UNITED NATIONS

UNFCCC Framework Convention on Climate Change

Report of the individual review of the greenhouse gas inventory of the United States of America submitted in 2009[*]

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[*] In the symbol for this document, 2009 refers to the year in which the inventory was submitted, and not to the year of publication.

CONTENTS

<u>Annex</u>

I. Overview

A. Introduction

1.   This report covers the centralized review of the 2009 greenhouse gas (GHG) inventory submission of the United States of America, coordinated by the UNFCCC secretariat, in accordance with decision 19/CP.8. The review took place from 31 August to 5 September 2009 in Bonn, Germany, and was conducted by the following team of nominated experts from the UNFCCC roster of experts: generalists – Ms. Anke Herold (European Community) and Mr. Harry Vreuls (Netherlands); energy – Ms. Maria Lidén (Sweden) and Mr. Jongikhaya Witi (South Africa); industrial processes – Mr. Teemu Oinonen (Finland) and Mr. Samir Tantawi (Egypt); agriculture – Mr. Steen Gyldenkærne (Denmark); land use, land-use change and forestry (LULUCF) – Mr. Rizaldi Boer (Indonesia) and Mr. Daniel Martino (Uruguay); and waste – Ms. Tatiana Tugui (Republic of Moldova). Ms. Herold and Mr. Martino were the lead reviewers. The review was coordinated by Mr. Javier Hanna (UNFCCC secretariat).

2.   In accordance with the "Guidelines for the technical review of greenhouse gas inventories from Parties included in Annex I to the Convention" (hereinafter referred to as the UNFCCC review guidelines), a draft version of this report was communicated to the Government of the United States, which provided comments that were considered and incorporated, as appropriate, into this final version of the report.

B. Inventory submission and other sources of information

3.   In its 2009 submission, the United States submitted, on 13 April 2009, a complete set of common reporting format (CRF) tables for the period 1990–2007 and a national inventory report (NIR). Where necessary, the expert review team (ERT) also used the previous year's submission, additional information provided during the review and other information. The full list of materials used during the review is provided in the annex to this report.

C. Emission profiles and trends

4.   In 2007, the main GHG in the United States was carbon dioxide (CO_2), accounting for 85.7 per cent of total GHG emissions[1] expressed in CO_2 eq, followed by methane (CH_4) (7.8 per cent) and nitrous oxide (N_2O) (4.3 per cent). Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) collectively accounted for 2.1 per cent of the overall GHG emissions in the country. The energy sector accounted for 86.8 per cent of the total GHG emissions, followed by agriculture (5.8 per cent), industrial processes (5.0 per cent), waste (2.3 per cent) and solvent and other product use (0.1 per cent). Net removals from the LULUCF sector offset 14.3 per cent of the total GHG emissions. Total GHG emissions amounted to 7,107,161.69 Gg CO_2 eq and increased by 16.8 per cent between 1990 and 2007.

5.   Tables 1 and 2 show total GHG emissions by gas and by sector, respectively.

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[1]   In this report, the term "total GHG emissions" refers to the aggregated national GHG emissions expressed in terms of CO_2 eq excluding LULUCF, unless otherwise specified.

Table 1. Greenhouse gas emissions by gas, 1990–2007

Greenhouse gas (without LULUCF)	Gg CO$_2$ eq							Change 1990–2007 (%)
	1990	1995	2000	2004	2005	2006	2007	
CO$_2$	5 068 576.19	5 399 817.48	5 946 408.84	6 039 372.69	6 081 905.12	6 006 103.66	6 094 390.11	20.2
CH$_4$	611 971.33	609 676.45	570 469.46	556 141.75	547 508.47	550 716.44	556 312.80	-9.1
N$_2$O	313 470.93	332 119.16	325 524.81	315 259.52	312 638.86	307 099.01	306 988.74	-2.1
HFCs	36 924.10	61 803.33	100 098.22	112 376.34	116 073.33	119 072.79	125 531.42	240.0
PFCs	20 759.93	15 587.02	13 479.45	6 125.08	6 194.63	6 030.44	7 479.87	−64.0
SF$_6$	32 787.70	28 080.98	19 199.54	17 756.95	17 893.06	17 026.87	16 458.76	−49.8

Abbreviation: LULUCF = land use, land-use change and forestry.

Table 2. Greenhouse gas emissions by sector, 1990–2007

Sector	Gg CO$_2$ eq							Change 1990–2007 (%)
	1990	1995	2000	2004	2005	2006	2007	
Energy	5 193 603.06	5 520 063.22	6 059 934.22	6 140 416.84	6 169 162.03	6 084 385.29	6 170 343.23	18.8
Industrial processes	325 243.41	345 768.84	356 315.05	335 893.15	337 598.92	343 943.73	353 779.52	8.8
Solvent and other product use	4 404.02	4 587.52	4 879.50	4 387.15	4 387.15	4 387.15	4 387.15	−0.4
Agriculture	384 152.60	401 954.09	399 444.64	407 657.36	410 825.55	410 297.98	413 064.72	7.5
LULUCF	−827 212.31	-834 741.57	-684 459.12	−1 276 660.34	−1 096 340.99	−1 005 488.87	−1 019 674.76	23.3
Waste	177 087.09	174 710.76	154 606.92	158 677.84	160 239.81	163 035.05	165 587.07	−6.5
Other	NA	NA	NA	NA	NA	NA	NA	NA
Total (with LULUCF)	5 257 277.87	5 612 342.86	6 290 721.21	5 770 371.99	5 985 872.47	6 000 560.33	6 087 486.93	15.8
Total (without LULUCF)	6 084 490.17	6 447 084.43	6 975 180.33	7 047 032.33	7 082 213.46	7 006 049.20	7 107 161.69	16.8

Abbreviations: LULUCF = land use, land-use change and forestry, NA = not applicable.

D. Key categories

6.   The United States has reported key category analyses using the tier 1 and tier 2 approaches, both level and trend assessment, and also applied a qualitative approach in determining its key categories, as part of its 2009 submission. The key category analysis performed by the United States and that performed by the secretariat[2] produced similar results. However, the United States identified a greater number of categories as key than the secretariat (38 in comparison with 35 by the secretariat), which was due to the Party's use of the tier 2 approach and qualitative criteria. The United States has included the LULUCF sector in its key category analysis, which was performed in accordance with the Intergovernmental Panel on Climate Change (IPCC) *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (hereinafter referred to as the IPCC good practice guidance) and the IPCC *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (hereinafter referred to as the IPCC good practice guidance for LULUCF).

7.   The United States used the results of its key category analysis together with those of the uncertainty assessment as drivers for planning and prioritizing improvements to its inventory. The ERT noted that, for its 2009 submission, the United States applied a higher-tier approach for the emission estimations for many key categories, but not for the estimation of emissions from stationary fuel combustion activities, noting the circumstances explained in paragraph 37 below.

E. Main findings

8.   The inventory is generally in line with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the Revised 1996 IPCC Guidelines), the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. Additionally, the United States has begun to incorporate new methodologies and parameters from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* (hereinafter referred to as the 2006 IPCC Guidelines) in several sectors, in particular for categories in the industrial processes sector.

9.   The methodologies, country-specific methods and models used by the United States to calculate its estimates have, in general, been presented in the NIR in a transparent way. The ERT noted that the United States had used higher-tier methods for many key categories and that many recommendations made in previous review reports had been incorporated into the estimation methodologies and implemented in the NIR. However, despite the recommendations having been made in numerous previous review reports, a number of key methodological improvements have not yet been addressed: higher-tier methods have still not been used to estimate emissions from stationary combustion, which is the largest category in the inventory but has still been reported at a very aggregated level; the unusual inter-annual changes in the emissions from navigation have not yet been clarified (see para. 41 below); and explanations for the significant differences between the energy data reported by the International Energy Agency (IEA) and the data used to calculate estimates using the reference approach have still not been provided (see para. 31 below). In addition, the United States has still not implemented a standardized system for updating its CO_2 emission factors (EFs) for fuels, with a view to updating in particular the rather old EFs used for coal (see para. 38 below). The ERT reiterates the recommendation made in the previous review report that the United States address the above-mentioned problems, which

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[2] The secretariat identified, for each Party, those categories that are key categories in terms of their absolute level of emissions, applying the tier 1 level assessment as described in the Intergovernmental Panel on Climate Change *Good Practice Guidance for Land Use, Land-Use Change and Forestry*. Key categories according to the tier 1 trend assessment were also identified for those Parties that provided a full set of CRF tables for the base year. Where the Party performed a key category analysis, the key categories presented in this report follow the Party's analysis. However, they are presented at the level of aggregation corresponding to a tier 1 key category assessment conducted by the secretariat.

have been highlighted in several previous review reports, as soon as possible. The ERT also recommends that the United States address the sector-specific issues raised in the sector chapters of this report.

F. Cross-cutting issues

1. Completeness

10.   The inventory covers all source and sink categories for the period 1990–2007. In addition, the United States has frequently identified additional subcategories under the categories other, thereby improving the completeness of its inventory. Furthermore, the Party has provided in its NIR estimates of nitrogen trifluoride (NF_3) emissions from semiconductor manufacture for the period 1990–2007. The reporting of NF_3 emissions is not part of the mandatory requirement of reporting of fluorinated gases under the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part 1: UNFCCC reporting guidelines on annual inventories" (hereinafter referred to as the UNFCCC reporting guidelines). Therefore, the ERT commends the United States for this voluntary addition which shows the strongly growing trend of NF_3 emissions that increased by a factor of 10 between 1990 and 2007.

11.   A few categories have been reported as not estimated ("NE"), including: CO_2 emissions from ethylene, CO_2 emissions and recovery from food and drink, and CO_2 emissions from solvent and other product use; CH_4 emissions from ammonia, calcium carbide and styrene production; N_2O emissions from ammonia production and from degreasing and dry cleaning; PFC emissions from production of halocarbons and SF_6; CH_4 and N_2O emissions from buffalo, camels and llamas, and mules and asses; CO_2 emissions/removals from land converted to forest land, wetland, settlements and other land; emissions from biomass burning on cropland and grassland; and CH_4 and N_2O emissions from sludge in wastewater handling. The ERT recommends that the United States further improve its coverage of categories in the inventory, focusing its efforts on quantitatively more important categories and particularly for those categories which the Revised 1996 IPCC Guidelines and/or the IPCC good practice guidance and the IPCC good practice guidance for LULUCF provide methodologies. Indirect CO_2 emissions from solvent and other product use were not estimated, but estimates of non-methane volatile organic compound (NMVOC) emissions have been provided.

12.   The United States' inventory includes Hawaii, Alaska and other United States territories (American Samoa, Guam, Puerto Rico, United States Virgin Islands, Wake Island and other United States Pacific Islands). However, data were not available for all categories and for all territories (e.g. carbon stock changes in forest land in Alaska have not been included), and available data did not always allow for the same level of disaggregation (e.g. information on energy use) as for the rest of the country. The definition provided in the 2009 submission lacks clarity because "other U.S. Pacific Islands" are not clearly identified. Due to data collection procedures, United States territories are treated as a separate aggregate category, and the required sectoral disaggregation (e.g. to residential, industry or transport in the energy sector) is missing. After the centralized review, the United States informed the ERT that it will provide more information defining the United States territories in its next submission and information on coverage of categories in these territories in the NIR of its future inventory submissions.

2. Transparency

13.   In the United States' 2009 submission, the NIR has been improved in terms of its transparency and it follows in general the structure outlined in the UNFCCC reporting guidelines. However, the ERT recommends that the United States include time-series consistency as a topic together with uncertainty in the category-specific sections of the NIR, as recommended in the UNFCCC reporting guidelines. The transparency of the inventory in the Party's 2009 submission has been improved through the addition

of more information on category/sector-specific quality assurance/quality control (QA/QC) procedures. The NIR, in particular the information provided in the annexes to the NIR, is very detailed and comprehensive. Sector-specific recommendations related to transparency are provided in the sector chapters of this report.

14.　　In general, CRF table 8(b) has not been used to document recalculations. The ERT recommends that the United States report consistent information on recalculations, stating the reasons for recalculations both in the CRF table and the NIR. CRF table 1.A(b), which provides information on the reference approach, includes some adjustments for fuels accounted for under the industrial processes sector, which is not in line with the UNFCCC reporting guidelines and reduces the comparability and transparency of the data provided. The ERT recommends that the United States provide unadjusted data in its next inventory submission.

3. Recalculations and time-series consistency

15.　　The recalculations in the 2009 submission resulted, overall, in a 0.8 per cent decrease for 1990 and a 0.2 per cent decrease for 2006 in the estimated total GHG emissions without LULUCF. When the LULUCF sector is included, the impact of the recalculations is a 2.8 per cent decrease in the estimated total GHG emissions, for both 1990 and 2006. These recalculations led to a slight increase in the emission trend: in the previous submission, total GHG emissions without LULUCF were reported to have increased by 14.4 per cent from 1990 to 2006, while, according to the 2009 submission, there was a 15.1 per cent increase in emissions over the period 1990–2006. Recalculations of CO_2 emissions from metal production, transport, and manufacturing industries and construction; of N_2O emissions from agricultural soils; of CH_4 from enteric fermentation; and in the LULUCF sector (CO_2 from forest land, cropland and grassland) had the greatest impact on the estimate of total GHG emissions for 2006.

16.　　The rationale for these recalculations has been provided in the NIR (in chapter 10 on recalculations as well as in the sector chapters). The information given in CRF table 8(b), in most cases, only refers to the NIR in a general way. The recalculations reported by the United States of the [not hyphenated unless used in an adjectival sense, as in "time-series consistency" – please amend throughout] 1990 to 2006 for the LULUCF sector were due to newly available activity data (AD) and improved methods. The changes in estimated N_2O emissions from agricultural soils were due to the use of a new operational version of the DAYCENT model. Recalculations for iron and steel production involved the implementation of the methodological changes from the 2006 IPCC Guidelines for this category, which also included some reallocation of emissions; the recalculations for manufacturing industries and construction corresponded to these reallocations. The availability of updated energy data had an impact on the estimates of CO_2 emissions from fuel combustion for 2006. The recalculations for enteric fermentation involved correcting the data on animal populations and making adjustments to the model used. In addition, emissions from the non-energy use of petroleum coke have been reported for the first time in the 2009 submission.

4. Uncertainties

17.　　The United States applied a tier 2 method using Monte Carlo analysis for its quantitative uncertainty assessment for all but two categories, namely composting and parts of agricultural soils. The uncertainty analysis has been documented in an annex to the NIR and the category-specific uncertainties have been discussed in the sector chapters. The ERT noted that the United States has not followed the recommendation made in the 2007 review report to add columns containing information on AD and EF uncertainties to the tables in annex 7 to the NIR, where the uncertainty analysis is described. After the centralized review, the United States informed the ERT that it is developing a comprehensive uncertainty addendum to accompany future inventory submissions, including the information requested. The ERT encourages the United States to make this addition in its next inventory submission.

The United States uses and documents the results of its uncertainty analysis to prioritize further improvements to the inventory.

18.   As indicated in the NIR, the United States plans to improve its uncertainty assessment by refining the category-specific uncertainty estimates, adopting rigorous elicitation protocols for expert judgements, and using more uncertainties based on statistical data analysis than on expert judgement. The United States also intends to include global warming potential (GWP) uncertainty in its estimation of the overall level and trend uncertainty of the inventory. Although including GWP uncertainty in the general uncertainty assessment would not be in line with the IPCC good practice guidance requirements, it would facilitate a better characterization of overall inventory uncertainty for other purposes; therefore it could be done, but separately from the uncertainty assessment provided in the Party's inventory submissions.

19.   The overall uncertainty of the total GHG emissions in 2007 was estimated to be in the range of −1 to 5 per cent excluding LULUCF and of −3 to 7 per cent for net emissions including LULUCF. The uncertainty of the trend in total GHG emissions was estimated to range from 11 to 22 per cent. The United States used the results of its uncertainty assessment together with those of the key category analysis as drivers for planning and prioritizing improvements to its inventory.

5. Verification and quality assurance/quality control approaches

20.   The United States has a quality assurance/quality control (QA/QC) plan in place in accordance with the IPCC good practice guidance. QA/QC procedures are documented in specific forms and include manual as well as semi-automated checks. Descriptions of the specific QA/QC activities for important categories have been described in the sector chapters of the NIR, but this is sometimes at a rather aggregate level (e.g. for stationary combustion and mobile combustion). Improvements made as a result of the QA/QC procedures performed have also been documented in the NIR.

21.   With regard to the industrial processes sector, category-specific QA/QC procedures have not been documented in a detailed way in the relevant chapter of the NIR. The ERT recommends that the United States develop and apply, on a case-by-case basis, category-specific (tier 2) QA/QC procedures for the key categories in the inventory for which such procedures have not yet been implemented. The ERT also recommends that the United States describe these procedures and their application in the category-specific sections of the NIR of its next inventory submission, as recommended by the UNFCCC reporting guidelines.

22.   The IPCC good practice guidance recommends that external data providers use QA/QC procedures. Therefore, the ERT recommends that the United States add some information to the general description of QA/QC activities in the NIR, explaining such procedures applied by major data providers outside the inventory agency.

23.   QA activities implemented in the United States include annual expert reviews and public reviews prior to the submission of the inventory. The United States' QA/QC system tracks in a very systematic way potential additional small emission sources/sinks that are not yet covered in the inventory and potential additional coverage of existing sources/sinks, and includes activities for adding such additional sources/sinks of emissions/removals to the planned improvements. However, some of the current gaps in the estimation of emissions/removals, such as the categories land converted to forest land and land converted to settlements, have not been clearly addressed in the planned improvements listed in the NIR. The ERT recommends that the United States include these currently missing land-conversion categories in its inventory improvement plan.

6. Follow-up to previous reviews

24.   The United States' 2009 submission includes several improvements with regard to issues which had been previously addressed by ERTs, such as the provision of a tier 2 uncertainty analysis and the use of a tier 2 key category analysis. While the United States is continuously incorporating recommendations made by ERTs into its inventory submissions, there remain some key issues that have not yet been addressed despite the fact that they have been raised in several previous review reports, as indicated in paragraph 9 above. The United States does not systematically document the improvements implemented in response to recommendations made in previous review reports and, therefore, the available information has to be checked in detail in order to assess the improvements. The ERT encourages the United States to document the follow-up activities arising from recommendations made in previous reviews in a more systematic way in chapter 9 of the NIR. After the centralized review, the United States informed the ERT that it will consider a transparent manner in which to provide this information in future inventory submissions.

25.   During the centralized review, in response to questions raised by the ERT, the United States referred to its proposed rule of mandatory GHG reporting from large sources, which is currently in the rulemaking development and implementation process. The ERT encourages the United States to include plant-specific information gathered in the future under this rule in its national GHG inventory.

G. Areas for further improvement

1. Identified by the Party

26.   The NIR identifies several areas for improvement. The planned improvements comprise:

(a)   The continued updating of methodologies and parameters in line with the 2006 IPCC Guidelines in the areas of non-energy use of fuels and industrial processes;

(b)   The improvement of the uncertainty analysis by replacing uncertainties based on expert judgement with the rigorous statistical characterization of uncertainties;

(c)   The improvement of the characterization of flows of fossil carbon in organic chemical wastewater, plasticizers, adhesives, films, paints and coatings, as well as of the treatment of fuel additives and backflows;

(d)   The development of country-specific carbon storage factors for industrial coking coal and distillate oil over a longer-term time horizon;

(e)   The improvement of the allocation of fuel consumption for the United States territories;

(f)   The development of updated EFs for several categories in different sectors (e.g. road transportation and industrial processes);

(g)   The use of plant-specific data for estimations in the category adipic acid production;

(h)   The addition to the inventory of estimated emissions from calcium carbide production;

(i)   The estimation of CO_2 capture at the four electric power plants where capture takes place;

(j)   The incorporation of area data on major portions of Alaska, Hawaii and other United States territories in the LULUCF sector;

(k)   The improvement of AD on waste deposited in landfills and of data on flaring.

2. Identified by the expert review team

27.   The ERT identified the following cross-cutting issues for improvement:

(a)   The enhancement of consistency between the NIR and the CRF tables in accordance with the UNFCCC reporting guidelines;

(b)   The use of higher-tier methods to make estimations for key categories, in particular for CO_2 emissions from stationary combustion;

(c)   The improvement of the country-specific parameters and EFs where problems or potentially out-of-date parameters have been indicated in the sector chapters of this report, in particular for coal in the energy sector;

(d)   The inclusion of time-series consistency as a topic in the category-specific sections of the NIR, as recommended in the UNFCCC reporting guidelines;

(e)   The development and application, on a case-by-case basis and where not yet implemented, of category-specific (tier 2) QA/QC procedures for the key categories in the inventory, and the description of these procedures and their application in the category-specific sections of the NIR, as recommended by the UNFCCC reporting guidelines.

28.   Recommended improvements relating to specific categories are presented in the relevant sector chapters of this report.

II. Energy

A. Sector overview

29.   The energy sector is the main sector in the GHG inventory of the United States. In 2007, emissions from the energy sector amounted to 6,170,343.23 Gg CO_2 eq, or 86.8 per cent of total GHG emissions. Since 1990, emissions have increased by 18.8 per cent. The key drivers for this increase in emissions are the increase in activity in energy industries and transport, from which emissions increased by 32.8 per cent and 27.7 per cent, respectively. Within the sector, 39.4 per cent of the emissions were from energy industries, followed by 30.7 per cent from transport, 13.8 per cent from manufacturing industries and construction and 9.1 per cent from other sectors. Emissions from the category other accounted for 3.4 per cent and fugitive emissions from oil and natural gas accounted for 2.6 per cent. The remaining 1.0 per cent were from the category fugitive emissions from solid fuels.

30.   As noted in previous review reports, emissions from combustion of biomass and other fuels in the United States territories have been reported as "NE" since data are not currently available for the GHG inventory. However, in its response to questions raised by the ERT during the centralized review, the United States indicated that data do exist at the Department of Energy (DOE) but that these data are not provided for the purpose of the GHG inventory. The ERT recommends that the United States improve the completeness of its inventory and work closely with DOE to gather all data relevant for estimating all emissions from the United States territories, for its next inventory submission.

B. Reference and sectoral approaches

1. Comparison of the reference approach with the sectoral approach and international statistics

31.   The United States has reported estimates of CO_2 emissions from fuel combustion for 2006 calculated using both the reference and the sectoral approach. The difference between the estimates

calculated using the reference and sectoral approaches was –0.05 per cent for energy consumption and 0.32 per cent for CO_2 emissions. The reference approach shows a number of significant differences when compared with the data from IEA. The United States informed the ERT that efforts had been made by the Energy Information Administration (EIA) of the United States' DOE to investigate these differences but that it remained unclear how the reported data are processed by IEA. The ERT acknowledges these efforts and encourages the United States to continue working closely with EIA in order to cross-check data and improve consistency with the reporting to IEA, and to explain the above-mentioned differences in the NIR of its next inventory submission.

32.   The ERT recognizes the effort made by the inventory compilers to bring the energy data from EIA in line with the UNFCCC reporting requirements for CRF table 1.A(b), as described in annex 4 to the NIR. However, as also indicated in the 2008 review report, the ERT noted that the United States has not closely followed the UNFCCC reporting guidelines when completing CRF table 1.A(b). For example, adjustments made for fuels accounted for under the industrial processes sector have been included in the stock change column of this table (affecting the comparability and transparency of the data), whereas, according to the Revised 1996 IPCC Guidelines, these fuels should be treated as feedstocks and non-energy use of fuels and reported in table 1.A(d). The ERT reiterates the recommendation made in previous review reports that the United States follow the UNFCCC reporting guidelines and the Revised 1996 IPCC Guidelines more closely and complete these CRF tables as required, bearing in mind that they are an important tool for checking the estimates calculated using the sectoral approach. The ERT also recognizes that the United States had difficulty allocating fuels in CRF table 1.A(b); therefore, it encourages the United States to add additional rows to tables, where necessary, to allow for the reporting of country-specific data and fuel types.

33.   In the documentation box of CRF table 1.A(b), it is indicated that the reference approach has also been reported on a separate Excel spreadsheet providing more detailed information. The ERT noted, however, that no such spreadsheet was included in the Party's 2009 submission. Following a request made by the ERT during the centralized review, the United States provided this information. Reiterating the suggestion made in the previous review report, the ERT encourages the United States to include this information as a regular part of its future inventory submissions, when it has been referenced in the CRF tables.

2. International bunker fuels

34.   The ERT noted discrepancies between the data provided in CRF tables 1.C and 1.A(b) for jet kerosene (international aviation) and for gas/diesel oil and residual fuel oil (international marine bunkers) for all years of the time series. During the centralized review, the United States informed the ERT that it would work to correct these inconsistencies. The ERT welcomes this effort and recommends that the United States provide consistent estimates for these fuels in its next inventory submission.

35.   The ERT noted some considerable inter-annual changes in CO_2 emissions from marine bunkers, most noticeably for the periods 1998–1999 (–19.8 per cent) and 2003–2004 (20.8 per cent). These inter-annual changes were also identified by the ERT in the previous review report, but the United States has neither taken corrective action nor offered any explanation for the changes. Therefore, in the absence of any explanation, it is difficult to rule out the possibility of errors having been made in the estimates. Since fuel consumption for domestic navigation is estimated as the difference between total fuel consumption and marine bunker fuel consumption, any errors in the marine bunkers estimates will affect the estimate of total national emissions. The ERT recommends that the United States examine this issue closely, as it is linked to the estimates for domestic navigation (see para. 41 below), and either revise its estimates, if appropriate, or provide additional explanations for these significant inter-annual changes in its next inventory submission. After the centralized review, the United States informed the ERT that it is continually seeking an improved data set for marine bunkers that decreases the degree to

which inter-annual variations exist and that it will continue to provide information in future inventory submissions as to the progress of these efforts.

3. Feedstocks and non-energy use of fuels

36.   As indicated also in the previous review report, the ERT noted that the United States has reported a significant amount of CO_2 emissions (127,246.50 Gg CO_2 for 2007) under the subcategory other (stationary – non-energy use of fuels (1.A.5a)). This accounts for 2.1 per cent of the energy sector's total emissions or 1.8 per cent of the total GHG emissions in 2007. In addition, the United States has reported some CO_2 emissions from the non-energy use of liquid fuels under the subcategory other (stationary – U.S. territories (1.A.5a)). The ERT reiterates the view of the ERT in the previous review report that a large proportion of these emissions might have been wrongly allocated to the energy sector. In the previous review report, the ERT estimated that around 55.0 per cent of these emissions could be reported under energy industries (fuel combusted for energy recovery). In addition, emissions from hazardous waste could be reported in the waste sector (around 1.0 per cent), and other parts of these emissions (around 8.0 per cent) could be allocated to the industrial processes and solvent and other product use sectors. The ERT reiterates that, according to the Revised 1996 IPCC Guidelines, only emissions from fuels combusted for the use of their energy should be reported under fuel combustion. Reiterating a similar recommendation made in the 2007 and 2008 review reports, the ERT recommends that the United States reallocate, in its next inventory submission, the relevant emissions currently reported under the subcategories other (stationary – non-energy use of fuels) and other (stationary – U.S. territories), as the Party's current practice reduces the comparability of its inventory. The ERT also recommends that this reallocation be undertaken as part of a general revision of the reference approach, as recommended in paragraph 32 above.

C. Key categories

1. Stationary combustion: all fuels – CO_2, CH_4 and N_2O[3]

37.   For CO_2 emissions from stationary combustion, the United States uses a methodological approach by estimating consumption data by end-use sector at a highly aggregate level and fuel types from national energy statistics, adjusting these fuel consumption data for several parameters in accordance with the Revised 1996 IPCC Guidelines and multiplying them by country-specific carbon contents of the fuels consumed. This approach is equivalent to a tier 1 sectoral approach in the Revised 1996 IPCC Guidelines, whereas the bottom-up tier 2/tier 3 approach in the Revised 1996 IPCC Guidelines is a detailed technology-based method, based either on plant-specific data sources or on data from aggregated plant types with similar combustion technologies. In the 2006 IPCC Guidelines, the existing tier methods have been categorized in a different way and the approach currently used by the United States is equivalent to a tier 2 approach. As noted in the previous review report, GHG emissions from combustion under the category manufacturing industries and construction were estimated and reported in an aggregated way under the subcategory other (other non-specified (1.A.2f)). According to the information provided by the United States during the centralized review, disaggregated data are not currently available and the United States Environmental Protection Agency (EPA) is working with DOE to determine which of the available data sets can provide information on fuel consumption by key industries. These disaggregated data will assist the United States in completing the CRF tables with regard to data on fuel consumption and emission estimates for the subcategories under manufacturing industries and construction. The ERT acknowledges this effort and reiterates the recommendations made

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[3] Not all emissions related to all fuels and gases under this category are key categories, particularly biomass and CH_4 and N_2O emissions. However, since the calculation procedures for and issues related to stationary combustion are discussed as a whole, the individual categories under stationary combustion are not assessed in separate sections.

in the previous review reports that the United States continue its efforts to develop disaggregated data on combustion in manufacturing industries and construction and report these data in its next inventory submission. The ERT also encourages the United States to consider using for this purpose the additional facility-specific data that will be collected under the planned GHG reporting rule starting from 2010.

38.   As also noted in the previous review report, emissions from solid fuels in stationary combustion were calculated on the basis of data on fuel consumption and estimates of the country-specific carbon content of the fuel. The ERT noted that, while the United States has a complex process of changing the estimated carbon content of the coal year by year on the basis of the origin and type of the coal, this process is based on data from 6,588 coal samples collected by the United States Geological Survey between 1973 and 1989. As in the previous review report, the ERT questions whether these data are sufficiently up to date for use in the estimates, as these values do change over time. The ERT notes that, according to the previous review report, the United States has indicated its intention to explore the possibility of implementing a standardized system for updating the CO_2 EFs on a rotational basis, whereby individual, discrete fuel types can be analysed on a continuous multi-year basis. The ERT reiterates the recommendation made in the previous review report that the United States implement the above-mentioned system and also explore the possibility of improving the estimates for the carbon content of solid fuels by making more use of existing contacts with data suppliers and also by obtaining additional data from other relevant entities, such as gas companies, fuel associations and refineries. After the centralized review, the United States informed the ERT that it is currently performing a large-scale examination and, as appropriate, update of the carbon content factors used from fuel combustion calculations of the United States inventory. These data will be incorporated in future inventory submissions as studies are completed.

39.   The CO_2 implied emission factors (IEFs) for other fuels in the category public electricity and heat production (ranging from 214.94 to 417.08 t/TJ) for 1990–2007 are the second highest of those of the reporting Parties for the period 1990–2003 and the highest since 2004. No information on the corresponding very high EFs for other fuels has been provided in the NIR. The ERT recommends that the United States, for its next inventory submission, verify both the EFs used in the estimates of CO_2 emissions from other fuels and the emission estimates in this category. The ERT also recommends that the United States provide transparent information on the EFs for other fuels in the NIR of its next inventory submission.

40.   In the CRF tables, combustion of municipal solid waste (MSW) for energy recovery has been reported as other fuels under the category public electricity and heat production. However, according to the NIR, combustion of MSW has been reported under the category other (1.A.5). The United States informed the ERT that the NIR would be updated in its next submission to reflect the current allocation of emissions. Furthermore, emissions of CH_4 from combustion of MSW have currently been reported as not applicable ("NA") in the CRF tables; however, according to the information provided by the United States during the centralized review, these emissions will be estimated in the 2010 submission. The ERT welcomes these planned improvements and recommends that the United States, in its next inventory submission, estimate emissions of CH_4 from waste incineration and update the NIR to reflect the current reporting of combustion of MSW.

2. Navigation: liquid fuels – CO_2

41.   As noted in the previous review report, the fuel consumption for navigation shows large inter-annual changes: 1991–1992 (21.2 per cent), 1994–1995 (20.4 per cent), 1996–1997 (–35.5 per cent), 1997–1998 (–23.0 per cent), 1999–2000 (128.6 per cent), 2000–2001 (–31.1 per cent), 2002–2003 (–36.0 per cent) and 2003–2004 (27.6 per cent). According to the NIR, data on marine bunker fuels are collected from the Foreign Trade Division of the Census Bureau of the United States Department of Commerce and from the bunker report of the Department of Homeland Security. Fuel

consumption for domestic navigation is calculated as the difference between total fuel consumption for a given fuel and consumption of this fuel as marine bunker fuel. Since fuel consumption for marine bunkers is much higher than fuel consumption for domestic navigation, small errors in the estimates for marine bunker fuel would imply large errors for the estimates of fuel consumption for domestic navigation. The ERT noted that this might be one factor contributing to the large inter-annual changes observed in the emissions trend of this category. The ERT welcomes the United States' plans to develop an alternative approach that will be a better reflection of the data on domestic navigation and marine bunkers. The ERT reiterates the recommendation made in the previous review report that the United States review the total fuel sold for shipping, reconsider its estimation of emissions from domestic navigation and international marine bunkers, and make revisions to this information for the 1990–2007 time series, accordingly. In addition, the ERT recommends that the United States clearly explain significant variations over the time series, in the NIR of its next inventory submission.

3. Oil and natural gas: gaseous fuels – CH_4

42. There were significant inter-annual changes in the estimates of CH_4 emissions from production/processing in the periods 1999–2000 (7.2 per cent) and 2004–2005 (–20.4 per cent). However, no information on the reason for these large inter-annual changes has been provided in the NIR. After the centralized review, the ERT received detailed information from the United States clarifying these changes. The ERT recommends that the United States, in the NIR of its next inventory submission, provide these explanations for the inter-annual changes in this emission trend.

D. Non-key categories

Other transportation: gaseous fuels – CH_4 and N_2O

43. Emissions of CH_4 and N_2O from gaseous fuels under the category other transportation have been reported as "NE". According to information given to the ERT during the centralized review, this category includes emissions from the pipeline transport of natural gas, and all calculations for this category were performed by EIA, which estimates only CO_2 emissions. The ERT recommends that the United States' inventory team work more closely with EIA to gather all the necessary data to estimate all emissions from this category, in its next inventory submission.

III. Industrial processes and solvent and other product use

A. Sector overview

44. In 2007, emissions from the industrial processes sector amounted to 353,779.52 Gg CO_2 eq, or 5.0 per cent of total GHG emissions. Emissions from the solvent and other product use sector amounted to 4,387.15 Gg CO_2 eq, or 0.1 per cent of total GHG emissions. Since 1990, emissions have increased by 8.8 per cent in the industrial processes sector, and decreased by 0.4 per cent in the solvent and other product use sector. The key driver for the rise in emissions in the industrial processes sector is the substitution of the use of ozone-depleting substances for HFCs and PFCs. In 2007, within the industrial processes sector, 35.5 per cent of the emissions were from consumption of halocarbons and SF_6, followed by 25.9 per cent from metal production, 19.6 per cent from mineral products and 14.2 per cent from chemical industry. The remaining 4.8 per cent were from production of halocarbons and SF_6.

45. The CRF tables provide an almost complete set of emission estimates. Categories reported as "NE" include: CO_2 emissions from ethylene, CO_2 emissions and recovery from food and drink, and CO_2 emissions from solvent and other product use; calcium carbide and styrene production; N_2O emissions from degreasing and dry cleaning; and PFC emissions from production of halocarbons and SF_6. After the centralized review, the United States noted regarding CO_2 emissions from ethylene that in chapter 4.9 of its NIR on petrochemical production, it is indicated that CO_2 emissions from petrochemical processes

other than carbon black are currently included in the carbon stored in products from non-energy use of fossil fuels in the energy sector. The ERT recommends that the United States use the notation key included elsewhere ("IE") for this category in its next inventory submission. With regard to CO_2 emissions and recovery from food and drink, the Party explained that CO_2 produced for commercial applications (other than enhanced oil recovery and including food processing, chemical production, carbonated beverage production, and refrigeration) was estimated as part of emissions from CO_2 consumption (2.B.5), addressed in chapter 4.11 of the NIR. The ERT also recommends that the United States use the notation key "IE" for this category in its next inventory submission. With regard to CO_2 emissions from calcium carbide production the United States noted that there is limited production in the country and currently no data on production are available to develop a reasonable estimate of emissions from this process, as noted in annex 5 to the NIR. The ERT encourages the United States to explain in the NIR of its next inventory submission, where information is not already provided in annex 5 to the NIR, why the emissions from the categories reported as "NE" re considered to be negligible, particularly for those categories which the Revised 1996 IPCC Guidelines and/or the IPCC good practice guidance provide methodologies. The Party has provided in its NIR estimates of NF_3 emissions from semiconductor manufacture for the period 1990–2007. The reporting of NF_3 emissions is not part of the mandatory requirement of reporting of fluorinated gases under the UNFCCC reporting guidelines. Therefore, the ERT commends the United States for this voluntary addition, which shows the strongly growing trend of NF_3 emissions that increased by a factor of 10 between 1990 and 2007.

46.   The ERT noted significant inter-annual fluctuations in the reported data on emissions from ammonia production and iron and steel production, and from the subcategories production of HCFC-22 and other under the category production of halocarbons and SF_6. The ERT recommends that the United States include time-series consistency as a topic in the category-specific sections of its NIR, as recommended in paragraph 43 and annex I of the UNFCCC reporting guidelines.

47.   The ERT noted limited application of category-specific QA/QC measures in the industrial processes sector. During the centralized review, the United States informed the ERT that the QA/QC measures were summarized in chapter 1.6 of the NIR because the QA/QC procedures are consistent and do not vary among the categories in the industrial processes sector. The ERT recommends that the United States develop and apply, on a case-by-case basis, category-specific (tier 2) QA/QC procedures for the key categories in the inventory. The ERT also recommends that the United States describe these procedures and their application in the category-specific sections of the NIR of its next inventory submission, as recommended in paragraph 43 and annex I of the UNFCC reporting guidelines.

B. Key categories

1. Cement production – CO_2

48.   In this category, emission estimates were based on the IPCC default values for the cement kiln dust (CKD) correction factor and the EF. These assumptions were checked by national experts. The ERT commends the United States for its transparent reporting of these assumptions in the NIR. However, because cement production is a key category, the ERT recommends that the United States develop country-specific values for these parameters, based on national data on the chemical composition of the raw materials and the amount of CKD generated in the production process, in its next inventory submission. After the centralized review, the United States informed the ERT that it will evaluate additional data collected under future rulemakings for GHG reporting in order to explore developing a country-specific CKD correction factor and country-specific EF for cement production for application to its future inventory submissions.

2. Iron and steel production – CO_2

49.   In its 2009 submission, the United States recalculated the estimates in this category, incorporating methodological changes from the 2006 IPCC Guidelines, which resulted in, on average, a 40.7 per cent increase in the estimate of emissions from iron and steel production for the period 1990–2006. During the centralized review, the United States informed the ERT that considerable effort was made to obtain historical data in order to produce a more robust time series. The Party's current use of more detailed data together with a new methodology that more closely approximates the structure of the iron and steel industry is considered by the United States to produce estimates that are closer to the true level of emissions. The ERT commends the United States for increasing the accuracy of its reporting.

3. Other (consumption of halocarbons and SF_6) – HFCs

50.   In the CRF tables, the United States has allocated emissions of HFC-134a from foam manufacturing under the category other (consumption of halocarbons and SF_6). During the review, the United States explained that this allocation was due to the fact that its calculations do not differentiate between hard and soft foams, a division that appears in the CRF tables. In order to improve comparability with the data provided by other Parties, the ERT encourages the United States to clarify whether these HFC emissions originate from rigid foams (as has been stated in the NIR, pp. 4–60 – 4–61) and, if this is the case, to report these emissions under the category foam blowing (hard foams).

51.   The United States has reported, as an unspecified mix of HFCs, confidential quantities of HFC-152a, HFC-227ea, HFC-245fa, HFC-43-10mee, C_4F_{10} (perfluorobutane) and PFC/PFPEs (perfluoropolyethers) from commercial refrigeration, transport refrigeration, foams, aerosols, fire extinguishers, metered dose inhalers and solvents under the category other (consumption of halocarbons and SF_6). The ERT recommends that the United States ensure that only gases for which GWP values are listed in the UNFCCC reporting guidelines are included in this subcategory. To report GHGs not listed in the UNFCCC reporting guidelines, CRF table 9(b) should be used. The ERT also recommends that the United States document in the NIR of its next inventory submission the use of this category to report confidential business information. The NIR should be consistent with the CRF tables so that information reported in table 9(b) should also be included in the NIR.

IV. Agriculture

A. Sector overview

52.   In 2007, emissions from the agriculture sector amounted to 413,064.72 Gg CO_2 eq, or 5.8 per cent of total GHG emissions. Since 1990, emissions have increased by 7.5 per cent. The key drivers for the rise in emissions are the increase in the number of beef cattle and the fact that a higher percentage of dairy cattle were raised in liquid-based manure management systems. Within the sector, 50.3 per cent of the emissions were from agricultural soils, followed by 33.6 per cent from enteric fermentation, 14.2 per cent from manure management and 1.5 per cent from rice cultivation. The remaining 0.3 per cent were from field burning of agricultural residues.

53.   The United States used the 2006 IPCC Guidelines together with country-specific data and models to estimate emissions from the agriculture sector. While the methodologies used were in line with the IPCC good practice guidance, the ERT identified some problems with the Party's choice of input parameters and EFs. For CH_4 emissions from manure management, the ERT notes that the methane conversion factors (MCFs) used for several animal waste management systems (AWMS) are likely too high. The ERT also believes that the overall nitrogen (N) excretion rates (Nex) in the United States' inventory were underestimated by 40 to 60 per cent, as further explained in paragraph 63 below. During

the centralized review, the ERT received information from the United States indicating its plan to update the Nex in the near future based on the mass balance approach; therefore, the ERT recommends that the United States update these values in its next inventory submission.

54.   In the United States' 2009 submission, recalculations have been performed for many categories in the agriculture sector. In total, these recalculations led to a decrease in the estimated emissions for 2006 by 9.7 per cent, from 454,144.99 Gg CO_2 eq to 410,297.98 Gg CO_2 eq. For CH_4, the recalculation led to an increase in the emission estimate for 2006 by 7.1 per cent, primarily as a result of the increased estimate of feed consumption; while, for N_2O, the recalculation resulted in a 20.1 per cent reduction in the emission estimate for 2006 owing to the improvement of the DAYCENT model. The recalculations were performed for the whole time series and have been explained in the NIR. Further information on the recalculated estimate of N_2O emissions from the agricultural soils category is provided in paragraph 60 below.

55.   The United States' inventory is complete for the agriculture sector, as emissions for all categories covering the whole national territory have been reported. At subcategory level, emissions from some very minor animal populations (buffalo, mules and asses, and camels and llamas) have been reported as "NE", an omission which does not significantly affect the overall emissions from the livestock categories. Sectoral uncertainty analyses were performed using mainly the IPCC tier 2 estimation methodology (Monte Carlo stochastic simulation technique), excluding the fraction of N_2O emissions from agricultural soils owing to non-major crops, and a small portion of grassland (federal grassland), for which a tier 1 approach was used for both the estimates and the uncertainty analyses. The IPCC tier 1 and tier 2 QA/QC procedures were implemented consistent with the Party's QA/QC plan for the livestock categories; whereas, for agricultural soils, estimates were compared with field data, and for other categories, a category-specific QA/QC plan was implemented.

B. Key categories

1. Enteric fermentation – CH_4

56. CH_4 emissions from enteric fermentation were estimated applying a tier 2 method for cattle (the Cattle Enteric Fermentation Model, developed by EPA), with national data on feed diets and the related digestibility of the feed, as well as modelled EFs (Ym – CH_4 conversion rate). For other animal species, a tier 1 method was used, applying the default parameters from the 2006 IPCC Guidelines. These methodological approaches are in line with the IPCC good practice guidance.

57.   Recalculations have been performed for the complete time series, thus increasing the IEF for dairy cows and beef cows, owing to new knowledge on the animals' final live weight. In response to a request made by the ERT, during the centralized review the United States provided new data on feed digestibility (DE) and Ym which are different from the values currently used. The new data indicate that especially Ym was underestimated by approximately 5–8 per cent for dairy cows and by 10 per cent for feed lot cattle. The ERT recommends that the United States investigate the validity of these new data and, if they can be scientifically proven to be more accurate than those currently used, include these parameters in its next inventory submission. After the centralized review, the United States explained to the ERT that there is a high level of uncertainty among any estimate of diet components in the United States and that the updated diets for the next inventory submission are based on the summation of the current literature in the field. A reference to a published peer-reviewed article detailing the model selection process for estimating the EF for enteric fermentation was provided to the ERT.

2. Manure management – CH_4

58.   The recalculations performed for the category enteric fermentation, which incorporated an increased value for the animals' live weight into the calculation of the estimates, thereby increasing the

feed consumption and thus the amount of animal excreta (VS – volatile substance), have not been reflected as a subsequent increase in the CH_4 emissions from manure management. This indicates problems in the performance of the mass-flow estimation (in terms of both energy and N flows) in the United States' inventory. During the centralized review, in response to questions raised by the ERT, the United States acknowledged that there are some problems with its methodologies for estimating excreted VS and it provided new data on VS which will be included in future submissions. The ERT recommends that the United States implement a full mass-flow model for VS based on the revised parameters, in its next inventory submission. After the centralized review, the United States informed the ERT that a full mass balance could not yet be implemented for the next inventory submission, but that improvements will be made to improve data consistency and to rectify the models.

59.   Manure management in anaerobic lagoons, liquid/slurry and deep pits is common in several states of the United States. These three AWMS were responsible for 88.9 per cent of the total CH_4 emissions from manure management. The MCFs used to calculate estimates of CH_4 emissions from these AWMS seem very high and were based, in part, on information in a short note from an informal meeting with Dr. Mac Safley (Safley, 2000). This note indicates that "many livestock waste treatment systems classified as anaerobic lagoons are actually holding ponds that are substantially organically overloaded and therefore not producing methane at the same rate as a properly designed lagoon". The MCFs used were also based on data in Mangino et al. (2001), which covers only two CH_4-producing optimized lagoons, one for pig slurry and one for dairy slurry, with unmeasured rates of CH_4 production. Furthermore, in order to optimize the production of CH_4, these lagoons are emptied only in the autumn, thereby storing the majority of the volatile substance over summer under high temperature conditions in order to produce the maximum amount of CH_4. Such handling may not reflect the actual conditions on many farms in the United States, as mentioned by Safley (2000), where manure is often applied in spring as fertilizer. Therefore, the ERT assumes that CH_4 emissions from manure management were likely overestimated. The ERT recommends that the United States collect data on how these AMWS are managed in practice and, where appropriate, apply updated MCFs in its estimations of emissions, taking into account the handling and actual storage time of manure, for its next inventory submission.

3. Agricultural soils – N_2O

60.   The United States used a tier 3 methodology – the DAYCENT model – to estimate N_2O emissions from agricultural soils. The DAYCENT model handles all N-fluxes in mineral soils except for some federal land, for which emissions were estimated using the IPCC tier 1 methodology. DAYCENT is a very complex model. In both the 2008 and the 2009 submission, these N_2O emissions were recalculated, reducing the overall level of estimated emissions from agricultural soils by 40 per cent over these two years, without any significant changes in the overall N input to agricultural soils. In the 2007 submission, the uncertainty for the DAYCENT model was given as $\pm$ 20–22 per cent for direct soil emissions; in the 2009 submission, this uncertainty increased slightly to $\pm$27–54 per cent. Therefore, the recalculations performed increased the uncertainty of the model, which may raise some doubts as to the reliability of the uncertainty estimate for this category. A qualified validation of the DAYCENT model is difficult. A simple comparison of the overall N input to DAYCENT with the estimated N_2O emissions for all major N inputs gives an IEF of 0.0067 kg N_2O-N per kg N, which can be compared, in part, with the default value provided in the 2006 IPCC Guidelines of 0.01 kg N_2O-N per kg N. This slightly lower IEF than the default value might be acceptable owing to the relatively more dry conditions in the United States compared to the climatic conditions in which the IPCC default EF was established. After the centralized review, the United States explained to the ERT that the methodology used to estimate uncertainty has now been completed for its application, and has been approved for publication in peer-reviewed journals, references to which were provided to the ERT. Because of the constant changes in model parameters and inputs of the DAYCENT model, the ERT recommends that the United States

include a more thorough validation of and more detailed documentation for these estimates, in the NIR of its next inventory submission.

61.   As the Nex values are likely to have been underestimated, the N input into DAYCENT would consequently also have been underestimated. A recalculation of the Nex would therefore require a recalculation with DAYCENT for the whole time series. During the centralized review, in response to a question raised by the ERT, the United States explained that an increase in the Nex of 40–50 per cent would increase the estimate of N_2O emissions from agricultural soils by approximately 13 per cent. The ERT recommends that the United States, in its future inventory submissions, update its estimates of N_2O emissions from agricultural soils, if appropriate, when a revised Nex would be included in the calculations. After the centralized review, the United States informed to the ERT that it is planning an update of Nex values in the next inventory submission and has already updated the time series in the current draft submission for 2010.

62.   In principle, the estimation of N_2O emissions is based on knowledge of the N mass-flow. The ERT believes that the transparency of the United States' NIR could be substantially improved by the inclusion of an illustration of the N mass-flow with the appropriate amounts of N, indicating how and where the corresponding emissions are estimated. Therefore, the ERT recommends that the United States include such an illustration in its next inventory submission.

C. Non-key categories

<u>Manure management – N_2O</u>

63.   The level of N_2O emissions from manure management depends on the amount of N excreted by the animals and how this N is stored and treated in the different AWMS. The values for the Nex currently used to calculate the emission estimates are based on data from the United States Department of Agriculture's Agricultural Waste Management Field Handbook from 1996. The same value was used for all years of the time series regardless of the fact that productivity has increased in the dairy sector and that there has been a recalculation owing to the increased weight of the livestock. Many internationally peer reviewed articles of United States' scientists indicate that the Nex values used are far too low.[4] The 2006 IPCC Guidelines contain a methodology which for dairy cows would almost double the Nex compared with the actual values used and would also substantially increase the Nex for many other cattle groups. The ERT believes that, overall, the Nex in the United States' inventory were underestimated by 40 to 60 per cent. During the centralized review, the ERT was informed by the United States that it would update the Nex in the near future. The ERT strongly recommends that the United States do so for all cattle groups and for swine, in order to improve the estimates of N_2O emissions from manure management. After the centralized review, the United States informed the ERT that it will utilize the mass balance equations to estimate Nex for cattle in its next inventory submission, but that currently it does not have the required information to implement the mass balance equations for swine.

V. Land use, land-use change and forestry

A. Sector overview

64.   In 2007, net removals from the LULUCF sector amounted to 1,019,674.76 Gg CO_2 eq, offsetting 14.3 per cent of total GHG emissions. Since 1990, net removals have increased by 23.3 per cent. The key driver for the rise in removals is the increase in carbon stocks in forests and settlements. Within the LULUCF sector, in 2007, the most important net CO_2 sinks were: forest land remaining forest land (809,631.52 Gg), settlements remaining settlements (97,648.60 Gg), harvested wood products in solid waste disposal sites (63,524.68 Gg) and harvested wood products in use (36,912.97 Gg). In these years,

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[4] Cornell University, 2008; Nennich et al., 2006; Groff and Wu, 2005.

the most important sources of emissions in this sector were: biomass burning in wildfires (31,947.84 Gg CO_2 eq), application of lime and urea on cropland (8,007.06 Gg CO_2), land converted to cropland (5,947.33 Gg CO_2) and application of N fertilizers in settlements (1,608.69 CO_2 eq). The following categories have been reported as "NE": CO_2 emissions/removals from land converted to forest land, land converted to settlements, land converted to wetlands, and land converted to other land; and biomass burning in mandatory categories under cropland, grassland and wetlands.

65.   The ERT noted the substantial improvements made by the United States to achieve a consistent representation of the land use in the country, in spite of the difficulties posed by the use of several sources of data using different classification criteria and covering different areas of land. The ERT also welcomes the planned improvements described in the NIR (pp. 7–11) and particularly encourages the United States to provide, in its next inventory submission, a complete representation of the land use in the country, including the land areas currently excluded (most of Alaska and parts of Hawaii and the United States territories). There are still some inconsistencies in the United States' reporting that would merit further improvement: the areas reported in the CRF tables are different from those reported in the NIR, grassland and settlements being the most extreme cases (areas reported in the CRF tables for 2007 are 29 and 71 per cent lower, respectively, than reported in the NIR); and the areas of wetlands and other land have not been included in the CRF tables. After the centralized review, the United States informed the ERT that these inconsistencies are due to the fact that some portions of the land base are not included in the carbon stock inventory even though these areas are part of the managed land base. These areas are mainly federal grasslands and a portion of the wetlands. The United States currently plans an improvement to estimate carbon stocks on these lands for completeness and estimates will be available in future inventory submissions. For settlements the discrepancy related to the area is a result of the difference between the data reported in CRF table 5.E and that reported in the NIR Section 7.1. In table 5.E, the data reported are restricted to urbanized areas in the country, based on the United States census data. These AD are used for estimating net carbon stock changes in urban trees, and so these are included in table 5.E, instead of the data on total settlement area. The ERT acknowledges the explanations provided by the Party during and after the centralized review and encourages the United States to continue with its efforts to improve the consistency of reporting between the NIR and the CRF tables in its future submissions.

66.   The United States performed several recalculations of previous years' estimates in order to reflect the adoption of a new approach to the classification of land use, the incorporation of the National Resources Inventory as the official source of land areas estimates, and other improvements. However, some of these recalculations (e.g. limestone and dolomite consumption and emissions from biomass burning in forest land) have not been properly documented and reported. The ERT welcomes the information provided by the United States after the centralized review, indicating that the NIR of its next inventory submission will be reviewed to include complete documentation of recalculations.

67.   With regard to the LULUCF sector, the inventory is in general complete, although there are some inconsistencies and the use of notation keys is not adequate in some cases (e.g. "NE" has been used in CRF table 5.D instead of reporting the estimates provided for wetlands in table 5). In addition, the ERT noted that the United States has not provided estimates for certain land-conversion categories (e.g. land converted to forest land); an issue that was also raised in previous review reports. Finally, some time-series inconsistencies identified in previous review reports (e.g. for carbon stock changes in mineral soils on grassland remaining grassland) have not been resolved. The ERT recommends that the United States address the above-mentioned issues and implement improvements in its next inventory submission, in particular providing estimates for land conversions to forest land.

B. Key categories

1. Forest land – CO$_2$

68. The ERT identified a significant inconsistency in the time series of carbon stock changes in forest land. The reported annual net removals increased abruptly from an average of 521,480 Gg CO$_2$ over the period 1990–2001 to an average of 883,420 Gg CO$_2$ over the period 2002–2007, indicating the possibility of overestimations or underestimations of removals or both. This almost 70 per cent increase in removals occurred without any significant changes in the area of forest land. The United States explained in its NIR (pp. 7–20) that this "is largely associated with forest areas reported by surveys and is a product of the interpolated stock differences from the FIADB"[5], but it has not provided an assessment of the accuracy of these annual estimates or any other background information. After the centralized review, the United States explained to the ERT that improved forest management practices, the regeneration of previously cleared forest areas and timber harvesting result in this pattern of carbon sequestration and increase the amount of biomass stored in forest ecosystems. It also explained that any errors associated with the interpolation method were already considered in the estimated uncertainty. The ERT encourages the United States to provide a more in-depth assessment of the causes of this strong increase of annual net removals after 2001 in its next inventory submission.

2. Settlements – CO$_2$

69. The United States has reported all changes in carbon stocks under the category settlements remaining settlements, since, as mentioned in the NIR, these changes were due entirely to an expansion of the area of settlements. The areas covered by trees under the land-use change categories (different lands converted to settlements) have been reported separately in the NIR from those under the category settlements remaining settlements, but the estimates of carbon stock changes were not disaggregated. The United States explained during the centralized review that the methodology currently used does not allow for the estimates of carbon stocks to be disaggregated in such a way. The ERT welcomes the Party's planned improvement to develop a long-term data set that will define urban-area boundaries and make it possible to identify the areas that are forested under settlements, thus making it possible to estimate carbon fluxes in these areas. The ERT encourages the United States to make the necessary effort to conclude this work as soon as possible.

C. Non-key categories

Biomass burning – CH$_4$ and N$_2$O

70. For its 2009 submission, the United States recalculated the emissions from biomass burning on forest land. The ERT noted that this recalculation has not been addressed in the NIR. The recalculation was based on a reduction of the area affected by forest fires by approximately 33 per cent over the 1990–2006 time series. In spite of this large reduction in the area affected by forest fires, the resulting emissions increased. In the case of CO$_2$, the reported estimate of emissions for 2006 increased from 267,900 Gg CO$_2$ (2008 submission) to 316,600 Gg CO$_2$ (2009 submission). The estimates of emissions of CH$_4$ and N$_2$O also increased, the IEFs having doubled from the 2008 to the 2009 submission. It is not clear from the documentation provided in the NIR how the EFs for CH$_4$ and N$_2$O emissions were chosen, and why these factors were recalculated. The ratio of CH$_4$ to N$_2$O emissions is significantly higher than the IPCC default. The United States explained during the centralized review that there was an error in the completion of the CRF table in 2008 that was fixed in 2009. In addition, the United States informed the ERT that the estimates of non-CO$_2$ emissions were based on the IPCC good practice guidance for LULUCF and that it intends to adopt the updated EFs given in the 2006 IPCC Guidelines in its next inventory submission. The ERT recommends that the United States improve the background

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[5] The database of the United States Department of Agriculture's Forest Inventory and Analysis (FIA) Program.

documentation provided for this category and include the rationale and explanations for any recalculations made, in the NIR of its next inventory submission.

VI. Waste

A. Sector overview

71.   In 2007, emissions from the waste sector amounted to 165,587.07 Gg CO_2 eq, or 2.3 per cent of total GHG emissions. Since 1990, emissions have decreased by 6.5 per cent, owing mostly to the increase in landfill gas recovery. Within the sector, 80.2 per cent of the emissions were from solid waste disposal on land, followed by 17.6 per cent from wastewater handling. The remaining 2.1 per cent were from waste composting.

72.   The United States has reported estimates for all gases in the sector. Emissions from waste incineration have been reported under the energy sector; however, CH_4 emissions from waste incineration have been reported as "NE" and not as "IE" as the other gases have. The ERT recommends that the United States either correct the notation key, if appropriate, or include emission estimates for CH_4 from waste incineration in its next inventory submission.

73.   The United States used a methodology based on the first order decay model to estimate CH_4 emissions from solid waste disposal on land and the default IPCC methodologies to estimate CH_4 and N_2O emissions from wastewater handling. The methodologies and assumptions used in the estimation of emissions from the waste sector have been described in the NIR and comprehensive background data have been included in the annexes.

74.   The United States has provided recalculated CH_4 estimates for the complete time series for the categories solid waste disposal on land and wastewater handling, owing to the availability of updated AD (waste generation rate, data on industrial waste disposed at industrial landfills and the fraction of biochemical oxygen demand (BOD) in sludge that degrades anaerobically). This change in data resulted in a 0.1 per cent increase in the estimate of CH_4 emissions for 1990 and a 3.5 per cent increase in that estimate for 2006. N_2O emissions from domestic wastewater were also recalculated, based on the re-estimation of per capita protein consumption to account for the N loss as N_2O from the nitrification and de-nitrification system. This recalculation led to a 38.9 per cent decrease in the estimate of N_2O emissions for 1990 and a 33.5 per cent decrease in that estimate for 2006. Recalculation tables have been provided in the CRF tables for the period 1990 to 2006 and explanations included in the NIR.

B. Key categories

Solid waste disposal on land – CH_4

75.   Solid waste disposal on land is a key category and CH_4 emissions from this category contributed 1.9 per cent of the total national emissions in 2007. During the period 1990–2007, CH_4 emissions from landfills decreased overall by 10.9 per cent, with small increases occurring in some years. The United States explained, in its response to questions raised in previous stages of the review, that this downward trend in emissions was a result of the increase in landfill gas recovery.

76.   The per capita waste generation rate for the United States is above 2 kg/person/day with small fluctuations during the period 1990–2007. During the centralized review, the United States explained that a new methodology for data collection began for the 2004 State of Garbage in America survey based on actual tonnages and that the fractions in actual tonnages of the different categories of waste collected in this survey indicated inconsistencies in the previously used waste classification data across federal states, without the possibility of correcting the historic data retrospectively. In other countries, for example Canada, a constantly growing per capita waste generation rate reflects economic growth and an

increase in consumption. The per capita waste generation rate of the United States is rather constant over the time series. The ERT recommends that the United States make additional efforts to further explain the factors influencing the waste generation rate over time in its next inventory submission.

77. The ERT noted that the United States is continuously improving its inventory; however, the degradable organic carbon (DOC) value used to estimate CH_4 emissions remained constant for the entire period 1990–2007. This may not be an accurate reflection of the changing composition of waste in the United States, as waste recovery and recycling increased over this period. During the centralized review, the United States informed the ERT that this DOC value could be refined on the basis of data acquired as part of the country's forthcoming GHG reporting rule. The ERT recommends that the United States verify and potentially revise its DOC values using the new information that will be collected under the new GHG reporting rule, starting from 2010 and if possible before.

78. Following the recommendations made in the previous review reports, for its 2009 inventory submission the United States updated and improved the methodology used to estimate CH_4 emissions from the disposal of industrial waste, and performed recalculations. As a result of these recalculations, the share of emissions from industrial waste increased from 7 per cent for the complete time series (2008 submission) to 10 per cent of total emissions from landfills (2009 submission), which is still relatively small compared with other Parties. During the centralized review, the United States confirmed that the uncertainty of the methods and data used to estimate emissions from the disposal of industrial waste was very high. The ERT recommends that the United States continue its efforts to improve the AD for industrial waste, in order to improve accuracy in its next inventory submission.

C. Non-key categories

1. Wastewater handling – CH_4 and N_2O

79. In 2007, emissions from wastewater handling accounted for 29,225.08 CO_2 eq and they increased by 7.4 per cent since 1990 consistent with the increase in the country's population. The default IPCC methodology was used to estimate CH_4 emissions from wastewater handling and the 2006 IPCC Guidelines used to estimate N_2O emissions from human sewage.

80. The estimates in the 2009 submission of CH_4 from industrial wastewater treatment increased in the range from 9.0 to 10.0 per cent over the period 1990–2007, owing to the addition of petroleum refining wastewater treatment to the inventory, following the recommendations made in the previous review report. During the centralized review, the ERT was informed that the United States is planning to include in its next inventory emissions from the wastewater treatment of organic chemical industries. The ERT encourages the United States to increase its efforts to complete its coverage of emission sources in this category.

81. In the 2009 submission, N_2O emissions from human sewage have been estimated based on the 2006 IPCC Guidelines methodology, which recommends using the annual per capita protein consumption. The United States used the amount of protein available to be consumed, estimated on per capita annual food available data and its protein content, and adjusted the results using a factor to account for the fraction of actually consumed protein. The resultant value of actually consumed protein was 29.7 per cent lower than in the previous submission, which led to a 41 per cent decrease in the estimate of N_2O emissions from human sewage. The ERT noted that previous data on protein consumption were comparable to data from the Food and Agriculture Organization of the United Nations (FAO). The United States justified the recalculation and the deviation from FAO data with the explanation that the use of country-specific data from the Economic Research Service of the United States Department of Agriculture provides a more accurate emission estimate for the United States.

2. Waste incineration – CO_2

82.   In the United States, almost all incineration of MSW occurs in waste-to-energy facilities and, therefore, emissions from waste incineration have been included under the energy sector and the methodologies explained in the energy sector chapter of the NIR. However, it would be useful for the review if the waste sector chapter were to include a reference to the corresponding section in the energy sector chapter, explaining the allocation of these emissions and the information included. In the NIR of its 2007 submission, the United States indicated that 50.0 per cent of hazardous waste was combusted with energy recovery and that the remaining portion was incinerated solely for waste management purposes without energy recovery. Now, however, all combustion emissions from waste incineration have been included under the energy sector and the previous situation with regard to the combustion of hazardous waste seems to have changed. In section 3.7 of the NIR, it has been explained that "almost all" waste incineration occurs in waste-to-energy facilities, thereby indicating that some emissions may occur in the waste sector. After the centralized review, the United States provided additional information to the ERT, indicating that it does not currently include emissions from solid (non-hazardous) waste incineration without energy recovery because data on the amount of solid waste incinerated without energy recovery has not been reported since 1990. The national capacity for incinerating waste without energy recovery has not been reported since 1995 when it was 2,445 tonnes/day compared with a capacity for incinerating waste with energy recovery of 101,360 tonnes/day. Therefore the amounts of waste incinerated without energy recovery are considered negligible. The ERT recommends that the United States include additional information on the potential incineration of waste without energy recovery in the NIR of its next inventory submission, together with information explaining why the corresponding emissions are considered negligible.

VII. Conclusions and recommendations

83.   The ERT concludes that the inventory submission of the United States has been prepared and reported in accordance with the UNFCCC reporting guidelines. The inventory submission is complete and the United States has submitted a complete set of CRF tables for the years 1990–2007 and an NIR; these are generally complete in terms of geographical coverage and sectors, as well as generally complete in terms of categories and gases. Some of the categories, particularly in the industrial processes and LULUCF sectors, have been reported as "NE", and some categories were "NE" for all territories of the United States (e.g. carbon stock changes in forest land in Alaska). The ERT recommends that the United States explain in the NIR of its next inventory submission why the emissions from the categories reported as "NE" are considered being negligible, where information is not already provided in annex 5 to the NIR, particularly for those categories which the Revised 1996 IPCC Guidelines and/or the IPCC good practice guidance and the IPCC good practice guidance for LULUCF provide methodologies, in order to improve the completeness of its inventory in terms of both categories reported and geographical coverage.

84.   The United States' inventory is generally in line with the Revised 1996 IPCC Guidelines, the IPCC good practice guidance and the IPCC good practice guidance for LULUCF. In addition, the United States has used some methodologies and parameters from the 2006 IPCC Guidelines. However, there are a number of areas, such as the disaggregation of emissions from fuel combustion, where further improvements should be made.

85.   In the course of the review, the ERT formulated a number of recommendations[6] relating to the completeness of the United States' annual inventory submission and the transparency of the information presented in its NIR. The key recommendations are that the United States:

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[6] For a complete list of recommendations, the relevant chapters of this report should be consulted.

(a)   Use higher-tier methods to estimate emissions for key categories, in particular for CO_2 emissions from stationary combustion;

(b)   Continue to update methodologies and parameters in the areas of non-energy use of fuels and industrial processes;

(c)   Improve its allocation of fuel consumption for the United States territories as resources become available;

(d)   Develop updated EFs or country-specific parameters for several categories in different sectors (e.g. road transportation and industrial processes);

(e)   Update the N excretion rates used in the agriculture sector;

(f)   Verify and justify the current values used for DE and Ym in the category enteric fermentation;

(g)   Implement a full mass-flow model for volatile substance based on the revised parameters for CH_4 emissions from manure management;

(h)   Improve the data on AMWS and related EFs;

(i)   Further investigate the time-series inconsistencies in the LULUCF sector and either provide revised estimates, if appropriate, or revise the uncertainty estimate;

(j)   Incorporate area data for major portions of Alaska, Hawaii and other United States territories into the LULUCF sector;

(k)   Provide estimates for certain land-conversion categories (e.g. land converted to forest land and land converted to settlements);

(l)   Improve AD on waste deposited in landfills and data on flaring;

(m)   Include time-series consistency as a topic in the category-specific sections of the NIR;

(n)   Develop and apply, on a case-by-case basis and where not yet implemented, category-specific (tier 2) QA/QC procedures for the key categories in the inventory and describe these procedures and their application in the category-specific sections of the NIR.

Annex

Documents and information used during the review

A. Reference documents

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

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"Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories". FCCC/SBSTA/2006/9. Available at <http://unfccc.int/resource/docs/2006/sbsta/eng/09.pdf>.

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Synthesis and assessment report on the greenhouse gas inventories submitted in 2009. Available at <http://unfccc.int/resource/webdocs/sai/2009.pdf>.

FCCC/ARR/2008/USA. Report of the individual review of the greenhouse gas inventory of the United States of America submitted in 2008. Available at <http://unfccc.int/resource/docs/2009/arr/usa.pdf>.

B. Additional information provided by the Party

Responses to questions during the review were received from Mr. Leif Hockstad (United States Environmental Protection Agency), including additional material on the methodology and assumptions used. The following documents were also provided by the United States:

Cornell University. *Nitrogen Management on Dairy Farms.* Available at <http://www.dairyn.cornell.edu/pages/40dairy/410utilization/416excretion.shtml>.

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Kebreab E, Johnson KA, Archibeque SL, Pape D and Wirth T .2008. Model for estimating enteric methane emissions from United States dairy and feedlot cattle. *J. Anim. Sci.* 86: 2738-2748.

Mangino J, Bartram D and Brazy A. 2001. *Development of a Methane Conversion Factor to Estimate Emissions from Animal Waste Lagoons.* Eastern Research Group, Inc., Engineering and Analysis

Division, 14555 Avion Parkway, Suite 200, Chantilly, VA 20151. Presented at the United States Environmental Protection Agency's 17th Annual Emission Inventory Conference, Atlanta GA, 16–18 April 2002.

Nennich TD, Harrison JH, Van Wieringen LM, St-Pierre LM, Kincaid RL, Wattiaux MA, Davidson DL and Block E. 2006. Prediction and Evaluation of Urine and Urinary Nitrogen and Mineral Excretion from Dairy Cattle. *J. Dairy Sci*. 89:353–364.

Ogle SM, Breidt FJ, Eve MD and Paustian K. 2003. Uncertainty in estimating land use and management impacts on soil organic carbon storage for US agricultural lands between 1982 and 199. *Global Change Biology*. 9, 1521-1542.

Ogle SM, Breidt FJ, Easter M, Williams S and Paustian K. 2007. An empirically based approach for estimating uncertainty associated with modelling carbon sequestration in soils. *Ecological Modelling*. 205, 453-463.

Ogle SM, Breidt FJ, Easter M, Williams S, Killian K and Paustian K. 2010. Scale and uncertainty in modeled soil organic carbon stock changes for US croplands using a process-based model. *Global Change Biology. doi*: 10.1111/j.1365-2486.2009.01951.x, in press.

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