GENERAL BACKGROUND PAPER

1 OVERVIEW OF THE WORKSHOPS SCOPE AND GOALS

In June 1998, the Subsidiary Body on Scientific and Technological Advice (SBSTA) asked IPCC to "...give high priority to completing its work on uncertainty, *as well as to prepare a report on good practice in inventory management* (emphasis added) and to submit a report on these issues for consideration by the SBSTA, if possible by COP 5." The IPCC developed its work-plan for preparing this report at an expert meeting held in Paris in October 1998.

The current state of practice in national greenhouse gas inventories is reflected in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC Guidelines)*. The use of the *IPCC Guidelines* was agreed at Kyoto. These *IPCC Guidelines* contain a detailed list of source categories, but they are less prescriptive about calculation methods. In fact, the *IPCC Guidelines* encourage Parties to use their national methods and assumptions where these are more accurate than the methods described in the Guidelines. At the Paris expert meeting, it was agreed that the use of *good practice* procedures in the selection of emission factors, methodologies, and activity data could reduce uncertainties and minimise the possibility of bias in emission inventories. In this case, the values recorded (although uncertain) would be the best available estimates of actual emissions, and therefore presumably the best available basis for assessing compliance with commitments under the Convention and the Protocol. *Good practice* can refer not only to estimation methods, but also to the way in which inventories are managed, including the management of uncertainty. The idea of *good practice* was also extended to ensuring transparency for review purposes, to quantify uncertainties and to cross-checking national estimates with independent calculations and empirical data.

Good practice guidance developed to supplement the *IPCC Guidelines* could be considered by the Parties for incorporation into the guidelines for national inventory systems to be decided under the provisions of Article 5 of the Protocol or as supplementary information under Article 7. How prescriptive the *good practice* guidelines should be will of course be for the Parties to decide; the role of the IPCC is to provide necessary technical information on what is feasible. This could include the selection and application of estimation methods and management of inventories in terms of quality control and review procedures to ensure unbiased estimates.

In order to define *good practice* within the context of the *IPCC Guidelines*, the Paris meeting proposed that the IPCC should organise four sectoral workshops dealing with *good practice* in inventory estimates. A fifth workshop will deal with cross cutting issues on quality assurance/quality control (QA/QC) and the quantification and management of uncertainties, and a concluding workshop to ensure consistency in the definition of *good practice* as a whole. These workshops would be held in 1999 and 2000 and be scheduled so that a substantive report on progress could be made available, bearing in mind the timetable suggested by SBSTA.

The sectoral workshops will focus on developing *good practice guidance* that will promote the development of emission inventories that contain unbiased, reliable and accessible data that can be readily assessed in terms of quality and completeness, and can be reasonably achieved considering the resource considerations of all applicable Parties. In essence, the fundamental question for consideration at the sector workshops is: *How do we define good practice for a particular emission source category?* Based on discussion at the Paris meeting, the following issues will be considered at the sector workshops at the source level:

- Identification of preferred emission estimation methods, including selection and use of emission; factors and activity data, completeness, and uncertainty;

- Considerations for transparency and reporting, and

- Considerations for quality assurance (QA) and quality control (QC).

The good practice guidance should outline a high standard for inventory quality within the context of the *IPCC Guidelines* that will give confidence in the use of inventories for assessing compliance. The *good practice guidance* should recognise the diverse national conditions of data availability, resource constraints, and infrastructure, and should recognise that inventories will improve over time.

Table 1 summarises these issues and the following sections discuss them in more detail. The sector workshops will develop recommendations on these specific components of good practice guidance as they relate to each source category. A model of the areas to be addressed in the *good practice guidance* is attached as Annex B to this paper. It is anticipated that the results of each expert group's work will be approximately 5 pages long and follow this format.

To assist expert groups in their work, technical papers are being prepared for each source category, outlining how these issues may apply to the source. These technical papers will form the basis of discussion at the sector workshops.

<table>
<tr><td colspan="2" align="center">TABLE 1
EXPECTED OUTPUTS FROM SECTORAL WORKSHOPS</td></tr>
<tr><td align="center">Inventory Attribute</td><td align="center">Output</td></tr>
<tr><td>Methodological Issues</td><td>

i. Identification of good practice for methodological choices for estimating emissions, including development of a decision tree for determining what method is most appropriate, given national circumstances.

ii. Guidance on the use and/or development of emission factors and associated uncertainty ranges

iii. Guidance on the use and/or development of activity data and associated uncertainty ranges

iv. Information on uncertainty for the upcoming meeting (in October 1999 in the United Kingdom)

v. Guidance on completeness of emission estimates in the source category

vi. Guidance on other important issues, such as consistency in time series, etc.
</td></tr>
<tr><td>Reporting and Documentation</td><td>

i. Clear definitions of the end uses of data and corresponding implications on reporting and documentation

ii. Minimum elements for transparency and reproducibility on a source category basis using IPCC reporting tables, taking UNFCCC Guidelines into account

iii. Existing tools, or recommended new approaches, to collecting and storing emissions-related data to facilitate comparisons, transfer, and review of inventory data
</td></tr>
<tr><td>Inventory Quality Assurance and Quality Control</td><td>

i. Guidance on which QA/QC tools best represent good practice in inventory management for particular sources

ii. Recommendations on how to document good practice in QA/QC procedures
</td></tr>
</table>

2   METHODOLOGICAL ISSUES

The selection and application of emission estimation methods are fundamental to inventory quality. Under the *IPCC Guidelines,* Parties have a great degree of flexibility in their selection of emission estimation methods. A variety of approaches or "tiers" are outlined in the *IPCC Guidelines,* ranging from simple default methods to much more complex approaches. Complete standardisation in methodologies is neither likely nor desirable, given differences among Parties. Thus, good *practice guidance* provides an alternative means of ensuring that the method employed is used appropriately. To this end, *good practice gui*dance on emission estimation methods should address the following:

- Which method is chosen;

- How emission factors are developed and used;

- How activity factors are developed and used;

- Uncertainty associated with various methods;

- Completeness, and

- Other Important Issues.

2.1   Choice of method

The main goal of the sector workshops will be to review the emission methodologies described in the *IPCC Guidelines* and develop good practice guidance on how to select and apply the most rigorous method appropriate for each source, taking into consideration available national circumstances and resources.

Good practice methods should yield a high quality unbiased emissions estimate. They should be challenging yet allow for Parties' varying capabilities in terms of resources. *Good practice* should take account of all methods consistent with the *IPCC Guidelines*, up to and including direct monitoring of emissions where feasible. A *good*

practice method employing the "emissions factor X activity data" or other appropriate algorithm should be disaggregated spatially and by sub-source to the furthest extent possible, and take into consideration the unique characteristics of the country. Disaggregation allows for the algorithm to be applied to increasingly homogenous data sets. One or more *good practice* methods should be identified for all sources, together with a decision tree or equivalent to guide Parties to the method most appropriate to their circumstances. Decision trees should recognise that any Party may choose to use most detailed methods consistent with the *IPCC Guidelines* and the associated reporting requirements. The relative size and/or rate of change of a source in a national inventory may play a role in determining *good practice,* but an evaluation of whether a particular source is "key" is not an issue that will be addressed by expert groups at the sector workshops.

In source breakout groups at the sector workshops, experts should identify *good practice* methods for estimating emissions from their source. They should also develop a decision tree that describes the process by which a Party would determine which method or tier was most appropriate given its national circumstances. Annex B includes a sample decision tree which should be adapted for each source. Guidance has also been developed on how groups are to work within the *IPCC* Guidelines as they consider the issue of methodological choice (see Box 1).

BOX 1

DRAFT CRITERIA FOR GOOD PRACTICE BEING CONSISTENT WITH IPCC GUIDELINES

Applying good practice guidance should reduce uncertainties and minimise the bias in greenhouse gas inventories produced through the use of the IPCC Guidelines. The breakout groups should use the following criteria to decide whether the good practice guidance that they are proposing is consistent with the IPCC Guidelines:

(a)   Good practice guidance should address the same source categories and gases as the IPCC Guidelines;

(b)   Good practice guidance should use the same functional forms for the equations used to estimate emissions that are used in the IPCC Guidelines;

(c)   New default emission factors can be suggested where high quality data are available that are more up-to-date or appropriate for use in particular circumstances that can be identified through the decision tree. Such new factors should give more accurate estimates than the current factors and must be documented;

(d)   Good practice guidance should identify any errors that there may be in IPCC Guidelines, and

(e)   Where relevant, groups can identify and describe good practice for additional sources, source categories, or gases (i.e., those included in the Other category).

Breakout groups should provide guidance on the choice of method (by decision trees), the selection of parameter values which are linked to particular circumstances, situations in which national methods are appropriate, and propose corrections for any errors.

2.2   Choice of emission factor

The quality of emission factor or other model parameter[1] data is critical to the quality of the resultant emission estimates. Thus, availability, applicability, and quality of the emission factor data needed for each method must be assessed. For each source, experts will need to identify the types of emission factor data required to implement the different methods. Once the necessary emission factors are determined, experts should evaluate how they should be obtained and identify any areas of concern with the development of new emission factors. Key considerations for using national emission factors or IPCC default factors should also be identified.

Several Parties develop their emission estimates using national emission factors derived from measurement programmes undertaken in their own countries or regions. These emission factors are generally more appropriate than IPCC default factors, because they specifically address national circumstances. Where national or regional emission factors are used, experts should develop guidance for selecting or developing emission factor data for a given estimation approach. Experts should specify the key elements of a high-quality emissions measurement programme for particular sources and/or methods. In addition, they should identify the documentation necessary for reviewers to assess the quality of emission factors. Such documentation might include a description of the

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[1] Such as the parameters of a process model which play an equivalent role to emission factors. Emission factors referred to here include these parameters

measurement programme, references to technical literature, and /or a discussion of why national emission factors differ from IPCC defaults.

Many Parties, particularly those with limited financial and/or personnel resources, use default emission factors identified in the *IPCC Guidelines* in developing their inventories. To ensure highest quality, the default emission factors presented in the *IPCC Guidelines* should be reviewed and updated where possible, consistent with the guidance in Box 1.

In certain cases, it may be good practice to "borrow" emissions factors from another country which has completed a domestic measuring programme and developed its own data. In these cases, the country should have similar economic and physical circumstances, as they apply to the source in question. Experts should also consider whether the *good practice* guidance should contain an updated registry of emission factors for various sources. A registry listing the values and pedigree of a range of emissions factors could make it easier for countries to choose the most suitable data. The development of such a registry would be a central function for the IPCC or possibly for the UNFCCC Secretariat.

The review of emission factors at the sector workshops may also identify areas for substantial improvement in emission factor data. For some sources, there may not be a readily available set of emission factors with acceptable quality and applicability to apply the preferred estimation method. This scenario could lead to a recommendation for further research into the literature or for Parties undertaking the development of improved emission factor data from measurement programmes within their country.

At the sector workshops, expert groups should determine what emission factors are needed for each tier or method, and describe *good practice* in obtaining these default factors. The applicability of default factors in the *IPCC Guidelines* should be reviewed and *good practice* guidance provided as necessary. Uncertainty issues related to emission factors should be addressed (see discussion in Section 2.4). If new data are available to enable improvement in default emission factors, they can be discussed and documented.

2.3   Choice of activity data

The accuracy and reliability of activity statistics varies widely. Fuel consumption data are usually reliable in most Annex I countries, but problems can arise; for example, the division between domestic aviation and international aviation bunker fuels (the emissions from which are not currently included in national totals) is usually not well defined. For some other sectors the activity statistics may be of much poorer quality. Examples of these are: waste statistics may not be collected or may be incomplete, and statistics on some agricultural treatments are not collected.

The first step is to determine the type of activity statistics required for the various estimation methods. It is crucial that the activity data match the level of aggregation of emissions factors as called for by the methodology. For example, a disaggregated method for estimating methane emissions from livestock requires that dependable livestock population data be available to match the emission factors. Otherwise, there will be a specification error in the estimate. There may be a point at which the gains to disaggregation are outweighed by the scarcity of activity data at that level.

Once the necessary activity data are specified, the next step is to evaluate how to obtain the data and identify any areas of concern. As is the case with emission factor data, there may be a variety of reference sources and formats for the activity statistics that can be used to support a particular method. For some emissions sources, it will be possible to collect activity data annually solely for the purpose of constructing an emissions estimate. In the absence of customised data collection, however, pre-existing data collected for other purposes by other government agencies or independent organisations will be necessary. This has the benefit of conserving scarce resources, but there are issues to be aware of. Depending on the transparency of the data, it may be difficult to ascertain its quality or bias. Some data sets (such as livestock populations) may not be collected annually, so it is necessary to interpolate or scale to other annual data. More often, the data may be published in one format, and has to be transformed into another before it is applied to the estimation of emissions. If there are two competing data sets with different results, they will have to be reconciled.

At the sector workshops, expert groups should determine the types of activity data required for each tier or method and describe how they should be obtained. Uncertainty issues related to activity data should be addressed (see Section 2.4).

2.4   Uncertainty assessment

At the October 1998 expert meeting, it was decided that the current *IPCC Guidelines* on uncertainty assessment should be expanded to provide more detailed guidance to Parties on how to assess and communicate the

uncertainty in their emissions inventories. Much work remains to be done to identify the most appropriate methods for assessing inventory uncertainty, however, and a separate workshop addressing the approaches for estimating and reporting uncertainty will be held in October 1999. In preparation for that meeting, expert groups at sector workshops are requested to consider the issues presented in Box 2.

BOX 2

REQUEST TO BREAKOUT GROUPS CONCERNING UNCERTAINTIES (BY IAN GALBALLY, AUS)

The Expert Meeting on Uncertainties (UK October, 1999) will require input from experts from the Sector Workshops to aid its overarching discussions on design of a good practice system for uncertainties. As part of your breakout group discussion and report to the Sector Workshop you have been given a "framework for Breakout Group Two Page Summaries". The document indicates in three places where you need to provide information on uncertainties. These notes are to clarify those tasks as follows:

Section: Choice of emission factor
The first requirement for uncertainties in the Framework document is for "Default emission factors and associated uncertainty ranges". These uncertainty ranges that we are soliciting are default uncertainty estimates. As part of your report please provide a list of default quantitative uncertainty ranges (expressed as a +/-percentage of the mean value) for emission factor, along with the default emission factors for each component of the IPCC Inventory that your breakout group considers. These uncertainty ranges are 95 percent confidence limits on the annual values entered into the IPCC Inventory worksheets. Please specify for each uncertainty whether it is based on numerical data (by providing a reference) or expert judgement (with a note of the source). The default uncertainty is the reasonable estimate of uncertainty to be applied to an activity, emission factor or emission rate for the national inventory of a Party to the Convention where no local information (in that nation or Party) on the uncertainty exists.

Section: Choice of activity data
The second requirement for uncertainties in the Framework document is the uncertainty associated wit activity data. These uncertainty ranges that we are soliciting are default uncertainty estimates. As part of your report please provide a list of default quantitative uncertainty ranges (expressed as a +/- percentage of the mean value) for activity data for each component of the IPCC inventory that your breakout group considers. These uncertainty ranges are 95 percent confidence limits on the annual values entered into the IPCC Inventory worksheets. Please specify for each uncertainty whether it is based on numerical data by providing a reference) or expert judgement (with a note of the source).

Section: Input to Uncertainty Workshop
Are there any examples covered in your considerations where there are multiple determinations on a particular system of either the emissions, emission factors or activities that would be adequate to characterise the variability of the system and determine a probability distribution of the parameter. Please provide an explicit reference or contact person for the source of the data.

Are there any examples where there is likely to be correlation between the activity and emission data, or correlation between two activities used in the same emissions estimation equation. Can these correlations be quantified? Please provide an explicit reference or contact person for the source of the data.

Are there any national conditions where the methodology for emissions estimation is inappropriate or fails because the methodology was not designed to present those conditions? Please indicate any possible cases and proposed reasons for those breakdowns.

2.5 Completeness

For many sources, ensuring completeness is straightforward. For others, however, it may be difficult for Parties to develop emission estimates for numerous sub-sources and difficult for inventory reviewers to determine how complete the estimates are. Thus, *good practice guidance* should address the following issues for each source category:

- Clear definitions of what is included in a particular IPCC source category (i.e., the sub-sources), and

- Whether completeness is likely to be an issue for a particular source. If necessary, the *guidance* should describe those sub-sources that may merit particular attention to ensure completeness. They should also

indicate whether the terms NA, NE, or NO are likely to be used for this source and if there are any special considerations on how these terms are applied (see Box 3 for the UNFCCC definitions).

BOX 3

UNFCCC DEFINITIONS REGARDING COMPLETENESS

Where methodological or data gaps in inventories exist, information on these gaps should be presented in a transparent manner. Parties should clearly indicate the sources and sinks not considered in their inventories but included in the *IPCC Guidelines,* and explain the reason for the exclusion. In addition, Parties should use the standard indicators presented below to fill the blanks in all the tables of an inventory. This approach facilitates assessment of the completeness of an inventory. The standard indicators are as follows:

(a)   "NO" (not occurring) for emissions by sources and removals by sinks of greenhouse gases that do not occur for a particular gas or source/sink category within a country;

(b)   "NE" (not estimated) for existing emissions by sources and removals by sinks of greenhouse gases which have not been estimated. Where "NE" is used in an inventory for emissions or removals of CO_2, N_2O, CH_4, HFCs, PFCs, or SF_6, the Party should indicate, using the completeness table of the common reporting format, why emissions could not be estimated;

(c)   "NA" (not applicable) for activities in a given source/sink category that do not result in emissions or removals of a specific gas. If categories in the common reporting format for which "NA" is applicable are shaded, they do not need to be filled in;

(d)   "IE" (included elsewhere) for emissions by sources and removals by sinks of greenhouse gases estimated but included elsewhere in the inventory instead of the expected source/sink category. Where "IE" is used in an inventory, the Party should indicate, using the completeness table of the common reporting format, where in the inventory the emissions or removals from the displaced source/sink category have been included and the Party should give the reasons for this inclusion deviating from the expected category;

(e)   "C" (confidential) for emissions by sources and removals by sinks of greenhouse gases which could lead to the disclosure of confidential information, given the provisions of paragraph 19 above, and

(f)   "0" for emissions by sources and removals by sinks of greenhouse gases which are estimated to be less than one half the unit being used to record the inventory table, and which therefore appear as zero after rounding. The amount should still be included in the national totals and any relevant subtotals. In the sectoral background tables of the common reporting format Parties should provide data as detailed as methods allow.

2.6   Other issues

In addition to issues of completeness and uncertainty, several other important methodological issues may need to be considered with respect to certain sources. Possible issues for consideration include:

- Establishing base year emission levels – for some sources, it may be necessary to consider the most appropriate means of developing a base year estimate, given the possibility that estimation methods or data sources used in later years may differ from the base year. This issue may be particularly important for sources where measured data were unavailable in the base year, but such data are available for developing more accurate estimates in later years;

- Treatment of imported/exported emission sources – the issue of how to treat an emission source that is imported or exported may arise for some sources (an example is the chemicals that replace ozone-depleting substances). Experts may want to consider where such emissions should be accounted for and/or how estimates should be reported to ensure transparency in the coverage of these sources;

- Consistency among sources – some sources may use similar sets of activity data in preparing estimates. These linkages should be identified, to ensure that the data sets are manipulated in a consistent manner across the sources;

- Double counting – experts should consider the interactions among sources to ensure that emissions are not double counted, and

- Confidentiality – experts should determine whether confidentiality is a potential concern with respect to the data used in developing the estimates. If so, they should make recommendations about how maximum transparency can be achieved while protecting confidentiality.

3 REPORTING AND DOCUMENTATION

Reporting of national greenhouse gas inventories allows Parties to evaluate their progress towards meeting the goals outlined in the UNFCCC, and will be used by developed countries to determine compliance with binding emissions targets outlined in the Kyoto Protocol. Without sufficient reporting, it will be impossible for third parties to judge whether or not national inventories reflect a rigorous attempt to estimate the true annual emissions within a country. In short, without *good practice* in reporting, it is impossible to assess inventory quality. In fact, poor reporting may lead reviewers to conclude that the inventory is highly uncertain, or possibly suspect, even if the data are of high quality. From a global inventory perspective, poor reporting makes it difficult to compare inventories across countries, and to compare global atmospheric budgets with inventory estimates.

Sufficient reporting means that inventories can meet the standards of the Parties to the Convention and the Protocol. The UNFCCC, in its "Guidelines for the Preparation of National Communications by Parties Included in Annex I to the Convention, Part I: UNFCCC Reporting Guidelines on Annual Inventories" (FCCC/CP/1999/7), outlined guidelines for reporting national inventories. Decision 10/CP.2 of the same document outlines guidelines for non-Annex I Parties. In this document, the standards for reporting and documentation are defined as follows (see Box 4):

BOX 4

UNFCCC REPORTING GUIDELINES PRINCIPLES AND DEFINITIONS

Transparency means that the assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of information;

Consistency means that an inventory should be internally consistent in all its elements with inventories of other years. An inventory is consistent if the same methodologies are used for the base and all subsequent years and if consistent data sets are used to estimate emissions or removals from sources or sinks. Under certain circumstances, an inventory using different methodologies for different years can be considered to be consistent if it has been recalculated in a transparent manner, taking into account any *good practices*;

Comparability means that estimates of emissions and removals reported by Parties in inventories should be comparable among Parties. For this purpose, Parties should use the methodologies and formats agreed by the COP for estimating and reporting inventories. The allocation of different source/sink categories should follow the split of the *IPCC Guidelines, at the level of its summary and sectoral tables.*

Completeness means that an inventory covers all sources and sinks, as well as all gases, included in the *IPCC Guidelines*, as well as other existing relevant source/sink categories which are specific to individual Parties, and therefore may not be included in the *IPCC Guidelines*. Completeness also means full geographic coverage of sources and sinks of a Party.

Accuracy is a relative measure of the exactness of an emission or removal estimate. Estimates should be accurate in the sense that they are systematically neither over or under true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable. Appropriate methodologies conforming to guidance on good practices should be used to promote accuracy in inventories.

The UNFCCC Guidelines also prescribe the use of standard data tables and formats for reporting as recommended in the *IPCC Guidelines*. The *IPCC Guidelines: Reporting Instructions* establish:

- Standard tables, definitions, units, and time intervals for reporting all types of emissions;

- The necessary documentation to enable comparison of national inventories, including worksheets, major assumptions, methodological descriptions, and enough data to allow a third party to reconstruct the inventory from national activity data and assumptions, and

- An uncertainty assessment.

Sector workshops should discuss, on a source by source basis, the suitability of the IPCC tables, the key aspects of an emissions estimate that should be reported or documented, and suggestions for improvement in light of the goals of the *good practice* guidelines. Specifically, expert groups may want to consider the suitability of reporting the following information for particular sources:

- An identification and description of the underlying method, including algorithms and equations;

- A discussion of methodological changes from previous years and the impact on estimates;

- Any and all assumptions made or exceptions taken to good practice in the light of the *IPCC Guidelines;*

- An analysis of the trends, with special emphasis on explaining anomalies;

- All activity data, including any permutations performed on standard data to derive a value used in the inventory;

- All emissions factors, including explanations of why emissions factors were changed from previous years;

- Complete bibliographical information for activity data and emissions factors, and

- Results of the QA/QC programme and external reviews.

4   INVENTORY QUALITY ASSURANCE/QUALITY CONTROL

An IPCC workshop on uncertainty and QA/QC issues in general will be held in October 1999 as part of the development of *good practice* guidance. Historically, the *IPCC Guidelines* have not devoted a lot of attention to general QA/QC protocols although they were discussed at the Paris expert meeting in October 1998. The QA/QC good practices that are ultimately developed should reflect practicality, acceptability, cost-effectiveness, existing experience, and potential for codification in order to be implemented uniformly on a worldwide basis. For purposes of the sector workshops, however, it will be important to consider when and how QA/QC procedures should be integrated into the development of the source-level inventory.

A successful QA/QC programme should have two distinct components. The first component is quality control (QC), which is a system of routine technical activities, implemented by inventory development personnel to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

- Provide routine and consistent checks and documentation points in the inventory development process to verify data integrity, correctness, and completeness;

- Identify and reduce errors and omissions;

- Maximise consistency within the inventory preparation and documentation process, and

- Facilitate internal and external inventory review processes.

Quality control activities include technical reviews, accuracy checks, and the use of approved standardised procedures for emission calculations. These activities should be included in inventory development planning, data collection and analysis, emission calculations, and reporting. For each source, experts should determine which aspects most heavily influence the ultimate emissions estimate. It is on these sensitive aspects that QA/QC usually needs to be targeted.

The second component of a QA/QC programme consists of external quality assurance (QA) activities, which include a planned system of review and audit procedures conducted by personnel not actively involved in the inventory development process. The key is to have a review by an independent, objective third party to assess the effectiveness of the internal QC programme and the quality of the inventory, and to reduce or eliminate any inherent bias in the inventory processes. In essence, the QA programme ensures that the inventory QC process was correctly performed. Different types of audits and reviews may be suitable for specific sources:

- Third party audit;

- Expert (peer) review;

- Stakeholder review, and

- Public review.

A common thread throughout both of these components and, in fact, the whole QA/QC process, is the need for thorough documentation and complete transparency. Documentation and transparency are intrinsic to QA/QC

and should not be separated. For example, a government agency responsible for compiling a national inventory from regional offices or companies needs full documentation of this data and calculations in order to perform its own QA. The agency also needs to document the national compilation process and the QC performed so that it is transparent to external reviewers and the UNFCCC. In short, each group should have the necessary information with which to fulfill its function.

An effective QA/QC programme will include planning, numerous QC checks during inventory development, and QA audits at strategic points in the process. Depending on the source, the exact QA/QC steps that should be followed will vary; however, *good practice* for each source should consider the appropriateness of using the following tools:

- Sample calculations: Reproducing a small set of calculations is a quick way to assess quality.

- Sensitivity analyses: Sensitivity analysis helps to focus QA/QC efforts on the most important inputs.

- Statistical checks: Is the data set representative?

- Emissions validation: Is the final estimate consistent with other estimates?

- Reality checks: Does the final estimate make sense? (e.g., Does the answer follow stoichiometric ratios, or conserve energy and mass?)

At the sector workshops, expert groups should describe any specific QA/QC issues related to their particular source and determine if there are certain types of QA/QC activities that would be recommended for the source based on its characteristics.

REFERENCES

Guidelines for the Preparation of National Communications by Parties included in Annex I to the Convention, Part I: UNFCCC Reporting Guidelines on Annual Inventories (FCCC/CP/1999/7).

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ANNEX 1   CONSIDERATIONS FOR IMPLEMENTING GOOD PRACTICE GUIDELINES

There are a number of important considerations to keep in mind as the inventory workshops proceed, specifically in the context of how to implement *good practice* guidance for each sector or source category. Following is a list of these considerations with an explanation for each:

- *How can we instil good practice guidance into the IPCC Guidelines (i.e., for each sector and source category, how do we develop a written and structured framework for good practice method approaches)?*

It will be necessary to overlay the *good practice* guidance developed as part of these workshops onto the existing *IPCC Guidelines*. Whereas no definitive format or means for implementing the *good practice* techniques has been decided at this point, it would be practical to think in terms of how the existing *IPCC Guidelines* could form the basis for communicating *good practice* techniques. Considering this type of application will also be helpful in designing *good practice* guidance that meets the protocol objectives of the IPCC format.

- *Identifying priority areas for further technical review*

In developing decision trees to select preferred methods, weaknesses in existing procedures will be identified and may lead to investigations into areas for technical improvement in methods, emission factors, and/or activity statistics. These areas for investigation should be prioritised to the extent possible in the workshops. The extent to which these investigations can be carried out will need to be decided upon completion of the workshops and with feedback from the parallel workshop on uncertainty issues.

- *Identifying key elements of good practice for each source*

Within the sector workshops it will be critical to identify key elements of *good practice* for the available methods. If the sector workshops can highlight those key elements that most significantly impact the quality of emissions for a given source category, Parties can focus attention on those key elements to improve their inventories. Also, if the workshops can point to any known deficiencies in key elements, this will accelerate the process to improving methods.

- *Coordination with parallel workshop on uncertainty*

The attendees of the *good practice* workshops should be aware of the parallel IPCC workshop being held on uncertainty assessment and management. That workshop will consider the development of a multi-tiered methodology for the assessment of uncertainty. This methodology will include definitions of technical terms; default methods for estimating uncertainty; and one or more higher Tier options which will include the use of expert judgement, appropriate measurements and a methodology (including probability distributions for emission factors and activity data) for combining these uncertainties. The uncertainty workshop will also develop guidance for communicating these uncertainties to a non-technical audience.

- *Recognition of the diverse national conditions of data availability, resource constraints, and infrastructure*

In developing initiatives and guidelines to improve inventory methods, it must be remembered that priorities may differ by country in relation to the contribution that a particular sector makes to a country's national emissions. For example, a summary of the national feedback on the *IPCC Guidelines* from the September 1998 IPCC meeting held in Havana, Cuba, showed unique priorities at the source category level from country to country. The best approach to addressing these differences may be to establish groupings of categories and priorities relative to countries with common characteristics or concerns.

- *Inventory improvement and refinement is often an iterative process, with feedback from QA review and end-users*

The inventory data produced in response to the FCCC requirements and the Kyoto Protocol will have an increasing number of end-users, and as a result, intensive review and commentary. As a result, the process by which inventories are developed becomes an iterative one, where review and usage provide feedback for improvement to original emission estimates. Even after more formal review processes are in place for evaluating fulfillment of commitments, there may be additional requirements for quality, uncertainty assessment, and reporting associated with other end uses such as emissions trading.

## ANNEX 2   FRAMEWORK FOR BREAKOUT GROUPS TWO PAGE SUMMARIES

1   METHODOLOGICAL ISSUES

1a. Choice of Method

Good practice method is to use [country-specific measured data on emissions and assumptions wherever possible]. This means that emission factors should reflect the specific conditions of a country and the technologies involved (including any emissions mitigation technologies), and be measured often enough to reflect the variability of the process to a level of accuracy [that would be provided by daily monitoring measurements to establish the relationship between emissions and production] although [experience has shown that less frequent monitoring than this may be sufficient to give this level of accuracy].

[Continuous monitoring of emissions would also be consistent with *good practice*], but [is not regarded as feasible].

Breakout groups should provide guidance on the choice of method (by **decision trees**), the selection of parameter values which are linked to particular circumstances, situations in which national methods are appropriate, and propose corrections for any errors (see decision tree below)
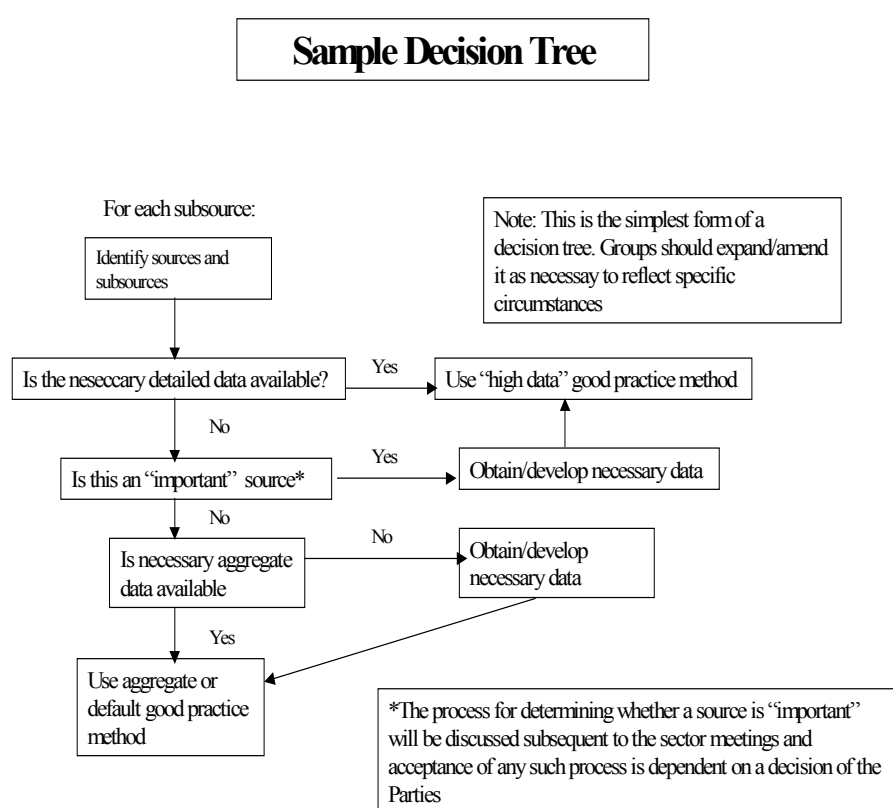
1b. Choice of emission factor

Good practice emission factors involve the measurements at the sources as described above. These should be carried out using [describe instrumentation and measurement process]. The nature of the instrumentation and the frequency of measurement will determine the associated uncertainty for typical measurements for this source, the associated uncertainty is expected to be about [X] percent

[Where complete coverage of variability within a source is not feasible, the inventory agency should establish and describe whether the sample available is representative, and where not, take steps to establish representative data for the missing variability/source, in the following manner...]

Default emission factors are available in the IPCC methodology. If their use is essential because of lack of measurements in national circumstances [groups should make recommendations about what *good practice* would be, e.g. regionally specific defaults, technology dependent defaults, etc]

Default emission factors and associated uncertainty ranges could be arranged as in the following table:

Technology	Default emission factor	Associated uncertainty
A		
B		
Etc		

1c. Choice of activity data

For the good practice method, activity data consist of production statistics which should be collected by [National Bureau of Statistics using yearly census data. These data should be comparable to international data sources like IEA. Differences with IEA should be explained]. The accuracy will be [x percent]/ [high compared to the accuracy of the emission factor].

1d. Input to Uncertainty workshop

[For this source good practice methods should permit determination of uncertainties using standard statistical methods]

[Uncertainties for this source have been estimated using expert judgement based on knowledge of the performance of the engineering components involved].

1e. Completeness

Complete coverage for this category requires estimation of emissions from the following activities, where present: [List them]

Experience has shown that the following sub-sectors may be missed in existing inventories and their presence should be checked specifically [List any]

1f. Other Issues such as base line determination

If all the necessary historical data are present, the base year emissions estimate should be made using the *good practice* method.

Where some historical data are missing [it should still be possible to use source- specific measurement made under the *good practice* regime to establish an acceptable relationship between emissions and activity data in the base year].

2   REPORTING AND DOCUMENTATION

The worksheets contained in the *IPCC Guidelines* [do/do not] provide transparent reporting. [To improve transparency emissions estimates form this source should be reported [separately] as follows]

The following information is necessary to document the estimate in order to ensure transparency: [list items]

[Identify any issues that hamper reporting and documentation of emissions and recommend how to eliminate barriers to reporting and documentation]

3   INVENTORY QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC)

[Say what kind of QA/QC records should be maintained at the plant/source level to allow auditing of the measurements made, data records kept and the information supplied to the inventory agency]

[Identify any national or international data sets that could be used for comparison during review. These need not be completely independent of the plant data]

[Say whether it would be feasible to cross-check emissions estimates form this source by external measurements]