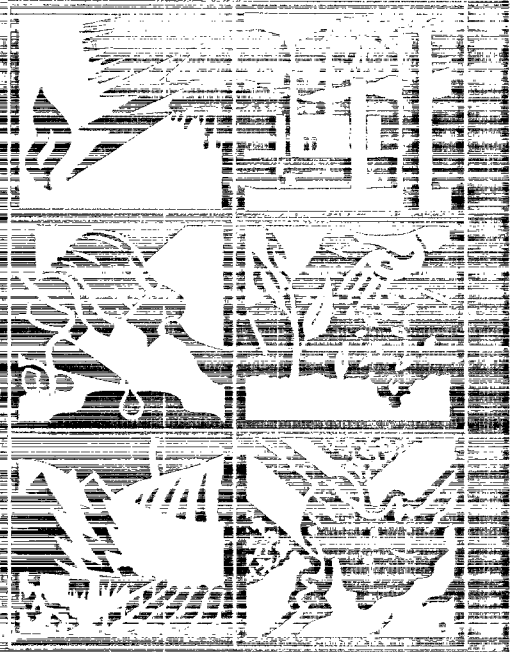
EPA-230-B-94-002A

UNEP WMO

Greenhouse Gas Inventory Reporting Instructions

Final Draft



IPCC Draft Guidelines for National Greenhouse Gas Inventories

Volume 1

IPCC/OECD Joint Programme

IMPORTANT NOTICE

The material contained in this document is in draft, and is sent to you for comment as part of the IPCC review process. The document has not yet been approved by the IPCC and must not be published or cited as an official IPCC report.

As a result of the review process this draft is expected to undergo amendment and correction before being presented for approval by IPCC WGI in September 1994 and by IPCC plenary in November 1994.

Material contained in this draft may be copied in whole or in part for review by others, but a copy of this notice should be attached to all such copies.

Recycled/Recyclable
Printed with Soy/Canola Ink on paper that contains at least 50% recycled fiber

Printing support provided by the U.S. Environmental Protection Agency

ACKNOWLEDGEMENTS

The IPCC/OECD Programme on the Development of a Methodology for National Inventories of Net Greenhouse Gas Emissions would like to thank those governments, international organizations, and individuals whose contributions have made the development of this methodology possible.

Financial support for the programme has been provided by the United Nations Environment Programme, the Global Environment Facility, the Organization for Economic Co-operation and Development, the International Energy Agency, the European Community, and the governments of the United States, the United Kingdom, Switzerland, Italy, Norway, Sweden, and the Netherlands, Germany, France, Canada, and Australia. Significant (non-financial) contributions and resources in kind came from the United Nations Environment Programme, the United States, the Netherlands, the United Kingdom, Japan, the Organization for Economic Cooperation and Development, and the International Energy Agency.

Many individuals have contributed in various ways to the programme. Those who have drafted, commented, and advised in the direct support of the production of these documents include: Jane Ellis, Tim Simmons, and Karen Treanton, of the International Energy Agency; Craig Ebert and Barbara Braatz of ICF Inc.; Karl Jörss of the Federal Environment Agency in Germany; Gordon McInnes of the CEC/European Environment Agency Task Force & UNECE Task Force on Emission Inventories; James Penman of the UK Department of the Environment; André van Amstel of the National Institute for Public Health and Environmental Protection (RIVM) in the Netherlands; Jan Feenstra, Ella Lammers, and Pier Vellinga, of the Institute for Environmental Studies in the Netherlands; Berrien Moore of the University of New Hampshire; Gerald Leach, Jack Siebert, Susan Subak, and Paul Raskin, of the Stockholm Environment Institute; Lucy Butterwick, Martin Parry, and Martin Price, of the University of Oxford;; Michael Short and Peter Usher of the United Nations Environment Programme; N Sundararaman of the IPCC Secretariat; Bert Bolin, Chairman of the Intergovernmental Panel on Climate Change; Tim Weston, Peter Bolter and Austin Pearce of TMS Computer Authors Ltd.; Bruce Callander, Buruhani Nyenzi, and Kathy Maskell of the IPCC Working Group I Secretarait; Paul Schwengels, Jan Corfee-Morlot, Jim McKenna, Scott Lurding, and Hans Sperling, of the OECD Environment Directorate.

The IPCC/OECD Programme would like to thank all the participants in the expert groups and in the various regional workshops, especially the coordinators and co-chairs of expert groups process to provide improvements in technical methods; L Gylvan Meira, Filho of the National Institute for Space Research, Brazil; Berrien Moore of the University of New Hampshire; Paul Crutzen of the Max Planck Institute for Chemistry; Elaine Matthews of NASA; A P Mitra, of the National Physics Laboratory in India; Nigel Roulet of York University in Canada; K Minami of the National Institute for Agro-Environmental Sciences in Japan; M A K Khalil of the Oregon Graduate Institute; Alan Williams of the University of Leeds; Dina Kruger, Susan Thornloe, and Lee Beck, of the US Environmental Protection Agency; Audun Rosland of the State Pollution Control Authority in Norway; Frank Shephard of British Gas plc; Richard Grant of the E&P Forum; Michael Gibbs and Jonathan Woodbury of ICF Inc.; Lis Aitchison of the Energy Technology Support Unit; Ron Leng of the University of New England in Australia; Mark Howden of the Bureau of Resource Sciences, Australia; T Ramasami of the Central Leather Institute in India; Robert Delmas of the Université Paul Sabatier; Dilip Ahuja of the Bruce Company; Chris Veldt and Jan Berdowski of the National Organisation for Applied Scientific Research (TNO-IMW) in the Netherlands; and Jos Olivier of the RIVM.

National case studies were contributed by: Audun Rosland of the State Pollution Control Authority in Norway, Peter Cheng of the Department of Arts, Sport, the Environment, and Territories in Australia, Jane Legget of the US Environmental Protection Agency, Art Jacques of Environment Canada, Sture Boström of Finland, and Karl Jörss of the Federal Environment Agency in Germany, Simon Eggleston of Warren Spring Laboratory in the United Kingdom, André van Amstel of the National Institute for Public Health and Environmental Protection (RIVM) in the Netherlands, I B Obioh of Obafemi Awolowo University Nigeria, P A Ratnasiri of the Ceylon Institute of Scientific and Industrial Research, Gordon McInnes of the CEC/European Environment Agency Task Force & UNECE Task Force on Emission Inventories, Anne Arquit-Niederberger of the Federal Office of Environment, Forests and Landscape in Switzerland, and Kendaro Doi of the Japan Environment Agency.

A very large number of experts have participated in IPCC/OECD expert groups and workshops. All of these contributors have played contructive roles in shaping methods presented here. These efforts reflect an important contribution to the implementation of the Framework Convention on Climate Change, and are greatly appreciated.

REPORTING INSTRUCTIONS CORRIGENDA

p.2.2

In the table, section "5 LAND USE CHANGE AND FORESTRY":

Replace: sum of all agricultural activities 4A, B, C, D, E &F
With: sum of all agricultural activities 4A, B, C & D

p. 2.5:

Revise definition of "IB FUGITIVE FUEL EMISSIONS" as follows:

Total "fugitive" emissions of $C0_2$, CH_4 and NMVOC from fuel production. transmission, storage and distribution (as noted below). (Sum of 1BI and 1B2)

p.2.7

Definition for "2A IRON AND STEEL". Remove the bracketed note [[Definitions to be supplied]] missing.

p.2.9

Section "4B ANIMAL WASTES".

Sub sections listed as 4A1-4A9 and should be listed as 4B1-4B9.

p. 2.11

Section "5 Land Use Change and Forestry". In the main title:

Replace: (Sum of the parenthetical 5 A, B, C, D, E, F)
With: (Sum of the parenthetical 5 A, B, C, D)

Add category to "5A Forest Clearing" section as follows:

	5A4 OTHER	Emissions from forest clearing not otherwise covered in any of the above categories

Section "5C LOGGING/MANAGED FORESTS" should be labelled 5D.
Section "5D ABANDONMENT OF MANAGED LANDS" should be labelled 5C.

Revise new section "5C ABANDONMENT OF MANAGED LANDS" as follows:

New section "5C ABANDONMENT OF MANAGED LANDS" should read:

5C	ABANDONMENT OF MANAGED LANDS	Removals (sinks) of C02 from the abandonment of formerly managed lands (e.g. croplands and pastures). The categories below are determined by the type of biomass which regrows on the abandoned land.

Add a section "5C3 OTHER".

5C3 OTHER	Removals from abandoned land regrown to any biomass type other than forests or grasslands.

Revise new section "5D LOGGING/MANAGED FORESTS" as follows:

Add a section "5D4 OTHER"

5D4 OTHER	Emissions and removals (sinks) of C02 from other categories, including afforestation programmes, harvest/regrowth of village and farm trees, etc.

p. 2.12

Revise section "6 WASTES". Revise definition of "6C OTHER".

6C OTHER	Release of greenhouse gases from any other public service activity (e.g., all non CO_2 GHG from waste incineration and $C0_2$ from non-organic waste incineration, when it is not part of waste to energy schemes).

p. 2.13

After Residual Fuel Oil the rows of the table should be revised as follows.

Liquified Petroleum Gas / Ethane
Naptha
Bitumen
Lubricants
Petroleum Coke
Refinery Feedstock / Additives
(then as before .....)

p. 2.14

Revise note under the "BIOMASS" fuel heading as follows:

Replace: (Excluded from totals of greenhouse gases sources, but useful to report).
With: (Excluded from CO_2 emission totals).

p. 2.16

Under "2.4 Standard summary tables", the third bullet, starting at the third sentence. Make the following revisions.

Replace:

Several gases such as Polyflourinated Compounds (SF_6, C_2F_6 and CF_4), sulfur oxides and HFCs are known to be relevant to climate change and may be included in future versions of the Guidelines. However, countries which wish to report these substances for completeness may do so using copies of the Summary Tables.

With:

Several gases such as Perfluorocarbons (C_2F_6 and CF_4), sulfur hexaflouride (SF_6), sulfur oxides and HFCs are known to be relevant to climate change and may be included in future versions of the Guidelines. Countries with data on these gases are encouraged to report them. Also, to avoid duplication of effort, reporting of substances covered under the Montreal Protocol is not required. However, countries which wish to report these substances for completeness may do so using copies of the Summary Tables.

p.3.2

Revise the Source/sink categories section, second paragraph.

Replace: Compare the IPCC source/sink categories (Table 3).....
With: Compare the IPCC source/sink categories (Table on pages 2.2 to 2.12).....

p. 3.3

Revise the "Time Periods" section, first paragraph, second sentence.

Replace: In some of the agricultural and .....
With: In the agricultural and .....

Table 3-1, sections 4A and 4B should be revised as follows:

4 Agriculture	
A Enteric Fermentation	Three-year average
B Animal Wastes	Three-year average

p. 3.5

Revise the first sentence under the text box as follows:

Replace: If you have already performed some cross-country verification.....
With: If you have already performed some verification.....

p.Tables.11

On page Tables.11, table entitled "lBl Fugitive Fuel Emissions (Oil and Gas)", the following revisions should be made:

Add a column entitled NMVOC under each of the "Emission Estimates" and the "Aggregate Emission Factors" sections of the table. So the top two rows of the table will read:

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES			AGGREGATE EMISSIONS FACTORS		
	Fuel Quantity (PJ)	CH_4 (Gg)	CO_2 (Gg)	NMVOC (Gg)	CH_4 (kg/GJ)	CO_2 (kg/GJ)	NMVOC (kg/GJ)

Add a footnote to the row entitled "lBlb Natural Gas (total) ii Consumption" as follows:

This item refers to the "consumption" related source categories listed on page 2.6 as: 1Blb Gas ii Processing; iii Transmission and iv Gas Distribution Pipelines. The basic consumption related activity data and the sum of these three categories should be reported here.

p.Tables.15

Move table on page Tables.15 entitled "Fugitive Fuel Emissions (Distribution of Oil products)" should be combined with the table on page Tables.11 "lBl Fugitive Fuel Emissions (Oil and Gas)".

Units for Aggregate Emission Factors column should be revised as follows:

Replace: (kg/Gg)
With: (kg/GJ)

p.Tables.13

Revise the labelling of rows as follows:

SOURCE AND SINK CATEGORIES
Coal Mining
1B2 a Underground
b Surface

p.Tables.17

The table entitled: "Minimum Data Tables 2 Industrial Processes" should be revised as follows:

Replace unit under column A "Activity data" column with kt for kilo-tonnes]

Edit heading under "Aggregate Emission Factors" as follows:

Replace: Pollutant per tonne of product (kg or t/t)
With: Tonne pollutant per tonne of product (t/t)

p.Tables.19

The table entitled: " Minimum Data Tables 3 Solvents" should be revised as follows-

Edit heading under "Aggregate Emission Factors" as follows:

Replace: Pollutant per tonne of Product (t/t)
With: Tonne pollutant per tonne of Product (t/t)

p.Tables.21

Add row for poultry as follows:

6 Buffalo
7 Camels and Llamas
8 Poultry
9 Other

p.Tables.23

Table entitled; "4C :Rice Cultivation" should be edited as follows:

Replace heading in column A: Area cultivated in hectares
With: Area cultivated in megahectares

Replace heading in column B: Hectare-days of Cultivation
With: Megahectare-days of Cultivation

Replace heading on last row: 3 Dry Regime
With: 3 Other

p.Tables.25

The table entitled "4E Agricultural Soils" should be edited as follows:

Change title to "4D Agricultural Soils"

Revise heading in column D as follows:

Replace: Nitrogen dioxide released per tonne N applied
With: Nitrous Oxide released per tonne N applied (tonne N_2O/tonne N)

p.Tables.43

Revise table entitled "5C1 Abandonment of Managed Lands" as follows:

Replace top line of title: "5C1 Abandonment of Managed Lands"
With: "5C Abandonment of Managed Lands (Part I)"

p.Tables.45

Revise table entitled "5C2 Abandonment of Managed Lands" as follows:

Replace top line of title: "5C2 Abandonment of Managed Lands"
With: "5C Abandonment of Managed Lands (Part II)"

p.Tables.49

Edit table title to read: " 5D Managed Forest (Part I): Annual Growth Increment"

Add new rows to the table as follows:

Tropical
Temperate
Boreal
Other
Afforestation Programs
Village and Farm Trees
Other (specify)

p.Tables.51

Edit table title to read: "5D Managed Forests (Part II): Harvest

p.Tables.59

Revise table entitled "6A Summary Report for the National Greenhouse Gas Inventories (Part I)".
Revise heading on third row as follows:

Replace: Total National Emissions

With: Total National Emissions and Removals

Add numbers (1,2, 3 ...) to all rows under "1A Fuel Combustion" and "1B Fugitive Fuel Emission". The rows of the table will then appear as follows:

Summary Report for National Greenhouse Gas Inventories (Part I)
GREENHOUSE GAS SOURCE AND SINK CATEGORIES
Total National Emissions and Removals
1 All Energy.....
A Fuel Combustion
1 Energy and Transformation Industries
2 Industry (ISIC)

B Fugitive Fuel Emission
1 Oil and Natural Gas
2 Coal Mining

p. A1.1

Last paragraph on the page. Revise the first sentence as follows:

Replace: It is important to provide as thorough an understanding of the uncertainties involved that when estimates are .....
With: It is important to provide as thorough an understanding as possible of the uncertainties when national estimates are .....

Revise the fourth sentence as follows:

Replace: This Annex provides some initial suggestions for developing qualitative .....
With: This Annex provides some initial suggestions for developing quantitative.....

p. A1.2

Revise the first paragraph, first sentence as follows:

Replace: Use of the IPCC methodology.....
With: Use of the IPCC Reporting Instructions.....

Delete the last sentence in the first paragraph which starts "The methodologies correspond to the.....".

p. A1.4

Table Al-l, in the row: C02, Land Use Change and Forestry - delete the upper row of numbers "[+/-33%], [+/-33%], [+/-50%]"

p. A1.5

In the 2 formulae on this page complete square root signs should be shown

In the first formula, the entire quantity $(U_E^2 + U_A^2)$ should be under the square root sign.

In the second formula, the entire quantity $(U_{TJ}^2 . C_i^2)$ should be under the square root sign.

p. A2.3

Revise the following headings of "Table A2-1 Correspondences between IPCC and CORINAIR Main source categories":

2 Industrial Processes
5 Land Use Change and Forestry

PREFACE

Signature of the UN Framework Convention on Climate Change (UNFCCC by around 150 countries in Rio de Janeiro in June 1992 indicated widespread recognition that climate change is a potentially major threat to the world's environment and economic development. Human activities have substantially increased atmospheric concentrations of greenhouse gases, thus perturbing the earth's radiative balance. According to projections from climate models, a global rise of temperature is a likely consequence. The potential impacts of climate change such as sea level rises and changes in local climate conditions - such as temperatures and precipitation patterns - could have important negative impacts on the socio-economic development of many countries.

The ultimate objective of the Convention is the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level is to be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change.. The Convention also calls for all Parties to commit themselves to three objectives:

- To develop, update periodically, publish, and make available to the Conference of Parties their national inventories of anthropogenic emissions of all greenhouse gases not controlled by the Montreal Protocol.
- To use comparable methodologies for inventories of greenhouse gas emissions and removals, to be agreed upon by the Conference of Parties.
- To formulate, implement, publish and update regularly national programmes containing measures to mitigate climate change by addressing anthropogenic emissions.

The IPCC *Guidelines* are intended to assist the Parties directly in implementing the first two of these requirements. They have been under developed for several years, in anticipation of this need.

By the time of the Second World Climate Conference in Geneva in October - November 1990, the need for a standard methodology for compiling national emission inventories was obvious. Under the auspices of the Organisation for Economic Cooperation and Development (OECD) and the International Energy Agency (IEA), with support from the USA, the UK and Norway, an initial compendium of methods was compiled. This document covered six direct and indirect greenhouse gases -- carbon dioxide, methane,

nitrous oxide, carbon monoxide, nitrogen oxide and non-methane volatile organic compounds. Chlorofluorocarbons (CFCs) and other substances already accounted for under the Montreal Protocol were intentionally excluded from the compendium. The document was discussed in detail by a meeting of experts (including many representatives of non-OECD countries) in Paris in February 1991. It was then adopted in a slightly modified form at the fifth session of the Intergovernmental Panel on Climate Change (IPCC) in March 1991 as the starting point for a set of IPCC guidelines to be used by countries drawing up national inventories of greenhouse gas emissions and removals.

The *IPCC Guidelines for National Greenhouse Gas Inventories* consist of three volumes: the *Greenhouse Gas Inventory Reporting Instructions,* the *Greenhouse Gas Inventory Workbook* and the *Greenhouse Gas Inventory Reference Manual.* Development of the *Guidelines* has been undertaken by the Scientific Assessment Working Group (WGI) of the IPCC, working in close collaboration with the OECD and the IEA under the IPCC/OECD programme on emissions inventories. The objectives of the programme are:

- to develop and refine an internationally agreed methodology and software for calculation and reporting of national net emissions.
- to encourage widespread use of the methodology by countries participating in the IPCC and Parties to the UN Framework Convention on Climate Change.
- to establish procedures and a data management system for collection, review and reporting of national data.

In the *Guidelines*, default methods and assumptions have been developed for characterising the major sources and sinks of greenhouse gases. Other more detailed methods are also discussed. Countries have the option of using various methods and levels of detail depending on their own needs and capabilities. The IPCC/OECD *Guidelines* also provide a common reporting and documentation framework for all inventories. This will allow for comparison of these methodologically diverse national estimates.

The *Guidelines* include simple, default methods and assumptions covering the major sources and sinks of greenhouse gases, and also discuss more detailed methods. Countries have the option of using various methods and levels of detail depending on their own needs and capabilities. The *Guidelines* also provide a common reporting and documentation framework for all inventories. This is needed to allow for consistent comparison of national estimates even though they may have been prepared with varying methods.

It is essential that these *Guidelines* are internationally agreed upon, and considerable effort has been expended to ensure this result. The draft methodology has been discussed, evaluated and refined through a international process which has included:

- wide dissemination of early drafts and collection of comments from national experts
- testing of methods through development of preliminary inventories

  About thirty-five countries around the world have submitted some national data, developed using a range of approaches, including the draft IPCC methodology

- country studies which ensure that methods are tested in a wide variety of national contexts

  The IPCC/OECD programme gives technical support to the greenhouse gas inventory components of the country study projects sponsored by UNEP, the Asian Development Bank, individual countries, etc. Objectives include development of national capacity to carry out emissions inventories and testing of the draft IPCC methods. Over thirty countries are currently working on country studies with support from various donors.

- technical workshops held in several locations including Western Europe, Africa, Latin America and Central Europe

- informal expert groups convened to recommend improvements on specific aspects of et methodology

The results of all the above activities have been considered in development of the current draft IPCC *Guidelines*. From this point, the work of the IPCC/OECD programme will continue on two parallel paths.

1 The draft *Guidelines* are being circulated world-wide, in six UN languages for an extensive by national and other technical experts. This process will allow for incorporation of any further improvements necessary for international acceptance and is scheduled to result in approved IPCC *Guidelines* by November, 1994 and publication by the end of 1994. The Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (INC/FCCC) is undertaking a simultaneous review of the draft *Guidelines* and will make recommendations regarding their use in connection with the UNFCCC.

2 Work is continuing on development of improved methods which can be proposed, review and approved by the IPCC over a longer time horizon. This will allow additions to the methodology where current gaps are recognized. For example, some gases (e.g., hydrofluorocarbons - HFCs, tetrafluoromethane - CF_4, sulphur hexafluoride - SF_6) not covered in the current draft will need to be added to the current methodology. Other gases (.e.g. nitrous oxide) need to be given a more complete treatment in future supplements to the current *Guidelines*. Finally, all of the currently proposed methodologies need to be reviewed in light of evolving scientific understanding and updated where appropriate.

Work on both these paths will continue until at least the end of 1994, and will continue to be supported by all of the mechanisms for international communication and consensus (e.g. expert groups, workshops, country studies) discussed above. The scope and timing of future updates to the IPCC *Guidelines* will be determined over the next several months based upon guidance from the IPCC and in consultation with the INC/IPCC.

CONTENTS

Annex 1
Managing uncertainties in the IPCC/OECD methodology

Annex 2
IPCC and CORINAIR Source Categories

Index

1 USING THE IPCC GUIDELINES

This document is one volume of the *IPCC Guidelines for National Greenhouse Gas Inventories*. The series consists of three books:

- THE GREENHOUSE GAS INVENTORY REPORTING INSTRUCTIONS
- THE GREENHOUSE GAS INVENTORY WORKBOOK
- THE GREENHOUSE GAS INVENTORY REFERENCE MANUAL

These books together provide the range of information needed to plan, carry out and report results of a national inventory using the IPCC system.

The *Reporting Instructions* (Volume 1) provide step-by-step directions for assembling, documenting and transmitting completed national inventory data consistently, regardless of the method used to produce the estimates. These instructions are intended for all users of the IPCC Guidelines and provide the primary means of ensuring that all reports are consistent and comparable.

The *Workbook* (Volume 2) contains suggestions about planning and getting started on a national inventory for participants who do not have a national inventory available already and are not experienced in producing such inventories. It also contains step-by-step instructions for calculating emissions of carbon dioxide (CO_2) and methane (CH_4) (also some other trace gases) from six major emission source categories. It is intended to help experts in as many countries as possible to start developing inventories and become active participants in the IPCC/OECD programme.

The *Reference Manual* (Volume 3) provides a compendium of information on methods for estimation of emissions for a broader range of greenhouse gases and a complete list of source types for each. It summarizes a range of possible methods for many source types. It also provides summaries of the scientific basis for the inventory methods recommended and gives extensive references to the technical literature. It is intended to help participants at all levels of experience to understand the processes which cause greenhouse gas emissions and the estimation methods used in compiling inventories.

The three books are designed to be used together and include these features:

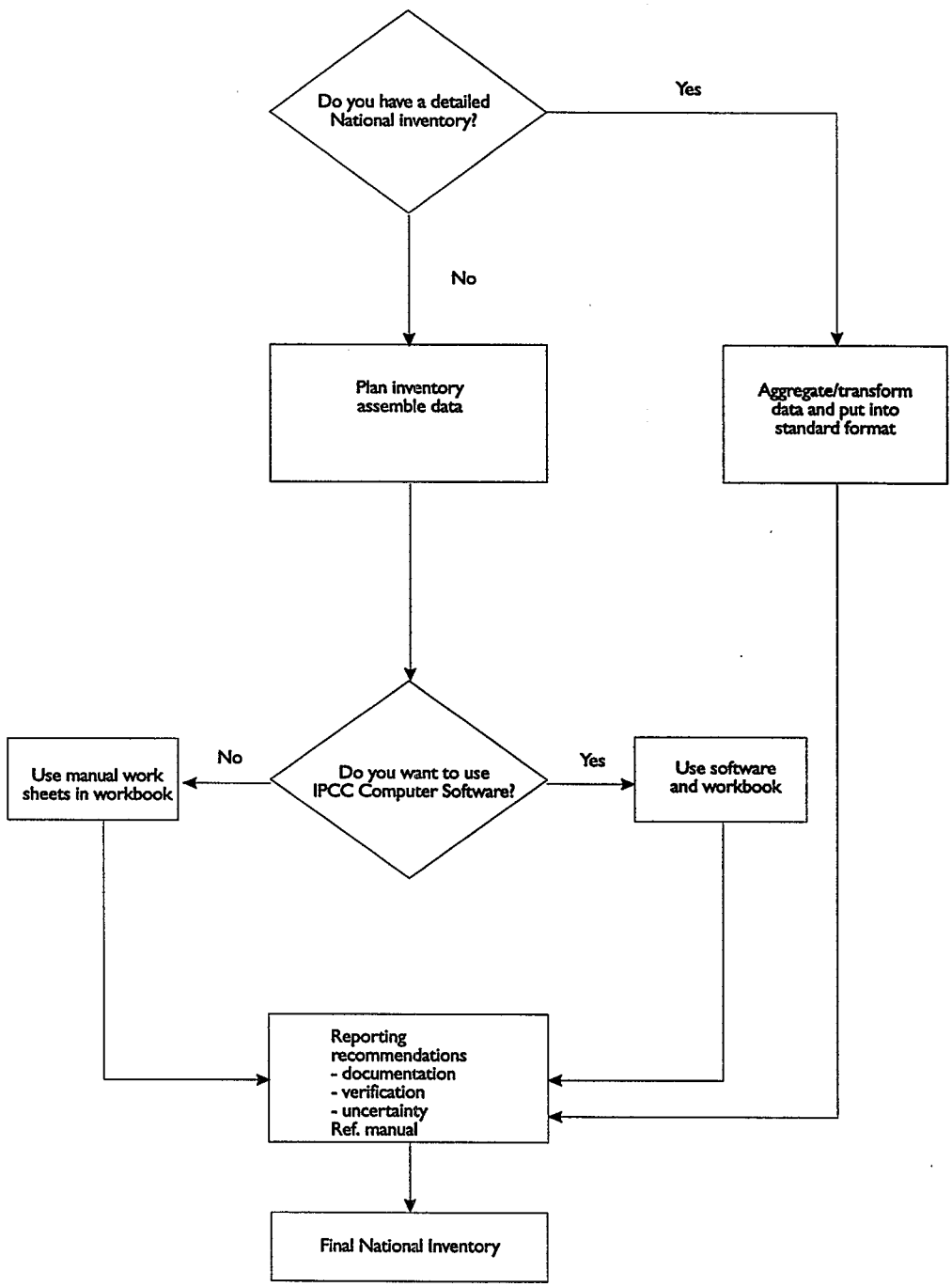
- all three volumes use an identical arrangement and numbering by source category for ease of cross reference
- all the books have a common index which allows you to follow up all references to a topic

  (The common index will be included in the final, approved version but not in the December 1993 review draft.)
- icons in the margin of each book indicate the source category
- colour coding on the page indicates source category.

  (Colour will be included in the final, approved version but not in the December 1993 review draft.)

Before you start...

This diagram explains the stages needed to make a national inventory which meets IPCC standards.



The stages are:

Question 1
Do you have a detailed national inventory?

Answer: Yes

If your country already has a complete national inventory, you should transform the data it contains into a form suitable for use by IPCC. This means transforming it into a standard format. In order to do this, use Volume 1 of the *IPCC Guidelines, Reporting Instructions.* This gives details of the way in which data should be reported and documented.

Answer: No

You should start to plan your inventory and assemble the data you will need to complete the Worksheets in this book. Refer to the *Getting Started* section of this *Workbook.*

Question 2
Do you want to use the IPCC computer software?

Answer: Yes

If you want to use the IPCC software, you will still follow the instructions are included in the *Workbook* to assemble the data you have collected into an inventory (see margin box). You will use the software instead of the printed worksheets to enter data.

Answer: No

If you do not use the IPCC software, use the *Workbook* and the Worksheets it contains to assemble the data you have collected into an inventory.

Finally...

Inventory data should be returned to IPCC in the form recommended in the *Reporting Instructions.* It is important that, where you have used a methodology other than the IPCC Default Methodology, it is properly documented. This will ensure that national inventories can be aggregated and compared in a systematic way in order to produce a coherent regional and global picture.

AVAILABILITY OF COMPUTER SOFTWARE

It is expected that IPCC computer software will be incorporated and distributed with the Final Approved IPCC Guidelines. Software is not included with this review draft version. Draft computer software is available for review and testing in English language only. This software includes the same simple default methods as presented in the *Workbook.* If you would like to receive a copy of the draft software, send a letter or fax to:

IPCC/OECD NATIONAL GHG INVENTORY PROGRAMME
Attn. Scott Lurding,
OECD, Environment Directorate,
2, rue André-Pascal
75775 PARIS CEDEX 16
FRANCE

FAX 33-1-4524-7876

General Notes on the Guidelines

1 The flow diagram above is intended as a simple schematic to illustrate the different types of users (working at different levels of inventory detail) and how they should be able to use the various volumes of the Guidelines. You should recognise that reality is more complex than this simplest explanatory chart. Many countries may have some parts of the inventory complete at a high level of detail but may only be getting started on other parts. It is quite likely that some users will need to do several iterations of the thinking process reflected in the diagram with regard to different parts of their inventory.

2 Throughout the Guidelines there is an intentional double-counting of carbon released from human activities. On one hand, CO_2 is calculated based on the assumption that all of the carbon in original fuel, biomass, soils etc. which oxidizes produces CO_2. For combustion sources,

however, methods are also provided to estimate portions of the original carbon which are released as CH_4 and CO. The primary reason for double counting this is that carbon is that carbon released as CH_4 or CO is eventually converted to CO_2 in the atmosphere. This occurs in less than 15 years, which is short relative to the 100+ years lifetime of CO_2 in the atmosphere. Therefore carbon emitted as CH_4 and CO can have two effects. First, in the form initially emitted, and, second, as part of long term CO_2 accumulation in the atmosphere. In order to have a very precise estimate of the actual emissions of carbon species for a given year (i.e. as input to a complex atmospheric model) you should subtract carbon in reported CH_4 and CO from CO_2 to get net annual CO_2 emissions.

3 Many of the categories of greenhouse gas emissions and removals can only be estimated with large ranges of uncertainty. Quite naturally, some national experts have developed methods which are designed to produce ranges of estimates rather than point estimates for highly uncertain categories.. The IPCC Guidelines, however, require that users provide a single point estimate for each gas and emissions/removal category. This is simply to make the task of compilation, comparison and evaluation of national reports manageable. Users are encouraged to provide uncertainty ranges or other statements of confidence or quality along with the point estimates. The procedures for reporting uncertainty information are discussed in the *Greenhouse Gas Inventory Reporting Instructions*.

1.1 Using the Reporting Instructions

If you are engaged in making a national inventory you should read the *Reporting Instructions*. Even if you already have made an inventory, or have started to do so, and are simply reporting existing data to IPCC, you should still read them. These instructions provide the primary means of ensuring that all reports are consistent, transparent and comparable. The rest of the chapters in this book are as follows:

Chapter 2: *Understanding the Common Reporting Framework* contains a listing of the source categories you should use when reporting sources and sinks. Each of the categories is further broken down into sub categories and given a definition if necessary. It also contains a listing of the basic fuel categories, and descriptions of the minumum data tables and summary tables used for reporting an inventory in IPCC format.

Chapter 3: *Reporting the National Inventory* contains step-by-step instructions for completing the Summary Worksheets which are used to bring together and make a record of the estimates which have been made in your own inventory or in using the Worksheets in the *Workbook*.

Annex 1: *Managing uncertainties in the IPCC/OECD methodology* provides guidance on the theoretical considerations involved in taking account of uncertainties in creating an inventory.

Annex 2: *IPCC and CORINAIR Source Categories* looks at the ways in which data assembled for the CORINAIR inventory conducted by the Commission of the European Communities and IPCC data relate to each other.

At the end of this book you will find the *Standard Tables* which you use to compile and pull together data from your national greenhouse gas inventory into IPCC reporting format.

Finally, having completed the Summary Tables, you can transfer the key data to the *Overview Table* which enables you to take a synoptic view of the results of the IPCC Greenhouse Gas Inventory.

1.2 Underlying Principles

The IPCC Guidelines allow for the use of a range of methods at different levels of detail, including methods which are appropriate to specific national conditions. Default methods and assumptions are povided for calculating the major sources and sinks of greenhouse gases at the minimum credible level of detail. More detailed methods are also discussed in the *Guidelines* and national experts are encouraged to work at a more detailed level wherever this is possible and likely to produce more accurate national estimates. In some cases, national experts may choose to use an entirely different methodology if they believe this better reflects their national situation. Common reporting instructions are therefore needed to accommodate inventories developed at different levels of detail and (potentially) different methods. The objective of the instructions is to establish minimum requirements for reporting data which allow for comparison and identification of differences in inventory construction (transparency). For this reason the IPCC recommends that all users of these *Guidelines* follow the

Reporting Instructions explicitly when they communicate their national inventories to the IPCC or other international bodies.

Several main principles underlie the IPCC *Reporting Instructions*:

- Common Reporting Framework

  The core of the reporting system is the establishment and use of a standard table format using common source/sink categories and common fuel categories. Common definitions of pollutants, units, and time intervals are necessary. Emission inventory results and all main assumptions (in summary form) should be transmitted using the standard tables, which can be adapted to the level of detail appropriate for the reporting country. Use of these reporting conventions will not only enhance the comparability of data, it will facilitate the speed with which inventories can be processed, made available in summary form, aggregated and reviewed internationally.

- Documentation Standards

  Documentation standards are necessary to ensure transparency of national inventories and hence to allow the inventory to be reviewed. By providing the necessary documentation, the comparability of national inventories can also be evaluated. The IPCC therefore recommends that along with GHG emission results countries submit a description of the method used, any definitions, activity data and emissions factors, as well as other relevant assumptions that cannot be summarised in table form. Enough data should be provided to allow a third party to reconstruct the inventory from national activity data and assumptions (the working definition of *transparency*). To limit the volume of data to be provided, documentation should focus on describing fully any differences in method and assumptions from the IPCC default method.

- Verification and Uncertainty Assessment

  To improve the quality of inventory data and to help assess the uncertainty surrounding estimates, IPCC Reporting Instructions recommend that inventories be verified through the use of a set of simple checks for completeness and accuracy of submissions. These checks can be performed centrally, although it is preferable for the countries to do as much as possible themselves. The recommended procedures include:

  - checking for arithmetic errors
  - assessing whether the estimate for each gas is complete
  - reviewing the validity of methods used to estimate each gas by main source activity (where they differ from default methods)
  - comparing emission estimates against results using the default method and default assumptions
  - checking activity data and emission factors against independently published estimates
  - simple cross-country comparisons of emission factors.

Finally, uncertainty assessment should also be conducted as far as possible and summarised for each major part of the inventory. Conceptual guidance for the assessment of the uncertainty of emission estimates are provided in Annex I *Managing Uncertainties*. Other approaches to describing uncertainty associated with point estimates of emissions and removals are also possible. Whether you use one of the approaches provided by the IPCC or another approach, you should include an uncertainty discussion in your inventory submission.

Each of these three principles is addressed in more detail in the following chapters.

2 UNDERSTANDING THE COMMON REPORTING FRAMEWORK

This chapter contains a listing of the source categories you should use when reporting sources and sinks. Each of the categories is further broken down into sub categories and given a definition if necessary.

The six categories are:

- *Energy*
- *Industrial Processes*
- *Solvent Use*
- *Agriculture*
- *Land Use Change and Forestry*
- *Waste*

The categories are reflected in the six main chapters in the Workbook *and the* Reference Manual.

The chapter also contains a list of the fuel categories you should use when reporting an inventory.

Finally, it also contains the principles underlying the standard tables for reporting national inventories. You can find the tables at the end of this book.

2.1 Source/sink categories

- Users of the IPCC *Guidelines* are requested to estimate and report all anthropogenic sources and sinks of greenhouse gases. The recommended list of source and sink categories is provided below. The proposed categories are designed to include all major source and sink activities for each pollutant for the majority of countries.
- The list of categories is intended to provide complete coverage of all possible anthropogenic sources and sinks of the main greenhouse gases. Some countries may find that it is not complete for their purposes and therefore choose to report an additional source or sink activity or additional gases. If adding new categories in the appropriate "other" category, the country should explain what precisely is included. The source and sink categories will be modified and updated as new information becomes available.
- Recognizing that IPCC needs to accommodate other existing inventory programmes, Annex 2 *IPCC & CORINAIR Source Categories* provides details of correspondences with CORINAIR, a programme developed by the Commission of European Communities for use in Europe.

	SOURCE/SINK CATEGORY	DEFINITION OF EMISSION SOURCE / SINK ACTIVITY
	TOTAL NATIONAL EMISSIONS & REMOVALS	Total emissions and removals, by greenhouse gas, of all categories listed below. (Sum of 1 through 6)
1	**ENERGY**	Total emission of all greenhouse gases from energy activities (fuel combustion as well as fuel production, transport, storage and distribution). Sum of categories 1 A and B.
2	**INDUSTRIAL PROCESSES**	Total emission from industrial process where greenhouse gases are a by-product of the various production processes. Emission are produced from the process and exclude greenhouse gases from the combustion of energy used during the production process (reported under 1 above). These emissions should be reported by ISIC activity, with separate detail of the particular production process noted where possible. Some of the identified source processes are identified below. Sum of categories 2 A, B, C, D, E & F.
3	**SOLVENT USE**	This category pertains mainly to NMVOC emission resulting from the use of solvents and other products containing volatile organic compounds.
4	**AGRICULTURE**	Describes all anthropogenic emissions from this sector. Fuel combustion emissions from the agricultural sector are covered in Energy module (1 A). Sum of all agriculture categories 4 A, B, C, D, E & F.
5	**LAND USE CHANGE & FORESTRY**	Total emission and removals from forest and land use change activities as described below. Sum of categories 5 A, B, C, D, E & F.
6	**WASTE**	Total emissions and removals from waste management Sum of categories 6 A, B & C.

1	**ENERGY**	Total emission of all greenhouse gasses from energy activities (fuel combustion as well as fuel production, transport, storage and distribution). Sum of categories 1 A and B.
1 A	FUEL COMBUSTION ACTIVITIES	Total emissions of all greenhouse gases from all fuel combustion activities as described further below. CO_2 emissions from combustion of biomass fuels are **not** included in totals fro the energy sector. They may not be net emissions if the biomass is sustainably produced. If biomass is harvested at an unsustainable rate (that is, faster than annual regrowth), net CO_2 emissions will show up as loss of biomass stocks in the *Land Use Change and Forestry* module. Other greenhouse gases from biomass fuel combustion are considered net emissions and are reported under *Energy*. Fuel combustion emissions should also include emissions from international bunker fuels, although it is recognised that a procedure for allocating these emissions may be agreed upon at some point in the future. (Sum of 1 A 1 to 1 A 8)
1 A 1	ENERGY AND TRANSFORMATION INDUSTRIES	Energy and transformation comprises emissions from fuels combusted by the energy producing industries and the conversion of primary forms of energy to secondary forms and further transformation (e.g. coking coal to coke, crude oil to petroleum products, heavy fuel oil to electricity).
1 A 1 a	Electricity Generation	Comprises emissions from all fuel use for electricity generation from public, private, and industrial generation units, except where it is combined heat and power.
	i *Public Electricity*	Publicly or privately owned power plants which supply primarily to public utility grids.
	ii *Industrial / Auto-generation*	Industry owned power plants for primarily own use of electricity, but electricity may be sold to the public grid.
1 A 1 b	Combined Heat and Power Generation (CHP)	Production of heat and power at a single facility; co-generation.
	i *Public*	Publicly owned facilities.
	ii *Auto*	Privately or industry owned facilities, for on-site use or resale to other consumers and to all kinds of heat distribution enterprises.
1 A 1 c	District Heating	Include all heat generation (except CHP) from public, private and industrial generation units for on-site use or resale to other consumers and to all kinds of heat generation enterprises.
1 A 1 d	Petroleum Refining	All combustion activities from the refining of petroleum products. Does not include evaporative emissions, which should be reported separately under 1 B below.
1 A 1 e	Solid Fuel Production	Combustion emissions arising from energy use during the production of coke, brown coal briquettes and patent fuel.
1 A 1 f	Other Energy Industries	Combustion emissions arising from the energy producing industries own (on-site) energy use. This includes the emissions from own-energy use in coal mining and oil and gas extraction, and electricity generation. This also includes combustion emission arising from the use of energy during the production of gaseous fuel (e.g. blast furnace gas, coke oven gas, gas works gas).

1 A 2		INDUSTRY (ISIC - 2ND REVISION)	Emissions from final consumption of fuels in industry; implies that fuel consumed for transformation and for own use of the energy producing industries is excluded. Emissions from the industry sector should be specified by sub-sectors that correspond to the International Standard Industrial Classification of All Economic Activities (ISIC). Energy used for transport by industry is not reported here but under Transport (1A 3 below). For each country, the largest fuel consuming industrial categories (ISIC) should be reported. A suggested list of categories is outlined below.
1 A 2	a	Iron and Steel (371)	
1 A 2	b	Non-Ferrous Metals (372)	
1 A 2	c	Chemicals (35)	
1 A 2	d	Pulp, paper and Print (34)	
1 A 2	e	Food processing, beverages and tobacco (31)	
1 A 2	f	Other (and / or non-specified)	The remaining emissions from fuel combustion in industry should be reported here. Please specify what is reported, as far as possible by ISIC categories.
1 A 3		TRANSPORT	Emissions from the combustion and evaporation of fuel for all transport activity, regardless of the sector, specified by sub-sectors as follows.
1 A 3	a	Air Transportation	Emissions from international civil aviation and domestic air transport (commercial, private, agricultural, etc.) Exclude airline use of fuel for road transport which is reported under 1 A 3 b *Road Transportation* (below).
		i *International Aviation (Bunkers)*	Portion of 1 A 3 a *Air Transportation* (above) that is international civil aviation only. For other inventory purposes, landing and take off (LTO) cycle emissions are often considered as domestic emissions. For the purpose of greenhouse gas emissions inventories, fuel used during landing and take off in international aviation are considered to be *Bunkers*.
		ii *Other*	Emission from air transport fuel combustion not considered to be bunkers.
1 A 3	b	Road Transportation	All combustion and evaporative emissions arising from fuel use in road vehicles, including agricultural highway use. Evaporative emissions are included here because they need to be estimated with the same activity data as necessary for combustion source emissions. Specify by sub-category where possible as shown below.
		i *Passenger cars*	Automobiles designated primarily for transport of persons and having a capacity of 12 persons or fewer. Gross vehicle weight rating of 3900 kg or less.
		Passenger cars with 3-way catalysts	Portion of passenger car emissions (above) from vehicles with 3-way catalysts (for NO_x control).
		Passenger cars without 3-way catalysts	Portion of passenger car emissions (above) from vehicles without 3-way catalysts (for NO_x control).
		ii *Light Duty Trucks*	Automobiles designated primarily transportation of cargo or which are equipped with special such as four-wheel drive for off-road operation with a gross vehicle weight of 3900 kg or less.

		Light duty trucks with 3-way catalysts	Portion of Light Duty Truck emission (above) from vehicles with 3-way catalysts (for NO_x control).
		Light duty trucks without 3-way catalysts	Portion of Light Duty Truck emission (above) from vehicles with 3-way catalysts (for NO_x control).
	iii	*Heavy Duty Trucks and Buses*	Any diesel or gasoline fuel vehicle rated at more than 3900 kg gross vehicle weight or designed to carry more than 11 passengers at a time.
	iv	*Motorcycles*	Any motor vehicle designed to travel with not more than three wheels in contact with the ground and weighing less than 680 kg.
1 A 3	c	Railways	Include emissions from both freight and passenger traffic routes.
1 A 3	d	Internal Navigation	All internal and coastal navigation, including small craft and fishing vessels not included under International Marine Bunkers.
1 A 3	e	International Marine (Bunkers)	Comprises emissions related to fuels burned by sea-going ships of all flags, including fishing vessels. These emissions should be included, for the time being, in national totals.
1 A 3	f	Other Transportation	All remaining transport activities excluding pipeline transportation and military transport (see 1 A 7 *Other*, below).
1 A 4		COMMERCIAL / INSTITUTIONAL	Emission from fuel combustion in commercial and institutional buildings. (All activities included in ISIC categories 4103, 42, 6, 719, 72, 8, and 91-96)
1 A 5		RESIDENTIAL	All emissions from fuel combustion in households.
1 A 6		AGRICULTURE / FORESTRY	Emissions from fuel combustion in agriculture or forestry. This includes traction vehicles, pump fuel use, grain drying, horticultural greenhouses and other agriculture or forestry related fuel use. (Activities included in ISIC categories 11, 12, 1302). Highway agricultural transportation is excluded.
1 A 7		OTHER	All remaining emissions from non-specified energy combustion except from wood and vegetal fuel use (see below). Include emissions from military fuel use.
1 A 8		TRADITIONAL BIOMASS BURNED FOR ENERGY (Unallocated to sub-sectors)	Emissions of CO_2, CH_4, CO, N_20, NO_x and NMVOC from the burning of wood, charcoal, bagasse and agricultural wastes, among other vegetal fuels. (CO_2 emissions should not be included in totals of national emissions form energy. If there is non-sustainable use of biomass fuels, emissions should be accounted for in loss of biomass tsocks and reported in the *Land Use Change and Forestry* module.)
1 B		FUGITIVE FUEL EMISSIONS	Total "fugitive" emissions of CO_2 and CH_4 from fuel production, transmission, storage and distribution (as noted below). (Sum of 1B 1 and 1B 2)
1 B 1		OIL AND NATURAL GAS	Total non-combustion or fugitive emissions -- primarily CH_4, but also CO_2 and NMVOC -- from oil, gas, and LNG production and processing, storage and distribution. These categories generically cover: fugitive emissions; equipment exhaust (non-combustion); upsets and mishaps. All are fugitive (evaporative) emissions with the exception of flaring. Flaring is the single exception where fugitive fuel combustion emissions are being accounted for.

1 B 1 a	Oil	Leaks, venting or flaring emissions from systems used to bring crude oil and raw gas streams from the wells to collection points on the production field. Because oil and gas are frequently produced simultaneously from the same geologic formation, it is not always possible to separate the emissions from oil from those of gas in the production phase.
i	*Oil Production*	Emissions from the production of oil only.
ii	*Oil Transportation*	Emissions from leaks and venting of crude oil in transport .
iii	*Oil Refining / Storage*	Emissions from the refining of oil and from storage in tanks afterwards.
iv	*Distribution of Oil Products*	Transport and handling of oil products, especially gasoline and diesel fuels can result in evaporative (fugitive) emissions, primarily of NMVOCs.
1 B 1 b	Gas	
i	*Production*	Emissions from the production of gas.
ii	*Processing*	Emissions from leaks during the processing of natural gas to produce products with specific characteristics.
iii	*Transmission*	Emissions from leaks in the high-pressure transmission lines which transport gas from production fields, processing plants, storage facilities, and other sources over long distances to distribution centres or large volume customers. Transmission lines, buried or above ground facilities and metering stations, maintenance facilities, and compressor stations, which support the system, and may emit greenhouse gases due to leakage
iv	*Gas Distribution Pipelines*	Emissions from leaks in the extensive networks of small diameter, low pressure pipelines used to distribute gas within cities or towns. This includes the *gate stations* where the pressure is reduced for entry into the local distribution system.
1 B 1 c	Oil and Gas Production	Emissions from the production of oil and associated gas (when the two cannot be separated).
1 B 2	COAL MINING	Total release of methane during coal mining and post-mining activities. The release of methane is caused by the release of pressure on the coal due to mining, and by the exposure of the surface of the coal. (Does not include fuel used during coal mining).
1 B 2 a	Underground Mines	Total emissions from underground mining and post mining activities.
i	*Underground Mines - Mining activities*	Emissions from underground mines, brought to the surface by ventilation systems. Systems which recover some of the emissions and use the gas as fuel, or flare it, should be accounted for here.
ii	*Underground Mines - Post - Mining activities*	Emissions from coal after extraction from the ground, during preparation, transportation, storage, or final crushing prior to combustion.
1 B 2 b	Surface Mines	Total emissions from surface mining and post mining activities.
i	*Surface Mines - Mining activities*	Emissions primarily from the exposed coal surfaces and coal rubble, but also emissions associated with the release of pressure on the coal.
ii	*Surface Mines - Post-Mining Activities*	Emissions from coal after extraction from the ground, during preparation, transportation, storage, or final crushing prior to combustion.

2	**INDUSTRIAL PROCESSES**	Total emissions of all greenhouse gases from industrial process where greenhouse gases are a by-product of the various production processes. Emission are produced from the process and exclude greenhouse gases from the combustion of energy used during the production process (reported under 1 above). These emissions should be reported by ISIC activity, with separate detail of the particular production process noted where possible. Some of the identified source processes are identified below.
2 A	IRON AND STEEL	[[Definitions to be supplied]]
2 B	NON-FERROUS METALS	
2 B 1	ALUMINIUM PRODUCTION	
2 B 2	OTHER	
2 C	INORGANIC CHEMICALS	
2 C 1	NITRIC ACID PRODUCTION	
2 C 2	FERTILIZER PRODUCTION	
2 C 3	OTHER	
2 D	ORGANIC CHEMICALS	
2 D 1	ADIPIC ACID	
2 D 2	OTHER	
2 E	NON-METALLIC MINERAL PRODUCTS	
2 E 1	CEMENT	
2 E 2	LIME	
2 E 3	OTHER	
2 F	OTHER (ISIC)	

3	**SOLVENT USE**	This category pertains mainly to NMVOC emission resulting from the use of solvents and other products containing volatile organic compounds.
	3 A PAINT APPLICATION	
	3 B DEGREASING & DRY CLEANING	
	3 C CHEMICAL PRODUCTS, MANUFACTURE & PROCESSING	
	3 D OTHER	

4	**AGRICULTURE**		Describes all anthropogenic emissions from this sector. Fuel combustion emissions from the agricultural sector are covered in Energy module (1 A). Sum of all agriculture categories (4 A, B, C, D, E, F).
	4 A	ENTERIC FERMENTATION	Methane production from herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream. Both ruminant (e.g. cattle, sheep) and non-ruminant animals (e.g. pigs, horses) produce CH_4, although ruminants are the largest source (per unit of feed intake).
		4 A 1 CATTLE	
		4 A 1 a Beef	
		4 A 1 b Dairy	
		4 A 2 GOATS	
		4 A 3 SHEEP	
		4 A 4 PIGS	
		4 A 5 HORSES / MULES / ASSES	
		4 A 6 BUFFALO	
		4 A 7 CAMELS AND LLAMAS	
		4 A 8 OTHER	Please specify
	4 B	ANIMAL WASTES	Methane is produced from the decomposition of manure under anaerobic conditions. These conditions often occur when large numbers of animals are managed in a confined area (e.g. dairy farms, beef feedlots, and swine and poultry farms), where manure is typically stored in large piles or disposed of in lagoons.
		4 A 1 CATTLE	
		4 A 1 a Beef	
		4 A 1 b Dairy	
		4 A 2 GOATS	
		4 A 3 SHEEP	
		4 A 4 PIGS	
		4 A 5 HORSES / MULES / ASSES	
		4 A 6 BUFFALO	
		4 A 7 CAMELS & LLAMAS	
		4 A 8 POULTRY	
		4 A 9 OTHER	

4 C	RICE CULTIVATION	Methane production from the anaerobic decomposition of organic material in flooded rice fields produces methane, which escapes to the atmosphere by ebullition (bubbling up) through the water column, diffusion across the water/air interface, and transport through the rice plants. It is suggested that these emissions be reported by the irrigation regime sub-categories below. Any N_2O emissions from the use of nitrogen based fertilizers in rice cultivation should be reported under 4 D *Agricultural Soils*.
	4 C 1 FLOODED REGIME	Methane from fields inundated with water for the duration of the growing season.
	4 C 2 INTERMITTENT REGIME	Methane from fields under water only intermittently, either when water is not readily available (managed irrigation), or when rains do not maintain flooded conditions throughout the growing season.
	4 C 3 OTHER	Please specify.
4 D	AGRICULTURAL SOILS Sub-categories may be added here as the method evolves.	Sinks and sources of CH_4 and N_2O from agricultural soils. These sources may relate to quantity of nitrogenous organic fertilizer use, irrigation practices, and climatic variables (e.g. soil temperature and humidity). Any N_2O emissions from the use of nitrogen-based fertilizers in rice cultivation should be reported here.
4 E	AGRICULTURAL WASTE BURNING	Emission of non-CO_2 greenhouse gases from burning of (in the field) crop residue and other agricultural wastes on site. These include woody crop residues (e.g. coconut shells, jute sticks, etc.); cereal residues (e.g. rice and wheat straw, maize stalks, etc.); green crop residues (e.g. groundnut straw, soybean tops, etc.). The burning of agricultural waste for energy is excluded here but included under fuel combustion activities in section 1 A 8. At this time, CO_2 from vegetal or biomass burning is noted for information but is not included in the inventory total, since it is assumed that a roughly equivalent amount of CO_2 is removed by regrowth of the next crop.
	4 E 1 CEREALS	Emissions from the on-site burning of residue from cereal crops harvested for dry grain, including but not limited to wheat, barley, maize, oats, rye, rice, millet and sorghum.
	4 E 2 PULSE	Emissions from the on-site burning of residue from pulse crops harvested for dry grain, including but not limited to pea, bean and soya.
	4 E 3 TUBER AND ROOT	Emissions from the on-site burning of residue from tuber and root crops, including but not limited to potatoes, feedbeet, sugarbeet, girasol (Jerusalem artichoke) and peanut.
	4 E 4 SUGAR CANE	Emissions from the on-site burning of sugar cane crop residue.
	4 E 5 OTHER	Emissions from the on-site burning of residue from crops not included above.
4 F	SAVANNA BURNING	Emissions of CH_4, CO, N_2O, and NO_x from the burning of savannas - tropical and subtropical formations with continuous grass cover, occasionally interrupted by trees and shrubs, which exist in Africa, Latin America, Asia, and Australia -- to control the growth of vegetation, to get rid of weeds and pests, to promote the nutrient cycle, and to encourage the growth of new grass for animal grazing. CO_2 from savanna burning is noted for information but is not included in the inventory total since it is assumed that equvalent amount of CO_2 is removed by regrowing vegetation over the next year.
4G	OTHER	Describe each emission source/sink in detail.

5	**LAND USE CHANGE & FORESTRY**		Total emissions and removals from forest and land use change activities as described below. (Sum of 5 A, B, C, D, E, F)
	5 A	FOREST CLEARING Time period is an important element in estimating emissions from many of these categories. For example, the IPCC default method recommends time periods of 10 years for biomass decay and 20 years for soil carbon loss estimates.	Emissions and removals of CO_2, CH_4, CO, N_2O, and NO_x from the burning and decay of biomass and from the disturbance of soil due to cultivation or tilling of land, where these activities are associated with the conversion of forest by clearing to permanent cropland or pasture.
		5 A 1 TROPICAL	Emissions from both closed and open tropical forests as defined below.
		5 A 1 a Closed Forest	A closed forest is dense forest with closed canopy through which sunlight does not penetrate sufficiently for grasses to grow on the forest floor. These forests contain a significantly greater amount of biomass per hectare than open forests.
		5 A 1 b Open Forest	Open forests are less dense than closed forests, do not have a closed canopy and have grasses growing on the forest floor. These forests contain less biomass per hectare than closed forests.
		5 A 2 TEMPERATE	Emissions from primary and secondary deciduous and evergreen forests.
		5 A 3 BOREAL	Emissions from primary and secondary boreal forests.
	5 B	CONVERSION OF GRASSLANDS TO CULTIVATED LANDS	Emissions of CO_2 from the conversion of grasslands to cultivated lands due to the disturbance of the soil and resultant oxidation of the soil carbon.
	5 C	LOGGING / MANAGED FORESTS	CO_2 from the decay of products of logging, e.g. paper, lumber for construction, etc., and from the decay of biomass damaged or killed in the logging process. These emissions are at least partially countered by the regrowth of biomass. Afforestation.is included in this category.
		5 C 1 TROPICAL	Emissions and removals from the logging/regrowth of closed broadleaf, closed coniferous, and open forests, as well as of other tropical forests.
		5 C 2 TEMPERATE	Emissions and removals from the logging/regrowth of temperate forests, including: commercial evergreen, commercial deciduous and other non-commercial forests.
		5 C 3 BOREAL	Emissions and removals from the logging/regrowth of boreal forests.
	5 D	ABANDONMENT OF MANAGED LANDS	Emissions and removals (sources and sinks) of CO_2 from the abandonment of formerly managed lands (e.g. croplands and pastures). The categories below are determined by the type of biomass which regrows on the abandoned land.
		5 D 1 FORESTS	Net accumulation (sink) of carbon on abandoned land regrown to tropical, temperate, or boreal forests.
		5 D 1 a Tropical	
		5 D 1 b Temperate	
		5 D 1 c Boreal	
		5 D 2 GRASSLANDS	Net accumulation (sink) on abandoned land regrown to grasslands.
		5 D 3 OTHER	Emissions from abandoned land regrown to any biomass types other than forests and grasslands.

6	**WASTES**	Total emission from waste management described below. (Sum of 6 A, B, C)
6 A	LANDFILLS	Methane is produced from anaerobic decomposition of organic matter in landfills by bacteria. CO_2 is also produced but to the extent that it is organic in origin it is in a closed cycle and therefore not accounted for in inventory totals.
6 B	WASTEWATER	Methane is produced from anaerobic decomposition of organic matter by bacteria in sewage facilities during treatment and disposal.
6 C	OTHER	Release of greenhouse gases from any other public service activity (e.g. from non-organic waste incineration, when it is not part of waste to energy schemes).

2.2 Fuel Categories

Common terms and definitions of fuels are necessary for countries to describe emissions from fuel combustion activities consistently. A list of fuel types is provided below. Definitions for each of these fuels are given in the Glossary of the *Greenhouse Gas Emissions Workbook*. The list is organised into five major fuel types: solid, liquid, gas, biomass and other. You are asked to separate these emission estimates into these major fuel categories when completing the Minimum Data Tables. More detailed inventory estimates and supporting data are instructive and your country is invited to provide such information if it is available.

BASIC FUELS HIERARCHY
(Energy Combustion Only)

MAIN FOSSIL FUEL CATEGORIES
(Included in totals of greenhouse gases Sources)

CATEGORY	*SUB-CATEGORY*	
LIQUID (Crude oil and petroleum products)	CRUDE OIL	
	N. GAS LIQUIDS	
	GASOLINE	Motor Gasoline
		Aviation Gasoline
		Jet Gasoline
	KEROSENE (OTHER THAN JET FUEL)	
	JET FUEL	
	GAS OIL/DIESEL OIL	
	RESIDUAL FUEL OIL	
	LIQUIFIED PETROLEUM GAS	
	NAPHTHA	
	PETROLEUM COKE	
	REFINERY GAS	
	REFINERY FEEDSTOCK	
	OTHER OIL	Refinery Gas
		Paraffin Waxes
		White Spirit
		Other

CATEGORY	*SUB-CATEGORY*	
SOLID (Coal and coal products)	COKING COAL	
	STEAM COAL	
	LIGNITE	
	SUB-BITUMINOUS COAL	
	PEAT	
	COKE	Coke Oven Coke
		Gas Coke
	BKB/PATENT FUEL	Patent Fuel
		Brown Coal Briquettes
	COAL-DERIVED GASES	Gas Works Gas
		Coke Oven Gas
		Blast Furnace Gas
GAS (Natural gas and derived products)	NATURAL GAS	
	OTHER GAS	
OTHER FUELS	MUNICIPAL WASTE (GARBAGE)	
	INDUSTRIAL WASTE	
	SULPHUR LIES (BLACK LIQUOR)	
	OTHER	
BIOMASS (Excluded from totals of greenhouse gases Sources, but useful to report)	SOLID	Wood
		Wood Waste
		Charcoal
		Vegetal Fuels
		Vegetal Waste
	LIQUID	Bio-alcohol
	OTHER	
TOTAL (Primary fossil fuel supply, including bunkers)		

2.3 Reporting major sources at differing levels of detail

The Minimum Data Tables at the end of this book are intended to allow reporting at different levels of detail. There is at least one Minimum Data Table for each emission source category. The principles underlying the Minimum Data Tables are summarised below.

- Energy

  Emissions and main assumptions from fuel combustion and production should be reported for a minimum of the five main categories fossil fuels (liquid, soild, gas, biomass, other) and preferably by sector for both transformation and end-use activities.

- Industry and Solvents

  Emission and main assumptions should be described for each individual process that releases greenhouse gases.

- Agriculture

  All six activities should be reported at a minimum (enteric fermentation, animal waste, rice cultivation, agricultural soils, and agricultural waste and savanna burning) with sub-activities (e.g. animal type) where relevant. A maximum level of detail is requested for the reporting of emissions from rice and agricultural soils, for the purpose of methods development. Emissions and main assumptions (in aggregate form) should be provided.

- Land use change and forestry

  Each of the four main activities (forest clearing, conversion of grasslands, managed forests, abandonment of managed lands) should be reported with as much geographic and species detail as is used in the original calculations. This detail is specifically requested to assist in the improvement of default estimation methods. Emissions and main assumptions should be reported.

- Waste

  Main activities of landfills, wastewater treatment and incineration should be included at a minimum. Additional detail is useful, for the purpose of methods development.

2.4 Standard summary tables

- As far as possible, countries should use the standard summary tables outlined in this document. The Overview Table (Table 7) is to be used to report the coverage and quality of final emissions estimates. The notation shown in the key which is attached should be used to show where countries believe the identified source is zero (0). Where countries have opted not to estimate (NE) a particular source of each greenhouse gas, this should be shown. Data problems may limit the possibility of separating out each source individually; in this case it is included elsewhere (IE) and this should also be indicated in the table. Finally, countries may report a particular category as not occurring (NO) in their country.
- Summary tables should be altered to reflect different levels of detail, for example for countries that lack sub-sector detail in one or more of the main sectoral categories. The standard notation and terminology shown in the complete list of source categories (above) should always be used.
- Additional gases can be added as thought necessary by the reporting country. Copies of the Summary and short Summary Tables (6A and 6B) with blank column headings are included to allow users to fill in additional relevant gases. Several gases such as Polyflourinated Compounds (SF_6, C_2F_6 and CF_4), sulphur oxides and HFCs are known to be relevant to climate change and may be included in future versions of the Guidelines. However, countries which wish to report these substances for completeness may do so using copies of the Summary Tables.
- The Overview Table (7A) should be used by countries to summarise their own assessment of completeness and quality (high, medium or low) of major source/sink inventory estimates. It gives a brief overview of the categories which have been taken into account in the emission inventory, as well as of the level of documentation and disaggregation of the categories. The Disaggregation Key (7B) which follows the Overview Table gives a detailed explanation of the key used for the level of disaggregation for an inventory.
- In all tables used by countries to summarise their inventory data, footnotes should be added to indicate if emission estimates are incomplete, or representative of only a part of the total activity, for any particular source or sink category. In this way countries are expected to report on the completeness of each individual emission estimate.

3 REPORTING THE NATIONAL INVENTORY

This chapter contains step by step instructions for reporting a national greenhouse gas inventory..

How To Report Your Inventory

At the end of these reporting instructions you should have

- filled in the Minimum Data Tables
- filled in the Summary and Overview Tables
- prepared an Inventory Report which contains the required numerical and text documentation (see margin box)

Do Step 1 if you have an existing inventory and would like to report it to the IPCC. If you are working from a completed CORINAIR inventory see Annex 2. If you are using the *Workbook* methods and you now want to report your inventory, go directly to Step 2 to begin to fill out the Minimum Data tables.

DOCUMENTATION STANDARDS

- National inventory reports should provide minimum information to enable the results to be reconstructed, and to justify the choice of methodology and data used. This means, for example, that to the extent possible, activity data should be provided at the level of detail at which the emissions are estimated.
- Documentation should contain enough information to explain differences between national methods and data, and the IPCC default methods and assumptions. Reasons for the differences should be explained and sources of emission factors and other national data should also be clearly cited. Minimum requirements include: emission factors, activity data, and a list of references documenting any differences from IPCC recommendations.
- Measurement studies containing new values should be referenced, and made available upon request. It is preferable that new emission factor data be contained in published sources.
- Documentation should be kept for future years (by the country and by the IPCC) and countries are encouraged to publish the documentation of their inventories. This extensive record keeping will facilitate the recalculation of historical inventory estimates when changes in national methods or assumptions occur.

STEP 1 REVIEW THE IPCC COMMON REPORTING FRAMEWORK

Pollutants

You are requested to provide a complete inventory for 1990. This should include all anthropogenic emission sources and removals by sink of greenhouse gases and ozone precursors, except those covered by the Montreal Protocol.

The *IPCC Greenhouse Gas Inventory Workbook* describes how to estimate greenhouse gases for all anthropogenic sources and sinks of CO_2 and CH_4. The *IPCC Greenhouse Gas Inventory Reference Manual* also provides background information on estimation for N_2O and also tropospheric ozone precursors, i.e. CO, NO_x and NMVOC. The reporting instructions provide detailed instructions for these six gases.

You also have the option to add other greenhouse gases or precursors to your inventory report. If you add other gases you should use the IPCC source category structure as far as possible. If you add or change the definitions of any categories to report these additional gases, you should clearly explain these changes. Use the spare copies of Tables 6A & 6B with blank column headings to report these emissions. Countries which wish to report Montreal Protocol substances for completeness may do so using this procedure.

Reporting CO_2, CH_4, CO from fuel combustion

If you have an inventory for fuel combustion that includes more than one greenhouse gas which contains carbon (e.g. CO_2, CH_4, CO), you are requested to develop the CO_2 inventory by assuming that all carbon oxidised during fuel combustion is released as CO_2. You will indeed be "double-counting" the carbon that may be released as CH_4 or as CO. However the difference to the CO_2 total will be quite small and your inventory will be certain to include all carbon that is contained in a fuel. At the same time, full estimates of CH_4 and CO should be provided.

Standard units (pollutants, activity data and emission factors)

Emission estimates should be reported in total mass of CO_2, CH_4, N_2O, NO_x and CO. NMVOC should be reported in estimated total mass of the sum of individual compounds. All estimates should be reported in gigagrams (Gg) of the pollutant.

Preferred units for activity data, emission factors and other data are indicated in each of the standard tables which we ask you to fill in (see below).

Source/sink categories

Your inventory data should conform to the IPCC source/sink category structure as far as possible. The minimum level of detail requested for reporting is summarised in the Minimum Data Tables at the end of this book.

Compare the IPCC source/sink categories (Table 3) to the categories already used in your national inventory. Where there are differences it should be possible to allocate (a larger category) among appropriate smaller IPCC categories. Alternatively, if there is no way to allocate the category, you could report several of your smaller categories at a higher level of aggregation in the IPCC structure. Sink categories potentially occur in 5 C and 5 D of the inventory source and sink category structure.

If your inventory cannot be re-structured to fit the IPCC model, or if you must show estimates under an "other" category, you should:

- explain precisely where there are differences and what they are, and
- explain precisely what is included in "other" categories.

Time Periods

The current request for inventories is for the calendar year 1990. In some of the agricultural and land use/forestry categories, it may be desirable to estimate emissions for an average year over a several year period. The Workbook methods describe default recommendations which are summarised in the table below.

TABLE 3-1
TIME PERIODS

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	TEMPORAL PERIODS
1 Energy	
A Fuel Combustion Activities	Yearly figures
B Fugitive Fuel Emission	Yearly figures
2 Industry	Yearly figures
3 Solvents	Yearly figures
4 Agriculture	
A Enteric Fermentation	Yearly figures
B Animal Wastes	Yearly figures
C Rice cultivation	Three-year average
D Agricultural Soils	Three-year average
E Agricultural Waste Burning	Three-year average
F Savannah Burning	Three-year average
5 Land Use Change/Forestry	
A Forest Clearing	
- Immediate release from on-site burning	Three-year average
- Delayed release from decay	Average figures previous 10 years
- Long-term loss of soil carbon	Average figures previous 25 years
B Conversion of grasslands to cultivated lands	Three-year average
C Logging/Managed forests	Three-year average
D Abandonment of managed lands	1 Cumulative figures over previous 20 years 2 Total figures more than 20 years ago
6 Waste	Yearly figures

Review these assumptions and be prepared to:

- explain if, and precisely where, your inventory has different time period assumptions, and
- explain the reasoning why the averaging periods were chosen.

STEP 2 FILL IN THE MINIMUM DATA TABLES

You should fill in a table for each of the main source/sink categories that you have included in your inventory. If differences in data structure prevent you from providing specifically the information requested in each table, please provide data that match as closely as possible the request and explain clearly the differences. If you have estimated ranges of uncertainty for emission or supporting data, read Task c of this step before beginning.

Task a: Fill in the activity data and emission estimates columns.

EITHER: transfer data from worksheets

OR convert your existing inventory data into Minimum Data table format. As explained above under Step 1, this may require transforming your data to better fit the IPCC source/sink category structure.

CONVERTING CORINAIR INVENTORIES

CORINAIR is one type of detailed inventory system.. Guidance for converting a CORINAIR inventory into an IPCC inventory are given in Annex 2.

Task b: Fill in aggregate emissions factor columns for each table.

CALCULATE:

an aggregate emission factor for each source/sink category and subcategory.

Task c: Report uncertainty ranges

An approach to estimating the uncertainty associated with point emission estimates and emission factors is described in Annex 1.

If you have ranges of uncertainty for point emission estimates by source/sink of greenhouse gas, as well as for emission factors or activity data, you can report the ranges by using the same Minimum Data tables. These tables should be in addition to the point estimates that are requested in Task (a) of this Step (above).

If you have ranges that you would like to report, please:

- make copies of the Minimum Data tables
- mark them clearly with a heading "UNCERTAINTY RANGES"
- for each data point fill in the ranges if available.

STEP 3 VERIFICATION

Task a: Checking results

Countries are encouraged to carry out the following forms of verification and summarise results (in text form) in the inventory report:

- checks for arithmetic errors
- checks of country estimates against independently published estimates
- checks of national activity data with international statistics (default data)

Further verification checks that may be done centrally, or assisted centrally are:

- cross-country comparisons of estimates through use of a single set of source categories
- cross-country comparisons of emission factors

A more detailed sample set of questions for countries to consider in reviewing the quality of their own inventories is provided below.

Verification

In completing the inventory you should also make a report in which you summarise the verification procedures you have used. This report should include an overall assessment of the quality and completeness of each of the main source and sink estimates for each greenhouse gas. Here are the sorts of question you should consider in your inventory.

Method

- Is the approach well documented and reproducible?
- Have results been checked against other methods of estimation? or with measurement data?
- Are measurement data part of the estimate? If so, has the source activity been summarised in part (for the remaining non-measured part of the activity) and has it been summarised in total? Have you verified that double counting of source/sink activities is not taking place?

Emission estimates

- Have any estimates been compared with measured emission and concentration data?
- In some instances it is possible to cross-check emission estimates against roughly comparable statistics (e.g. for NMVOC, solvent production + imports-exports should equal total of applications; similarly for CO_2 from energy, CEEM provides an important point of comparison for source-sector (bottom-up) derived estimates.) Have these checks been done and if so how do these data compare?
- Have results been compared for reasonableness with outside or independently published estimates? This could include comparison to estimates from a country of similar size or economic profile.

Activity data assumptions

- Does the rate of activity reported cross-check reasonably well with other sources of information on this activity, e.g. with international statistics?
- Do units match emission factors reported?

Emission factors

- Do emission factors represent operating cycles or conditions from the region reporting?
- Are the sources of emission factors well documented? Are the conventions the same as those found in the activity data e.g. LHV or HHV?
- Have emission factors been compared with other sources (taking into account technologies, maintenance, operating cycles, or other inventory conditions that may influence emissions factors)?

If you have already performed some cross-country verification, please describe what you did and what you found.

Task b: Assessing quality

Prepare a brief self-assessment of the quality of the resulting inventory and of the verification that has been performed. A simplified format for reporting on the quality and completeness of the inventory is suggested in the Overview Table and Disaggregation Key (Tables 7A and 7B) at the end of this book. This should be included with the other tables in the Inventory Report.

STEP 4 COMPLETE MASTER SUMMARY TABLE

Task a: Complete the Master Summary Table (Table 6A or 6B)

This is done by transferring data from the Minimum Data Tables, Emission Estimate columns. If you have estimated ranges of uncertainty, read Task b before completing this step.

Task b: Report Uncertainty Ranges.

If you have ranges that you would like to report, please:

- make copies of the Master Summary Table
- mark it clearly with a heading "UNCERTAINTY RANGES," and
- for each data point fill in the ranges available, by transferring from the appropriate column of the Minimum Data Tables (Step 2, Task d above).

Task c: Documentation of differences in definitions or structure

If your data do not conform to the IPCC source/sink category structure, you should clearly footnote on this table any differences and provide an explanation of the differences in the documentation note of the inventory.

STEP 5 DOCUMENTATION

Prepare text to accompany the inventory which:

- describes any differences from IPCC source/sink category structure
- describes any differences from IPCC default methods for the estimation of CO_2 and CH_4
- clearly describes the estimation methods, as well as major assumptions that may not have been captured in the Minimum Data Tables, for all greenhouse gases contained in the inventory
- provides complete references to all data sources used to construct the inventory
- highlights any new or interesting data sources, references or research findings used to construct the inventory.

You are also invited to report any difficulties you faced in developing and reporting the inventory (e.g. lack of data, lack of resources etc.)

STEP 6 ASSEMBING AND TRANSMITTING THE INVENTORY

Assemble all elements of the National Inventory, including:

- Minimum Data Tables
- Summary Tables
- Overview Table
- Uncertainty Estimates (if available)
- Written documentation

DOCUMENTATION STANDARDS

- National inventory reports should provide minimum information to enable the results to be reconstructed, and to justify the choice of methodology and data used. This means, for example, that to the extent possible, activity data should be provided at the level of detail at which the emissions are estimated.
- Documentation should contain enough information to explain differences between national methods and data, and the IPCC default methods and assumptions. Reasons for the differences should be explained and sources of emission factors and other national data should also be clearly cited. Minimum requirements include: emission factors, activity data, and a list of references documenting any differences from IPCC recommendations.
- Measurement studies containing new values should be referenced, and made available upon request. It is preferable that new emission factor data be contained in published sources.
- Documentation should be kept for future years (by the country and by the IPCC) and countries are encouraged to publish the documentation of their inventories. This extensive record keeping will facilitate the recalculation of historical inventory estimates when changes in national methods or assumptions occur.

- Computer diskette containing data (if applicable)
- Any supporting documents

Mail the complete package to:

IPCC/WGI Technical Support Unit

Meteorological Office

Hadley Climate Centre

London Road

Bracknell, RG12 2SY

United Kingdom

Title of Inventory	
Contact Name	
Title	
Organization	
Address	
Phone	
Fax	
E-Mail	
Is uncertainty addressed?	
Related documents filed with IPCC	

MINIMUM DATA TABLES 1 ENERGY

1A Energy Fuel Combustion Activities (Part 1)

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
Sector Specific Data (units)	A Apparent Consumption (PJ)	B (Gg of full mass of pollutant)						C (kg (pollutant)/GJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A Fuel Combustion Activities													
Oil													
Gas													
Coal													
Biomass													
Other (specify)													
1 A 1 Energy and Transformation Activities													
Oil													
Gas													
Coal													
Biomass													
Other (specify)													
1 A 2 Industry (ISIC)													
Oil													
Gas													
Coal													
Biomass													
Other (specify)													

1A Energy Fuel Combustion Activities (Part 2)

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
Sector Specific Data (units)	A Apparent Consumption (PJ)	B (Gg of full mass of pollutant)						C (kg (pollutant)/GJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 3 Transport													
Oil													
Gas													
Coal													
Biomass													
Other (specify)													
1 A 4 Commercial/Institutional													
Oil													
Gas													
Coal													
Biomass													
Other (specify)													
1 A 5 Residential													
Oil													
Gas													
Coal													
Biomass													
Other (specify)													

1A Energy Fuel Combustion Activities (Part 3)

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES						AGGREGATE EMISSION FACTORS					
Sector Specific Data (units)	A Apparent Consumption (PJ)	B (Gg of full mass of pollutant)						C (kg (pollutant)/GJ)					
								C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1 A 6 Agriculture/Forestry													
Oil													
Gas													
Coal													
Biomass													
Other (specify)													
1 A 7 Other													
Oil													
Gas													
Coal													
Biomass													
Other (specify)													

1 A 8 Optional Reporting Format for Traditional Biomass Burned for Energy

	ACTIVITY DATA	EMISSION ESTIMATES					AGGREGATE EMISSIONS FACTORS				
Sector Specific Data	A Apparent Consumption (kt dm)	B (Gg)					C (t /t dm)				
							C=B/A				
		CH_4	N_2O	NO_x	CO	NM VOC	CH_4	N_2O	NO_x	CO	NM VOC
Fuelwood											
Charcoal Production											
Charcoal Consumption											
Dung											
Agricultural residues											
Bagasse											
Other (specify)											

1 B 1 Fugitive Fuel Emissions (Oil and Gas)

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES		AGGREGATE EMISSIONS FACTORS	
	Fuel Quantity (PJ)	CH_4 (Gg)	CO_2 (Gg)	CH_4 (kg/Gg)	CO_2 (kg/Gg)
1 B 1 a Crude Oil (Total)					
i Production					
ii Transported					
iii Refined					
1 B 1 b Natural Gas (Total)					
i Production					
ii Consumption					
1 B 1 c Oil/Gas Joint Production					

1 B 2 Fugitive Fuel Emissions (Coal Mining)

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSIONS ESTIMATES			AGGREGATE EMISSIONS FACTORS	
Coal Mining	Production (mt)	Total CH_4 (Gg CH_4)	Production (Gg CH_4)	Post Processing (Gg CH_4)	Production (kg CH_4 / t)	Post Processing (kg CH_4 / t)
1 B 2 a Surface						
b Underground						

1 B 3 Fugitive Fuel Emissions (Distribution of Oil Products)

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES	AGGREGATE EMISSION FACTORS
Consumption of Oil Products (specify)	Fuel Quantity (PJ)	NMVOC (Gg)	NMVOC (kg/Gg)

Minimum Data Tables 2 Industrial Processes

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES (shaded boxes not applicable)						AGGREGATE EMISSION FACTORS (shaded boxes not applicable)					
Sector Specific Data (units)	A Production quantity (t)	B Full Mass of Pollutant (Gg)						C Pollutant per tonne of product (kg or t / t)					
								C=B/A					
		CO	CO_2	CH_4	N_2O	NO_x	NMVOC	CO	CO_2	CH_4	N_2O	NO_x	NMVOC
2 INDUSTRIAL PROCESSES													
A Iron and Steel													
B Non-Ferrous Metals													
Aluminium Production													
Other													
C Inorganic Chemicals (excepting solvent use)													
Nitric Acid													
Fertilizer Production													
Other													
D Organic Chemicals													
Adipic Acid													
Other													
E Non-Metallic Mineral Products													
Cement													
Lime													
Other													
F Other (ISIC)													

MINIMUM DATA TABLES 3 SOLVENTS

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES	AGGREGATE EMISSION FACTORS
Sector Specific Data (units)	A Quantity Consumed (kt)	B Full Mass of Pollutant (Gg)	C Pollutant per tonne of Product (t / t)
			C=B/A
		NMVOC	NMVOC
3 SOLVENT USE			
A Paint Application			
B Degreasing and Dry Cleaning			
C Chemical Products Manufacture / Processing			
D Other			

MINIMUM DATA TABLES 4 AGRICULTURE

4 A & B Enteric Fermentation & Animal Wastes

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES		AGGREGATE EMISSION FACTOR	
	A	B		C	
Sector Specific Data (units)	Number of Animals	Enteric Fermentation	Animal Wastes	Enteric Fermentation	Animal Wastes
	(1000)	(Gg CH_4)		(kg CH4 per animal)	
4 AGRICULTURE				C=(B/A) x 1000	
A & B Enteric Fermentation & Wastes					
1 Cattle					
i Beef					
ii Dairy					
2. Goats					
3 Sheep					
4 Pigs					
5 Horses/Mules/Asses					
6 Buffalo					
7 Camels And Llamas					
8 Other					

4 C Rice Cultivation

SOURCE AND SINK CATEGORIES	ACTIVITY DATA		EMISSION ESTIMATES	AGGREGATE EMISSIONS FACTOR
Sector Specific Data (units)	A Area cultivated in hectares (Mha)	B Hectare-Days of Cultivation (Mha-days)	C Emissions of CH_4 (Gg CH_4)	D CH_4/N_2O Average Emission Factor (kg CH_4 per ha-day)
				D=C/B
C Rice Cultivation				
1 Flooded Regime				
2. Intermittent Regime				
3 Dry Regime				

4 E Agricultural Soils

SOURCE AND SINK CATEGORIES	ACTIVITY DATA		EMISSION ESTIMATES	AGGREGATE EMISSIONS FACTOR(S)	
Sector Specific Data	A Amount of nitrogen applied in fertilizer and manure (t N)	B Area Cultivated (ha)	C ($Gg\ N_2O$)	D Nitrogen dioxide released per tonne N applied ($kg\ N_2O$-N)	E Amount of biological fixation of nitrogen (t N)
				D=C/A	
List by type of crop					

4 E Agricultural Waste Burning

SOURCE CATEGORIES	ACTIVITY DATA		EMISSION ESTIMATE				AGGREGATE EMISSION FACTORS			
Sector Specific Data (units)	A Annual Burning of Crop Residues (kt dm)	B Carbon Fraction (t / t dm)	C Full Mass of Pollutant (Gg)				D Pollutant per tonne of dry matter (kg / t dm)			
							D=C/A			
			CH_4	N_2O	NO_x	CO	CH_4	N_2O	NO_x	CO
E Agricultural Waste Burning										
a..... List crop type here										

4 F Savanna Burning

SOURCE CATEGORIES	ACTIVITY DATA			EMISSION ESTIMATES				AGGREGATE EMISSION FACTORS			
F Savanna Burning				Full Mass of Pollutant (Gg)				Pollutant per tonne of dry matter (kg / t dm)			
Sector Specific Data (units)	Area of Savannah burned k ha / year	Biomass Burned kt dm	Carbon Fraction	N_2O	NO_x	CO	CH_4	N_2O	NO_x	CO	CH_4

MINIMUM DATA TABLES 5 LAND USE CHANGE AND FORESTRY

5 A 1 Forest Clearing: CO_2 Release from Burning Aboveground Biomass

SOURCE AND SINK CATEGORIES				ACTIVITY DATA			EMISSIONS ESTIMATES	AGGREGATE EMISSIONS FACTOR
				A Area Cleared (k ha)	B Total Biomass Change (kt dm)	C Quantity of Biomass Burned (on and off-site) (kt dm)	D Quantity of CO_2 Released ($Gg\ CO_2$)	E ($Mg\ CO_2$ / kt dm burned)
								E=D/C
Tropical	Closed Forests	Broadleaf	Undisturbed					
			Logged					
		Conifers	Undisturbed					
			Logged					
			Unproductive					
			Sub-Total					
	Open Forests		Productive					
			Unproductive					
			Sub-Total					
Temperate	Evergreen		Primary					
			Secondary					
			Sub-Total					
	Deciduous		Primary					
			Secondary					
			Sub-Total					
Boreal								
Other								

5 A 2 On-Site Burning of Cleared Forests

SOURCE AND SINK CATEGORIES	ACTIVITY DATA		EMISSIONS ESTIMATES				AGGREGATE EMISSION RATIOS			
	A Carbon Release Gg	B Nitrogen Release Gg	C Emissions Estimates Gg				D Aggregate Emissions Ratios			
							D=C/A		D=C/B	
			CH_4	CO	N_2O	NO_x	CH_4	CO	N_2O	NO_x
On-Site Burning of Cleared Forests										

5 A 3 Forest Clearing: CO_2 Release from Decay of Aboveground Biomass

SOURCE AND SINK CATEGORIES				ACTIVITY DATA			EMISSIONS ESTIMATES	AGGREGATE EMISSIONS FACTOR
				A 10-Year Average Area Cleared (k ha)	B 10-Year Average Actual Loss of Biomass (kt dm)	C Average Quantity of Biomass to Decay (kt dm)	D CO_2 Emissions (Gg CO_2)	E Emissions Factor Mg CO_2 / kt dm
								E=D/C
Tropical	Closed Forests	Broadleaf	Undisturbed					
			Logged					
		Conifers	Undisturbed					
			Logged					
			Unproductive					
			Sub-Total					
	Open Forests		Productive					
			Unproductive					
			Sub-Total					
Temperate	Evergreen		Primary					
			Secondary					
			Sub-Total					
	Deciduous		Primary					
			Secondary					
			Sub-Total					
Boreal								
Other								

5 A 4 Forest Clearing: Soil Carbon Release

SOURCE AND SINK CATEGORIES		ACTIVITY DATA		EMISSIONS ESTIMATES	AGGREGATE EMISSIONS FACTOR
Forest Types		A Average Annual Forest Converted to Pasture or Crops over 25 years	B Soil Carbon Content of Land Before Clearing t C/ha	C CO_2 Released from Soil Gg CO_2	D Aggregate Emissions Factor from Soil Carbon Mg / ha
					D=C/A
Tropical					
Temperate	Evergreen				
	Deciduous				
Boreal					

5 A 5 Total CO_2 Emissions from Forest Clearing

CATEGORY	EMISSIONS (Gg)
CO_2 from Burning of Cleared Biomass	
CO_2 from Decay of Cleared Biomass	
CO_2 from Soil Carbon Release	
TOTAL	

5 B Grassland Conversion (Annual CO_2 Emissions)

SOURCE AND SINK CATEGORIES	ACTIVITY DATA		EMISSION ESTIMATES	AGGREGATE EMISSIONS FACTORS
	A Area Converted (25 Year Total) k ha	B Average Carbon Content of Soil t C / ha	C CO_2 Emission Estimates Gg	D Average Emission Factors Mg / ha
				D=C/A

5 C 1 Abandonment of Managed Lands
(Annual Removals from Lands Abandoned Over the Previous 20 Years)

SOURCE AND SINK CATEGORIES				ACTIVITY DATA			REMOVAL ESTIMATES			AGGREGATE REMOVAL ESTIMATES	
				A Total Area Abandoned (Previous 20 Years) (k ha)	B Aboveground Biomass in Mature Systems (t dm / ha)	C Soil Carbon In Mature Systems (t C / ha)	D Aboveground Biomass (Gg C)	E Soils (Gg C)	F Total	G Carbon Removal in Aboveground Biomass (Mg / ha)	H Carbon Removal in Soils (Mg / ha)
									F=D+E	G= D/A	H=E/A
Tropical Forests	Closed Forests	Broadleaf	Undisturbed								
			Logged								
		Conifers	Undisturbed								
			Logged								
			Unproductive								
			Sub-Total								
	Open Forests		Productive								
			Unproductive								
			Sub-Total								
Temperate Forests	Evergreen		Primary								
			Secondary								
			Sub-Total								
	Deciduous		Primary								
			Secondary								
			Sub-Total								
Boreal											
Grasslands											
Other											

5 C 2 Abandonment of Managed Lands
(Annual Removals from Lands Abandoned For More Than 20 Years)

SOURCE AND SINK CATEGORIES				ACTIVITY DATA			REMOVAL ESTIMATES			AGGREGATE REMOVAL ESTIMATES	
				A Total Area Abandoned (Previous 20 Years) (k ha)	B Aboveground Biomass in Mature Systems (t dm / ha)	C Soil Carbon In Mature Systems (t C / ha)	D Aboveground Biomass (Gg C)	E Soils (Gg C)	F Total	G Carbon Removal in Aboveground Biomass (Mg / ha)	H Carbon Removal in Soils (Mg / ha)
									F=D+E	G= D/A	H=E/A
Tropical Forests	Closed Forests	Broadleaf	Undisturbed								
			Logged								
		Conifers	Undisturbed								
			Logged								
			Unproductive								
			Sub-Total								
	Open Forests		Productive								
			Unproductive								
			Sub-Total								
Temperate Forests	Evergreen		Primary								
			Secondary								
			Sub-Total								
	Deciduous		Primary								
			Secondary								
			Sub-Total								
Boreal											
Grasslands											
Other											

5 C 3 Abandonment of Managed Lands - Total CO_2 Removals

SINK CATEGORY	A Carbon Removals (Gg C)	B CO_2 Removals (Gg CO_2)
		B=Ax(44/12)
Lands Abandoned Over the Previous 20 Years		
Lands Abandoned More Than 20 Years Previously		
Total		

5 D 1 Managed Forests: Annual Growth Increment

SOURCE AND SINK CATEGORIES			ACTIVITY DATA	EMISSIONS / REMOVALS ESTIMATES	AGGREGATE REMOVALS FACTORS
Forest Type			A Area of managed Forest (k ha)	B Carbon Removal (Gg C)	C Carbon Removal Factor (Mg C)
					C=B/A
Tropical	Plantations (specify type)				
	Logged	Closed Broadleaf			
		Closed Coniferous			
		Open			
	Other				
Temperate	Plantations (specify type)				
	Commercial	Evergreen			
		Deciduous			
	Other				
Boreal					
			Number of Trees 1000	Carbon Removal (Gg C)	Carbon Removal Factor (Mg C)
					C=B/A
Afforestation Programs					
Village & Farm Trees					

5 D 2 Managed Forests: Harvest

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES	AGGREGATE EMISSION FACTORS
	A Amount of Biomass Harvested (kt dm)	B Carbon Emission/Removal Estimates (Gg-C)	C Carbon Emission Factors (Mg -C/ t dm)
			C=B/A
Commercial Timber			
Fuelwood)			
Other (specify			

5 D 3 Managed Forests: Net Emissions/Removals (Summary)

CATEGORY	EMISSIONS / REMOVALS
	CO_2 (Gg)
Total Growth Increment	
Total Harvest	
NET EMISSIONS (+) OR REMOVALS (-)	

MINIMUM DATA TABLES 6 WASTE

6 A Waste: Landfills

SOURCE AND SINK CATEGORIES	ACTIVITY DATA		EMISSIONS ESTIMATES	AGGREGATE EMISSIONS FACTORS	
Waste Type	A Total MSW (kg per year)	B MSW Landfilled (kg)	C CH_4 Emissions (kg)	D Emission Factor (kg CH_4 / kg MSW landfilled)	E Qty of CH_4 recovered (kg CH_4)
				D=C/B	
A Landfills					

6 B Waste: Sewage Treatment

SOURCE AND SINK CATEGORIES		ACTIVITY DATA		EMISSIONS ESTIMATES	AGGREGATE EMISSIONS FACTORS	
Waste Type		A Quantity BOD in Wastewater (kg)	B Quantity of CH_4 anaerobically digested (kg CH_4)	C CH_4 Emissions (kg)	D Emission Factor (kg CH_4 / kg BOD)	E Qty of CH_4 recovered (kg CH_4)
					D=C/B	
B Wastewater	Municipal					
	Industrial					
C Other						

Table 6A Summary Report for National Greenhouse Gas Inventories (Part 1)

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (PART 1) (Gg)						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Total (Net) National Emission						
1 All Energy (Fuel Combustion + Fugitive)						
A Fuel Combustion						
Energy & Transformation Industries						
Industry (ISIC)						
Transport						
Commercial/Institutional						
Residential						
Agriculture/Forestry						
Other						
Biomass Burned for Energy						
B Fugitive Fuel Emission						
Oil and Natural Gas Systems						
Coal Mining						
2 Industrial Processes						
A Iron and Steel						
B Non-Ferrous Metals						
C Inorganic Chemicals						
D Organic Chemicals						
E Non-Metallic Mineral products						
F Other						
3 Solvent Use						
A Paint Application						
B Degreasing and Dry Cleaning						
C Chemical Products Manufacture / Processing						
D Other						

Table 6A Summary Report for National Greenhouse Gas Inventories (Part 2)

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (PART 2) (Gg)						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2	NO_x	CO	NMVOC
4 Agriculture						
A Enteric Fermentation						
B Animal Wastes						
C Rice Cultivation						
D Agricultural Soils						
E Agricultural Waste Burning						
F Savannah Burning						
5 Land Use Change & Forestry						
A Forest Clearing & On-Site Burning of Cleared Forests						
B Grassland Conversion						
C Abandonment of Managed Lands						
D Managed Forests						
6 Waste						
A Landfills						
B Wastewater						
C Other						

Spare copy of Table 6A

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (PART 1) (Gg)						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES						
Total (Net) National Emission						
1 All Energy (Fuel Combustion + Fugitive)						
A Fuel Combustion						
Energy & Transformation Industries						
Industry (ISIC)						
Transport						
Commercial/Institutional						
Residential						
Agriculture/Forestry						
Other						
Biomass Burned for Energy						
B Fugitive Fuel Emission						
Crude Oil and Natural Gas						
Coal Mining						
2 Industrial Processes						
A Iron and Steel						
B Non-Ferrous Metals						
C Inorganic Chemicals						
D Organic Chemicals						
E Non-Metallic Mineral products						
F Other						
3 Solvent Use						
A Paint Application						
B Degreasing and Dry Cleaning						
C Chemical Products Manufacture / Processing						
D Other						

Spare copy of Table 6A

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (PART 2) (Gg)						
GREENHOUSE GAS SOURCE AND SINK CATEGORIES						
4 Agriculture						
A Enteric Fermentation						
B Animal Wastes						
C Rice Cultivation						
D Agricultural Soils						
E Agricultural Waste Burning						
F Savannah Burning						
5 Land Use Change & Forestry						
A Forest Clearing & On-Site Burning of Cleared Forests						
B Grassland Conversion						
C Abandonment of Managed Lands						
D Managed Forests						
6 Waste						
A Landfills						
B Wastewater						
C Other						

Table 6B Short Summary Report for National Greenhouse Gas Inventories

SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)						
Greenhouse Gas Source and Sink Categories	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
Total National Emissions and Sinks						
1 All Energy (Fuel Combustion + Fugitive)						
A Fuel Combustion						
B Fugitive Fuel Emission						
2 Industrial Processes						
3 Solvent and Other Product Use						
4 Agriculture						
A Enteric Fermentation						
B Animal Wastes						
C Rice Cultivation						
D Agricultural Soils						
E Agricultural Waste Burning						
F Savannah Burning						
5 Land Use Change & Forestry						
6 Waste						

Spare copy of Table 6B

SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)						
Greenhouse Gas Source and Sink Categories						
Total National Emissions and Sinks						
1 All Energy (Fuel Combustion + Fugitive)						
A Fuel Combustion						
B Fugitive Fuel Emission						
2 Industrial Processes						
3 Solvent and Other Product Use						
4 Agriculture						
A Enteric Fermentation						
B Animal Wastes						
C Rice Cultivation						
D Agricultural Soils						
E Agricultural Waste Burning						
F Savannah Burning						
5 Land Use Change & Forestry						
6 Waste						

Table 7 A Overview Table for National Greenhouse Gas Inventories

OVERVIEW TABLE															
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2		CH_4		N_2O		NO_x		CO		NMVOC		Documen-tation	Disaggregation	Footnotes
	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality			
Total National Emission and Sink															
1 All Energy (Fuel Combustion + Fugitive)															
A Fuel Combustion															
B Fugitive Fuel Emission															
2 Industrial Processes															
3 Solvent and Other Product Use															
4 Agriculture															
A Enteric Fermentation															
B Animal Wastes															
C Rice Cultivation															
D Agricultural Soils															
E Agricultural Waste Burning															
F Savannah Burning															
5 Land Use Change & Forestry															
6 Waste															

KEY							
Estimates		**Quality**		**Documentation**		**Disaggregation ***	
code	*meaning*	*code*	*meaning*	*code*	*meaning*	*code*	*meaning*
PART	Partial Estimate	**H**	High Confidence in Estimation	**H**	High (all background information included)	**1**	Total emissions estimated
ALL	Full Estimate of all possible sources	**M**	Medium Confidence in Estimation	**M**	Medium (some background information included)	**2**	Sectoral split
NE	Not estimated	**L**	Low Confidence in Estimation	**L**	Low (only emission estimates included)	**3**	Sub-sectoral split
IE	Estimated but included elsewhere						
NO	Not Occurring						
NA	Not Applicable						
* See following table for a complete explanation of each code							

Table 7B Explanation of Diaggregation Key for Overview Table

DISAGGREGATION KEY FOR OVERVIEW TABLE				
Disaggregation 1	Disaggregation 2		Disaggregation 3	
Total (Net) National Emission				
1 Total Energy)				
1 A Fuel Combustion	1 A 1 to 1 A 8	Energy & Transformation Industry Biomass burned for energy	1 A	Any subsectors of 1 A 1 to 1 A 8. For example, rail transport or industry sectors
1 B Fuugitive Fuel Emission	1 B 1	Crude Oil and Natural Gas	1 B	Any further breakdown, for example gas venting or post mining activities
	1 B 2	Coal Mining		
2 Industrial Production Processes	2A	Chemicals	2	Any further quantitative breakdown by industrial sector, for example, paper, nitric acid, cement.
	2 B	Non-Metallic Mineral Products		
	2 C	Other (ISIC)	2	
3 Solvent and Other Product Use			3	Any further quantitative breakdown by product
4 Total Agriculture				
4 A Enteric Fermentation	4 A		4 A	Animal Types e.g. cattle, goats
4 B Animal Wastes	4 B		4 B	
4 C Rice Cultivation	4C		4 C	Any further quantitative breakdown
4 D Agricultural Soils	4 D	Breakdown by type of fertilizer or by one or other characteristic	4 D	Several characteristics taken into account, such as type of fertilizer, soil, crop or area
Agricultural Biomass Burning				
4 E Agricultural Waste Burning			4 E	Any further quantitative breakdown
4 F Savannah Burning				
5 Land Use Change & Forestry	5 A	Forest Clearing & On-Site Burning of Cleared Forests	5 A	Any further quantitative
	5 B	Grassland Conversion	5 B	breakdown
	5 C	Abandonment of Managed Land	5 C	e.g. Amount of forest or amount
	5 D	Managed Forests	5 D	of prescribed burning
6 Waste	6 A	Landfills	6 A	Any further quantitative
	6 B	Sewage	6 B	breakdown
	6 C	Other	6 C	

ANNEX I
MANAGING UNCERTAINTIES IN THE IPCC/OECD METHODOLOGY

Uncertainties are inevitable in any estimate of national emissions or removals. Some important causes of uncertainty are:

- *differing interpretations of source and sink category or other definitions, assumptions, units etc.*
- *use of simplified representations with "averaged" values, especially emission factors and related assumptions to represent characteristics of a given population*
- *uncertainty in the basic socio-economic activity data which drives the calculations*
- *inherent uncertainty in the scientific understanding of the basic processes leading to emissions and removals.*

A major objective of the IPCC methodology is to help national experts reduce uncertainty in their greenhouse gas inventories to the minimum level possible. However, the approach also recognises that significant uncertainties will remain despite these efforts, and that these uncertainties will vary widely:

- *between different greenhouse gases*
- *between source categories for each gas*
- *between countries reporting the same gases and sources (depending on approach, levels of detail, use of default or country specific data etc.)*

It is important to provide as thorough an understanding of the uncertainties involved that when estimates are provided for scientific or policy uses. A simple method for expressing the confidence or uncertainty of point estimates qualitatively is given elsewhere in this book. However it is more useful to express uncertainty quantitatively and systematically in the form of well developed confidence intervals. This Annex provides some initial suggestions for developing qualitative uncertainty information. However, at present, it is only possible to provide a conceptual framework which relies on users to supply statistical data or equivalent expert judgement. IPCC/OECD consider the consistent estimation of uncertainty to be critically important, and will make it the focus of future work. Individual experts are encouraged to estimate uncertainty ranges as well as possible and to report results with their inventories. This will be of assistance with the ongoing work of developing methods.

A1.1 Sources of Uncertainty

Definitions

Use of the IPCC methodology will minimize variability or uncertainty which would otherwise be introduced by issues of definition. The IPCC methodology provides common definitions of source categories and other terms, units, procedures, etc. The source categories are set out in Chapter 2 *Source and Sink Categories*. The methodologies correspond to the source categories or aggregations of them.

Estimation Methodology

The IPCC/OECD programme has sought consensus among researchers, sectoral interest groups and national technical experts on the best practicable default estimation procedures for priority gases and sources. These default methodologies are described in Volume 2 of the Guidelines, the Greenhouse Gas Inventory Workbook. By using these methods countries can minimize variations or uncertainties in national estimates which would be introduced by a *choice* of methodology. However, it must be recognised that default methods represent a compromise between the level of detail which would be needed to create the most accurate estimates for each country and the input data likely to be available or readily obtainable in most countries. In many cases, the simplest default methods are simplifications with general default values which introduce large uncertainties into a national estimate. Within many of the default methods different optional levels of detail are provided to reflect whether users have detailed data for their national situation or have to rely strictly on general default values. There may be considerable variation in how well the general default values represent conditions of the actual population of source activities in a particular country. For example, the uncertainty relating to default carbon emission coefficients for the global population of fossil fuel combustion sources may be characterized as quite low (5-10%) in the IPCC methodology; but national experts for a particular country may know that the characteristics of such fuels in their country vary widely from global average values. In such a country, use of default values would introduce a larger uncertainty. Thus, even for the simplest application of the default methods, it is not possible to provide general uncertainty values for all countries.

The *Reference Manual* provides more options, including ways of doing calculations at greater levels of detail and, in some cases, alternative methodologies. Users of the IPCC Guidelines may use their own methodologies if they believe these will provide more accurate results for their national situation. Alternative methods should be carefully documented and results reported in the standard IPCC source and sink categories. Documentation of alternative methods may involve presentation of new empirical data which may in turn provide a basis for the improvement of the default procedures and data. However, whichever methods are used - default methods, more detailed versions of default methods, or entirely different methods - users should determine as far as possible the ranges of uncertainty introduced by the emission factors and other input assumptions used, whatever their source.

Socio-economic Activity Data

The IPCC default methodologies identify activity data from international socio-economic data series wherever possible. International compilations of socio economic activity data do not generally include quantitative uncertainty estimates around country level data summaries. Some of the national sources which provide data to the international series may have quantified uncertainty for their own national data. As with uncertainty in methodology and emission factors, the inventory developers must judge the quality of activity data used in their own national inventory.

Underlying Scientific Understanding

Current scientific understanding of the various human-induced processes which lead to emissions and removals of greenhouse gases to and from the atmosphere is incomplete. In some cases, where substantial measurement data exist and have been thoroughly analyzed, this understanding provides a basis for accurate calculations of global and national emissions. In many cases, however, data and analysis have not attained this state. This variation affects the uncertainty inherent in the various components of the default methods, as well as the estimates using other methodologies. Table A1-1 provides an illustrative assessment of the relative uncertainties in the scientific basis for global emission estimates for some key components of the IPCC methodology. The overall uncertainty ranges shown here are based on an interpretation of the uncertainty information presented by the IPCC (Reference 1). The allocation of overall uncertainty to the emission factor and activity data components has been made for illustrative purposes only on the basis of judgement by the IPCC/OECD technical staff. These values should not be used for estimating uncertainty for a particular national inventory. They are provided to assist users of the *Guidelines* to consider relative uncertainties in the basic science underlying different components of their inventories.

TABLE A1-1
UNCERTAINTIES DUE TO EMISSION FACTORS AND ACTIVITY DATA

1	2	3	4	5
Gas	**Source category**	**Emission factor** U_E	**Activity data** U_A	**Overall uncertainty** U_T
CO_2	Energy	7	7	10
CO_2	Industry	7	7	10
CO_2	Land Use Change and Forestry	[±33%] 33	[±33%] 50	[±50%] 60
CH_4, N_2O	Biomass burning	1/2	1/2	100%
CH_4	Oil & gas	55%	20%	60
CH_4	Coal	55%	20%	60
CH_4	Rice	3/4	1/4	100%
CH_4	Landfill & sewage	2/3	1/3	100%
CH_4	Animals	25%	10%	25%
CH_4	Animal waste	20%	10%	20%
N_2O	Industry	35%	35%	50%
N_2O	Soils			2 orders of magnitude
N_2O	Biomass Burning			100%

Note: Individual uncertainties which appear to be greater than ±60% are not shown. Instead judgement as to the relative importance of emission factor and activity data uncertainties are shown as fractions which equal 1 (one).

A1.2 Procedures for Quantifying Uncertainty

Estimating Uncertainty of Components

To estimate uncertainty by source category and gas for a national inventory, it is necessary to develop information like that shown in Table A1-1, but specific to the individual country, methodology and data sources used. In scientific and process control literature the 95% (±2%) confidence limit is often regarded as appropriate for range definition. Where there is sufficient information to define the underlying probability distribution for conventional statistical analysis, a 95% confidence interval should be calculated as a definition of the range. Uncertainty ranges can be estimated using classical analysis (Reference 2) or the Monte Carlo technique (Reference 3). Otherwise the range will have to be assessed by national experts.

If possible ranges should be developed separately for

- emission factors (and other assumptions in the estimation method) (column 3 Table A1-1).
- socio-economic activity data (column 4 Table A1-1)

Combining Uncertainties

It is necessary to derive the overall uncertainty arising from the combination of emission factor and activity data uncertainty. IPCC/OECD suggest that emission factor and activity data ranges are regarded as estimates of the 95% confidence interval, expressed as a percentage of the point estimate, around each of two independent components (either from statistically based calculations or informal *ex ante* judgements).

On this interpretation (for quoted ranges extending not more than 60% above or below the point estimate) the appropriate measure of overall *percentage* uncertainty U_T for the emissions estimate would be given by the square root of the sum of the squares of the *percentage* uncertainties associated with the emission factor (U_E) and the activity data (U_A). That is, for each source category:

$$U_T = \pm \sqrt{(U_E^2 + U_A^2)}; \text{ so long as } |U_E|, |U_A| < 60\%^1$$

For individual uncertainties greater than 60% the sum of squares procedure is not valid. All that can be done is to combine limiting values to define an overall range, though this leads to upper and lower limiting values which are asymmetrical about the central estimate[2].

Estimated total emission for each gas is of course the summation ΣC_i where C_i is the central estimate of the emission of the gas in the source category. The appropriate measure of *uncertainty* in total emissions in emissions units (not percentages) is then:

$$E = \pm (1/100) \cdot \sqrt{(\Sigma U_{T,i}^2 \cdot C_i^2)}$$

where $U_{T,i}$ is the overall percentage uncertainty for the source category of the gas from Table A1-1. Source categories for which symmetrical limiting values cannot be defined (because $|U_E|$ or $|U_A|$ exceeds 60%) cannot sensibly be treated in this way. The uncertainty might be handled by reporting that total emissions from gas X are estimated to be Y Mt, of which Y_1 Mt had an estimated uncertainty of $\pm E_1$ Mt and Y_2 Mt had a range of uncertainty between - L Mt and + U Mt.

---

[1]The 60% limit is imposed because the rule suggested for U_T requires σ to be less than about 30% of the central estimate, and we are interpreting the quoted range as $\pm 2\sigma$

[2]If uncertainties due to the emission factor and the activity data are ±E% and ±A% respectively, and the upper and the lower limits of overall uncertainty are U% and L% respectively, then U% = (E+A+E.A/100) and L% = (E+A-E.A/100).

A1.3 Implications

Typical uncertainties in global emissions estimates range between:

- [±10%] for CO_2 from fossil fuels although this may be lower for some countries with good data and where source categories are well defined (Reference 4 & 5)
- [±20% and ±100%] for individual methane sources (though the overall error might be ±[30%])
- perhaps two orders of magnitude for estimates of nitrous oxide from agricultural soil

These uncertainties will affect the level of quantitative understanding of atmospheric cycles of greenhouse gases that can be derived using the summation of inventories.

The situation is less critical for monitoring emissions mitigation options, because the profile of the emissions time series will be relatively insensitive to revisions to the emissions estimation methodology. However very different levels of uncertainty for different gases will be inevitable for some time to come, and this will need to be recognised in any move towards a comprehensive approach to greenhouse gas mitigation.

A1.4 References

1 Intergovernmental Panel on Climate Change (IPCC), *Climate Change 1992: The Supplement to the IPCC Scientific Assessment*, 1992.

2 The method for combining errors in a multiplicative chain are given in many statistical textbooks, but note Jennifer Robinson's discussion (On uncertainty in the computation of global emissions from biomass burning, *Climatic Change*, **14**, 243-262) about the difficulties which arise at high coefficients of variation.

3 H S Eggleston, *Uncertainties in the estimates of emissions of VOCs from Motor Cars*, paper presented at the TNO/EURASAP workshop on the reliability of VOC emission databases, Delft, Netherlands June 1993.

4 *Preliminary IPCC National GHG Inventories: In Depth Review*. Report presented at the IPCC/OECD Workshop on National GHG Inventories, Bracknell, October 1993.

5 See the discussion of reconciliation in von Hippel et al: Estimating greenhouse gas emissions from fossil fuel combustion, *Energy Policy*, 691-702, June 1993.

ANNEX 2
IPCC AND CORINAIR SOURCE CATEGORIES

This chapter briefly explains the differences and correspondences between the IPCC recommendations and the CORINAIR/UNECE recommendations and outlines an interim proposal on how to report the results from the CORINAIR inventory system in an IPCC format. In addition, the chapter describes the on-going effort to harmonise the inventory recommendations of the two programmes. At present CORINAIR/UNECE is the only known inventory programme used by many countries of which the scope and objectives significantly overlap those of the IPCC. Many individual countries certainly have other detailed national inventory approaches which have similar characteristics to CORINAIR. For these countries this example of reconciling IPCC and CORINAIR source categories may be helpful in addressing similar conversion problems. The IPCC/OECD Programme will work with interested countries and other organisations as far as possible to help achieve correspondence with IPCC categories in order to avoid duplication of effort at national and international levels.

A2.1 Origins

At the present time the IPCC recommends a set of source and sink categories for the estimation and reporting of national inventories of greenhouse gas emissions which is slightly different than categories that have been developed by the Commission of European Communities (CEC) for use in Europe. The reasons for these differences lie, first, in the origin of the two inventory systems and, second, in the primary uses for the inventory data.

Unlike the IPCC, the CEC emission inventory programme (CORINAIR), was initially established to assist in the development of comparable national inventories for "conventional" air pollutants of SO_x, NO_x, and VOC. The first CORINAIR inventories from European Community (EC) Member countries were developed for the year 1985 and were released for the first time in 1990. The next CORINAIR inventory year has been identified as 1990 and for this inventory the pollutant list has been extended to include NH_3, CO, CO_2 and N_2O, as well as to separate CH_4 from VOC. A further development of the CORINAIR system came in 1991, when the UNECE helped define the eleven main CORINAIR categories as a basis for reporting under the LRTAP Convention. The pollutants of interest in the context of the LRTAP Convention include not only those that are covered in specific protocols limiting emissions (i.e. SO_x, NO_x, and VOC) but also pollutants that influence the critical loads of acidic deposition, hence NH_3. The UNECE also established a Task Force on Emission Inventories, which began in 1992 and has as a main objective to develop a guidebook for emission inventories summarising the CORINAIR/UNECE recommendations on estimation and verification methods. The Task Force is scheduled to complete its work including the guidebook in 1995.

A2.2 Applications

The purpose of inventory development under UNECE is to support the monitoring of progress of the implementation of the LRTAP protocols. One of the principal users of the inventories are modellers who support the implementation of the European Monitoring and Evaluation Monitoring under the LRTAP. The main requirement of the modellers is to estimate the sources of SO_x, NO_x, NMVOC, and NH_3 emissions on a 50 km x 50 km square grid basis across Europe. These data are then the basis of the calculations estimating the acidic deposition and photochemical oxidants across Europe which ties back to the concept of "critical loads" and the monitoring of national progress to meet "critical load" levels of acidic deposition.

A2.3 Differences and correspondences

The UNECE requirement to establish a much more detailed understanding of the geographic distribution of emissions has led to source categories based on the physical characteristics of the sources of pollutants. The IPCC has proceeded on the basis that socio-economic sources are the easiest and most appropriate groupings for describing emissions, which in turn will facilitate the use of inventories for policy analysis.

The CORINAIR/UNECE system uses type of physical plant or vehicle, without regard to the socio-economic category, as the fundamental basis for emission estimation. This allows high accuracy in description of individual point or mobile sources and in use of appropriate emission factors for conventional pollutants.

An example of a source that is handled differently is that of industrial co-generation. The IPCC proposed to group all co-generation, in industry or in the power sector, as part of "energy transformation." CORINAIR groups all industrial co-generation together under industrial combustion, since this allows one to consider all similar industrial sources collectively, and simply to estimate emissions in the same way from like source points. Similarly, these plant data facilitate the estimation by grid squares by allowing a simple geographic tracking system based on size and type of physical plant.

Table A2-1 in the next section shows how the IPCC and CORINAIR source categories relate to each other.

A2.4 Proposed interim solution: allocate or aggregate

A proposed interim solution for reporting is summarised in Table A2-1. Here the CORINAIR reporting country is requested either to allocate emissions of the problem subcategory to the appropriate IPCC main category, or to aggregate the two source categories in question and provide them as a combined total.

TABLE A2-1
CORRESPONDENCES BETWEEN IPCC AND CORINAIR MAIN SOURCE CATEGORIES

IPCC	CORINAIR
Emissions by Sector	CO2 Emissions by Sector
1 A Fuel Combustion Activities	**Fuel Combustion Activities**
1 A 1 Energy Industries	01 Public power, co-generation and district heating
1 A 1 Other energy and transformation industries[1]	03 Industrial combustion
1 A 2 Industry	
1 A 3 Transport	07 Road Transport
	08 Other mobile sources and machinery
1 A 3 Air/marine bunkers	-- not included in 1990 inventory
1 A 4 Commercial/institutional	02 Commercial / institutional / residential[2]
1 A 5 Residential	
1 A 6 Agriculture/forestry	
1 A 7 Other	
1 A 8 Biomass for energy[3]	Biomass fuels in categories 01, 02, 03, 07 and 08.
1 B Fugitive Fuel Emissions	**05 Extraction and distribution of fossil fuels**
2 Industry	**04 Production processes**
3 Solvent use	**06 Solvent use**
4 Agriculture	**10 Agriculture**
5 Land use change	-- not included in 1990 inventory
6 Wastes	**09 Waste treatment and disposal**

1 Include under energy industries if there is no separate breakdown

2 Include under Commercial/institutional if there is no breakdown to allow separation further into residential, agriculture/forestry, and other categories.

3 Biomass for energy and agricultural waste burning should not be included in CO2 emission total for IPCC.

A2.5 Looking forward

The development of the CORINAIR/UNECE Guidebook is a major opportunity to extend and publicise the basic set of IPCC default methods on estimation of CO_2 and CH_4 as well as the state of knowledge on N_2O. Because the CORINAIR system has only recently begun to address these pollutants they have not yet elaborated estimation methods for all sources and sinks. The IPCC has recently revised methods for all major sources and sinks of CO_2 and CH_4, and the *Reference Manual* on N_2O. This material has been proposed to CORINAIR/UNECE to be considered for inclusion in the Guidebook.

Of course, it will be desirable for countries using CORINAIR to follow the decisions of the CoP on greenhouse gas inventory methodologies. Once initial guidance for inventory development under the UN Framework Convention on Climate Change (FCCC) is issued, further development of detailed default methods could be advocated for use in Europe and North America. In contrast to countries outside of the OECD, more detailed data sets on the relevant source activities should be available. Such methods development could draw on the initial CORINAIR/UNECE Guidebook and would add to the simpler approaches described in this document.

Over the period 1993-94, the IPCC/OECD are investigating options for how more closely to harmonise the reporting recommendations and, in particular, its source categories with those recommended by CORINAIR. It may not be desirable or necessary to harmonise source categories beyond a high level of aggregation due to the very different uses of the data and the need to preserve flexibility among pollutants. For example, for the estimation of CO_2 it is not desirable to consider the physical characteristics of the plant where the fuel combustion occurs. However, for the estimation of NO_x or NMVOC, these data are essential. But, even if differences at a detailed level of estimation are acceptable and in some instances desirable, an aggregate level of reporting should be developed that is completely transferable from one system to another. Complete correspondence at an aggregate level is therefore the objective by the time the Convention comes into force.

A2.6 How to Transform a CORINAIR Inventory into an IPCC Inventory

Table A2-1 gives an overview of the correspondence between CORINAIR and IPCC source/sink categories. In early 1994, the CORINAIR programme will provide an additional computer programme to national experts to facilitate the aggregation and allocation of CORINAIR emission estimates into IPCC reporting tables. Until this programme is available, proceed as explained below.

For most categories there is direct correspondence between CORINAIR and IPCC. Transfer these data directly into the Minimum Data Tables and the Master Summary Table.

For the CORINAIR categories in Table A2-2 you will need to devise an approach to allocate or aggregate the emissions to the appropriate IPCC categories.

TABLE A2-2 ALLOCATING CORINAIR CATEGORIES TO IPCC CATEGORIES	
03 - Industrial combustion	Allocate between IPCC categories for "Fuel Combustion:" IA1 - Energy transformation and IA2 Industry.
07 - Road Transport and 08 - Other mobile sources and machinery	Aggregate to IPCC category "Fuel Combustion:" IA3 - Transport.
02 - Commercial / Institutional / Residential	Allocate to IPCC category "Fuel Combustion:" IA4 -Commercial / Institutional; IA5 - Residential; IA6 Agriculture/forestry; IA7 - Other.

Some IPCC categories are not yet included in CORINAIR inventories. To complete your IPCC inventory you will need to provide estimates for these categories. These IPCC categories are:

- 1 A 3 Air and Marine Bunkers
- 1 A 8 Biomass for Energy
- 5 Land Use/Forestry

You may want to refer to the *Workbook* if you do not already have alternative methods.

INDEX

The index will be supplied with the approved *Guidelines*.