness of value.
- Peer review: checklist of elements covered by peer review, written reviewer comments identifying issues.
- Sample calculations: replication of a complete calculation set, hand replication of most complex calculations, hand calculation using a different method.
- Computerized checks: Review built-in QA/QC functions, variable type and value range checks, look-up tables, cell dependency, cell precedence, and error identification.
- Sensitivity analysis: focus on key variables and effects on results, of emissions models and previous inventories/sensitivity analyses.
- Statistical checks: descriptive statistics, outlier detection for range checks.
- Independent internal reviews: evaluation to determine GHG inventory quality, confidence in accuracy and completeness of results, and QC effectiveness.

- Emission estimation comparisons: comparison of estimated emissions to real-world measurements (or their surrogates).

The higher the rigor of the inventory (i.e., the higher the tier), the more likely it is that the verifier will be required to conduct more of these activities. Conversely, for a Tier I verification, it may be limited to confirming the existence of general corporate QA/QC practices and guidelines with the inventory manager, and if/how they have been broadly applied to the corporate GHG inventory development.

Uncertainty [22, 23, 24, 25, 26, 27]

A key element of an entity GHG emissions inventory QA/QC program is an assessment of uncertainty. Significant sources with the largest uncertainty in their emission estimates should be targeted for improvements. The goal of this iterative QA/QC process is to minimize overall uncertainty in the GHG inventory.
The major sources of uncertainty associated with GHG emissions inventories include:

- Estimation or model: quantification methods and mathematical equations.
- Parameter: quantifying parameters in method (emission factor, activity data).
- Systematic: estimation bias (e.g., non-representative data, faulty equipment).
- Statistical: random variability of sample data.

If adequate data are not available to quantify these uncertainties, expert judgment is often used to estimate them. GHG data uncertainties should be addressed in the QA/QC plan (recommended for supporting Tier III level verifications), and assessed by the verifier for adequacy and implementation results. Some methods used for estimating GHG emissions uncertainty to be assessed by the verifier include:

- Qualitative Discussion: sources listed/discussed; relative magnitude of uncertainties.
- Subjective Data Quality Rankings: rankings based on professional judgment assigned to each key emission factor and activity parameter.
- Data Attribute Ranking System: relative uncertainty numerical value criteria.
- Expert Estimation: expert judgment used to estimate uncertainty.
- Propagation of Errors: statistical techniques applied to expert estimates.
- Direct Simulation: Monte Carlo or other numerical modeling methods.

An example data quality rating of quantitative uncertainty results is shown below.

Interval as %

22 EPA (1996-1997). Quality Assurance Procedures. EIIP. Volume 6.

23 , ISO (1995). Guide to the Expression of Uncertainty in Measurement.

24 WRI/WBCSD (2001). GHG Protocol Corporate Accounting Standard

25 WRI/WBCSD (2003). GHG Protocol Guidance on Uncertainty Assessment.

26 DEFRA (2003). Risk, Uncertainty, and Decision-Making

27 EPA (2002) Procedures Manual for Quality Assurance/Quality Control and Uncertainty Analysis, U.S. Greenhouse Gas Inventory Program

Data Quality	of Mean Value
High	+/-5%
Good	+/-15%
Fair	+/-30%
Poor	More than 50%

These ratings are often based on confidence intervals, where the true value of the estimate has a 95% probability of being within a range about the estimated value. It is the verifier's role to assess which (if any) GHG uncertainty analysis method was utilized in the entity's QA/QC program, its appropriateness for data quality objectives and end use, and its results. Verification of the entity's GHG uncertainty claims is a key element of the verifier's assertion. In all cases, the verifier should ensure that the appropriate uncertainty standards have been used if verifying against a specific reporting program.

Errors

Table B.4-3 below presents major categories of GHG inventory errors that QA/QC programs are designed to minimize/eliminate, and the verifier should investigate in the assessment of the entity's QA/QC program and inventory data quality.

TABLE B.4-1
QA/QC PLANNING AND VERIFICATION: VERIFICATION SCOPE AND ACTIVITIES

Tier I	Tier II	Tier III
Complete interviews with inventory manager to determine: 1. How inventory was developed, and if/how any provisions for QA/QC activities were made. 2. If written documentation of QA/QC procedures (e.g., QA/QC plan) exists for GHG inventory. 3. The QA/QC practices and procedures used during and after the inventory development process . 4. The inventory manager's general assessment of inventory's overall data quality, and areas of high uncertainty. Review relevant documentation (e.g., QA/QC plan, inventory protocol, corporate/EHS quality procedures applied to the GHG inventory, QA report, inventory report, etc.) to make broad, qualitative assessment of GHG inventory's overall, relative quality.	Tier I guidance plus the following. Identify problems encountered in the inventory development process, and resolution activities performed by the inventory team. Interview inventory manager and other relevant decision makers regarding representative number of inventory QA/QC activities performed by the entity and their results, to confirm that inventory QA/QC plan was implemented, and indicate if data quality objectives were met. Review QA/QC plan to determine consistency of data quality objectives with end use of data, and appropriateness of data quality indicators. Review specific QA/QC activities and results for facilities on audit list to confirm data quality indicator measurements, QA/QC procedure implementation, QA/QC results and findings, recommended corrective actions (RCAs), adequate documentation, and communication to inventory team and manager. Document QA/QC verification assessment and make assertion on inventory QA/QC program adequacy and needed improvements, and GHG inventory data quality and uncertainty.	Tier II guidance plus the following. Interview internal QA coordinator for details on GHG inventory internal QA procedures, and results from previous verification activities (management system, technical system, data/report results, data quality). Review QA/QC and inventory reports to prioritize facilities for on-site QA/QC evaluations, based on internal QA/QC findings, relative data quality, and potential risk of misstatement (considering both materiality and uncertainty of data). On-site evaluations at selected facilities to determine if QA/QC procedures were properly implemented, and degree to which GHG inventory data quality objectives have been met. Based on field audits, confirm proper implementation of QA/QC procedures. Verifier's discretion for facilities where data uncertainty and/or RCAs are greatest. Depending on the results of this additional level of Tier III review, the verifier may recommend internal investigation activities be conducted by the corporate entity and potential re-statement of reported emissions, without which could result in a highly qualified verification statement. QA/QC evaluation and assertion to include assessment of data uncertainty, quality rating of inventory, and complete documentation to substantiate verification assertion and statement.

TABLE B.4-2 QA/QC PLANNING AND VERIFICATION: DOCUMENTATION TO BE REVIEWED FOR VERIFICATION		
Tier I	**Tier II**	**Tier III**
Minimal QA/QC documentation available or required for review, typically the inventory report and corporate QA/QC policies and procedures.	Tier I documentation plus the following: • GHG emissions inventory development plan (i.e., protocol document), including data collection and handling procedures, data management systems descriptions, estimation methodology, and reporting. • Site-specific inventory data, and any QA/QC results (technical methodology reviews, accuracy checks, assumptions confirmed, checks for completeness and reasonableness). • Entity inventory QA/QC results summary, including qualitative assessment of inventory's quality, strengths/weaknesses, and uncertainties.	Tier II documentation plus the following: • GHG inventory QA/QC plan, including technical procedures, organization and responsibilities, documentation requirements, internal QC methods and activities (e.g., sample calculations, computerized checks, sensitivity analysis, etc.), and QA procedures. • Written data quality objectives statement, data quality indicators to be measured, and inventory quality rating procedure. • QA/QC report, including key problems found, inventory quality assessment, quantitative data quality indicators, uncertainty methodology and analytical results. • Corrective action plan/mechanisms, and recommendations for corrective actions and further improvements. • Peer reviewer comments and report.

TABLE B.4.4 QA/QC PLANNING AND VERIFICATION: AREAS OF POTENTIAL ERROR	
Area of Potential Error	**Error Source Examples**
Procedural Errors	• Unclear and ineffective management support of inventory development and implementation program. • Inadequate staff training for inventory development team members and QA/QC staff. • Improper planning, such as lack of inventory protocol document and QA/QC plan. • Lack of adequate QA/QC, including completeness and reasonableness checks, accuracy assessment, data documentation procedures, QC measures, and recommendations for corrective actions from prior reviews. • Lack of data handling and tracking protocols, standard operating procedures, technical procedures for calculating emissions, and reporting guidelines. • Other inventory process work flow problems, lack of continuous improvement mechanisms.
Technical Errors	• Incorrect use of spreadsheets/databases, e.g., inadvertent reference to wrong cell in a spreadsheet, or data retrieval from the wrong storage location in a database. • Mathematical errors in hand calculations or spreadsheets, such as incorrect conversion factors, mismatched units in emission factor and activity parameter, incorrect constants and equations, and arithmetic errors. • Incorrect use of emission inventory software, e.g., not following software instructions. • Use of incorrect data, such as out-of-date data, inappropriate surrogate data, incorrect factors, and data that do not match the right source category (activity data and emission factors). • Use of incorrect methodology and/or assumptions. • Double-counting emissions. • Failure to include all applicable sources.
Note: Technical errors in this context refer to the errors made during the QA/QC review of the quantified data. The same errors may be present in the Quantified data, but should not be confused with the activities that are conducted by the verifier under Section B.3. The purpose of the verifier in reviewing areas of potential error in QA/QC Planning and Verification is to check whether the QA/QC tools, not the quantification data tools, are technically correct.	

B.5 Base Year Emissions

The establishment of base year emissions allow for comparisons of emissions performance over time. Specifically, it allows for an assessment of performance against developed emission reduction targets and helps in the management of associated opportunities and risks.

The concept of base year emissions takes into account future advancements in greenhouse gas (GHG) emissions estimating over time, as well as the likely scenario of industry changes/consolidation. Different voluntary GHG reduction/trading programs may have specific rules governing the development of base year emissions. Base year emissions will be an extremely critical issue for corporate entities that will have to comply with mandatory emissions targets and required reductions (e.g., in the EU Emissions Trading Scheme starting in 2005). A base year may be a single year, or an average of performance over several years.

The objective of the base year verification effort is to check that both technically sound base year emissions and a base year emissions adjustment policy have been established and subsequently applied. The process of *verifying* the base year emissions of the inventory requires a review of the following four elements:

1. Appropriateness of base year selection, relative to the reporting program or to the intended end-use.
2. Assessment of the extent to which the base year emissions calculations adhere to relevant guidance.
3. Completeness and appropriateness of the developed base year adjustment policy.
4. Assessment of the extent to which the base year emissions adjustments adheres in practice to the declared base year adjustment policy.

The verifier must ensure that the base year chosen is one for which verifiable data are available. Companies may adjust the base year emissions to maintain consistency with current inventories that may have been changed due to structural changes, such as mergers or acquisitions, or changes in quantification methodologies. Companies may establish thresholds that include qualitative and quantitative criteria to define a significant structural change, depending on the use of the information, company characteristics, and structural change features. The verifier must review these thresholds established as part of the base year emissions adjustment policy and ensure this policy is applied in a consistent manner.

Documentation should include the base year selection rationale; the guidance followed for base year emissions estimation and consistency across post-base year emissions calculations (to provide accurate comparisons); the specific thresholds established as part of the adjustment policy and associated corporate goals (drives the specific rules and guidance that would need to be followed for adjustments); and documentation of the actual company's threshold triggers and resulting base year emission changes over time. Any inconsistencies with the stated base year emissions adjustment policy and associated explanations should be noted.

Definitions

Baseline: Typically used in the context of project-based accounting as opposed to inventory accounting, the baseline is the emissions scenario that would occur in the absence of the GHG reduction/sequestration project activity. Parties often apply this term to entity inventories to indicate base year emissions (see below), or post-base year emissions under future operating scenarios with consistent boundary conditions.

Base year: Historical performance datum for comparing entity emissions performance over time.

Base year adjustment: Adjustment in base year emissions to represent changes in the inventory due to changes in organizational boundaries (mergers, acquisitions, divestitures, outsourcing) or due to changes in quantification methodology.

Organic growth/decline: Refers to an increase or decrease in production output or changes in product mix. Organic growth or decline of sufficient magnitude may lead to structural change, such as the opening of new plants or plant closures.

What is to be Verified

The overarching elements that must be included in verification of base year emissions are listed here. Details of how to verify these elements are provided below.

- Ensure that the organization has a stated documented position defining how the base year was set.
- Where applicable, determine if both base year selection and adjustment policies are consistent with relevant voluntary or regulatory emissions inventory reporting program standards.
- Determine if the base year chosen per the stated position has verifiable data associated with it, and that the emission calculation guidance followed (and associated calculations) is consistent with post-year emission calculation guidance (and associated calculations) being followed.
- Ensure that the organization has a stated documented position defining a base year emissions adjustment policy, including clear documentation on the significant thresholds that will be applied for considering base year emissions adjustments.
- Ensure that there is a working method in place to evaluate base year adjustments.

How to Verify

The purpose of this step of the verification process is to confirm that a company's base year emissions are clearly defined, and that estimation of those emissions are conducted in an accurate manner using verifiable data. In addition, the purpose of the verification process is

also to confirm that a sound base year emissions adjustment policy is established according to the company's goals and consistently applied. This objective will be met using different processes for each of the three verification tiers. At a minimum, this part of the verification exercise should include identification of:

- Explanation of how the base year was chosen
- Verifiability of the data associated with the base year chosen and consistency in implementation of emissions estimating guidance for the base year and post-base years
- Whether a policy has been established for base year emission adjustments and whether it is being applied accurately and consistently

Table B.8-1 details the general process of verification for each of the three verification tiers. Specific documentation or interview topics that may be included in the verification effort are detailed in Table B.8-2.

Uncertainty

In the context of Base Year emissions, the uncertainty issues are the same as those discussed for the inventory in sections B.1 to B.4. Apart from those the issue of uncertainty in the base year is really one of appropriateness of the selection of the base year or averaging years, which is addressed above.

Errors

In establishing base year emissions and associated adjustments, a variety of inappropriate assumptions can lead to errors and/or inconsistencies. Verifiers ought therefore to carefully examine areas of potential error. Potential sources of error are summarized in Table B.5-4.

TABLE B.5-1

BASE YEAR EMISSIONS: VERIFICATION SCOPE AND ACTIVITIES

Tier I	Tier II	Tier III
Review base year selection and emission adjustment policy Complete interviews with corporate inventory manager to determine: 1. How the base year was chosen 2. If the data associated with the base year is considered to be verifiable 3. That a policy and working method exists for applying the base year emission adjustment policy 4. If the base year selection, calculation methodologies, and associated adjustment method is intended to comply with an external reporting program, and if so, whether they comply 5. Examine available supporting evidence for at least one base year adjustment to confirm or contradict implementation of the stated positions	Tier I guidance plus review base year emission adjustment application as follows. Some data may be obtained from site visits. Interview legal department regarding whether structural changes have occurred and when that warrant base year emissions adjustments (per the organization's policy). Interview inventory manager as to whether quantification methods have changed, and whether the base year was adjusted per these or structural changes For facilities on audit list, review sufficient documentation for *any* base year adjustments that increase or decrease total emissions by more than 5% to confirm that adjustments have been addressed per stated position, and that it is applied uniformly. • For adjustments made due to changes in quantification methods, confirm through random data sampling and recalculation (see Emission Factors or Quantification Methods chapters). • For adjustments made due to divestiture or outsourcing, review historical data in corporate inventory to confirm adjustment accuracy. • For adjustments due to acquisition, in sourcing, or merger, use all other chapters of this guidance to verify base year emissions at the newly added facilities.	Tier II guidance plus the following. For facilities on audit list, review sufficient documentation for *40 to 50% of* base year adjustments that increase or decrease total emissions by more than 1% to confirm that adjustments have been addressed per stated position. For adjustments made due to changes in quantification methods, confirm through random data sampling and recalculation (see Emission Factors or Quantification Methods chapters). For adjustments made due to divestiture or outsourcing, review historical data in corporate inventory to confirm adjustment accuracy. For adjustments due to acquisition, in sourcing, or merger, use all other chapters of this guidance to verify base year emissions at the newly added facilities.

TABLE B.5-2
BASE YEAR EMISSIONS: DOCUMENTATION TO BE REVIEWED FOR VERIFICATION

Position	Potential Verification Methods for Interview or Document Review of Accounting Method Application		
	Tier I	**Tier II***	**Tier III***
Base Year Selection	Confirm through interview (and review documentation) how the determination was made for the base year		
Base Year Emissions*	Confirm through interview whether the data and associated emissions are verifiable	Review the data and calculations (including methodology and tools) for sources that contribute to the majority of CO_2-equivalent emissions. Ensure consistency with the appropriate guidance provided in Sections B.1 – B.4 as well as consistency in applying the guidance across base and post-base years.	
Base Year Emission Adjustments	Confirm through interviews (and review of documentation) whether an adjustment policy has been established, and that the policy has been consistently applied Confirm that policy is in compliance with the requirements of any relevant reporting program	Identify whether adjustments made to the base year emissions are consistent with the thresholds and methodologies documented in the established policy. Examples of what could be reviewed (although policy-specific): • Corporate legal records on acquisitions, mergers, and divestitures (including when they occurred) • Corporate records and representation on transfers in ownership and/or control of the company • Consistency in the application of the policy • Correctness in the application of the policy (i.e. not adjusting for organic growth or for acquisitions of a facility that came into existence after the base year was set) • Changes in method and tools used to account and report GHG emissions that could significantly affect the base year emissions	

* In this table the difference between Tier II and Tier III (for the base year emissions and adjustments positions) is a matter of degree – i.e., the same type of material may be reviewed in each Tier. However, a more extensive onsite review is required, greater amounts and types of documentation are to be reviewed, and more facilities are subject to this review in Tier III than in Tier II, as shown in Table B.2-1.

TABLE B.8-3 BASE YEAR EMISSIONS: AREAS OF POTENTIAL UNCERTAINTY
• **This Table intentionally left Blank – See Uncertainty Guidance in Sections B.1, B.2, B.3, B.4**

TABLE B.8-4 BASE YEAR EMISSIONS: AREAS OF POTENTIAL ERROR	
Area of Potential Error	**Error Source Examples**
Inconsistency in base year emission data sources with the rest of the inventory	• Applying the protocol guidance inconsistently between the base year emissions estimation and the current year emissions • Inclusion of different greenhouse gases and/or different sources between the base year emissions estimation and the current year emissions
Inconsistency or incorrect application of threshold measures established in base year emission adjustments	(Examples based on the WRI/WBCSD *Greenhouse Gas Protocol*, which does not necessarily need to be followed, depending on the companies goals, see below): • Adjusting base year emissions based on organic growth or decline • Adjusting base year emissions for changes in insourcing or outsourcing activities if the company is reporting such emissions under Scope 2 or Scope 3 • Not adjusting base year emissions on a pro-rata basis if a structural change occurs in the middle of the year • Not adjusting base year emissions when changes in calculation methodologies or errors result in significant changes in the emissions • Adjusting for only increases or only decreases in emissions
Unclear understanding of the application of selecting a base year emissions and adjustment of base year against business goals	• Not following external rules (which influence the choice and adjustment of base year emissions) for achieving certified emission reductions targets

Section C: Reporting Verification Results/ The Verifier's Statement

Upon completion of the corporate verification activities defined in this document the verifier will issue a verification statement. The objective of the verification statement is to provide documented assurance with regard to the GHG information reported (internally or externally) by the organization.

The remainder of this section covers the verification statement and specifically deals with the following:

- Elements of a Verification Statement
- Assurance and Tier I, II and III Verification Approaches
- Qualified and Unqualified Verification Statements

Elements of a Verification Statement

The verification statement should describe several key points, including the level of assurance provided by the verification (dependent on the objectives and approach of Tier I, II or III), the scope of the verification, and criteria against which the verification was conducted (which is dependent on the reporting program[28]).

The verification statement should include four elements (additional elements may be added as necessary:

a) Cover
b) Introduction;
c) Definition of scope; and
d) Verifier's opinion.

The cover should include the following:

- Title,
- The name, address and contact information for the verifier (individual and firm),
- The name, address and contact information for the company (client),
- The place of issue and date the statement was signed,
- An authorized signature,
- Confidentiality statement (where required), and
- The distribution list indicating to whom the document is being sent.

See sample cover (following page):

[28] This verification guideline is designed to be useful under a variety of reporting programs and for a variety of accrediting agencies.

SAMPLE Cover Page:

Verification (Tier II) of ABC Corp.'s
Greenhouse Gas Emission Inventory for 2000

Company contact:
Name
ABC Corp.
Address
Contact info.

Verifier contact:
Name
XYZ Consultants
Address
Contact info.

FINAL REPORT

Verification Date:
February 15-20, 2003

Verification Report Date:
March 5, 2003

Report prepared by: _____
Name, Designation (if applicable)
XYZ Consulting
Address

Confidential:
This report and attachments may contain information that is proprietary to ABC Corp. and may not be copied or released without the express written permission of ABC Corp.

Distribution List:
Name(s)
ABC Corp.
Address
Contact info.

The introduction should include the following:

- Context
- Name and description of company (client)
- Company's (client) statement with regard to quantified GHG emissions

SAMPLE Introductory Element:

Between February 15th and 20th 2001 XYZ Consulting has carried out a verification of ABC Corp.'s annual greenhouse gas emissions inventory for year 2000 (January 1st 2000 through December 31st 2000). ABC Corp. owns and operates 8 pulp mills throughout California and a head office in Los Angeles. In 2000 ABC Corp. reported GHG emissions totaling 250,000 metric tonnes of CO_2 equivalent from these 9 facilities. ABC Corp. has tasked XYZ Consulting to undertake a verification and ultimately express an opinion on whether the inventory of GHG emissions was prepared in conformance to the WRI/WBCSD's "The GHG Protocol".

The definition of scope should include the following:

- The criteria against which the verification was conducted;
- The objectives, scope, *tier* of the verification;
- The level of assurance;
- Language making it clear that the verification:
  - Was an examination of GHG information and conducted on a test basis (define sampling, e.g., desk study, site visit…),
  - Included an assessment of GHG data collection (level of rigor dependent of applicable tier of verification).
- Any qualifications/limitations (see below);

SAMPLE Definition of Scope:

Per ABC Corps. request and requirements, XYZ Consulting carried out the verification according to the Tier II methodology. The Tier II methodology calls for a systematic application of verification procedures by knowledgeable reviewers for evaluating and reviewing a subset of reported data, calculations, and GHG management systems. The verification involved a thorough review of calculations and methodologies used to generate the 2000 GHG inventory report. Sample GHG documentation was examined and key facility-specific estimates were reviewed. XYZ Consulting conducted 2 site visits (one pulp mill and head office) to ensure a representative subset of key sources was verified. The Tier II approach is intended to provide a level of assurance and credibility to meet the needs associated with voluntary non-financial public reporting.

The verifier's opinion should include the following:

- Reference to the requirements used to prepare the GHG information
- Description of the GHG information verified
- An expression of opinion
- Qualifications to the opinion (where necessary)

SAMPLE Verifier's Opinion:

Based on the Tier II verification, it is the opinion of XYZ Consulting that ABC Corp.'s GHG inventory was compiled, and for 2000 reported, in conformance with "The GHG Protocol".

Additional optional element can include the following:

- Credentials of verifier
- Statement of verifier and verification body independence
- Liability statements

The verifier should provide a draft verification statement to the client for review and confirmation of correctness. Once the client is satisfied that verification is correct and meets the intended objectives, then the verifier can release the final verification to the distribution list. Where amendments to the draft statement are required, the revised content must be agreed to with the lead verifier and the client.

Assurance and Tier I, II and III Verification Approaches

As discussed earlier in this document, companies developing emission inventories may have different objectives, and as a result there are a variety of possible objectives when conducting the verification of each inventory. Similarly, objectives associated with a verification statement may vary from company to company. As discussed, the verification statement or assertion will clearly identify the tier (I, II or III) of verification applied and the criteria. However, it is important to note that the overall degree of assurance that a third party verifier can provide within the verification statement is dependent on the tier of verification carried out (degree of assurance will be greater with Tier III than Tier II and Tier II than Tier I)[29].

Qualified and Unqualified Verification Statements

A verification statement may be **qualified** or **unqualified**. The strongest assurance results from an unqualified statement. However, qualification may be required under various circumstances including:

- Where there is a material misstatement from the requirements specified by the criteria, and/or
- Where the verifier is unable to obtain sufficient appropriate evidence to determine whether there has been a departure from the requirements specified by the criteria.

- Where a qualified verification statement is deemed necessary, the verifier must decide what type of qualification or limitation to the verification statement is appropriate. In developing the qualification the verifier should consider whether the verification statement may be misleading (without a qualification).

The qualification, when read in conjunction with the verification statement, should serve to inform the intended user of the information of any deficiencies (or potential deficiencies).

[29] This potential constraints of the selected verification tier should be discussed and agreed to between the third party verifier and company prior to commencement of the verification activities.

Where qualification is deemed necessary, the associated language should be added to the verification statement (see requirements above). The language should list and explain all qualifications and associated limitations. The opinion paragraph should reference this language.

Section D: Key Performance Indicators (optional)

Key performance indicators (KPIs) are quantifiable measurements of the relative performance of an entity in terms of its emissions-related activities. In the case of greenhouse gases (GHGs) this is generally the mass of emissions per unit of activity, or its inverse, the amount of activity per unit mass of emissions. A set of carefully chosen KPIs can provide a "glance view" of a company's performance along specified activities and allow for benchmarking between facilities, business units, or other companies. For example, KPIs can be used to define reduction targets in a way that early actions are not penalized or allocate allowances for emissions trading. A simple example of a KPI is the number of tons of CO_2 emitted per MWh of electricity generated by an electric power company. Other more complex measures, though, can also be used such as anode effects per day at an aluminum plant, kWh of electricity used per square meter of office space for a retail company, tons of GHGs emitted per car manufactured, or tons of CO_2 per $1,000 of revenue.

Because of the complex nature of many company's operations, multiple indicators will often be necessary to present a more balanced assessment of the companies operations and to provide the desired set of incentives for employees to improve the company's performance.

The objective of the KPI verification effort is to collect and assess sufficient evidence to evaluate that KPI data and methods provide sufficiently accurate quantitative results and that the KPIs have been selected are appropriate measures of the corporate performance, given the predefined goals of the company.

In many cases companies will be focused on the monitoring and reporting of absolute greenhouse gas emissions and will use KPIs only for internal performance tracking (i.e., they may not be reported to stakeholders or reported to voluntary or mandatory compliance programs).[30] Companies, however, may still wish to have their KPIs be verified in conjunction with the rest of their inventory. Verifiers should use this guidance in conjunction with Section B.3 on Quantification Methods when examining KPIs. The process of verifying KPIs requires an assessment of the following elements:

- Methodology for estimating and procedures for collecting data associated with KPIs.
- Adequacy of supporting documentation.
- The time series consistency of KPIs
- Any relevant standards or requirements for rate-based or other indicators of voluntary or mandatory reporting programs the company is participating in.

[30] In some cases, data used to calculate KPIs may involve confidential business information, in which case verifiers should take appropriate steps to protect this information.

The verifier should also ensure that the chosen KPIs are meaningful to the organization's operations or management goals. Key characteristics to assess whether KPIs are being meaningful include:

- *Measurability*. Indicators can be reliably quantified.
- *Sensitivity*. Indicators are responsive to changes in operations and greenhouse gas emissions.
- *Consistency*. The time series of indicators are unbiased and present an accurate measure of changes in the performance of the company over time.
- *Practicality*. Indicators integrate well with existing company processes and are easy to collect and understand.
- *Verifiability*. The credibility of indicators can be established quite easily based on available documentation.
- *Actionability*. Indicators can be influenced by company policies and actions.

Companies may wish to establish internal KPI thresholds or set triggers for corporate incentive programs or for notification of senior management. Companies may also consider harmonization of their KPIs with other companies in order to benchmark performance. A typical practice in other benchmarking efforts that t involve concerns about confidential business information is to engage a neutral party to aggregate indicator data from various companies and then provide aggregate KPI data to all corporate participants.

What is to be Verified

The focus of KPI verification activities will be on data used for the calculation of KPIs that is ancillary to the core emissions inventory data collection efforts. Specific verification elements are listed below:

- Determine if KPIs have verifiable data associated with them, and that calculation methodologies are properly applied.
- If an external performance benchmark is utilized for comparison purposes, determine if the internal KPIs have been defined and calculated to be comparable.
- Determine if adjustment for changes in the company's boundaries are have been made, and if so that they reasonable and done appropriately across the entire time series.
- Determine whether the additional data collected for the purpose of calculating KPIs has been done so with adequate quality control measures and is of sufficient accuracy for the intended use (i.e., is the precision and/or accuracy insufficient to detect the changes that are to be tracked).
- Confirm that data used to calculate KPIs and data in the company's emission inventory report is consistent and that those values are consistent with the original data sources.

Included in the company's KPI documentation should be some description of the rationale for the selection of each KPIs.

How to Verify

The calculation of KPIs will often be straightforward, however, the underlying values used to derive ratio indicators may be complex, particularly when the number of sources is large or multiple data parameters are required. Table D.1-1 details the general process of verification of KPIs for each of the three verification tiers.

TABLE D.1-1

KEY PERFORMANCE INDICATORS: VERIFICATION SCOPE AND ACTIVITIES

Tier I	Tier II	Tier III
Review typically only at the reporting organization or business unit level. Data on individual facilities and sources, methodology assumptions, and detailed calculations not evaluated. General assessment of KPIs for completeness and consistency. Limited review of spreadsheets and tabular data of aggregate emissions and activities calculated at reporting organization or business unit level, and of their aggregation to create corporate KPIs. Interviews with corporate inventory manager to determine: 1. How the KPIs were determined 2. If the data associated with the KPIs is considered to be verifiable and credible 3. That a procedures exists for calculating the KPIs that are consistent across business units and facilities 4. Whether KPIs comply with any relevant external reporting program	Includes Tier I guidance plus the following: Based on field audits, identify any missing or incomplete data. In cases where a large number of KPI records exist and have been aggregated together, review data management practices used to compile final rolled-up data. Evaluate trends in calculated KPIs, including comparison against relevant production or activity data at the facility level. Preliminary evaluation of how KPI data are collected and aggregated, including desktop data reviews of some individual source category data at select facilities; compare against aggregated totals. Tier II requires that verifier has access to the original data sources for each KPI. Data listed in corporate emission inventory report should be compared against that in the original source. In cases where KPI values are expected to vary or be updated over the time period of the inventory, confirm that data has been adjusted accordingly.	Includes Tier II guidance plus the following: Examine consolidation of data at the reporting organization and business unit levels. Assess how KPI data are collected, handled, and stored at all levels in the organization. Field audit verification activities include (if not already performed as part of the Quantification Methodology verification): • Key personnel interviews (data management specialists, process engineers, monitoring maintenance personnel, etc.). • Review of raw data recording, daily/monthly rollups, and data transfer. • Review of meter calibration and maintenance records. • Evaluation of root data, quantification methods, and analytical results. KPI data may also be compared to known and accepted external sources to assess accuracy and appropriateness.

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