Convention on Long-range Transboundary Air Pollution

emep

Co-operative programme for monitoring and evaluation of the long-range transmission of air pollutants in Europe

TECHNICAL REPORT
MSC-W 1/2006

Inventory Review 2006

Emission Data reported to the LRTAP Convention and NEC Directive

Stage 1, 2 and 3 review

Evaluation of inventories of HMs and POPs

Vigdis Vestreng
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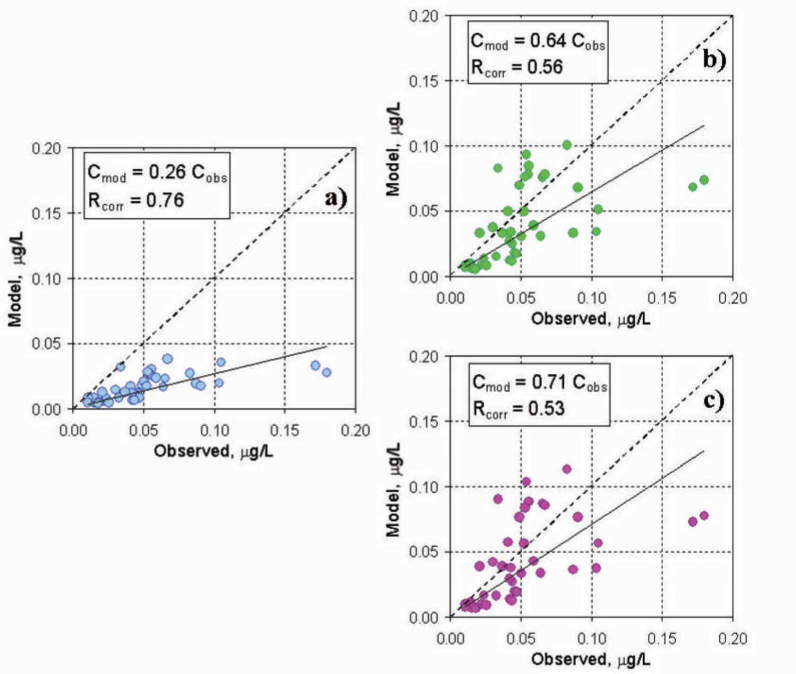
Comparison of observed Cd concentration in precipitation with modelling results based on official emissions data (a), ESPREME data (b), and ESPREME data along with re-suspension (c)



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EXECUTIVE SUMMARY

This report presents the second annual review of emissions data reported under the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP) and the National Emissions Ceilings Directive (NEC Directive). This annual review is a continuation of the 2005 inventory review that was formally performed for the first time last year. The review has been performed according to the Draft methods and procedures for the technical review of air pollutant emission inventories under the Convention on Long-Range Transboundary Air Pollution (EB.AIR/GE.1/2005/7, annex III) and informed by feedback obtained following the review and trial reviews of air emissions data in previous years.

The report is arranged in four main sections. The first two sections present results from the Stages 1 and 2 of the 2006 review of inventory data quality. The objective of the Stage 1 review is to assess compliance aspects such as the timeliness, format and completeness of submissions with respect to Protocol obligations, while Stage 2 considers additional aspects of inventory 'quality' such as key source analysis, transparency, source and time series completeness, consistency and comparability of the data, and evaluates the extent and scope of recalculations and inventory comparisons. The feedback to the countries from the Stage 1 and 2 reviews are first the form of country specific review reports, so called Synthesis and Assessment reports Part I (S&A-I). This report includes an example of a S&A-I as provided to all Parties and Member States. The next feedback constitutes an overview of the findings, a Synthesis and Assessment report Part II (this report). This year test results are presented separately for the NEC and the LRTAP data.

The preliminary results of the Stage 1 and 2 reviews were presented at the TFEIP/ Expert Panel on Review (EPR) meeting in Amersfoort, Netherlands, 14 June 2006. A main conclusion from this meeting was that the Parties acknowledged the usefulness of the review and considered it should be continued along the same general lines as present. Further support toward this opinion is provided by the increased active participation by countries in the annual review process.

The main messages generated from this year's Stage 1 and 2 review are summarised below. Further details on each issue are provided in the respective sections of the main body of the report.

- ***Completeness***: the overall completeness of reporting remains low for many LRTAP countries. The completeness of the EMEP sector data time series (independent of reporting format, and regardless of time series consistency) is largest for SOx and NOx (80%) and lower for NMVOC and NH3 (70%). The completeness of the reporting of sector data is still lower for the PMs than for the Main Pollutants, but has been steadily increasing, from around 40% completeness in 2000 to about 60% in the reported 2004 emissions.
- ***Timeliness***: The timeliness of reporting increased for the Convention countries compared to last year, but still only 27 Parties (55%) reported on time. By 15 June 2006, the total number of submissions had increased to 35 Parties (71%), an increase of 2 Parties compared to the same time last year. In contrast the number of countries reporting NEC data on time to the European Commission decreased. Only eleven of the twenty-five Member States reported emission data by the due date of 31 December 2005. Including late submissions, a total of twenty-one Member States reported data to the European Commission by July 2006.

- ***Transparency***. After several years of the review process, the level of transparency associated with the reported emissions data is increasing. Despite the fact that the Guidelines only ‘encourage’ Parties to submit Informative Inventory Reports, 35% of Parties submitted this information. Almost half of the Parties responded to the review questions.
- ***Time-series checks.*** Many countries reported a need for recalculation of their emission data having reviewed the results of the time series test. Therefore it is also clear that some of the data is not comparable and consistent between years.
- ***Comparability of data.*** Two tests to check the comparability of data across countries were performed – calculation of cross-pollutant ratios and implied emission factors. The comparability between pollutants and countries appears relatively good according to the cross-pollutant test, with relatively few outlying values determined. On the other hand, more than 40% of reporting countries showed more than 20 % flagged values in the Implied Emission Factor test. Responses from countries indicate that many of these differences are real, i.e. they correspond to differences in national circumstances such as different fuel splits, technologies etc.
- ***Fuel sold vs fuel used.*** This year’s review showed that more countries continue to report emission based on the amount of fuel used to estimate their emissions. The difference in emission values obtained from the two different methods is small in most countries. However, in countries with low fuel prices and resulting high fuel tourism from neighbouring countries, the difference can be as high as 40 %.
- ***Recalculations.*** A relatively large number of countries (46% of LRTAP Parties and 50% of NEC) reported significant recalculations (> 10%) between their 2005 and 2006 data submissions. All but two countries explain the reasons for their recalculation, mostly by means of Synthesis and Assessment report Part I; countries are to be thanked for providing this information. The magnitude of recalculations made also provides some indication of the general uncertainty of the emissions, relevant when emission ceiling targets are expressed in absolute terms, and not as percentage reduction targets. There was no general trend seen in the recalculations.
- ***Comparison of inventory submissions.*** Differences occur between inventories that countries submit to LRTAP, NEC and under the EU Monitoring Mechanism. Such differences were found to be mainly due to a) different reporting requirements, geographical scope etc and b) less stringent levels of QA/QC checking for air pollutant data reported to EU-MM leading to errors in reporting.
- ***Improvements for the review process.*** A number of improvements that could be made in the future in order to improve the utility of the review for countries have been identified. These include refinement of test on time series consistency and cross pollutant ratios, and improvements to REBDAB that countries may use to perform basic quality checks on their data prior to official submission.

The specific recommendations and requests made to the bodies from the 2006 review:

- Harmonisation of the LRTAP reporting Guidelines and NEC reporting on aspects such as source coverage and reporting deadlines;
- Provide a clear definition of completeness to allow this to be formally analysed for compliance purposes;
- Consider if the NEC data can be made publicly available through WEBDAB or an EEA website to improve public accessibility to, and transparency of this data.
- There is a clear need for improved coordination between the European Commission, the EEA and the review team to ensure that reported NEC data is made available for the review.

The third section of the report presents a summary of the main findings from the trial Centralised review performed for the first time in 2006 on the air emission inventories of SOx, NOx, NMVOC and NH3 submitted by Parties to the Convention on Long-Range Transboundary Air Pollution (LRTAP) and by Member States under the requirements of the National Emissions Ceilings Directive (NEC Directive).

General conclusions from the Stage 3 trial review consider that a Centralised review is a good model to follow for this type of review, but that time is needed to define the scope and purpose of future reviews. Also a clear guidance regarding what criteria to review against and definition of roles and responsibilities are needed. Further specific conclusions and recommendations were identified:

- ***Guidelines***. For review purposes clear guidance regarding what criteria to review against is necessary in order to be able to assess completeness i.e. the mandatory reporting requirements on a country-specific basis. Submission of an IIR is necessary for review purposes and should be made mandatory in the Guidelines if future detailed reviews are desired. Similarly activity data that can be used in verifying emissions should be made available. A number of recommendations for the reporting template were identified to improve the comparability, transparency and consistency of data reported by countries.
- ***Guidebook***. The Guidebook was considered suitable as a point of reference for the purposes of detailed review for the pollutants covered in this review. It was foreseen that the Guidebook will not provide sufficient information for other pollutants (e.g. PM_{10}, pesticides etc) and will need to be further developed to support future review activities.
- ***Usefulness of Stage 1 and 2 reviews.*** The country specific reports from the Stage 1&2 review were considered by the expert reviewers to provide very useful input to the detailed review and were considered an excellent way of giving feedback to countries.
- ***Value of a Stage 3 review.*** The review team identified a number of issues concerning the value added from a stage 3 detailed review as compared with Stage 1&2 review. A number of benefits that may be obtained from participating in a Stage 3 review were identified both for the countries being reviewed as well as for the experts participating in the review. The most important of these was seen as being able to provide country-specific feedback and recommendations to help in prioritisation and inventory improvement, as well as a deeper assessment of comparability, e.g. methodologies and emission factors used.

Finally, the fourth section of this document presents recent independent studies addressing emissions of Heavy Metals and Persistent Organic Pollutants within (parts of) the EMEP domain. The results of these may be useful in reviewing official submitted HM and POP emission data reported annually to the Secretariat of the UNECE under the Convention LRTAP. Furthermore, data collected in these projects, comparisons between expert and official data and lessons learned may provide suggestions to improve the current official data reporting.

Contents

1 INTRODUCTION

At its twenty-first session, 21st January 2004, the Executive Body of the Convention on Long-range Transboundary Air Pollution (LRTAP) recognized the importance of high-quality emission data and strongly encouraged further work on its improvement and validation (UNECE, 2004a, paras. 56 and 60(n)[1]). The Convention's Task Force on Emission Inventories and Projections (TFEIP), in collaboration with the European Environmental Agency (EEA) and the European Commission's Joint Research Centre (JRC), has subsequently initiated an Inventory Improvement Programme. This initiative has been supported by the European Commission, as it is also relevant to emission data submitted under Directive 2001/81/EC (EC, 2001) of the European Parliament and of the Council on national emission ceilings for certain atmospheric pollutants (the NEC Directive).

This report presents results from the second annual review of emissions data reported under the UNECE Convention on Long-Range Transboundary Air Pollution (LRTAP) and the NEC Directive. This annual review is a continuation of the inventory review that was performed in 2005, and the two preceding trial reviews performed in 2003 and 2004 (e.g. Vestreng et al., 2005). In 2006, as in the preceding reviews, the assessment of the inventory data has been performed on both emissions data reported under the LRTAP Convention and under the NEC Directive. The review results for the two datasets are shown separately under each of the review tests. The review itself has been performed according to the Draft methods and procedures for the technical review of air pollutant emission inventories under the Convention on Long-Range Transboundary Air Pollution (EB.AIR/GE.1/2005/7, annex III).

This formal review process currently consists of two stages: Stage 1 assesses compliance aspects such as the timeliness, format and completeness of submissions with respect to Protocol obligations, while Stage 2 considers additional aspects of inventory 'quality' such as key source analysis, transparency, source and time series completeness, consistency and comparability of the data, and evaluates the extent and scope of recalculations and inventory comparisons.

As in previous years, Parties were requested to report according to the criteria for reporting in the Emission Reporting Guidelines[2] (herafter referred to as the *Guidelines*), and were encouraged to check their submissions for correct formatting, internal consistency and completeness before transmitting them to the UNECE secretariat for stage 1 reviews. To facilitate this task, the latest update of the electronic data-checking tool, REPDAB, including key source analysis and trend plots, was made available to Parties at: http://webdab.emep.int/repdab.html.

In addition to the formal Stage 1 and 2 reviews, a main focus this year has also been on the development of a trial in-depth (Stage-3) review, as agreed at the 2005 joint EIONET/TFEIP meeting at Rovaniemi, Finland. The Stage 3 reviews are intended to build on results from Stages 1 and 2 and aim to assess several aspects of inventory quality, including accuracy. A trial stage 3 centralised, review was therefore carried out on the submissions from 11 countries in February 2006 on a voluntary basis. As with the Stage 1 and 2 reviews, this

[1] UNECE, 2004a, ECE/EB.AIR/79, Report on the twenty-first session of the Executive Body, UNECE, 21. January, 2004.
[2] UNECE, 2003, Emission Reporting Guidelines, Air Pollution Studies No. 15, United Nations, New York and Geneva, 2003

initiative has also been supported by the European Commission. Scope and purpose for future in-depth (Stage 3) reviews are currently being developed by the Task Force on Emission Inventories and Projections and will be discussed at the Steering Body at its thirtieth session (4-6 September, Geneva, Switzerland)..

We have also continued the review of Heavy Metals (HMs) and Persistent Organic Pollutants (POPs), initiated in the 2005 review. Moreover, both the NEC Directive and the Protocol to Abate Acidification, Eutrophication and Ground-level Ozone (Gothenburg Protocol) are being reviewed in 2006-2007. A focus has therefore also been to assess the completeness of emission data, emissions recalculations and the comparability of NEC and LRTAP data.

The report has four main sections. The two first sections present the summary of Stages 1 and 2 of the 2006 review of inventory data quality, referred to as the Synthesis and Assessment report Part II (S&A-II). The first Synthesis and Assessment report (S&A-I), were the country specific reports posted on a password protected site on the EMEP website (*http://www.emep.int/REVIEW/2006/*) on 15th May 2006. An example of a country-specific Synthesis and Assessment report is provided in Appendix 6. These S&A-I contain the same elements as covered in the two first sections of this report, but at a country specific level.

The review has included all data that were officially submitted and received by the review team of experts by 10th March 2006. The data was available to the countries from WEBDAB (http://webdab.emep.int/) (Vestreng and Klein, 2002) at the time the country specific reports were launched, and to the public in general from June 2006. Ten review tests have been performed. Two of these can be regarded as being compliance-focussed i.e. assessments of the timeliness and format of the submitted data. In contrast, the remaining eight tests (analysis of key sources, completeness, consistency, cross pollutant, recalculations, inventory comparison, time series, implied emission factors) share the general aim of providing countries with information to allow them to optimise their own inventory quality and hence future reporting in subsequent submission rounds. Additionally, it is intended that the more general findings from the review can also be used to prioritise future activities of the Task Force on Emission Inventories and Projections (TFEIP) and the European Environment Information and Observation Network (EIONET).

The third section of this report presents a summary of the main findings from the Stage-3, trial centralised review, prepared by the review Secretariat team.

Finally, the fourth section presents recent independent studies addressing emissions of Heavy Metals and Persistent Organic Pollutants within (parts of) the EMEP domain. The results of these may be useful in reviewing official submitted HM and POP emission data reported annually to the Secretariat of the UNECE under the Convention LRTAP. Furthermore, data collected in these projects, comparisons between expert and official data and lessons learned, may provide suggestions to improve the current official data reporting.

The preliminary results from the Stage 1-3 review were presented at the TFEIP/ Expert Panel on Review (EPR) meeting in Amersfoort, Netherlands, 14 June 2006. The experiences with the 2006 review procedures will also be further discussed at the joint EIONET/TFEIP meeting in Thessaloniki, Greece, 31 October – 2 November 2006. The results of the 2006 inventory review contained in this report will be presented there, and the TFEIP and EIONET will have the opportunity to give feedback, taking account of comments from the thirtieth session of the EMEP Steering Body, with the aim of improving review procedures in future years.

2 STAGE-1 REVIEW

An overview of the results from Stage-1 review together with information on the amount of documentation received for each LRTAP submission can be found in Appendix 1.

2.1 TIMELINESS OF SUBMISSIONS

Key messages –Timeliness

- *LRTAP: A total of 27 Parties reported emission data by the due date of 15 February 2006. This was an increase of 3 Parties compared to last year (2005) and implied that 55% of Parties reported their submissions in time. By 15 June 2006, the total number of submissions had increased to 35 Parties (71%), an increase of 2 Parties compared to the same time last year.*
- *NEC: Only eleven of the twenty-five Member States reported emission data by the due date of 31 December 2005. Six EU15 Member States reported by this date, a decrease of three Member States compared to last year. Five new EU10 Member States reported emission data on time, an increase of 2 Member States compared to last year. Including late submissions, a total of twenty-one Member States have reported data to the European Commission by July 2006. Stage 2 tests were performed for 15 countries (excluding Finland and Denmark and including Italy for 2003) for national totals and 14 countries (excluding Hungary) that reported in the NFR format.*

2.1.1 LRTAP

Figure 2.1 displays the timeliness of the Party submissions of data under the Convention of LRTAP. The submission date is annotated at the y-axis, while the Parties are listed on the x-axis. Parties listed to the left in the figure submitted data in the 2006 reporting round (71%), 55% of them within deadline (those listed to the left of the red line). Parties to the right have not submitted data in 2006 at the time of writing this report.

The issue of Parties resubmitting (corrected) data after the formal reporting deadline was discussed in the meeting of the Expert Panel on Review, June 14th 2006 in Amersfoort, theNetherlands. It was clarified that the review 'Draft Methods and Procedures' document (UNECE 2005) allows a 3-week window for Parties to resubmit data following the reporting deadline. The objective of this 3 week period is to provide Parties with an opportunity to find obvious errors and mistakes in their submissions (assisted by the Stage 1 review feedback provided by the UNECE Secretariat); countries then have an opportunity to further improve the quality of their submitted data that can subsequently be used in the review process and for EMEP modelling purposes.

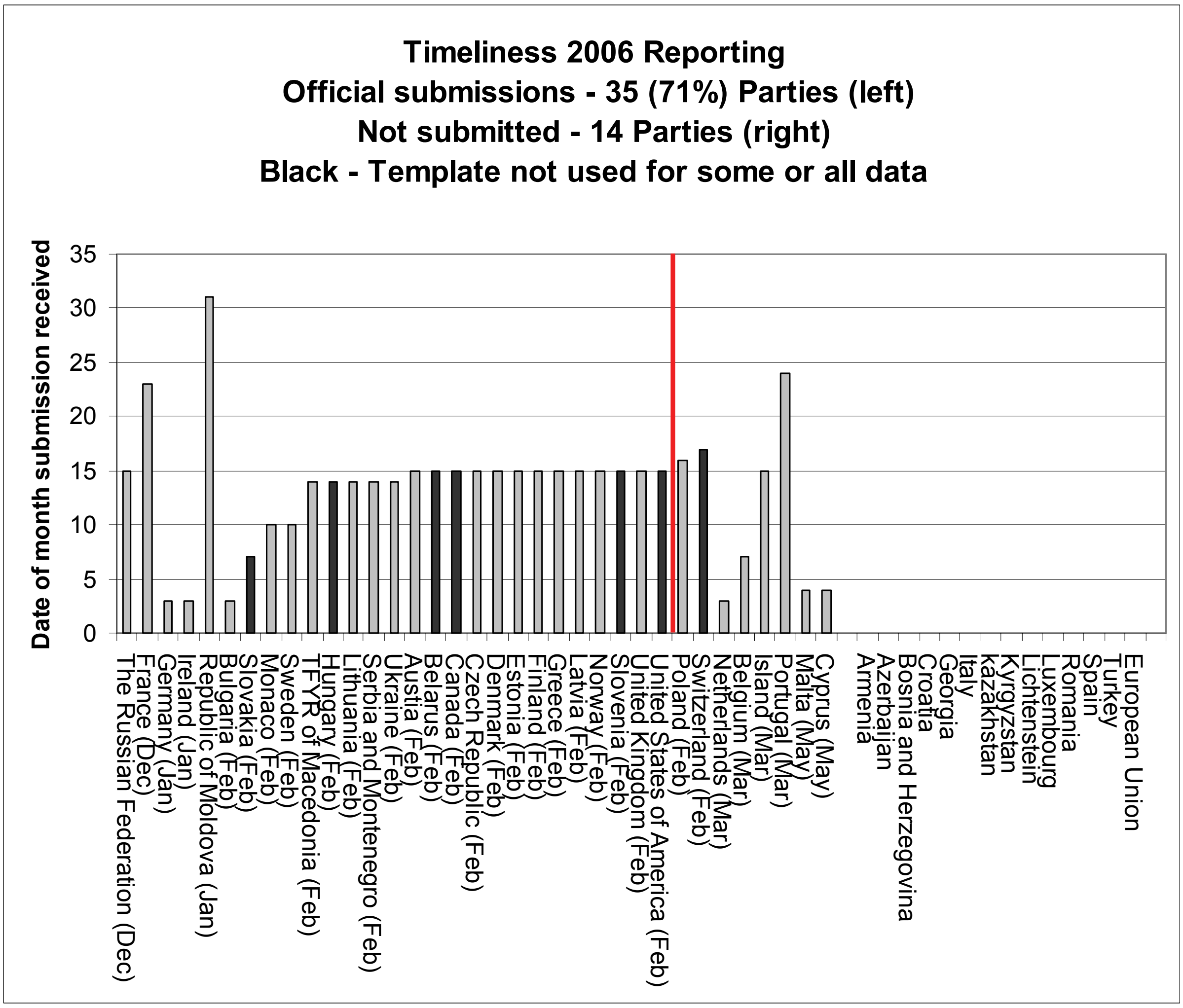

Figure 2.1. Timeliness of LRTAP submissions. Countries to the left of the vertical line reported submissions within the reporting deadline of 15th Feb.

2.1.2 NEC

Of the 25 EU Member States, eleven Member States (AT, BE, DK, FI, FR, HU, LV, LT, NL, SK, SI) submitted inventory data on time to the European Commission. Ten Member States reported their submissions after the reporting deadline. Four countries did not report to the Commission (Figure 2.2). The level of reporting in 2006 is identical to that observed in 2005, when again 5 Member States had not reported data to the Commission by July of that year. Poland is the only country not to have reported NEC data in either the 2005 or 2006 reporting years.

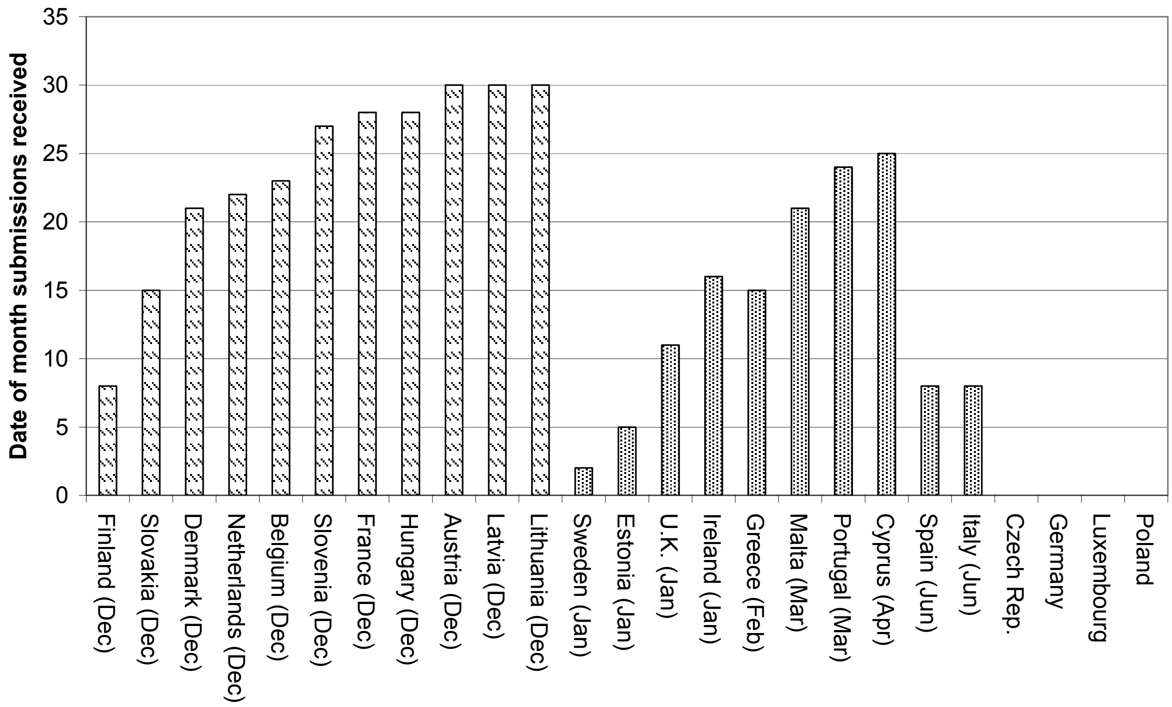

Figure 2.2. Date of first receipt of Member State NEC submissions received by the Commission or the EEA by 30 June 2006. Member States submitting data within deadline are displayed to the left (light), the others to the right (dark).

From the perspective of the review team, problems again experienced in 2006 in terms of receiving NEC data in time for inclusion in the review. Several countries (e.g. Finland, Denmark) reported NEC data to the European Commission, but this data was not made available to the EEA or the review team, which would have allowed it to be included within this year's review. This was evident when Parties responded to the Synthesis and Assessment Report Part I. As has been noted in previous years, there is still a clear need to improve the organisation and dataflow between the EC, EEA and the review team and to agree a clear definition of responsibilities.

It is also noted that there are more MS reporting to LRTAP than to NEC. The earlier NEC deadline is known to be one aspect behind the lower levels of reporting observed to NEC.

2.2 FORMAT

Key messages – Format

- *LRTAP: Reporting in the NFR format has increased dramatically for all Parties since 2000. In 2006, all Parties submitted data for source categories using the Nomenclature for Reporting (NFR) format specified in the Guidelines, with the exception of the United States.*
- *EMEP still has to use emissions reported using the old SNAP format, including the intermediate NFR 01 format, for a substantial amount of emission data in the 1990s as about 80% of Parties have not recalculated their time series with the new (NFR02) format.*
- *NEC: Of the Member States that had reported NEC emission data by 30 June 2006, only Hungary reported data in a non-standard format. All other Member States that did report used the new NFR format for reporting.*

2.2.1 LRTAP

All Parties submitted data in the 2006 reporting round according to the format specified in the Guidelines using the Nomenclature for Reporting (NFR) for source categories, with the exception of the United States. Seven countries reported additional data in formats other than in the NFR template provided. These countries are shown in black in Figure 2.1.

2.2.2 NEC

Of the Member States that had reported NEC emission data by 30 June 2006, only Hungary reported national totals in a non standard format (MS Word tables). All other Member States that did report used the new NFR format for reporting.

2.3 TRANSPARENCY

Key messages – Transparency

- *Seventeen Parties (i.e. 35%) submitted an Informative Inventory Report (IIR) to accompany their 2006 LRTAP submissions, an encouraging level given that that submission of an IIR is not mandatory.*
- *Twenty-three countries (47% of total or 66% of those reporting) replied to the stage-2 country specific Synthesis and Assessment review reports (Appendix 6). This was a considerable increase in the transparency from earlier years. The IIR submissions have more than doubled since 2004. Both the number of IIRs and the responses increased by 5 countries since last year.*

2.3.1 LRTAP

The overall transparency of the data submissions has increased substantially, particularly as a result of the introduction of the stage-2 review and its responses. The present reporting Guidelines do not request, but merely encourages, the submission of an Informative Inventory Report (IIR). Seen in this perspective it is indeed encouraging that 35% of the Parties do submit this information. The number of IIRs and review responses are quite similar (17 versus 23), but the content and structure of the IIR does not always make it easy or even possible to find the answers to the specific review questions posed to countries.

The challenges for Parties to provide an IIR suitable for informing the review process were discussed at the TFEIP meeting in 12-13 June 2006 in Amersfoort, the Netherlands. The proposal for a revision of the 2002 Guidelines will include a template for the IIR and a request to make this information mandatory. Appendix I gives an overview of Parties which have submitted IIRs and or Review responses.

3 STAGE-2 REVIEW RESULTS AND ANALYSIS

3.1 INTRODUCTION

This review was performed in accordance with the methods and procedures for review of emissions data under the LRTAP as outlined in Annex III of EB.AIR/GE.1/2005/7 (UNECE 2005). In addition, efforts have been made to meet the requests from the Parties following feedback from the first annual review in 2005 (Vestreng et al., 2005) and earlier trial reviews (e.g. Vestreng et al., 2004). The 2006 Stage 2 review presents the results of different types of review tests and lists specific questions about emissions inventory submissions to LRTAP and NEC. We have chosen to focus the tests on main pollutants, PMs and priority HMs and POPs and on key sources. This year's review was performed by EMEP/MSC-W in co-operation with the European Topic Centre on Air and Climate Change (ETC-ACC) partner institutes UBA-Vienna and AEA Technology.

An underlying objective of the review process is to encourage and support inventory improvements. As part of the Inventory Improvement Programme under the Task Force on Emission Inventories and Projections (TFEIP), Parties are encouraged to gradually improve the quality of their reporting. However, it is recognised that Parties do not always have the levels of resources required to implement all possible improvements in time for the next reporting round. We do appreciate ideas for better solutions that may be implemented at an international level to help improve the reporting and quality at national scale over a longer timescale.

The improvements introduced to this year's country specific review reports were:

- Separate testing and reporting of results for LRTAP and NEC data if the inventories are proved to differ by more than 0.1%;
- Improved key source analysis including percentage contribution for each sector;
- Introduction of two 'average' reports, one for Eastern Europe and one for Western Europe, to allow Parties to compare results against the 'average' results for their respective region;
- Improved completeness testing with a stronger focus on Protocol requirements, priority compounds, key sources and reporting of Not Estimated;
- Improved comparability testing by introducing ratios for a greater number of pollutants where relevant;
- Inclusion of inventory comparisons with EU Monitoring Mechanism data;
- Inclusion of summary trend plots;
- Streamlining and extension of the time series 'dips and jumps' check for main pollutants back to 1980;
- Improved implied emission factor (IEF) checks by analysis using the UNFCCC outlier tool.

The country specific review reports containing questions from the review tests were made available on a password protected website under EMEP the 15th May 2006, requesting response by 15 June 2005. An example country specific report is provided below in Appendix 6.

The emission data included in the 2006 review were those data reported to the UNECE under the LRTAP Convention, or to the European Commission under the NEC Directive, and received before 10th March 2006/28 February 2006 respectively. The LRTAP data included in the review was made available to Parties through a pre-release of WEBDAB, at the same time as the country specific reports were issued.

The draft review findings were discussed at the meeting of the TFEIP/Expert Panel on Review at its meeting in Amersfoort, the Netherlands, 12-14 June 2006. The countries present provided feedback that indicated they found the Stage 1 and 2 review process to be very helpful in terms of assisting to improve the quality of their own national inventories, and supported its continuation. Some recommendations for future developments were given, and these are listed in chapter 6 below.

The results from the Stage 2 review are also able to provide feedback to the more in-depth Stage 3 review assessments. For example, a trial Stage 3 centralised review was performed in Copenhagen 27 February-3 March 2006 (see Chapter 4). Feedback from the experts involved in this review showed the Stage 1 and 2 review reports were useful input for the purposes of the Stage 3 review.

3.2 KEY SOURCE ANALYSIS

Key messages – key source analysis

A modified key source analysis was performed in 2006 in order to identify major emission sources by country and compound.

- *Feedback received from Parties indicated they were pleased with the key source analysis developments, and appreciated that these analysis are also available from the submission checking tool REPDAB.*
- *The average key source analysis for West and East Europe shows few differences, except that the Western countries tend to report information on a more detailed level than the Eastern countries.*

This section describes the key source analysis performed under the Stage-2 review. Each country that had submitted data was provided with a key source analysis for 2004 in their review report. In addition, REPDAB provided key source analysis for each year submitted, for those countries that used this tool to check their data prior to submission. The analysis for the review report was made both at most aggregated and least aggregated sectoral (NFR02) levels if sufficient amount of data was provided. This was an improvement from last year where analysis at only one level of aggregation was provided.

An average regional key source analysis was also made available for countries: one for *Eastern Europe* (Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Poland, Republic of Moldova, Romania, Serbia and Montenegro, Slovakia, Slovenia, TFYR of Macedonia, The Russian Federation, Turkey, Ukraine); and one for *Western Europe* (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom).

Parties responded in their review replies that they appreciated these improvements. The analysis on the least aggregated level for Eastern and Western European countries is displayed in Table 3.1 and Table 3.2 below. A list of NFR02 sector codes can be found in Appendix 2. The tables present the key sources in order of importance on the x-axis and the priority pollutants on the y-axis. The table presents the NFR02 sector codes along with the percentage contribution of each respective sector to the national total. When 95% of national total or 10 sources (whichever came first) was reached, the sum of key sectors in percent was presented in column "Total %" and the number of sources not listed in the column "Not listed".

The most important key sources are very similar between the Eastern and Western European countries. The most striking difference is found in the level of detail provided within the two groups. The Eastern countries more often take the opportunity to report only aggregated levels of emissions, e.g. 1A3b, *Road Transport*, without detailing the emissions to different vehicle types. The larger number of sectors for emissions in the West is also reflected in the "Not listed" column, where except for a few exceptions, the West has a larger variation of sources. Differences occur for PMs and POPs. PM10 and PM2.5 from *Residential plants* (1A4bi) is more important in Western Europe than *Energy production* (1A1a), which seems to be most important in the East. *Petroleum refining* (1A1b) is the most important PCDD/F source in the West, while *Residential plants* (1A4bi) has this position in the East. While *Metal production* (2C) is the largest HCB source in the East, Manufacturing in industries of *Non-ferrous metals* (1A2b) is the largest source in the West.

Average key source distribution reports like this should be interpreted with care, as the overview is biased towards the distribution of the largest emitter countries in each group. A smaller country could have a very different source distribution. As mentioned before, the countries were provided with key source analysis for their own country. Countries responding to the stage-2 review had no comments to the key source analysis performed.

Table 3.1. Key source analysis for Eastern European countries

Component	Key source categories (Sorted from high to low from left to right)										Total (%)	Not listed
SOx	1 A 1 a (59.1%)	1 A 2 (16.2%)	1 A 4 b (5.3%)	1 A 3 b (4.0%)	1 A 3 e ii (2.8%)	1 A 4 a (1.8%)	2 C (1.2%)	1 A 1 b (1.2%)	1 A 1 c (1.0%)	1 A 4 c i (0.6%)	93.2	31
NOx	1 A 3 b (37.6%)	1 A 1 a (24.8%)	1 A 3 e ii (14.7%)	1 A 2 (9.0%)	1 A 4 b (3.0%)	1 A 4 c ii (1.9%)	2 C (1.2%)	1 A 3 c (0.9%)	2 B (0.8%)	1 A 4 a (0.7%)	94.5	2
NH3	4 B (77.0%)	4 D 1 (8.1%)	2 B 1 (3.0%)	1 A 4 c (0.8%)	6 B (0.8%)	6 D (0.7%)	1 B 2 (0.4%)	1 A 3 b (0.3%)	2 B 5 (0.2%)	4 F (0.1%)	91.4	26
NMVOC	1 A 3 b (51.4%)	1 A 2 (9.4%)	1 B 2 (8.5%)	7 (6.3%)	3 A (4.3%)	1 A 4 b i (3.0%)	3 D (2.2%)	1 A 4 b ii (2.0%)	3 C (1.3%)	3 B (1.3%)	89.8	7
CO	1 A 3 b (61.6%)	1 A 2 (11.2%)	1 A 4 b i (11.0%)	2 C (5.0%)	6 C (3.9%)	1 A 4 c i (1.2%)	1 A 1 a (0.6%)	1 A 4 b ii (0.5%)			95.1	0
TSP	2 C (15.3%)	1 A 1 a (4.5%)	2 A 6 (2.7%)	1 A 4 b i (1.4%)	1 A 2 b (0.6%)	1 A 2 f (0.5%)	1 A 2 a (0.2%)	2 A 1 (0.1%)	1 A 3 b (0.1%)	1 A 4 c ii (0.1%)	25.5	39
PM10	1 A 1 a (33.8%)	1 A 4 b i (20.2%)	1 A 3 b (6.8%)	1 A 2 a (6.5%)	1 A 2 b (4.8%)	2 A (4.7%)	1 B 2 (3.6%)	2 C (1.8%)	1 A 4 c i (1.7%)	1 A 1 c (1.7%)	85.6	10
PM2.5	1 A 1 a (30.8%)	1 A 4 b i (23.7%)	1 A 3 b (9.4%)	1 A 2 a (6.9%)	1 A 2 b (4.9%)	2 A (4.8%)	1 B 2 (3.7%)	1 A 4 c i (1.7%)	1 A 4 c ii (1.4%)	6 C (1.4%)	88.8	8
Pb	1 A 2 (43.7%)	1 A 1 a (13.9%)	2 A 7 (7.7%)	2 C (7.7%)	6 C (7.0%)	1 A 4 c i (6.4%)	1 A 3 b (4.4%)	1 A 4 b (3.5%)	1 B 1 b (1.2%)		95.4	0
Hg	1 A 1 a (41.6%)	1 A 2 (23.8%)	1 A 3 b (13.0%)	6 C (4.4%)	1 A 4 b i (4.2%)	1 A 1 c (3.2%)	2 A (2.4%)	1 A 4 c i (1.6%)	2 B 5 (1.4%)		95.6	0
Cd	1 A 2 (48.2%)	1 A 1 a (19.5%)	1 A 4 c i (13.5%)	1 A 4 b i (5.0%)	1 B 1 b (3.8%)	2 C (2.5%)	6 C (2.3%)	1 A 3 b (1.7%)			96.5	0
DIOX	1 A 4 b i (27.7%)	6 D (18.7%)	1 A 2 (17.7%)	1 A 1 a (13.3%)	2 C (10.9%)	6 C (5.0%)	1 A 3 b i (1.2%)	1 A 4 a (0.9%)			95.5	0
PAH	1 A 4 b i (71.6%)	1 A 4 c i (12.8%)	1 B 1 b (10.0%)	2 C (3.6%)							98.0	0
HCB	2 C (51.7%)	1 A 2 (25.9%)	1 A 1 a (8.7%)	1 A 4 b i (6.1%)	6 C (5.5%)						97.9	0

Table 3.2. Key source analysis for Western European countries

Component	Key source categories (Sorted from high to low from left to right)										Total (%)	Not listed
SOx	1 A 1 a (47.3%)	1 A 1 b (10.0%)	1 A 2 f (9.7%)	1 A 4 b i (5.6%)	1 A 2 a (2.9%)	1 A 3 d ii (2.3%)	1 B 2 a (2.3%)	1 A 4 a (2.3%)	2 B 5 (2.0%)	1 A 2 c (1.6%)	86.0	8
NOx	1 A 3 b iii (20.2%)	1 A 3 b i (15.3%)	1 A 1 a (15.3%)	1 A 2 f (9.1%)	1 A 4 c ii (5.1%)	1 A 4 b i (5.0%)	1 A 3 b ii (4.4%)	1 A 3 d ii (3.6%)	4 D 1 (2.3%)	1 A 1 c (2.1%)	82.5	14
NH3	4 B 1 b (24.8%)	4 B 1 a (21.7%)	4 D 1 (17.2%)	4 B 8 (15.2%)	4 B 9 (10.6%)	1 A 3 b i (2.2%)	4 B 3 (1.5%)	4 B 13 (1.4%)	4 B 6 (1.0%)		95.5	0
NMVOC	1 A 3 b (19.0%)	3 D (17.5%)	3 A (14.8%)	1 B 2 a (8.7%)	1 A 4 b i (8.3%)	3 C (3.4%)	2 D 2 (3.1%)	2 B 5 (3.1%)	4 D 1 (2.8%)	3 B (2.1%)	82.9	13
CO	1 A 3 b i (31.2%)	1 A 4 b i (21.1%)	1 A 2 a (10.3%)	2 C (9.5%)	1 A 2 f (3.9%)	1 A 3 b iv (3.2%)	1 A 4 b ii (2.5%)	1 A 3 b ii (2.3%)	1 A 1 a (1.7%)	6 C (1.6%)	87.1	12
TSP	2 A 7 (22.6%)	4 D 1 (17.4%)	1 A 4 b i (9.8%)	1 A 5 b (7.1%)	1 A 3 b vi (5.2%)	2 A 6 (4.9%)	2 C (4.2%)	1 A 2 f (2.8%)	7 (2.1%)	1 A 4 c ii (2.0%)	78.1	16
PM10	1 A 4 b i (20.2%)	2 A 7 (12.1%)	4 D 1 (7.8%)	2 C (5.5%)	1 A 3 b vi (4.6%)	1 A 2 f (4.2%)	1 A 3 b i (4.0%)	4 B 9 (3.6%)	1 A 1 a (3.2%)	7 (3.1%)	68.2	22
PM2.5	1 A 4 b i (29.5%)	2 A 7 (9.1%)	2 C (5.9%)	1 A 3 b i (5.7%)	1 A 2 f (5.1%)	1 A 3 b iii (4.5%)	1 A 3 b ii (4.2%)	1 A 4 c ii (3.8%)	1 A 1 a (3.2%)	4 D 1 (2.9%)	74.0	20
Pb	1 A 2 f (42.7%)	2 C (12.8%)	1 A 2 a (6.2%)	1 A 3 a ii (ii) (5.0%)	1 A 3 b i (4.5%)	1 A 4 b i (4.3%)	1 A 1 a (4.0%)	1 A 3 b iii (3.0%)	1 A 3 b ii (2.6%)	1 A 4 a (2.5%)	87.8	5
Hg	1 A 1 a (36.2%)	6 A (11.2%)	1 A 2 f (10.7%)	6 C (9.9%)	2 B 5 (8.3%)	2 C (5.5%)	1 A 4 b i (4.7%)	1 A 2 a (2.4%)	1 A 1 b (2.3%)	1 A 2 d (2.2%)	93.5	2
Cd	1 A 2 f (22.4%)	2 C (22.1%)	1 A 1 a (13.2%)	1 A 1 b (12.8%)	1 A 4 b i (8.3%)	1 A 2 a (3.7%)	1 A 2 d (3.1%)	1 A 2 b (3.0%)	6 C (1.4%)	1 A 3 b i (1.3%)	91.2	4
DIOX	1 A 1 b (67.7%)	6 C (10.5%)	1 A 1 a (4.1%)	1 A 3 b i (3.4%)	1 A 4 b i (3.0%)	2 C (3.0%)	1 A 2 f (1.9%)	1 A 2 a (1.4%)	1 A 3 b iii (0.9%)		95.8	0
PAH	1 A 4 b i (24.2%)	3 D (23.4%)	2 G (15.1%)	1 A 3 b i (12.9%)	2 C (7.9%)	1 A 3 b iii (3.5%)	1 A 3 b ii (2.1%)	1 B 1 b (1.9%)	1 A 2 f (1.3%)	2 A 6 (1.0%)	93.4	2
HCB	1 A 2 b (88.5%)	2 C (4.5%)	1 A 4 b i (2.8%)								95.7	0

3.3 COMPLETENESS

Key messages – completeness

LRTAP:

- *For the first time all Parties have now reported at least one emissions figure under the Convention on LRTAP.*
- *Only 20% of Parties report complete time series in NFR 1990-2004 for the main pollutants (2000-2004 for PMs), e.g. emissions are reported for all years and relevant source sectors .*
- *The completeness of the EMEP sector data time series (independent of reporting format) is largest for SOx and NOx (about 80%) and less (about 68%) for NMVOC and NH3. Reporting of PM began in 2000 and is almost solely reported in NR02 format. For PM, the completeness of sector data is still lower than for the Main Pollutants, but has been steadily increasing, from around 40% in 2000 to about 60% completeness in 2004.*
- *The completeness of sector time series data for priority heavy metals (cadmium, lead and mercury varies between pollutant and years, and is between 29-50% complete for lead and cadmium and 37-61% for mercury. Completeness for priority POPs was even lower, 29-48% for PCDD/F and PAH, while only eight countries (16%) reported HCB emissions.*
- *Parties should not report an emission figure more than once at the time. E.g. not report different or even similar national totals in both NFR and SNAP.*

NEC:

- *According to the requirements of the NEC directive, in 2006 countries had to report provisional emissions for the year 2004 and finalised data for 2003. However, 3 countries (AT, FR, LV) reported emissions for the whole time-series 1990- 2004. 2 countries (GR, LT) only reported for 2004. Italy submitted in May 2005 (late submission 2005) data for 1990-2003.*
- *Four countries filled more than 95% of their reporting template cells. Comparing all cells, notation keys are more often used than unique values are reported, which in itself is not necessarily problematic. The notation key NA ('not applicable') is used the most, followed by NO ('not occurring'). None of the countries used the notation key C ('confidential') and NR ('not relevant'). Sweden reported the most unique values, followed by Austria and Italy.*
- *Most unique values were reported for NMVOC (56 %), followed by NOx (43 %). Most '0' values were reported for NH3 (13 %).*

3.3.1 LRTAP

Malta officially submitted data for the first time to the Convention on LRTAP this year. All Parties have now reported at least one single emission value to the UNECE.

We reported last year that it was a real challenge to assess the overall completeness of emissions. This is both due to the three different formats of source categories available, SNAP (Selected Nomenclature for Air Pollutants), NFR01 (defined in the 2001 intermediate Guidelines) and NFR02 (from the current 2002 reporting Guidelines (ECE/EB.AIR/80)), and because there are differing definitions of completeness according to the Protocols and the

Guidelines. This issue is discussed in more detail in Chapter 4 below on the results of the Trial Stage-3 review.

In previous years, the review of completeness has only concerned data in NFR02 format. As noted by one of the Parties' comment to the completeness test: '*This analysis doesn't show the real situation. A low percentage of total reported values for time series is a consequence of using an old format for years before 2000. The old format doesn't provide use of notation key so the percentage of use of notation key is also unreal'*.

Since a majority of the emission data in the 1980 and 1990s are in SNAP format (see below), it was decided this year to assess the overall completeness of emission data held by EMEP that have been reported under the Convention of LRTAP also at SNAP level. Hence all NFR02 emissions data were converted to SNAP according to Table IIIA in the reporting Guidelines.

Thereafter we analysed the completeness of officially submitted data by means of *checking if a value was reported or not for the country, year and pollutant in question* and as available from the sixth version of WEBDAB. Figure 3.1 shows the result for main pollutant (1990-2004) and PMs (2000-2004) for selected sectors. Only one of the main sectors per pollutant is displayed, i.e. SOx: SNAP sector 1, *Combustion in energy and transformation*, NOx: SNAP sector 7, *Road Transport*, NMVOC: SNAP sector 6, *Solvent and other product use*, NH3: SNAP sector 10, *Agriculture*, and PMs: SNAP sector 2, *Non-industrial combustion plants*.

Nine Parties (20%) (Austria, Denmark, France, Germany, Latvia, Norway, Portugal, Sweden, United Kingdom) reported complete time series of main pollutants in the NFR02 format for 1990 to 2004, the period relevant for the revision of the Gothenburg Protocol. Three countries miss only one year of data, Estonia year 2000, Italy and Spain year 2004. The figure shows for each of the pollutants and sectors the completeness with respect to format. Data in NFR02 format requested from the 2002 Guidelines, are shown in blue; for the main pollutants there is a clear increase from 2000 onwards. In 2004 all sector data that was reported was in NFR02. The reporting in NFR01 format amounts to a few percent only, and vanishes in 2002. Reporting in SNAP is still substantial in the 1990s for all Main Pollutants. The completeness of the sector data time series independently of formats was largest for SOx and NOx (about 80%) and less (about 68%) for NMVOC and NH3. The PMs (lowermost row in Figure 3.1) are almost solely reported in NR02 format. Reporting of PM began in 2000. The completeness of the reporting of PM sector data is still lower than for the Main Pollutants, but has been steadily increasing, from around 40% in 2000 to about 60% in 2004 emissions.

The completeness of sector data time series 1990-2004 for priority heavy metals (cadmium, lead and mercury) (not shown) varied between pollutant and years, and was between 29-50% for lead and cadmium and 37-61% for mercury. Completeness for priority POPs was even lower, 29-48% for PCDD/F and PAH, while only eight countries (16%) reported HCB emissions.

It can be concluded that the overall completeness of reporting is still low for many countries. This becomes much clearer after quality control of comparability and in particular consistency. Appendix 5 gives an overview of the emission totals as considered in the modelling assessments under EMEP. Reported values are displayed with white background, expert estimates replacing gaps in grey. Values in bold italic show replacement of reported data by expert estimates. The procedure for replacements is documented in EMEP Report

1/2006. From these tables and the analysis documented in EMEP Report 1/2006 it is clear that much of the reported data lack time series consistency and therefore has to be replaced.

Confusion arises when countries report for the same year, an identical emission value in two different reporting formats (e.g. SNAP and NFR02), or as sometimes is observed, different values in different formats. Parties like Slovakia and Switzerland currently do this. Parties are requested not to double report emissions.

One Party noted that the completeness test is not very significant and useful to provide an informative basis of completeness. The review team will look at improving this test, whenever the definition of completeness becomes more clear.

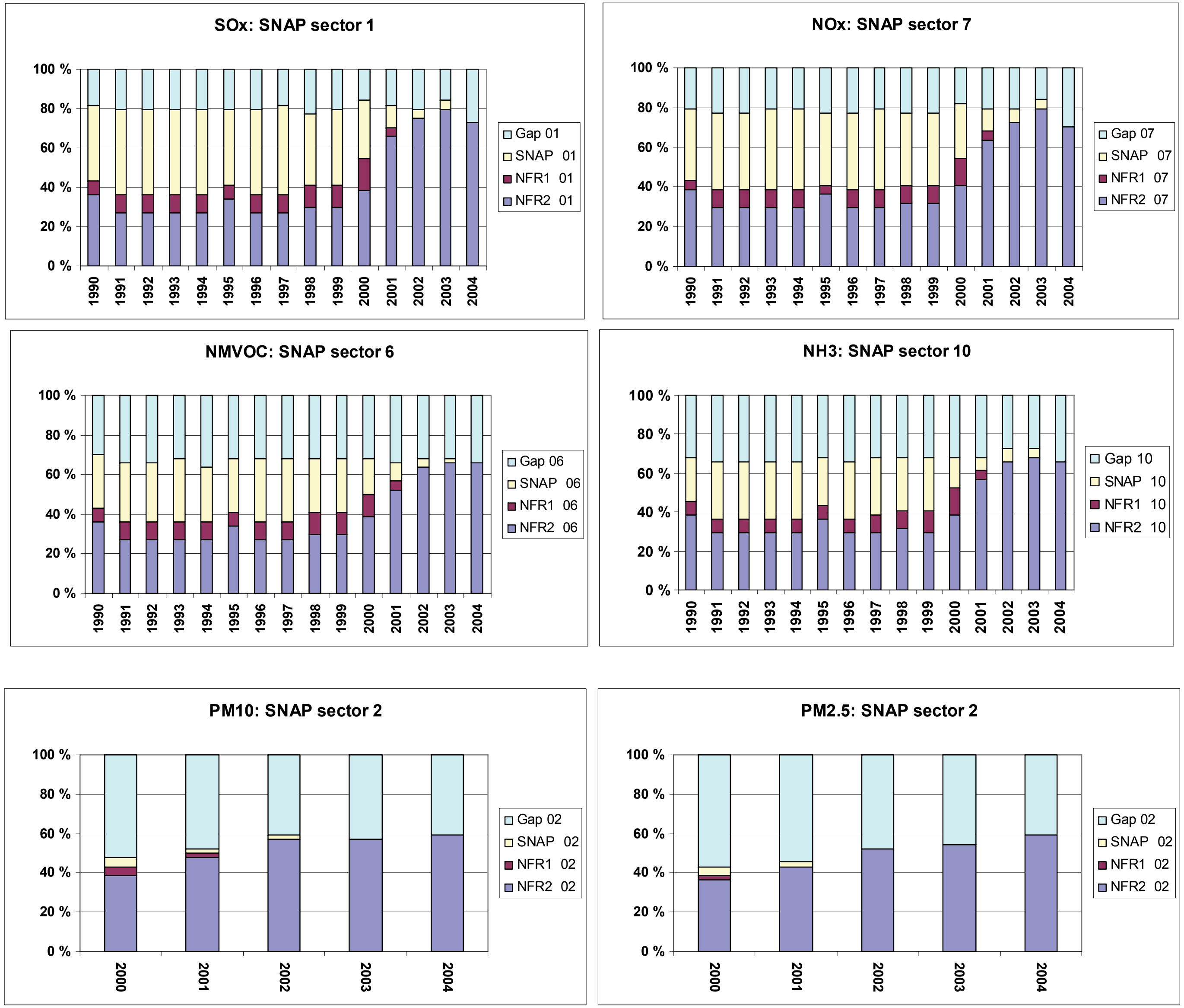

Figure 3.1. Overall completeness of Main Pollutants and PMs for selected pollutants and sectors (%)

3.3.2 NEC

This year for the first time a completeness analysis of NEC data has been performed for those countries that submitted data. 15 countries (60 %) of the EU25 Member States reported NEC emissions inventories in NFR format on time (including Italy for 2003). According to the NEC Directive requirements (Directive 2001/81/EC), countries have to report their final emission inventories for the previous year but one and their provisional emission inventories for the previous year. However, 3 countries (AT, FR, LV) reported emissions for the whole time-series 1990- 2004. 2 countries (GR, LT) only reported for 2004. Italy submitted in May 2005 (late submission 2005) data for 1990-2003. The Italian data should strictly not have been included in this year's review. Late submissions will not benefit from the review in the future. Figure 3.2 provides an overview for each year of the number submissions received in 2006 (although as noted above, formally Member States are only required to report data for 2003 and 2004).

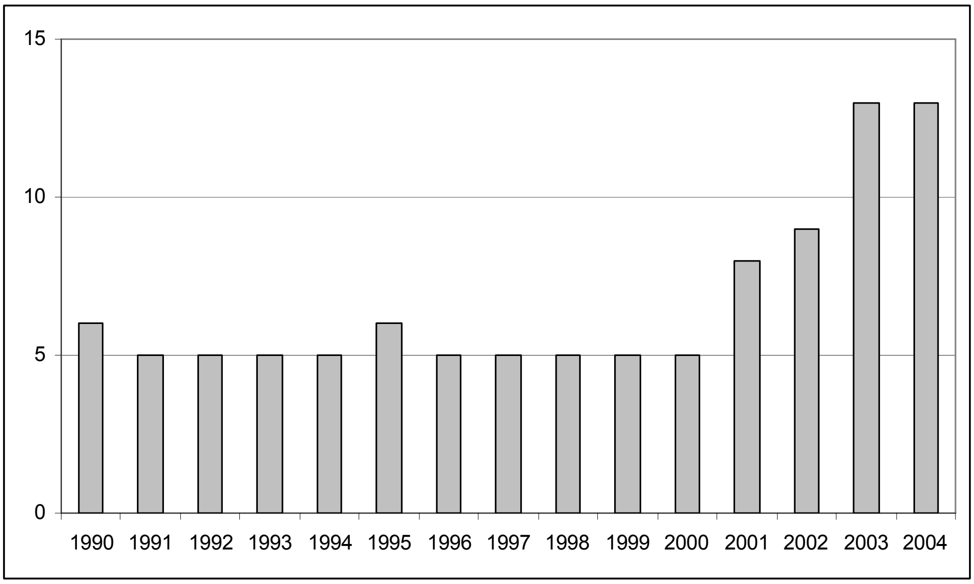

Figure 3.2. Number of submissions per year.

Figure 3.3 shows the analysis of completeness by country for the whole time series. Four countries filled more than 95% of their reporting template cells. Comparing all cells, notation keys are more often used than unique values are reported, which in itself is not necessarily problematic. The notation key NA ('not applicable') was used the most, followed by NO ('not occurring'). None of the countries used the notation key C ('confidential') or NR ('not relevant'). Sweden reported the most unique values, followed by Austria and Italy. France still do not use notation keys, but rather report zeros, although feedback from the country indicates these zeros are calculated values.

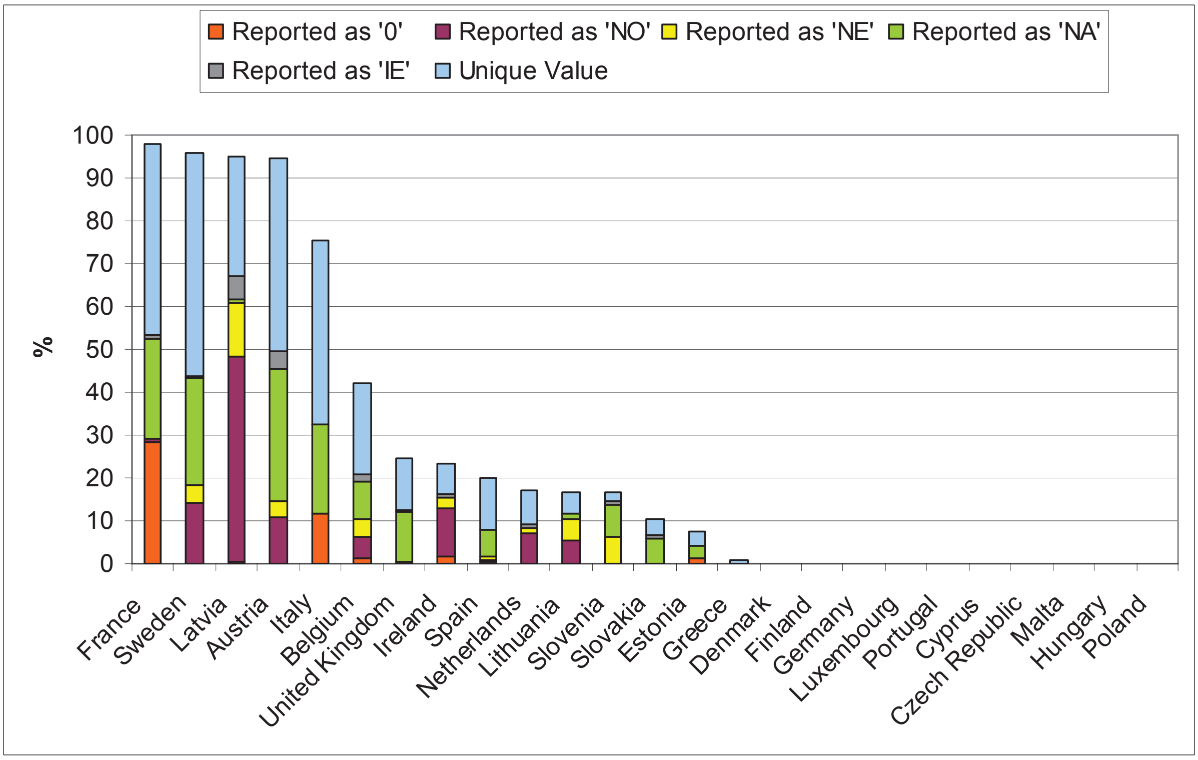

Figure 3.3. Completeness of NEC data for 1990-2004: by country.

Figure 3.4 shows the completeness of reported NEC data per pollutant. Most unique values were reported for NMVOC (56 %), followed by NOx (43 %). Most '0' values were reported for NH_3 (13 %).

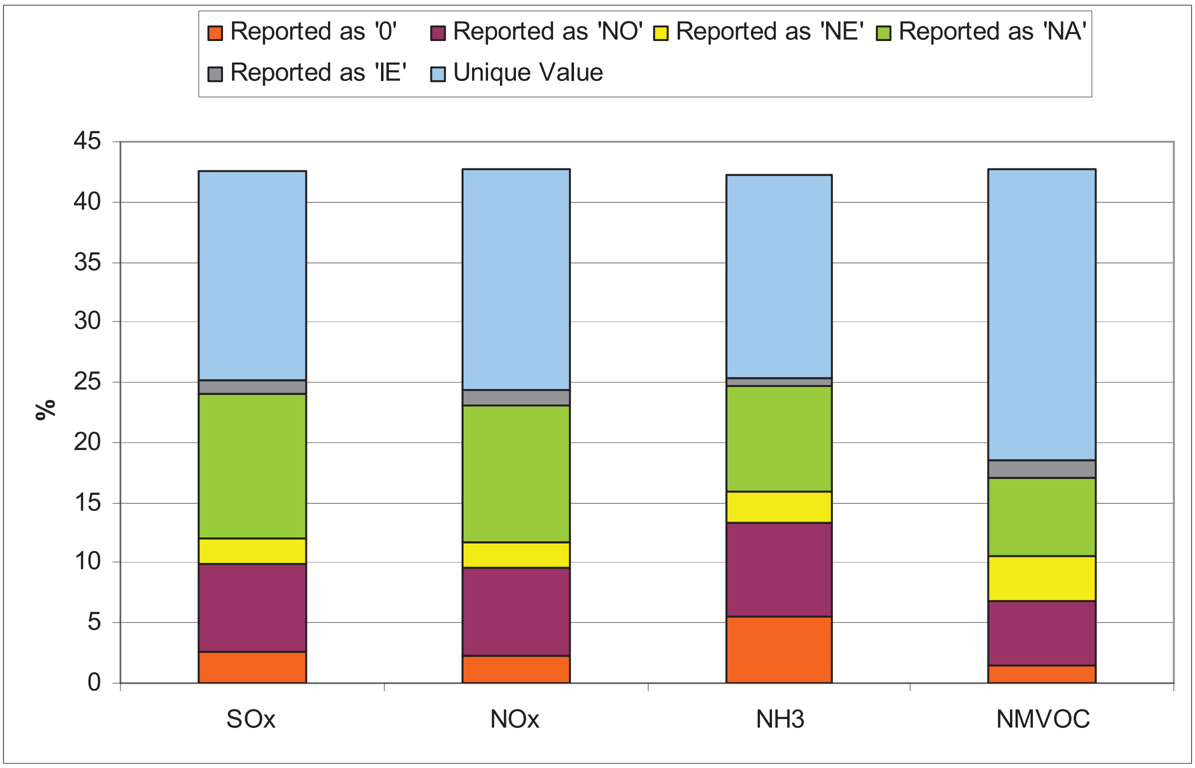

Figure 3.4. Completeness of NEC data for 1990-2004: by pollutant.

3.4 CONSISTENCY

Key messages – consistency
The aim of this test is to confirm the internal data consistency of submissions. It checks that values reported within sub-sectors add up to the reported sector total, and that the values reported for sectors add up to the reported National Total. All notation keys are converted to zero in the calculation. • *The internal consistency of LRTAP inventories is improving, assisted by the ability of countries to use the online software QC tool REPDAB which gives countries an easy way to check internal consistency before submitting their data. REBDAB will be developed further to improve the feedback it provides to countries on data inconsistencies.* • *2 of 14 countries that reported their NEC inventories in NFR format on time were found to contain internal inconsistencies. Member States are free to use REBDAB to check data prior to submission if they report using the LRTAP excel templates (as most countries presently do).*

3.4.1 LRTAP

Inconsistencies were found for 14 countries (BE, LV, CZ, DE, EE, IE, PL, SI, CA, GR, MD, NL, MK and UA) (40% of those reporting). This appears a significant level, but many of these inconsistencies were small (e.g. where decimal places had been removed in aggregated sectors) or correspond to situations where numbers were only reported at aggregated levels and notation keys, notably IE (included elsewhere), were reported in all sub sectors. It was agreed at the joint EIONET/TFEIP meeting in Pallanza in 2004 to calculate consistency with all notation keys set to zero, this will hence automatically lead to an inconsistency in this latter situation (i.e. a number compared to the sum of notation keys (= zero)). We will look into both improving the review check and REPDAB on this point. It was also noted that the COPERT tools only generate summary data for the POPs emissions, without separating activities, and hence no sub-sectors are able to be reported by countries.

3.4.2 NEC

Under the NEC Directive data from 14 Member States that reported their inventories in NFR format on time were reviewed. Of the 14 reporting Member States, the time series of twelve Member States did not contain any inconsistencies, while 2 Member States show inconsistencies (United Kingdom and Greece).

3.5 COMPARABILITY – CROSS POLLUTANT TESTS

Key messages – cross pollutant tests

A cross pollutant test was performed in order to check the consistency between reported pollutants and the comparability of pollutant ratios between countries. It is a further method to identify outliers across countries. The review team chose pollutant ratios which it assumed would be more or less identical in all countries.

- *Generally, some pollutant ratios turned out to be not useful as most countries did not report emissions for one of the selected sectors (e.g. landfills and agriculture). The ratios used in future checks will be reviewed.*
- *Next year, based on feedback from countries, more emphasis will be laid on the explanation of why certain pollutant ratio were chosen and on providing a range of expected ratios to make it easier for countries to compare their ratios against this range.*
- *Nevertheless, the cross pollutant test is considered to be a useful initial method to identify outliers and possible differences between countries.*

Table 3.3 provides an overview of explanations as to why particular pollutant ratios were chosen for comparison.

Table 3.3. Overview of reasons for the selection of pollutant ratios

Sector	Ratio	Background
National totals	TSP : PM2.5, PM10	
Fuel combustion	TSP : PM2.5, PM10	
Fuel combustion	PM10 : Pb, Cd, Hg	HM are part of PM10
Transport	NO_x : NMVOC, CO, PM2.5	Constant ratio in exhaust gas
Transport	NH_3 : N_2O	Constant ratio due to catalyst
Agriculture	NO_x, NH_3, N_2O	Microbial activity
Landfills	NMVOC, NH_3, CO	Constant ratio in landfill gas

Pollutant ratios were calculated for the following sectors: transport (sum of 1A3bi passenger cars, 1A3bii light duty vehicles, 1A3biii heavy duty vehicles, 1A3biv mopeds and motorcycles, 1A3bv gasoline evaporation), agriculture (sum of 4B and 4D), landfills (6A), fuel combustion (sum of all 1A sectors) and for national totals. An average pollutant ratio was subsequently calculated for each country region (Western and Eastern Europe country grouping) and individual country pollutant ratios flagged if they exceeded the average pollutant ratio for the respective country region by more than a factor of 5 or by less than a factor of 0.2. Results are presented in Table 3.4 for Western countries and in Table 3.5 for Eastern countries.

3.5.1 LRTAP

In most cases, flagged differences in cross pollutant tests could be simply explained by different fuel splits used in countries (e.g. the ratio of consumed Diesel oil/consumed gasoline in Monaco compared to other European countries; no solid fuel combustion except wood and waste incineration in Switzerland, use of natural gas and wood products for domestic fuel use in Latvia and Estonia etc). Some countries still have to identify the reason for the differences noted.

Generally, some pollutants turned out to be not useful as most countries did not report emissions for at least one of the selected sectors (e.g. especially landfills and agriculture). However, the cross pollutant test is a good method to identify outliers across countries. Next year, more emphasis will be laid on the explanation of why a certain pollutant ratio was chosen and on providing a range of expected ratios to make it easier for countries to compare their ratios against this range.

3.5.2 NEC

Results of the analysis of NEC data did not differ significantly from the LRTAP analysis results.

Table 3.4. Pollutant ratios for Western countries. Shaded cells indicate flagged values

Pollutant ratio	Sector	AT	BE	CA	CH	DE	DK	FI	FR	GB	GR	IE	MC	NL	NO	PT	SE	Mean
NOx/NMVOC	Transport	6.26	2.99	1.84	2.22	4.34		1.66	1.94	4.13	0.68	2.03	0.48	2.00	1.33	2.18	2.23	2.42
NOx/CO	Transport	0.77	0.41	0.12	0.22	0.43		0.23	0.30	0.44	0.40	0.26	0.13	0.46	0.20	0.35	0.28	0.33
NOx/PM2.5	Transport	18.04	16.64	1.10	24.54	22.16		14.30	12.61	20.88		14.39		14.68	16.09	13.85	17.35	15.89
NH3/N2O	Transport	1.46	0.83			2.62	1.80		0.97	0.65		1.81		1.63		0.92	9.61	2.23
NOx/NH3	Agriculture				0.09	0.04												0.07
NH3/N2O	Agriculture	5.07	4.41			4.63	4.69	2.61	3.98	3.53		4.53		3.71		3.82	2.72	3.97
PM10/Pb	Fuel combustion	3.17	1.21	0.86	0.99	1.80	0.82	2.03	1.56	1.04		2.04		3.97	8.96	0.09	4.34	2.35
PM10/Cd	Fuel combustion	26.41	35.84	7.37	4.99	13.10	9.11	42.13	40.47	23.10		26.60		67.83	111.45	11.53	147.56	40.54
PM10/Hg	Fuel combustion	33.88	5.64	46.82	9.05	4.69	4.52	90.58	36.48	25.30		45.78		81.64	150.82	21.11	121.14	48.39
TSP/PM2.5	Fuel combustion	1.64	13.32	14.49	2.23	1.54	1.26	1.84	1.63			2.08		1.23	1.18	2.14	1.89	3.57
TSP/PM2.5	National totals	3.52	9.43	18.16		2.10	1.89	2.08	4.60			2.11		1.99	1.40	3.17	1.92	4.36
TSP/PM10	Fuel combustion	1.43	5.90	3.34	1.15	1.31	1.15	1.32	1.35			1.54		1.10	1.14	1.99	1.28	1.85
TSP/PM10	National totals	2.02	4.59	3.22		1.17	1.39	1.41	2.80			1.55		1.18	1.26	2.50	1.30	2.03
NMVOC/CO	Landfills	0.01			0.03													0.02
NMVOC/NH3	Landfills	30.00			0.01					1.61						2.61		8.56
CO/NH3	Landfills	2265.05			0.28													1132.67

Table 3.5. Pollutant ratios for Eastern countries. Shaded cells indicate flagged values.

Pollutant ratio	Sector	BG	CS	CY	CZ	EE	HU	LT	LV	MD	MK	PL	RU	SI	SK	UA	Mean
NOx/NMVOC	Transport	2,37	1,21	0,48	2,05	2,04	1,88	2,88	1,96	1,21	1,04	2,04	0,67	2,71	1,50	0,49	1,64
NOx/CO	Transport	0,40	0,18	0,13	0,41	0,26	0,25	0,51	0,22	0,18	0,22	0,37	0,12	0,66	0,33	0,08	0,29
NOx/PM2,5	Transport		11,10		18,95	19,60	10,50	20,58		11,10		15,28	49,22	14,16	12,81	779,29	18,33
NH3/N2O	Transport				0,97	19,91	0,01	1,03	1,19					1,87	1,35		3,76
NOx/NH3	Agriculture																
NH3/N2O	Agriculture				4,03	3,40	2,47	5,88	3,28			4,23		4,63	2,86		3,85
PM10/Pb	Fuel combustion		7,54		0,55	0,76	1,50	2,11	128,56	7,54		0,49	2,63	3,23	0,43	0,90	2,52
PM10/Cd	Fuel combustion		140,50		14,80	48,70	17,65	29,04	268,25	140,50		5,68	13,71	6,46	5,59	60,09	62,58
PM10/Hg	Fuel combustion		43,29		9,43	52,80	19,96	33,93	606,49	43,29		11,05	45,04	13,67	15,21	14,71	75,74
TSP/PM2,5	Fuel combustion		4,44		2,82	2,01	2,95	1,68	1,19	4,44		2,78	2,69	2,09	1,87	52,97	6,83
TSP/PM2,5	National totals		3,02		2,16	2,16	3,31	1,75	1,42	3,02		3,37	2,69	3,05		49,69	6,88
TSP/PM10	Fuel combustion		1,87		2,23	1,54	1,72	1,37	1,10	1,87		1,41	1,59	1,82	1,44	5,97	1,99
TSP/PM10	National totals		1,56		1,60	1,61	1,91	1,43	1,15	1,56		1,62	1,59	2,27		6,10	2,04
NMVOC/CO	Landfills															0,93	0,93
NMVOC/NH3	Landfills																
CO/NH3	Landfills																

3.6 COMPARABILITY – RECALCULATIONS

Key messages – Recalculation

The aim of this test is to identify differences between national totals reported by Parties between the 2006 and 2005 reporting years

LRTAP:

- *46% of Parties reported at least one pollutant recalculation of more than 10% between 2005 and 2006.*
- *All but two countries have explained their recalculation, mostly by means of the review report.*
- *POPs and PM2.5 have the highest number of recalculations, followed by HMs and NMVOC. PM10 recalculations number less than half of the number of PM2.5 recalculations, which is somewhat concerning. In percentage terms, the largest recalculations are for PMs followed by PCDD/F , Pb, Cd, other POPs, Hg, CO, SOx, NMVOC, NH3 and NOx.*

NEC:

- *For 10 of 14 countries that submitted their NEC submissions on time a recalculation analysis could be performed. In 5 countries, recalculations exceeded 10 % for some pollutants and/or years. Most recalculations occurred for NMVOC emission, followed by NH_3. Compared to NOx and SOx, NMVOC emissions are more difficult to estimate.*

It is important and necessary to identify inventory recalculations and to understand their origin in order to correctly evaluate the officially reported emission data. This is especially the case when emission ceiling targets are expressed in absolute terms, and not as percentage reduction targets. From a country perspective, it is necessary to recalculate the whole of the time series when new information (i.e. activity or emission factor data) becomes available in order to provide comparable and consistent data. The magnitude of recalculations also provides some indication of the general uncertainty of the emissions.

The aim of the recalculation test is to identify differences between national totals reported by Parties between the 2006 and 2005 reporting years (100*[(X2006 – X2005)/ X2005]). Differences larger than 10% were flagged. Details with respect to the recalculations of LRTAP data are shown in Appendix 3. In these overviews, highlighted values show recalculations per country and priority pollutants larger than 10% between this year and last year's submissions. The greatest recalculation per recalculated time series is quoted, together with the period for which recalculations were provided. The annex also gives an overview of any explanations provided by countries concerning the recalculations, and from where this explanation was obtained (Informative Inventory Report (IIR) or Review Report (RR)).

3.6.1 LRTAP

The result of the recalculation test for the LRTAP data can be found in Appendix 3. The number of recalculations is relatively high. Of those 35 Parties reporting data in 2006, 16 Parties (46%) provided recalculations larger than 10%. Many countries do not recalculate their emissions and whether this is due to lack of resources, lack of scientific information on improved methodologies, or missing Guidebook improvements is not easy to say. It is likely a mix of these factors. As many Parties have the possibility to update their emissions, whiles other have not, there is evidently an element of resource requirements to this.

Perhaps not surprisingly, POPs and PM2.5 have the highest number of significant (> 10%) recalculations, followed by HMs and NMVOC (Table 3.6). Other main pollutants have relatively few recalculations. It seems like the focus on PM2.5, and more information being available has led to an increase in recalculations of PM2.5 compared to 2005. PM10 is recalculated less than half the number of times that PM2.5 is recalculated. It is somewhat concerning that Parties do not recalculate PM10 at the same time PM2.5 is recalculated, although as noted earlier, this may be related to more information on PM2.5 calculation methodologies becoming available. HCB has been calculated fewer times, which is not unexpected as very few Parties actually report HCB. The largest recalculations in terma os percentages are found for PMs followed by PCDD/F , Pb, Cd, other POPs, Hg, CO, SOx, NMVOC, NH3 and NOx.

Table 3.6. Number of significant (>10%)recalculations per pollutant for the LRTAP inventories (of 35 submissions received).

Component	No recalc
PAH	8
PM2.5	7
PCDD/F	6
Pb	5
Hg	5
NMVOC	4
Cd	4
NH3	3
PM10	3
SOx	2
NOx	2
CO	2
HCB	2

It is very encouraging that all but two countries explain their recalculation either through their IIR (3 countries), their Review Reply (9 countries) or both (2 countries). This shows a clear need for the country specific review reports in order to understand the changes in emissions form one year to another. In the long run it is appreciated that the recalculations are reported in the IIR upfront the review process.

3.6.2 NEC

Recalculation analysis was performed for 10 EU Member States which submitted their NEC inventories in time. For 4 countries, this analyisis was not possible as they reported data for 2004 only or not for 2004, but 1990 to 2003 only. All 10 countries recalculated their emissions. In Belgium, France, the Netherlands, the United Kingdom and Slovenia only minor recalculations were performed, while recalculations in Austria, Estonia, Ireland, Latvia and Sweden exceeded 10 % for certain pollutants. Table 3.7 shows these recalculations that exceeded 10 %.

Table 3.7. Recalculations of NEC submission by countries that exceeded 10%. ('v' recalculation < 10%, NA – data not received).

	SOx	NOx	NH3	NMVOC
Austria	v	v	20% (1990-2003)	v
Belgium	v	v	v	v
Denmark	NA	NA	NA	NA
Finland	NA	NA	NA	NA
France	v	v	v	v
Germany	NA	NA	NA	NA
Greece	NA	NA	NA	NA
Ireland	v	v	v	-14% (2002-2003)
Italy	NA	NA	NA	NA
Luxembourg	NA	NA	NA	NA
Netherlands	v	v	v	v
Portugal	NA	NA	NA	NA
Spain	NA	NA	NA	NA
Sweden	v	v	v	-14% (1990-2003)
United Kingdom	v	v	v	v
Cyprus	NA	NA	NA	NA
Czech Republic	NA	NA	NA	NA
Estonia	v	-14% (2003)	23% (2003)	v
Hungary	NA	NA	NA	NA
Latvia	-17% (1994), -36% (2000-2003)	v	v	v
Lithuania	NA	NA	NA	NA
Malta	NA	NA	NA	NA
Poland	NA	NA	NA	NA
Slovakia	NA	NA	NA	NA
Slovenia	v	v	v	v

3.7 COMPARABILITY - INVENTORY COMPARISON

Key messages – Inventory comparison

The aim of this test is to assess comparability through comparison of national totals reported by countries to NEC, LRTAP and under the EU Monitoring Mechanism.

NEC vs LRTAP:

- *Differences larger than 0.1% between emission data submitted under the Convention on LRTAP and under the NEC directive were found for seven countries. This is an increase by two from last year. All but two countries have provided explanations for the differences e.g. updates that occurred due to differences in submission dates (i.e. new EFs or statistics became available) and differences in the Guidelines definitions.*

LRTAP/NEC vs. EU Monitoring Mechanism:

- *Reasons for differences between emissions reported under CLRTAP/NEC and the EU Monitoring Mechanism are manifold and are mainly due to*
  a) different reporting requirements,
  b) different QA/QC requirements and
  c) errors in reporting.
- *The highest number of differences occurred for NMVOC and CO (65 % each), followed by SO_x (50 %) and NO_x (45 %). Differences in CO and NMVOC emissions are mainly due to whether or not memo items are included in the national total, due to the sector 1A3b, Transport and to errors in reporting.*

The aim of this test is to compare national totals reported to NEC, LRTAP and under the EU Monitoring Mechanism received by 10th March 2006 (LRTAP), 28th February 2006 (NEC) and 8th April 2006 (EU MM). A summary showing results of the EU25 comparison performed between officially reported data to NEC-LRTAP-EU MM for the most recent reporting year

(2004) is given in Appendix 4. Differences are expressed as percentages (%). Explanations for the noted differences are provided where these have been received in response to the review or where they were already documented by the respective country. Flagged values indicate differences of greater than 0.1% between the respective national totals.

3.7.1 NEC vs. LRTAP

Differences larger than 0.1% between emission data submitted under the Convention on LRTAP and under the NEC directive were found for seven countries (Belgium, Estonia, Hungary, Latvia, Lithuania, Netherlands and Slovenia). This is two more than last year. An overview of all inventory comparisons is given in Appendix 4. Differences occurred most frequently for NMVOC, followed by SOx, NOx and NH3. The differences were explained for those countries responding to the review. Only two countries did not explain their recalculations. In the case of the Netherlands, the differences could be explained by the differences in the definitions of 1 A 3 d ii *National Navigation* and 1 A 3 a ii (i) *Civil Aviation (Domestic, LTO).* For the other countries, the reason for the differences was that the NEC data was submitted earlier than the LRTAP data, hence the LRTAP data was more complete. For six of the reporting countries (Cyprus, Czech Republic, Finland, Germany, Poland, Portugal) the test could not be performed due to the lack of NEC data.

3.7.2 LRTAP/NEC vs. EU Monitoring Mechanism

Figure 3.5 shows the number of flagged values (i.e. differences > 0.1%) by pollutant expressed as a percentage of the number of inventory comparisons made between national totals reported under CLRTAP and NEC, and under the EU Monitoring Mechanism. For the LRTAP vs EU-MM comparisons, on a percentage basis the highest number of flags occurred for NMVOC and CO (65 % each), followed by SO_x (50 %) and NO_x (45 %). Differences in CO and NMVOC emissions are mainly due to differences in the sectors 5(E) and 1A3b and to errors in reporting. The percentage of flagged values for NEC vs EU-MM comparisons are higher than for the LRTAP vs EU-MM comparisons, as the lower number of NEC datasets received means the overall number of comparisons able to be made was lower.

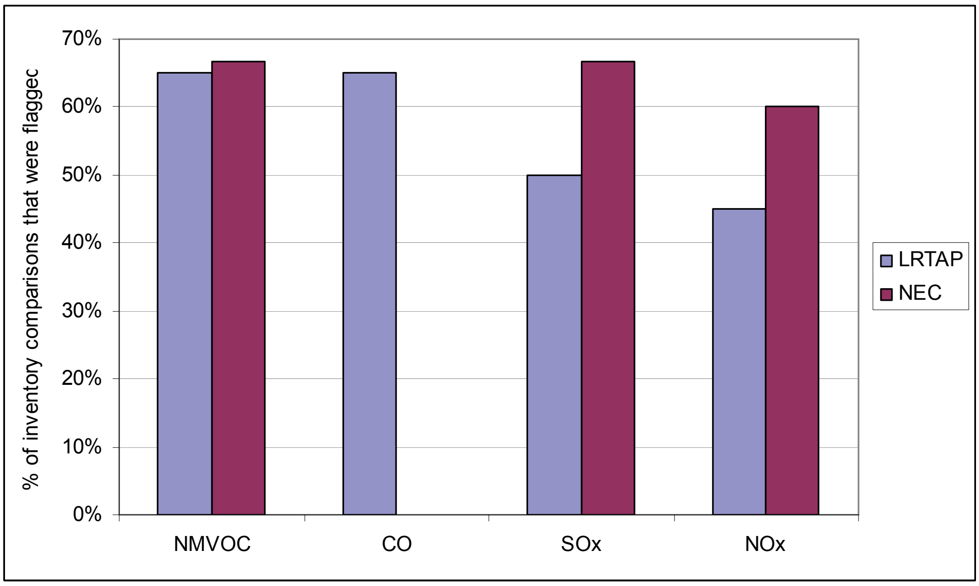

Figure 3.5. Number of flagged values by pollutant of inventory comparisons between CLRTAP/NEC and EU Monitoring Mechanism as a percentage of the number of inventory comparisons made.

For the NEC vs EU-MM comparison, the highest number of flags occurred for NMVOC and CO (65 % each), followed by SO_x (50 %) and NO_x (45 %). Differences in CO and NMVOC emissions are mainly due to whether or not memo item, sectors 5 E, 'OTHER' are included in the national total and due to sector 1A3b and to errors in reporting. 5E is reported under LRTAP as memo item, but is included in the CRF in the national total. This difference was found e.g. for France.

Reasons for differences between emissions reported under CLRTAP/NEC and the EU Monitoring Mechanism are manifold and are mainly due to a) different reporting requirements, b) different QA/QC requirements and c) errors in reporting.

a) Different reporting requirements

The three reporting obligations differ mainly in the geographical coverage of countries (e.g. France, Spain, Portugal, UK), and in emissions that are included in one format, but not the other. This relates mainly to the inclusion or exclusion of domestic and international aviation and navigation in the national total, but also to differences in the Land Use, Land Use Change and Forestry (LULUCF) sector. Additionally, emissions from road transport reported under the EU Monitoring Mechanism have to be calculated based on the amount of fuel sold, whereas emissions reported under CLRTAP/NEC may be calculated based on the amount of fuel either sold or used. The major differences are summarised in Table 3.8.

Table 3.8. Major differences between the reporting obligations under CLRTAP, NEC and the EU Monitoring Mechanism CRF (Council Decision 280/2004/EC)

	NFR (CLRTAP)	**NFR (NEC)**	**CRF**
Domestic aviation (LTO)	Included in national total	Included in national total	Included in national total
Domestic aviation (Cruise)	Included in national total	Not included in national total	Included in national total
International aviation (LTO)	Not included in national total	Included in national total	Not included in national total
International aviation (Cruise)	Not included in national total	Not included in national total	Not included in national total
International navigation on rivers	Not included in national total	Included in national total	Not included in national total
International marine	Not included in national total	Not included in national total	Not included in national total
Road transport	Calculations based on fuel sold or used	Calculations based on fuel sold or used	Calculations based on fuel sold

b) Different QA/QC requirements

The reporting of NOx, SOx, NMVOC and CO under UNFCCC is a "should" requirement for countries. Therefore the quality of this data is often not as robust as that reported to LRTAP. It is known for example, that some countries perform QA/QC checks under CLRTAP/NEC more extensively and carefully than for the main pollutant data reported under the EU Monitoring Mechanism.

3.8 COMPARABILITY – FUEL SOLD FUEL USED

Key messages – fuel sold fuel used

- *Results from the 2006 review show that still, more countries report using fuel consumed to estimate their emissions. However, it is not always clear for some countries as to the basis of their emission estimates.*
- *The difference in emission values obtained from the two different methods is small in most countries. However, in countries with low fuel prices, and resulting high fuel tourism from neighbouring countries, the difference can be as high as 40 %.*

Last year it was reported that most countries reported their emissions according to fuel used (Vestreng et al., 2005). We wanted to elaborate somewhat on this check this year because it may influence the revision of the Guidelines due in 2007 and provide information for the review of the Gothenburg Protocol and the NEC Directive. Likewise, we wanted to give an estimate of the difference in emissions that the two methodologies were likely to give. This year's review show that more countries still continue to report to use fuel used to estimate their emissions (Table 3.9). The amount of fuel consumed in a country is obtained from traffic models and therefore is more difficult to estimate than the amount of fuel sold from the energy statistics. Reporting according to fuel sold has the advantage of being less resource demanding, more accurate, and easier to verify and in accordance with the reporting guidelines under the Intergovernmental Panel on Climate Change (IPCC) (UNECE 2004c). However for countries that experience large amounts of 'fuel tourism' this can lead to over-estimation of 'national' emissions.

Table 3.9. Overview of emission estimation according to Fuel Sold (FS) and Fuel Used (FU) in 2005 and 2006 IIR= information obtained from the informative inventory report. Else the information is obtained form the footnote sheet in reporting table 1

COUNTRY	2005 FUEL SOLD / FUEL USED	2006 FUEL SOLD / FUEL USED
Austria	FU (IIR)	LRTAP: FS (IIR); NEC: FU
Belarus	FU	FU
Belgium	FU (IIR)	FU
Bulgaria	FS, FU: Agriculture (1A4ci)	FS, FU: Agriculture (1a4ci)
Cyprus	FU (IIR)	FU (IIR)
Czech Republic	FS, FU (IIR)	FS, FU
Estonia	FU (sold not available)	FU
Finland	FU	FU
France	N/A	FS: 1A3ai(ii), 1A3b, 1A3c, 1A3di(i), 1A3dii, 1A4ciii FU: 1A3ai(i), 1A3aii(i), 1A3aii(ii), 1A4ci, 1A4ciii
Germany	FS	FS
Ireland	N/A	LRTAP: FS; NEC: FS/FU
Latvia	N/A	FU
Lithuania		FS/FU
Norway	FS: 1A3b, 1A3dii, 1A4ciii, 1a5b	FS: 1A3b, 1A3dii, 1A4ciii, 1A5b
	FU: 1A3aii (i), 1A3aii (ii), 1A3ci, 1A4cii	FU: 1A3aii (i), 1A3aii (ii), 1A3ci, 1A4cii
Moldova	FU	FU
Sweden	FU (IIR)	FS, FU (1A3b, 1A3c, 1A5b)
Slovakia	FU	FU
Slovenia	N/A	FS
United Kingdom	N/A	FS, FU (1A4ci, 1A4cii, 1A5b)
Total	FS: 1, FU: 9, FS&FC:3	FS: 2, FU: 8, FS&FU: 9

The difference in emission values obtained from the two different methods is small in most countries. However, in countries with low fuel prices and resulting high fuel tourism, the difference can be quite high. Table 3.10 shows that in Austria, NO_x emission estimates based on the amount of fuel sold were by about 38 % higher than based on the amount of fuel consumed in 2004. In Ireland this difference was nearly 8 %. Austria provided information on both estimation methods in the short IIR and Ireland submitted two different NFRs (including and excluding fuel tourism) under NEC.

Table 3.10. Difference in emissions estimates based on fuel consumed and fuel sold for Austria and Ireland (2004)

	Austria			Ireland		
	incl. fuel tourism	excl. fuel tourism	difference	incl. fuel tourism	excl. fuel tourism	difference
NOx	226,91	164,19	38,2%	118,95	110,50	7,6%
SOx	28,89	28,22	2,4%	70,92	70,68	0,3%
NMVOC	172,20	168,14	2,4%	63,44	60,97	4,0%
NH3	63,84	63,54	0,5%	114,27	114,08	0,2%

3.9 TIME SERIES CONSISTENCY

Key messages – time series

The aim of this test was to identify instances of dips, jumps, and sudden trends in time series data reported by countries. Dips and jumps in the inventories were flagged for all countries providing sufficient amount of data to be analysed.

- *Based on responses received from countries, the reasons for outliers were:*
  - *Dips and jumps were real and had logical explanations;*
  - *Parties needed to recalculate data;*
  - *Parties needed to correct errors;*
  - *Emissions in WEBDAB had to be checked.*

The aim of this test was to identify instances of dips, jumps, and sudden trends in time series data reported by countries. Only data in new NFR reporting format were analysed, and data for which at least three years was reported. The table below shows data that was flagged where outliers in time series data were identified.

Reported time series data were log 10-transformed prior to analysis to reduce intra-series variability and improve general time series linearity. A linear regression was subsequently applied to the log-transformed values for each time series. Time series with a large sigma (standard deviation > 0.2) have been flagged generally. An individual value within the time series was identified as a dip/jump if the respective residual value (regression forecast value - reported value) was greater than 2.5 standard deviations from the mean of all residuals within the time series. Only time series responsible for a significant fraction (>3%) of the national total are included.

Identified dips and jumps have been flagged at both a detailed and aggregated sector level (due to inconsistencies that occur in some cases between the reported subsectors and aggregated sectors).

Dips and jumps in the inventories were flagged for all countries providing sufficient amount of data to be analysed. The explanations for the outliers were four fold; firstly, the majority of flagged values turn out to have a *reasonable explanation* according to the Review Response to S&A-I provided from 23 Parties: e.g. plants were shut down, new flue gas desulphurisation plant was installed in a power plant of large SOx emission, coal miners strikes, and emissions changing sector from “waste” to “energy” as a result of the plant being equipped with energy recovery were among the explanations given. Many countries also saw the need to *recalculate* part of their data, while other found *errors in their reporting*. A few Parties did not recognize their emission data from the test, and claimed *errors in WEBDAB.* Some of the reason for this was that Parties had also re-submitted data too late to be taken into account in the review, and hence discrepancies between WEBDAB data (that was used in the review) and the latest submission occurred.

One Party noted that: *Most of the time series identified have highly non-linear trends. Such series will be identified as anomalous with linear regression methods. The lack of most data points between 1980 and 1989 probably increases the risk of being identified as anomalous. This group includes:*

- *Series with high initial values that drop rapidly and then stabilise. Examples: SOx - 1A2d, Pb - 1A3bi.*
- *Series with high stable initial values that begin to drop in the middle of the period. Example: CO - 1A3bi.*
- *Series that peak in the middle of the period. Examples: NOx - 1A3bi, NMVOC - 1B2a*

The review team agrees with this comment, and we will look into how the time trend test might be improved to give an even better feedback to the countries in the future.

3.10 IMPLIED EMISSION FACTOR CHECKS

Key messages- Implies emission factors

The objective of the implied emission factors (IEF) check was to identify significant changes of IEFs within time series and/or significant differences in the IEFs across countries. This test therefore helps to identify outliers of IEF within time series for individual countries and across countries. Implied emissions factors were calculated for the sectors that had been identified as key sources for Western and Eastern European countries for the year 2004 and for the main air pollutants.

LRTAP: .

- *More than 40% of reporting countries showed more than 20 % flagged values. In general, the more data countries have reported, the greater the number of flagged values occur.*
- *In the Western Countries, CO emission values contain most flagged values (28%), SOx (25%), NH3 (19%), NOx (14%) and NMVOC (10%). The situation for Eastern Countries is somewhat different, most flagged values were also for CO (17%) reporting, but then SOx, NH3 and NMVOC are all on the same level (8%). Very few values are flagged in NOx reporting (3%).*
- *Five sectors (4B1b, 1A1c, 6C, 1A4a, 1A2a) contain more than 40 % flagged values. These sectors are concerning emissions from agriculture, energy and waste.*

NEC:

- *Additional findings for NEC were only observed for Ireland (SOx from 1A3d, Navigation) and Italy (SOx from 1A3d and 1A4a, Commercial/Institutional).*

Implied emissions factors were calculated for the sectors that had been identified as key sources for Western and Eastern European countries for the year 2004 and for the main air pollutants CO, NMVOC, NOx, and SOx. IEF values were derived from a) emissions data reported by Parties to the LRTAP Convention and/or under NEC and b) sectoral activity data reported to the European Commission under the EU Monitoring Mechanism. The IEFs were analysed with the UNFCCC outlier tool. The results of the outlier tool were analysed manually and obvious dips and jumps of generally more than 10 % difference to the previous and following years were flagged as well as obvious outliers across countries.

It should clearly be recognised that flagged IEF values are not necessarily themselves indicative of any underlying inconsistency in an inventory; dips and jumps within time series might simply be due to industries that have been closed or to changes in the fuel splits or higher fuel use in a single year etc. Differences across countries might be due to different types of emission abatement equipment, different fuel splits etc.

Another point to emphasise is that activity data being used in this analysis may be significantly different from the activity data actually used in the calculation of the emission estimate for the different countries, leading to differences between implied emissions factors across countries.

Examples of IEFs that have been flagged are shown in Figure 3.6 for outliers within time series and in Figure 3.7 for outliers across countries.

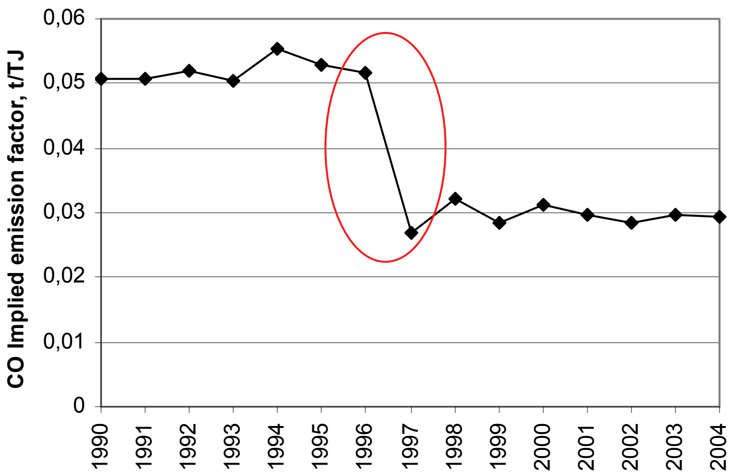

Figure 3.6. Example of implied emission factor analysis showing data points that would be flagged as an outlier in the time series 1990-2004 (CO, sector 1A1a).

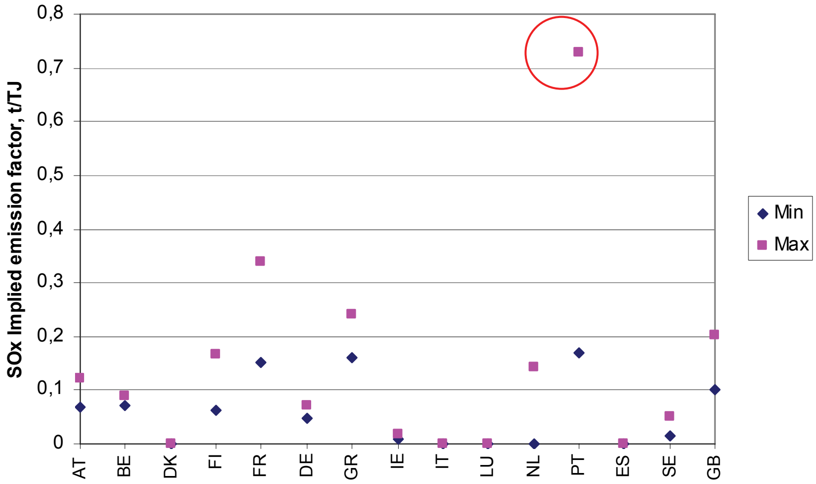

Figure 3.7. Example of IEF analysis showing points that would be flagged as outliers. The figure presents the highest and lowest IEF 1990-2004 for each country (SOx, 1A2a).

3.10.1 LRTAP

Figure 3.8 shows the number of flagged values as a % of the all unique values reported for each pollutant. All countries reporting both under CLRTAP/NEC and the EU Monitoring Mechanism were considered (Western Countries: EU15 without Luxembourg, Eastern Countries: EU10 without Cyprus, Czech Republic, Malta, Poland and Slovakia). Western Countries show more flagged values than Eastern countries, mainly because Western Countries have reported more values. In the Western Countries CO emission values contain most flagged values (28%), SOx (25%), NH3 (19%), NOx (14%) and NMVOC (10%). The situation for Eastern Countries looks somewhat different, most flagged values were also for CO (17%) reporting, but then SOx, NH3 and NMVOC are all on the same level (8%). Only a very few values are flagged in NOx reporting (3%).

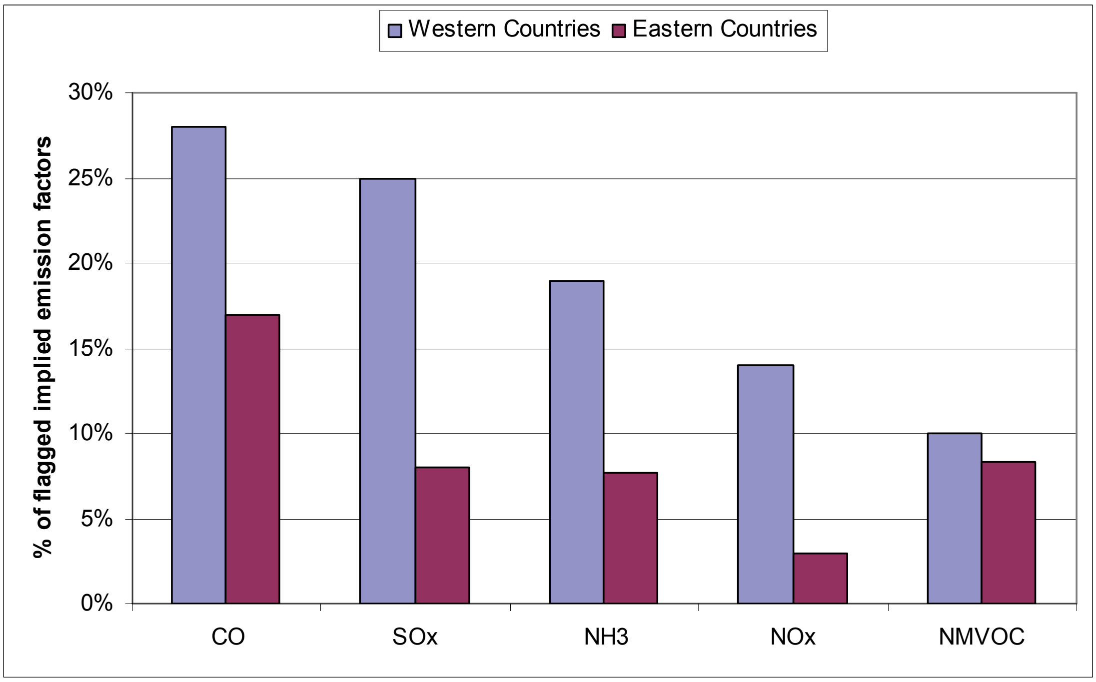

Figure 3.8. Number of IEF flagged values by pollutant expressed as a percentage of the number of IEF comparisons made.

Figure 3.9 lists all reporting countries according to their number of flagged values in comparison to all reported values. In general, the more data countries report, the greater the number of flagged values that occur. Of the 19 reporting countries, eight show more than 20 % flagged values. The low number of new Member States results from the low number of available data both from LRTAP and EU Monitoring Mechanism. Many new Member States only reported data for 2003/2004 which made it impossible to find outliers in time series.

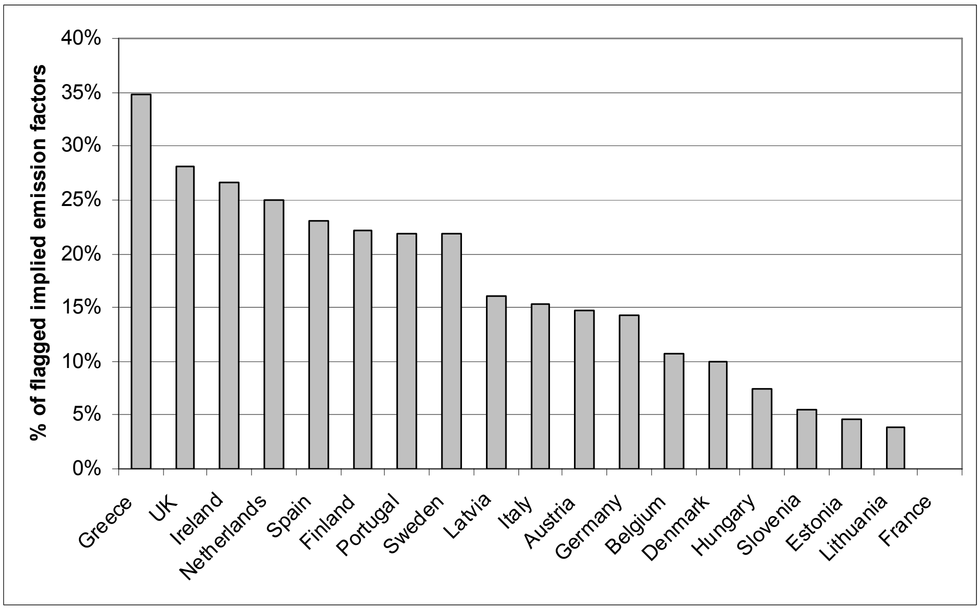

Figure 3.9. Number of IEF flagged values by country expressed as a percentage of the number of IEF comparisons made. Comparisons could not be made for a number of countries due to lack of emissions and /or activity data; these are not shown in the chart above.

Figure 3.10 compares the number of flagged values within different sectors. Five sectors (4B1b, 1A1c, 6C, 1A4a, 1A2a) contain more than 40 % flagged values in Western countries, concerning emissions from agriculture, energy and waste. Twelve sectors have less than 20 % flagged values.

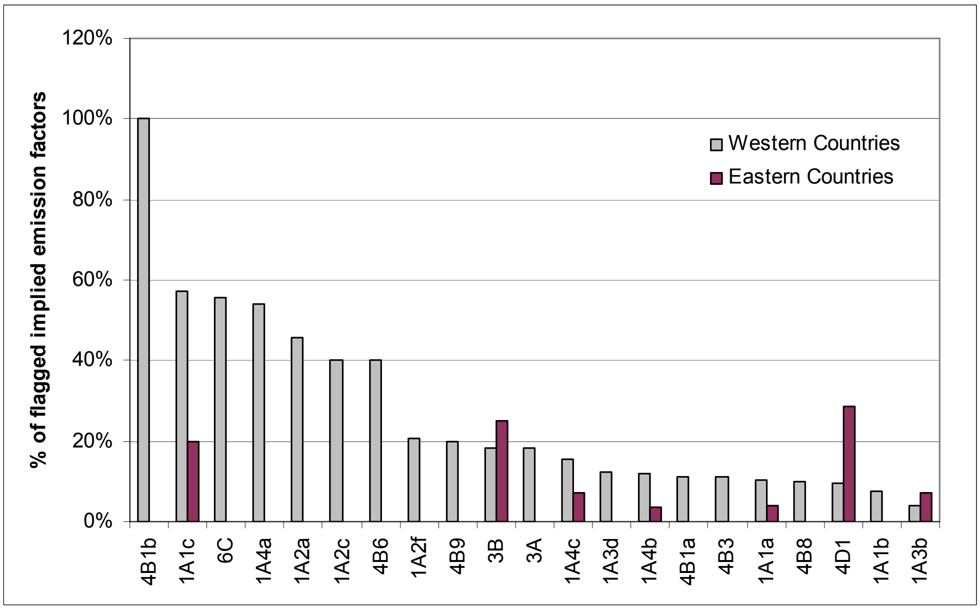

Figure 3.10. Number of IEF flagged values by sector expressed as a percentage of the number of IEF comparisons made.

3.10.2 NEC

Additional findings for NEC were only observed for Ireland (SOx from 1A3d, Navigation) and Italy (SOx from 1A3d and 1A4a, Commercial/Institutional).

3.11 CONCLUSIONS AND RECOMMENDATIONS FROM THE 2006 STAGE 1 AND 2 REVIEW

It can be concluded that the overall completeness of reporting remains low for many LRTAP countries. The completeness of the EMEP sector data time series (independent of reporting format) is largest for SOx and NOx (about 80% completeness) and less (about 68%) for NMVOC and NH3. The completeness of the reporting of sector data is still lower for the PMs than for the Main Pollutants, but has been steadily increasing, from around 40% completeness in 2000 to about 60% in 2004 emissions. In addition, many countries reported a need for recalculation of their emission data having reviewed the results of the time series test. Therefore it is also clear that some of the data is not comparable and consistent between years.

A number of instances have been noted where Parties report in the same reporting year the same value in different reporting formats, or worse, different values in different formats. Parties are requested not to double report emissions. Reporting of the same (and even different) emission figures in different reporting formats is confusing to data users, and can create errors in subsequent data analysis by users.

The timeliness of reporting increased for the Convention countries compared to last year and now 55% of Parties report on time. However, 20% of submissions are received after the reporting deadline. Late submissions hamper the review and modelling assessment work under the Convention. In contrast, in the 2006 reporting round, the number of countries reporting NEC data on time decreased. There is also a clear need for better coordination between the European Commission, the EEA and the review team to ensure that reported NEC data is made available for the review.

The level of transparency associated with the reported emissions data is increasing. Despite the fact that the Guidelines only 'encourage' Parties to submit Informative Inventory Reports, 35% of Parties submitted this information. Almost half of the Parties respond to the review questions. A real challenge is how to organise the large amount of information now provided, in addition to the emission data. An improved information system needs to be built which enable quick tracing of questions already replied. Efforts have been made to eliminate questions already answered by Parties in an earlier UNECE/NEC review or in one of the Informative Inventory Reports (IIR). This process takes a lot of resources, because it can involve the reading of several hundred pages of documentation.

The comparability between pollutants and countries appears relatively good according to the cross-pollutant test. On the other hand, more than 40% of reporting countries showed more than 20 % flagged values in the Implied Emission Factor test. Five sectors (4B1b, Cattle, 6C, Waste incineration, 1A1c , Manufacture of solid fuels, 1A4a, Commercial /institutional and 1A2a , Iron and Steel), contain more than 40 % flagged values, and further feedback will be required from countries as to whether reporting guidance in these sectors needs to be strengthened.

This year's review showed that more countries continue to report emission based on fuel used (in contrast to fuel sold) to estimate their emissions. The difference in emission values obtained from the two different methods is small in most countries. However, in countries with low fuel prices and resulting high fuel tourism from neighbouring countries, the difference can be as high as 40 %.

A relatively large number of countries (46% of LRTAP Parties and 50% of NEC) reported significant recalculations (> 10%) between their 2005 and 2006 data submissions. All but two countries explain their recalculation, mostly by means of the Stage 2 review Synthesis and Assessment report. POPs and PM2.5 have the highest number of recalculations, followed by HMs and NMVOC. It seems like the focus on PM2.5, and more information being available led to an increase in recalculations of PM2.5 compared to 2005. PM10 is recalculated less than half of the times PM2.5 is recalculated, and this needs to be looked into. The largest percentage recalculations are found for PMs followed by PCDD/F , Pb, Cd, other POPs, Hg, CO, SOx, NMVOC, NH3 and NOx. There was no general trend seen in the recalculations.

Differences occur between inventories countries submit to LRTAP, NEC and under the EU Monitoring Mechanism e.g. differences larger than 0.1% between emission data submitted under the Convention on LRTAP and under the NEC directive were found for seven countries. However, the overall improved level of transparency noted above assists in understanding these differences, all but two countries have reported explanations for differences noted in the review. Such differences were found to be mainly due to a) different reporting requirements, geographical scope etc and b) less stringent levels of QA/QC checking for air pollutant data reported to EU-MM leading to errors in reporting.

Feedback received from Parties present at the Expert Panel on review meeting in Amersfoort, 14 June 2006 were satisfied with the Stage-2 review, and indicated they wish it to continue along the same general lines as present. There are a number of improvements that could be made in the future in order to improve the utility of the review for countries, and given an adequate level of resourcing; those identified so far are:

- Dips and jumps in the inventories were flagged for all countries providing sufficient amount of data to be analysed. The majority of the outliers could be explained as real. The test has a weakness in that most of the time series identified have highly non-linear trends. The review team will investigate options for improvement of this test.

- The cross pollutant test could be strengthened by removing certain ratios checked this year e.g. landfills and agriculture where many countries do not report emissions of CO from these sectors. Next year, more emphasis will also be laid on the explanation as to why a certain pollutant ratio was chosen and on providing a range of expected ratios to make it easier for countries to compare their ratios against this range.

- Parties are also still encouraged to check their submission using REBDAB before the due date, both for NEC and LRTAP submissions. This provides a number of preliminary quality checks including identifying internal consistencies. REBDAB should be developed further to provide still better feedback in a more user friendly manner. Areas targetted for improvement include on inconsistencies, e.g. by acknowledging and accepting the use of notation keys better, and by increasing the internal threshold for when two values are accepted to be equal to take account of rounding in decimal places.

The specific recommendations and requests made to the bodies from the 2006 review:

- Harmonisation of the LRTAP reporting Guidelines and NEC reporting on aspects such as source coverage and reporting deadlines;
- Provide a clear definition of completeness to allow this to be formally analysed for compliance purposes;

- Consider if the NEC data can be made publicly available through WEBDAB or an EEA website to improve public accessibility to, and transparency of this data.

3.12 REFERENCES

UNECE, 2003. Emission Reporting Guidelines. Air Pollution studies No. 15. Guidelines for Estimating and Reporting Emission Data under the Convention on Long-Range Transboundary Air Pollution. ECE/EB.AIR/80. ISBN 92-1-116861-9. United Nations, New York and Geneva, 2003

UNECE, 2004. EB.AIR/GE.1/2004/8. Draft note on the differences between the revised and the previous emission reporting guidelines.

UNECE 2005. EB.AIR/GE.1/2005/7, Annex III. Draft methods and procedures for the technical review of air pollutant emission inventories reported under the Convention and its protocols.

Vestreng, V., Breivik K., Adams M., Wagner A., Goodwin J., Rozovskaya O., and Pacyna J. 2005. Inventory Review 2005. Emission Data reported to LRTAP Convention and NEC Directive Initial review for HMs and POPs. EMEP/EEA Joint Review Report, July 2005. Available: http://www.emep.int/reports/2005 ISSN 0804-2446

Vestreng, V. M. Adams and J. Goodwin, 2004, Inventory Review 2004. Emission data reported to CLRTAP and under the NEC Directive. EMEP/EEA Joint Review Report, July 2004. Available from: http://www.emep.int/reports/2004/emep_technical_1_2004.pdf

Vestreng, V. and Klein, H., 2002, Emission data reported to UNECE/EMEP: Quality assurance and trend analysis – Presentation of WebDab, EMEP/MSC-W Note 1/2002

All UNECE/EMEP documents are available from: http://www.unece.org/env/emep/

Other UNECE/CLRTAP documents are available from: http://www.unece.org/env/lrtap/

This report and other EMEP reports are available from the EMEP home page: http://www.emep.int/

4 REPORT OF THE TFEIP 'EXPERT PANEL ON REVIEW' SECRETARIAT ON THE TRIAL THIRD STAGE REVIEW OF THE LRTAP AND NEC AIR EMISSION INVENTORIES

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Martin Adams, ETC/ACC
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4.1 INTRODUCTION

This chapter presents a summary of the main findings from the trial centralised review performed on the air emission inventories submitted by Parties to the Convention on Long-Range Transboundary Air Pollution (LRTAP) and by Member States under the requirements of the National Emissions Ceilings Directive (NEC Directive). This was the first year that a centralised review of air emission inventory data has been performed using LRTAP and NEC inventory data. The review builds on the results of the annual Stage 1 and 2 review performed by the Expert Review Team in 2005 (EMEP/EEA 2005).

The Task Force on Emission Inventories and Projections (TFEIP) Expert Panel on Review thanks the national experts that contributed to this 3rd Stage review, and the national Agencies that provided funding to allow their participation. The European Environment Agency (EEA) is thanked for hosting the review team and providing meeting facilities.

4.2 MANDATE

The EMEP Steering Body, at its twenty-ninth session welcomed the 'Draft methods and procedures for the technical review of air pollutant inventories reported under the Convention and its Protocols' (EB.AIR/GE.1/2005/7, annex III), as developed by the TFEIP (http://www.emep.int/emis2006/annex3.pdf). These were subsequently adopted by the Executive Body at the 23rd session (ECE/EB.AIR/87). The review and improvement of emission data is an important part of the work of the Convention's TFEIP in its aim to achieve high quality emission inventories. The Executive Body, the Working Group on Strategies and Review (WGSR), the EMEP Steering Body (SB) and the European Commission (EC) have all underlined in recent years the importance of data quality for the effective implementation of the Protocols under the Convention and for policy development. The decision to conduct a trial centralised review was agreed at the 6th joint TFEIP/EIONET meeting, held in Rovaniemi, Finland October 2005. The review has been performed in accordance with the UNECE EMEP 'Draft methods and procedures' document (EB.AIR/GE.1/2005/7, annex III).

As the 3rd Stage review this year was a trial process only, the country specific review results were only communicated to the Party concerned.

4.3 OBJECTIVES

The overall objectives for the LRTAP review process are outlined in the 'Draft methods and procedures' document (EB.AIR/GE.1/2005/7, annex III, para 2).

- The review will check and assess Parties' data submissions with a view to improving the quality of emission data and associated information reported to the Convention.
- The review also seeks to achieve a common approach to prioritizing and monitoring inventory improvements under the Convention with those of other organizations with similar interests such as the United Nations Framework Convention on Climate Change and the European Union National Emission Ceilings (NEC) Directive.

In addition, the objective for this trial stage 3 review was to gain experience from a detailed review exercise in order to provide feedback to the TFEIP for future development of the reporting and review process. Issues for consideration were to:

- evaluate the perceived value added from a stage 3 review over stages 1&2;
- evaluate if the centralised review is an efficient stage 3 model;
- estimate resource requirements;
- assess the usefulness of the present Emission Reporting Guidelines (ECE/EB.AIR/80, Air Pollution Studies series, No. 15) and the Emission Inventory Guidebook (EEA, 2005) for detailed review purposes;
- discuss timing issues;
- consider organisation and management issues.

4.4 REVIEW MANAGEMENT

The trial review was planned and coordinated by the TFEIP Expert Panel on Review in cooperation with the European Topic Centre for Air and Climate Change (ETC-ACC). The review took place from 27th of February to 3rd of March 2006 in Copenhagen, Denmark and was conducted by the following team of experts nominated by the volunteering participating countries: Generalist - Mr. Justin Goodwin (ETC-ACC); Energy - Mr. Tomas Gustafsson (Sweden), Mr Tinus Pulles (ETC-ACC), Mr Stephan Poupa (Austria); Industrial Processes - Ms. Zuzana Elenicova (Slovakia), Ms Jitka Hlavicova (Czech Rep), Ms Kristina Saarinen (Finland); Agriculture - Mr. Chris Dore (United Kingdom), Mr. Steen Gyldenkærne (Denmark). Mr. Justin Goodwin and Mr. Tinus Pulles were the lead reviewers. The review was coordinated by a trial review secretariat led by Ms. Karin Kindbom (co-chair of the Expert Panel on Review) with additional support from Mr Martin Adams (ETC-ACC) and Ms. Vigdis Vestreng (EMEP MSC-W).

4.5 REVIEW PLANNING AND PROCESS

The planning and implementation of the trial stage 3 review followed the schedule outlined below.

- Sept-Oct 2005: TFEIP agreement to perform the trial review and invitation to countries to participate in the trial review issued;
- 11-12 Jan 2006: Planning meeting in Gothenburg (Kindbom, Goodwin, Vestreng);

- 27th Jan 2006: Review material and information distributed to review experts;
- 27 Jan - 27 Feb: Experts start to get acquainted and work with review material;
- 27 Feb - 3 Mar: Review week in Copenhagen;
- June: Lead reviewers edit draft review reports and send back to experts and review secretariat;
- June-August: Review experts and review secretariat approve of the draft reports;
- August: Draft reports sent by review secretariat to the individual country for comments and clarifications;
- September: Comments on reports from countries to review secretariat. Feedback from countries on the review process usefulness and timing;
- September: Clarifications of report comments from countries with Review Experts via review secretariat;
- September-October: Lead reviewers and review secretariat finalise review reports and send to countries;
- 15th July: Review Secretariat produce a trial review chapter for the annual review report.

4.5.1 Countries and data reviewed

In September 2005, the Chairpersons of the TFEIP sent a preliminary invitation to Parties who had submitted informative inventory reports (IIRs) with their 2005 LRTAP inventory submissions to participate in a voluntary centralised review. Eleven Parties subsequently volunteered to have their inventory submissions reviewed:

- Austria
- Belarus
- Belgium
- Cyprus
- Czech Republic
- Denmark
- Finland
- Slovakia
- Spain
- Sweden
- United Kingdom

As noted previously, a number of the volunteering participating countries also nominated national experts to contribute to the 3rd Stage review process. The trial review was organised in a way that the national experts participating as reviewers did not review their own country's submission.

The reviewers only assessed inventory data reported in the NFR reporting format and submitted up to 10th March 2005 to the UNECE secretariat under the LRTAP Convention. The scope of the review was on the pollutants covered by the Gothenburg Protocol, SO_2, NOx, NMVOC and NH_3, for the years 1980 – 2003, and covering the source sectors Energy, Industrial processes and solvent use, and Agriculture.

NEC data was not reviewed explicitly in this trial 3rd stage review. However results from the Stage 1 and 2 reviews performed in 2005 (EMEP/EEA 2005) indicated that, except for one of the countries reviewed, there were no differences larger than 0.1% between the respective LRTAP and NEC submissions.

Prior to the review, the following preparatory material was provided to the experts:

(a) Background material
   a. 2005 joint EMEP/EEA Review report (http://emep.int/publ/reports/2005/emep_technical_1_2005.pdf)
   b. Informative Inventory Report template

(b) Country Data and Reports
   a. Officially reported data (Excel file), instructions for using the file
   b. Informative Inventory reports (IIRs)
   c. Country specific Review reports (Questions and Responses from review stage 1&2),

(c) Guidelines
   a. UNECE, 2002. Emission Reporting Guidelines
   b. Link to EMEP/CORINAIR Guidebook
   c. Guidebook Chapter on Good Practice Guidance
   d. Overview of reporting requirements according to UN protocols signed by country (base year, pollutants, area included)

(d) Review Mandate and Guidance
   a. Guidance for Reviewers (draft, prepared for this trial centralised review).
   b. Draft methods and procedures for the technical review of air pollutant emission inventories reported under the Convention and its protocols (Annex III of EB.AIR/GE.1/2005/7)

(e) Review transcript and Review report template
   a. Review Report Template (derived from UNFCCC template)
   b. Review transcripts template (derived from UNFCCC template)
   c. Instructions for review transcript

4.6 TRIAL REVIEW ROLES AND RESPONSIBILITIES.

Table 4.1 summarises the tasks and responsibilities of those involved with the trial stage 3 review process.

Table 4.1. Roles and responsibilities for the trial stage 3 review process.

Secretariat	Lead reviewers	Expert Review Team
Provide the background preparatory material, guidance and templates for the review to the Expert Review Team (ERT)	Prepare a brief work plan for the review activity	Examine the adherence of the inventory information to guidelines etc
Present stage 1 & 2 review findings and clarify use of the templates, data and guidance for review	Monitor the progress of the review activity and ensure that there was good communication within the expert review team	Review the transparency of the inventories and examine whether good practice was applied
Available to provide administrative advice on the review process	Coordinate queries of the expert review team to the Party and coordinate the inclusion of the answers in the review reports	Compare emission estimates, activity data, implied emission factors and any recalculations to identify irregularities or inconsistencies
Communication of the ERT's questions and draft review reports to the parties and receipt of responses from the parties	Provide ad-hoc technical advice to the experts, if needed	Identify any missing sources and examine any explanatory information relating to their exclusion from the inventory
Finalisation of the review reports in cooperation with the Lead Reviewers	Ensure that the review is performed and the review report is prepared in accordance with the draft guidelines	Identify the reason for any differences between the Party's and the Stage 1 and 2 key source determination
Collecting and compiling experiences from the trial stage 3 review for a chapter in the annual review report	Verify that the review team gives priority to key source categories	Assess the consistency of information in the data with that in the IIR
		Identify if countries differ in terms of their implied emission factors and their sectoral allocation, and obtain explanations for differences
		Identify areas for further improvement of the inventories

4.7 TECHNICAL REVIEW FINDINGS (BY LEAD REVIEWERS)

This trial review has provided a great deal of insight into the possible usefulness and functioning of future stage 3 reviews. A summary of these from a lead reviewers perspective follow:

- A third stage of review is essential in order to understand and solve the real issues with reported inventories
- It provides a unique technical opportunity for inventory experts to exchange ideas and learn from each other
- It has the profile to attract attention from high up in Parties organisations and get support from ministries.

Due to the large number of UNECE pollutants and the absence of metrics to combine these pollutants the review and the review reports can not follow the same structure as that of the UNFCCC.

The review teams need specific training and review support to be able to review non GHGs. Even review experts with experience from the UNFCCC review process found this review difficult because of the lack of technical structure and mandate boundaries to review against. Agreement and guidance is needed on the reviews mandate and scope as well as the language to use that will be interpreted appropriately by parties politically and technically (e.g. sector, source, pollutant, compound, category, recommends, should, shall etc)

Review reports have the potential to be long and time consuming and unfocused, because of the wide scope of the inventories therefore, streamlining the review reports to concentrate on identifying the good practices and the key improvements needed is necessary. For example, summaries of the trends and important sources in similar detail to the UNFCCC review reports will be time consuming and not necessary for the desired review outcomes of improved emission estimates and compliance assessments.

Limiting the number of countries reviewed in a review week to 5-6 and not 11 as was done for this trial review.

Better reporting guidelines are needed for Parties and for review teams to review against.

Improvements to the guidebook are required to provide the review teams with a benchmark for methodology quality.

Specific findings from this trial Stage 3 review include:

- A general lack of description of trends and clear identification of the reasons for significant dips and jumps in the inventory time-series.
- A lack of clarity about the methods, emission factors and assumptions used for sectors in the inventory.
- Some time-series inconsistency resulting in methodology based changes in the inventory.
- The general quality and professionalism of the inventories was good and the review teams all felt that Parties inventory compilers were highly technically and professionally competent but hampered by limited resources.

4.8 FEEDBACK FROM THE EXPERT REVIEW TEAM ON THE TRIAL STAGE 3 REVIEW PROCESS AND FINDINGS

4.8.1 Assessment of completeness in relation to reporting requirements

A key problem experienced by the review team was that the legally required reporting requirements for each Party are not clear. The requirements as defined in the LRTAP Protocols, the Guidelines (Para 9 and 21) and the footnotes to the NFR reporting template in the Reporting Guidelines (Section D, Table IV 1 A and IV 1 B) are not consistent and therefore are somewhat ambiguous. This made it difficult for the expert review team to compare the reported data received from Parties against mandatory reporting requirements. It was a general agreement that for review purposes a clear guidance regarding what criteria to review against is needed in order to be able to assess completeness, especially concerning reporting years (time-series), pollutants and whether or not source categories or only national totals are required.

4.8.2 Availability of information for the review

A further challenge in performing a 3rd stage review was that the review team had to rely on additional information presently provided by countries on a voluntary basis such as an Informative Inventory report, IIR (Guidelines para 38). The review team considered the availability of IIRs to be essential to perform a stage 3 review. IIRs received from countries varied in the amount of information, level of detail and format. Despite the provision of an IIR template, not all countries included the necessary information in terms of detailed methodology description, sources of activity, emission factors etc. Detailed information on activity data, emission factors and methodology (and references for these) is necessary to ensure sufficient transparency for the review. From the review team it was stressed that it is important that in future years the IIR become mandatory and that countries are requested to provide IIRs in a standard format to facilitate the review.

The experts felt that the availability of relevant activity data is important to be able to perform a detailed review. At present reporting of activity data under LRTAP is required every 5th year, and in a rather aggregated format which is not detailed enough for 3rd stage review purposes. In stage 2 of the review, activity data reported by Parties to UNFCCC were used, but due to differences in sources and timing of submission of data, the activity data cannot be fully used in the LRTAP review.

Not all countries included details of their QA/QC systems in their submitted IIRs. The expert review team encourages Parties in the future to report this information to further increase confidence in the reported data.

4.8.3 Transparency, reporting template

The review team commonly found a lack of transparency of submitted data, especially for the NFR–codes “Other”. If the emissions included in “Other” are not separately explained in the IIR it is not clear what these emissions comprise. This limits the extent to which a detailed review can comment on the reported data. This problem was particularly noted for emissions from industrial processes reported as ”Other”. It was also stressed from the expert review team that it would be helpful if relevant information on process types used in the industrial sector within countries would be reported in the IIRs.

4.8.4 Consistency, reporting template

The stages 1&2 review consistency tests noted that for some of the countries reviewed in the stage 3 review, the reported aggregated data was not always internally consistent with the sum of the detailed sub sectors reported. This introduced an uncertainty if data in the sub-sectors provided really were meant to constitute all of the aggregated emissions, or if there were emissions added at aggregated level that were not allocated to any of the sub sectors. Alternatively, the inconsistencies could simply be a result of errors in summing the sub sectors to the aggregated level. These problems with inconsistencies in aggregations should be carefully considered in the revisions of the Guidelines and reporting template. The review team however, recognised the importance of not changing the reporting templates too often, which inevitably leads to problems and additional work for the Parties, as well as in the review process.

An additional problem for the reviewers was that for some countries only a limited set of data were available for review in the NFR format, and additional (older submissions) are only available in the SNAP system. There is a need to consider extending the review to cover data reported in other formats. It is however not always straightforward to compare data reported in different formats on a detailed level.

4.8.5 Comparability and source allocation

During the trial review it was discovered, or suspected, in several cases that there are inconsistencies in source allocation between Parties. It is not always clear if this is a result of misinterpretation of the reporting guidance or if it is not possible to split out the data within a respective country's inventory. The allocation and separation of emissions between e.g. Energy and Industrial processes involving combustion may be a problem in some countries. The review team suggested that a reference could be made in the Emission Reporting Guidelines at a generic level to UNFCCC guidance to define separation of process emissions from combustion of fuels. Sometimes, primarily for less significant sources and/or for sources emitting only particulate matter, it is probably not defined clearly enough in the reporting guidance where to allocate emissions. The review team stated that emissions may be aggregated and need not necessarily be split and reported in the correct reporting code, but reported data need to be transparent and traceable.

4.8.6 Usefulness of Guidebook for reviewers and for national experts compiling inventory

The guidebook was generally considered suitable as a point of reference for the purposes of detailed review for the pollutants covered in this review. In terms of assisting countries to compile emission inventories, the review team however commented that for some sources a large number (>30) of 'default' emission factors are provided in the Guidebook, which can encompass a wide range of values. It is maybe not clear for the inventory compiler to know what factor should be used in the first instance.

The review team anticipate that the guidebook won't provide sufficient information for other pollutants e.g. PM_{10}, pesticides etc. and that the Guidebook needs to be further developed to support review activities if these substances are to be included in future review activities.

The review team considered that there is a need to distinguish between the function of available guidance for review purposes within the UNFCCC system and that of LRTAP. The UNFCCC system could be described as being a review primarily targeted towards compliance while in the LRTAP system the function of guidance is also to provide and reference best science for emission inventory.

4.8.7 Usefulness of Stage 1&2 review

Feedback received from the review team indicated that generally the country specific reports from the Stage 1&2 review provided useful input to the 3rd stage review. Stage 1&2 was considered an excellent way of giving feedback to countries, and several instances of e.g. flagged data had been adequately commented and explained by the countries already in their responses to the Stage 1&2 review.

It was however noted that the time series test (dips & jumps) could be further refined since it was felt that some irrelevant flagging, as well as some missing dips & jumps that could have been flagged existed in the material. It was suggested from the review team to consider investigating the use of different thresholds for key sources and non-key sources, or different thresholds for sector/pollutant combinations.

It was also noted that the usefulness of the Stage 1&2 tests would be further increased if Implied Emission Factor (IEF) checks could be performed for a greater number of sectors. More IEF checks in stages 1&2 would provide early comments from the countries as an input for a detailed review. This would however require better availability of relevant activity data. Some caution is needed when interpreting the results of IEF analysis, especially if it is conducted on an aggregated level. It has to be clear that a deviating IEF does not necessarily mean that something is wrong, but rather an issue to investigate further. For the countries the information from the IEF tests could be used as an indication on what sectors they need to provide additional information for.

The review team noted that the compliance checks on the inventory submission data presently included in the Stage 1&2 review are not directly used as an input for the stage 3 review work. However these checks were recognised as necessary to the initial review process and need to be retained.

4.8.8 Recalculations and time series

In this trial review, data from only one inventory submission was examined so the issue of recalculations could not be addressed through the available data. However, it is noted that recalculations, and country explanations for these, are presently covered in the stages 1&2 review country reports. The review experts assessed if the recalculations were transparently explained and justified in the responses to the stages 1&2 review and in the IIRs.

4.8.9 Value added from a stage 3 review over stages 1&2

The feedback from the review experts on the value added from a stage 3 review over stages 1&2 concerned both the value added for countries being reviewed, as well as the benefits for the experts participating in the review.

The stage 1&2 review indicates possible errors and to a certain extent, sets emissions in context, but the technical steps and tests during these first stages of the review by their nature do not have the possibility to go into detail and assess and give feedback on e.g. choice of methodology, assess appropriateness of emission factors or make recommendations on improvements. These issues are addressed in a detailed review, given that suitable information such as a well developed IIR is available.

The 3rd Stage review also provides a number of additional longer-term benefits by providing confidence in the quality of reported data for compliance purposes for the work of the Convention and Commission, by providing feedback on the development needed for the Guidebook and the Guidelines, and by providing Parties/MS and national experts with information concerning the judged quality of their reported data and issues that might be addressed in the future to further strengthen the national emission inventories. The possibility of developing an indicator(s) to monitor progress and reflect improvements in the submitted inventory datasets over time was suggested for future consideration.

The review team was concerned about the reactions from countries on the usefulness and also the added workload that will be the result of a detailed review. The review team noted that many countries under the Convention have been interested and positive with respect to the Stage 3 review process. It was also noted that it is important that countries feel that the information received in the country reports from the review is useful for national inventory improvement, e.g. to prioritize future work. It is recognized that participation in a Stage 3 review will require additional resources from national inventory teams. An estimate of the resources required for participation in a Stage 3 review is provided in the Resource Requirements section below. Some countries will of course have other priorities in terms of inventory development. However, a clear aim of a Stage 3 review is to support the underlying objectives of the Protocols themselves, through encouraging and supporting countries to submit good quality inventory data. The fact that the national inventory has been reviewed by an independent international review team is seen to add credibility and importance to the submitted data and the work performed by countries.

The review team feedback was also that by participating in the review process the national experts themselves have the opportunity to study how other countries have organised and solved the inventory work. It is a good way of sharing best practice, to learn from other countries and to take ideas back for implementation in their own work etc.

One of the prime reasons for a detailed review is to help countries improve the quality of their inventories in the future. The feedback received from countries in terms of seeing whether they found the review to be useful or not should be an important factor in any future development of the review process.

Responses on the value of the stage 3 review from participating countries will be collected at the same time as the individual review reports are sent out for comments in August. The communication between contact persons in the countries and the review secretariat which took place during the review week in February, as responses to requests for clarification, were generally very informative and perceived by the review experts to be provided with a positive attitude.

Members of the expert review team identified several clear benefits of their participation in a detailed review process. One benefit of the review noted by the review team is that countries can be made aware of the inventory systems, organisation and processes used in other countries. This information can, in the future, be made available through the country review reports if these are made public.

4.8.10 Is a centralised review an efficient model?

The feedback from the review team was that a centralised review is an efficient and appropriate way of conducting a detailed review. It was also discussed how to further develop and focus future detailed reviews. There are several options e.g. in terms of covering all reported sectors for selected pollutants, or concentrating on a specific sector and more or all pollutants, or concentrating on specific pollutants such as PMs, POPs and heavy metals. Irrespective of what a detailed review is planned to cover, a centralised review model could be applied. Depending on the focus and objective of a detailed review, the composition of the expert review team may need careful consideration. If appropriate the expert review team could include relevant scientific expertise as well as national inventory experts.

The review team also raised the issue of future scheduling of detailed review activities. Issues that need to be considered are how often a detailed review should be performed, should there be a cycling between countries, sources, pollutants? There could also be a cycling of detailed reviews with different objectives, e.g. focussing on the review of inventory submissions from a compliance perspective, or a more scientific review.

4.8.11 Timing issues

The planning and implementation of the trial review, as described above, was a working timetable, where the first version turned out to be too optimistic. The planning and preparation went according to schedule, as did the review week activities in Copenhagen. Eleven countries was considered to be just possible to review during one week, but this was largely made possible due to limited information being available for some countries which made more detailed (and lengthy) assessments impossible. In future centralised reviews, given the availability of more extensive background material, fewer country submissions for review are recommended given an equivalently sized expert review team.

The work items to be performed after the review week, compilation of draft reports, distribution of reports to countries for comments and collating final reports incorporating country comments was delayed compared to the original planning as time originally allocated for these activities was underestimated.

4.8.12 Organisation and management issues

The expert review team found the preparation of review material received prior to the review week appropriate and useful. An excel file (spreadsheet tool) prepared with all relevant data from WEBDAB, was considered by the review team to be very useful and should be used in future reviews. Some improvements in the original spreadsheet tool were made during the review week, such as adding summary tools and functions for creating overview graphs.

If the review process will be formalized, careful consideration has to be given to the roles and responsibilities of the participants, as well as that of the secretariat. Evidently, in a formal process, country experts from a reviewed country would not be present. A clear role and organization of the review secretariat needs to be defined, as well as the role of the UNECE secretariat. Generally, the roles and responsibilities for the lead reviewers and the review experts as defined for this trial review was considered to be appropriate.

4.8.13 Harmonization with UNFCCC

One of the aims in the development of the LRTAP review process is to harmonize as far as possible with the UNFCCC process in order to make use of those experiences and the familiarity of that system within the countries and among the experts. From the discussions and feedback during the trial review it was concluded that the LRTAP review needs to take a somewhat different approach than the UNFCCC review approach since there are large difference in the information available, there are many more pollutants to cover within LRTAP etc. The purposes of the LRTAP review also go further than UNFCCC, which primarily checks compliance against IPCC guidelines, and which is also very procedural and extremely resource intensive with all steps described in detail. The LRTAP review process was considered to require a more scientifically oriented approach, aimed at policy needs, and sufficiently flexible in order to potentially focus on different issues in different years thus fulfilling the underlying objective of improving the quality of emission data. The conclusion is that for LRTAP it is not possible (or desirable) to copy the UNFCCC process directly, but that suitable elements from the UNFCCC system could be used as a basis to be further developed and adapted to the needs in the LRTAP system.

The harmonization between the two conventions is evident at country level in some of the IIRs in the review, where it is obvious that the IIR is derived and amended from the UNFCCC NIR (National Inventory Report). Harmonization is also justified by that the flow of data and information at the country level can be harmonized. This is apparently already the case in some countries, but not in all, where there are separate organizations compiling the LRTAP and UNFCCC inventories.

4.8.14 Resource requirements

To make an estimate of the resource requirements for performing a centralised review, all the parties concerned need to be considered. This includes the experts performing the review, the secretariat, and the resources available at the country level to answer questions and comment on the review report.

For one expert to participate in a one week centralised review the resources were estimated based on time required for:

1. preparation before the review week to read through the review preparatory material;
2. the week spent at the review;
3. checking the draft reports before distribution to the countries following the review week;
4. finally to go through country comments and revise the review reports as appropriate after comments have been received from the countries.

The level of resources used in this trial review are summarised in the following table.

Table 4.2. Estimated resource requirements (days) for this trial review.

Role (number of persons)	Estimate of resources (working days)
experts (7)	10/expert
lead reviewers (2)	15/lead reviewer
Secretariat (3)	10/person
TOTAL 2006 Trial Review	**~130 working days**
Country resources (11 countries)	~3/country

Should any future detailed Stage 3 review become more formalized, the estimated resources for a secretariat may well be different depending on how the organization will be set up and the respective responsibilities will be defined. The preparation of review material and communication with the reviewed countries will need to be performed, but the amount of resources required will depend on the level of ambition and also on the focus and objective of the specific review.

Resources are also required in the countries to answer questions communicated by e-mail during the review week and to comment on the draft country review reports before they are finalised. The resources needed may vary between countries, depending on the number and nature of the issues raised.

Additional resources required for a Stage 3 review include costs for traveling and accommodation during a centralised review week, as well as meeting facilities etc.

All costs for the individual national review experts in this trial review, and for one person at the secretariat, were covered by the individual countries. The costs for the lead reviewers and one person at the secretariat were covered by the EEA/ETC-ACC, and by EMEP for one person at the secretariat.

4.9 CONCLUSIONS AND ISSUES FOR CONSIDERATION FOR THE FUTURE DEVELOPMENT OF A STAGE 3 REVIEW

This section summarise the general findings and main observations resulting from the trial Stage 3 centralised review.

- **GUIDELINES**: The Expert Review Team provided feedback on a number of issues where it was considered that the Emission Reporting Guidelines could be amended to better assist Parties in their reporting and to facilitate future in-depth reviews.

  (a) For review purposes a clear guidance regarding what criteria to review against is necessary in order to be able to assess completeness i.e. the mandatory reporting requirements on a country-specific basis. The amended Reporting Guidelines need to refer to the review mandate (Annex 3), which can itself be updated as appropriate.

  (b) Submission of an IIR is necessary for review purposes and should be made mandatory in the Guidelines if future detailed reviews are desired. It was recognised that there is a need to provide Parties with an improved template to provide guidance on the types and scope of information that should be included in the IIR. It is suggested that this is included in the Guidelines.

  (c) The experts felt that the availability of relevant activity data is important to be able to perform a detailed review, and several options were discussed.

  (d) Reporting template:
     i. Comparability and source allocation: It was felt that the present template does not provide sufficient clarity for Parties as to where emissions from certain sources should be reported. Hence, Parties are allocating emissions to different sources
     ii. Transparency: The review team found lack of transparency of reported data, especially for the reporting codes "Other". The transparency of reported data would increase if the NFR codes were extended, but the need to harmonise the NFR inventory reporting code system with UNFCCC as far as possible was also recognised.
     iii. Consistency and aggregations: It was felt that the mix of aggregated and detailed sectors in the present reporting template does not allow a summary of emissions to be easily compiled for assessment purposes. The format of the

template also allows countries to report inconsistent aggregated emissions and increases the risk of errors in aggregation.

iv. Time series: The expert review team considered it to be useful for the purposes of future reviews if Parties were requested to report complete time series of emissions in NFR format.

- **GUIDEBOOK:** The Guidebook was considered suitable as a point of reference for the purposes of detailed review for the pollutants covered in this review. It was foreseen that the Guidebook will not provide sufficient information for other pollutants (e.g. PM_{10}, pesticides etc) and will need to be further developed to support future review activities.

- **USEFULNESS OF STAGE 1&2 REVIEW:** The country specific reports from the Stage 1&2 review were considered by the expert reviewers to provide very useful input to the detailed review and were considered an excellent way of giving feedback to countries. It was recommended to try to improve the time series test and to calculate Implied Emission Factors for more sectors.

- **STAGE 3 ADDED VALUE:** The review team identified a number of issues concerning the value added from a stage 3 detailed review as compared with Stage 1&2 review. A number of benefits that may be obtained from participating in a Stage 3 review were identified both for the countries being reviewed as well as for the experts participating in the review. The most important of these was seen as being able to provide country-specific feedback and recommendations to help in prioritisation and inventory improvement, as well as a deeper assessment of comparability, e.g. methodologies and emission factors used. The fact that several national experts cooperate in reviewing other countries submissions was seen as an excellent way of sharing good practice and to learn from the other reviewers present.

- **STAGE 3 REVIEW MODEL:** The centralised review format was considered to be an efficient way of performing a detailed review. Possible options for future reviews were discussed although no firm recommendations were reached i.e. how often a detailed review should be performed; possibilities to cycle a review between countries, sources, pollutants; and benefits of having a compliance-based review compared to a more scientific review. Opportunities for harmonizing the LRTAP Stage 3 review process with the UNFCCC review process were discussed by the expert review team. For LRTAP purposes it was concluded that it was not possible (or desirable) to copy the UNFCCC review process directly, but that suitable elements from the UNFCCC system could be used as a basis to be further developed and adapted to the needs in the LRTAP system. The LRTAP review process was considered to require a more scientifically oriented approach and be aimed at policy needs (in comparison with the more compliance-focused UNFCCC review). Furthermore, the experts felt that the LRTAP review should be sufficiently flexible in order to potentially focus on different issue s in different years thus fulfilling the underlying objective of improving the quality of LRTAP and NEC emission data.

- **STAGE 3 REVIEW ORGANISATION:** If the review process will be formalised, careful consideration has to be given to organisation and management issues. Roles and responsibilities have to be defined for participants and for the secretariat and administrative functions. In this trial review the original planned timing and resources for the process was too optimistic. The various preparatory information and software tools provided to the expert reviewers were considered useful and it was recommended that this should be used in any future Stage 3 reviews.

- **RESOURCE REQUIREMENTS**: The resource requirements for performing this trial review were estimated to a total of approximately 130 working days for the experts and the review secretariat. The resources needed in the reviewed countries for providing clarifying responses during the review week and commenting on the draft review reports was estimated to a few days per country. In a future formalised process the resources needed for the secretariat may well be different than for this trial review.

4.10 REFERENCES

EB.AIR/GE.1/2005/7, Annex III. Draft methods and procedures for the technical review of air pollutant emission inventories reported under the Convention and its protocols.

ECE/EB.AIR/80, Air Pollution Studies series, No. 15. Emission Reporting Guidelines - Guidelines for Estimating and Reporting Emission Data under the Convention on Long-range Transboundary Air Pollution.

EEA (2005) EMEP/CORINAIR Emission Inventory Guidebook – 2005, http://reports.eea.eu.int/EMEPCORINAIR4/en

EMEP/EEA (2005). Inventory Review 2005 - Emission data reported to LRTAP Convention and NEC Directive. EMEP Technical Report 1, 2005. http://www.emep.int/publ/reports/2005/emep_technical_1_2005.pdf

5 EVALUATION OF INVENTORIES OF HEAVY METALS AND PERSISTENT ORGANIC POLLUTANTS WITHIN THE CONVENTION ON LRTAP

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5.1 INTRODUCTION

Recently several independent studies have addressed emissions of Heavy Metals and Persistent Organic Pollutants within (parts of) the UNECE domain. The results of three such studies will be briefly presented in this chapter because their results may be useful in reviewing official submitted HM and POP emission data reported annually to the Secretariat of the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). Furthermore, data collected in these projects, comparisons between expert and official data and lessons learned may provide suggestions to improve the current data reporting. The three projects are briefly introduced below. It should be noted that there may well be other relevant projects in the field of HM and POP emissions which are not addressed in this chapter.

The term "expert estimates" is used throughout this chapter to indicate default emission estimates based on expert judgement in combination with literature data. A key feature of these estimates is that they are relatively consistent between countries as the same methodology is applied. However, it is important to note that the term "expert estimate" does not suggest a higher quality or accuracy than official emission data. In many cases local and/or national emission data and measurements may be better and more representative than a general "expert" methodology. Hence expert estimates are often used for gap filling. Improved expert estimates indicate a more thorough review of the available literature that may result in "improving" current or previously used expert judgement.

5.1.1 Estimation of willingness-to-pay to reduce risks of exposure to heavy metals and cost-benefit analysis for reducing heavy metals occurrence in Europe (ESPREME).

The ESPREME project is carried out under the EU 6th framework programme and aims at the development of methods and tools to support European environmental policy making in the specific case of reducing the harmful impacts of heavy metals. The study is carried out for the whole of Europe, both EU Member States and Accession Countries with more detailed assessments for several individual countries in Western Europe (Norway, Germany, Italy) countries and in 3 Accession Countries (Poland, the Czech Republic and Hungary). As part of the ESPREME project detailed emission inventories were compiled for all relevant heavy metals (base year 2000 and scenarios for 2010), improving the quality of the current datasets in terms of resolution (temporal, spatial and substance) and accuracy. These datasets also allow a comparison between official submitted emission data and expert estimates developed within the ESPREME project. These results are discussed in section 1.2 of this chapter. ESPREME is carried out by a consortium lead by the Institute of Energy Economics and the Rational Use of Energy (IER, University of Stuttgart). More information about the ESPREME project is available at http://espreme.ier.uni-stuttgart.de.

5.1.2 Study to the effectiveness of the UNECE Heavy Metals Protocol and UNECE Persistent Organic Pollutants Protocol and cost of additional measures (TNO HM & POP study)

In 2003 the UNECE Protocols for Heavy Metals (HM) and Persistent Organic Pollutants (POP) entered into force. Once the protocols enter into force automatically a review starts. Therefore, the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM) has asked TNO to execute a study to the effectiveness of the UNECE Heavy Metals Protocol and Persistent Organic Pollutants Protocol and an assessment of possible additional measures with their reductions and costs, based on projections of 2000 emission data to the years 2010, 2015 and 2020.

The study consists of two phases. Phase I comprises the construction of an emission inventory for the year 2000, including actualisation of emission data and projections for 2010, 2015 and 2020, geographical allocation of these emissions, efficiency of the current protocols and a preliminary inventory of possible additional reduction measures. It was completed in August 2005 and published in two reports (Denier van der Gon et al., 2005a, b). Phase II comprises an estimation of the emission reduction as well as costs of options for revision of the HM/POP Protocols and will be published in 2006. The domain of study is the European region falling under the UNECE Convention on Long Range Transboundary Air Pollution (CLRTAP) and thus does not include Canada and the United States.

5.1.3 Dioxin Emissions in Candidate Countries (TNO CC dioxin inventory)

At the EU Environment Council in December 2001 conclusions on the Dioxin Strategy were adopted and emphasised among other things the need to gather knowledge on the situation on dioxins in the new Member States. Against this background a project investigating the dioxin and furan emissions to air, water and land was commissioned to a consortium lead by TNO. The project " Dioxin Emissions in Candidate Countries" lays the foundation for a consistent and harmonised dioxin emission estimate for air, land and water releases in the new EU Member States. The report of the PCDD/F inventory (Pulles et al. 2005a) for candidate countries is available at http://ec.europa.eu/environment/dioxin/pdf/rapport_2005.pdf. The study assessed PCDD/F emissions in 13 countries (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovak Republic, Slovenia, Turkey).

5.1.4 Outline and scope of the chapter

The three studies have overlaps in their coverage. Unfortunately no time (and budget) was available to make a complete integration of the individual project results resulting in a coherent assessment and comparison with officially submitted emission data by Parties to the Convention on LRTAP. Hence a few practical choices are made.

The ESPREME project and the TNO HM & POP study both address heavy metal emissions in 2000 and 2010. The ESPREME project does not cover total UNECE-Europe; Azerbaijan, Armenia, Georgia, Kazakhstan and Kyrgyzstan are not included. The explicit aim of the TNO HM & POP study is to incorporate as much country data as possible (country data meaning emission data prepared by national experts of that country) and complement the inventory by TNO default estimates to achieve completeness. The ESPREME project made two types of emission inventories; an inventory based on official emission data with ESPREME expert estimates to fill in gaps and a “full expert” emission inventory. The ESPREME “official” emission inventory is comparable to the TNO study which was developed under similar prior conditions.

A quick informal comparison (data not shown) showed that the differences in the emission estimates for the two inventories were fairly small. For countries with officially submitted emission data this was by definition so, but for countries with no official emission data available, the deviations were limited. However, the ESPREME full expert emission inventory shows considerable deviation from the inventories based on official emission data and presents generally higher emissions. This suggests that the major differences are not caused by deviation between TNO expert estimates and ESPREME expert estimates but by deviation between expert estimates and official estimates. It is concluded that for the purpose of the present report the most useful contribution for heavy metals is a comparison between ESPREME expert emission data and official submitted heavy metal emission data. This comparison is made and discussed in section 5.2 of this chapter.

The TNO study (Denier van der Gon et al., 2005b) covers Persistent Organic Pollutants and eight substances possibly proposed for addition to the POP protocol. Official emission reporting of POP by Parties to the convention is much less complete than HM and the TNO expert estimates for the POPs fill an important cavity. These data are reported in section 5.3 of this chapter along with some recommendations on future reporting. The study on Dioxin Emissions in Candidate Countries (Pulles et al, 2005) reports emissions for a subgroup of countries covered in the TNO HM & POP study. The results are separately presented in section 5.3.2 because the studies are not entirely compatible in their source sector descriptions and scope. The expert estimates in the TNO CC dioxin study are thought to more accurately estimate real emissions because special effort went into defining emission factors for the local / national situation. In the TNO HM & POP study expert estimates only served to fill in gaps but are to be overwritten if, or as soon as, official data become available. An interesting addition of the TNO CC dioxin study is the emphasis on the uncertainty surrounding emission estimates and the consequences of such uncertainties for policymaking.

Parties to the protocol can propose new substances which can be added to annex I, II or III of the 1998 UNECE POP protocol. For several of these substances a first UNECE-wide emission inventories has been made by the TNO HM & POP study and the results are briefly discussed in section 5.4.

5.2 HEAVY METALS: DIFFERENCES BETWEEN ESPREME EMISSION DATA AND OFFICIAL DATA.

The EU 5th Framework Programme research project 'Estimation of willingness-to-pay to reduce risks of exposure to heavy metals and cost-benefit analysis for reducing heavy metals occurrence in Europe'3, in short ESPREME, aims at the development of methods and tools to support European environmental policy making in the specific case of reducing the harmful impacts of heavy metals. Heavy Metals (in particular mercury, cadmium, chrome, nickel, lead and arsenic) from various sources contribute to ambient concentrations in air as well as to the accumulation in water and soils, thus leading to the exposure of the European population to HM levels causing a variety of adverse health effects. In this context, initial model applications by the EMEP MSC-East indicated significant gaps between modelled and measured ambient concentrations of almost all key metals. While model uncertainties are still significant, these gaps are to a large extent likely to stem from considerable underestimations of anthropogenic emissions.

On this basis, ESPREME set out to revisit official emission estimates of all key metals and in most cases, conduct own expert estimates based on known activity rates and emission factors. The bulk of this work was executed by NILU, supported by NILU Polska, IETU and IER at the University of Stuttgart.

5.2.1 Emissions of As, Cd, Cr, Ni, and Pb

Two sets of emission data for As, Cd, Cr, Ni, and Pb were prepared within the EU ESPREME project for the reference year 2000, including:

- official emission data reported by national authorities in the European countries to the UN ECE LRTAP Convention through the EMEP program (*Annex 1*), and
- Emission experts estimates prepared by the ESPREME experts (Annex 2).

The official data in Annex 1 contain also estimates prepared by the ESPREME emission experts for the countries that no EMEP data were available. These expert estimates are marked in a final column in tables presented in Annex 1.

The major reason to develop another set of emission data within ESPREME has been the conclusion reached by dispersion modelling groups, including the ESPREME modellers that the official emission data for heavy metals in Europe, prepared by national emissions experts in various European countries are often underestimated. This conclusion is based on extensive comparisons of model results and measurement data and subsequent modelling attempts to derive 'true' emission source strengths by inverse modelling. It was pointed out by the EMEP and ESPREME modellers that the EMEP emission data for the above mentioned heavy metals seem incomplete in terms of reporting emissions from all major source categories, and sometimes inaccurate with regard to the emission factors used in these estimates. Therefore, it was decided within the ESPREME project that independent emission estimates should be prepared by the ESPREME emission experts in order to obtain more complete and accurate emission datasets for modelling, since the aim of ESPREME is to develop meaningful abatement strategies based on a willingness-to-pay assessment.

[3] See http://espreme.ier.uni-stuttgart.de for detailed information on the ESPREME project

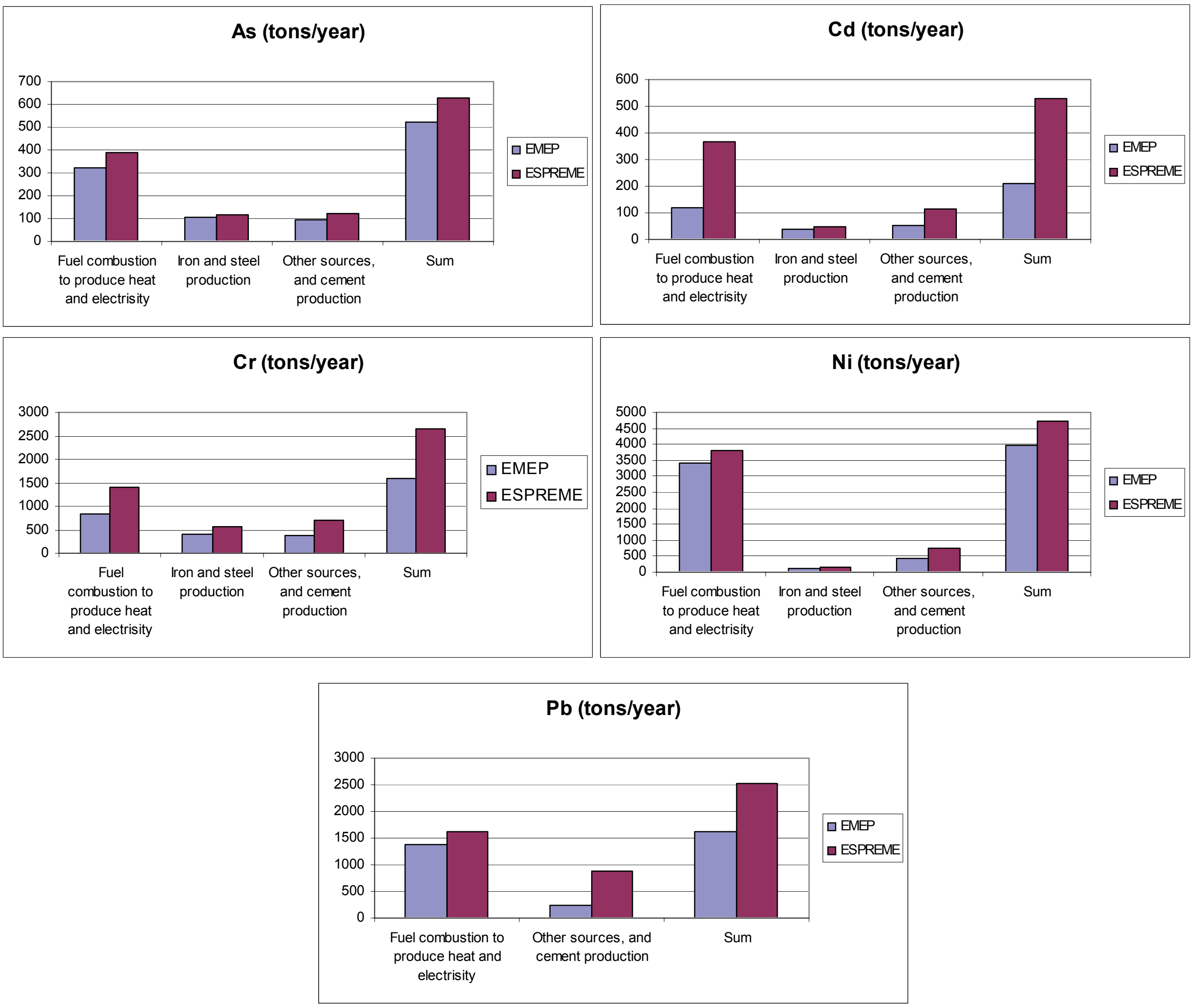

Figure 5.1. Overview comparison of ESPREME and EMEP emissions for major source categories.

The ESPREME 2000 emission data set was prepared using emission factors and statistical information on the production of industrial goods and the consumption of raw materials. The emission factors were selected on the basis of:

- information collected within the ESPREME project on available technologies to control emissions of heavy metals from various source categories, and
- information used to develop the EMEP/CORINAIR Atmospheric Emission Inventory Guidebook[4] and other projects carried out by the ESPREME emission experts in the past. The selected emission factors are presented in tables following the emission estimates at the ESPREME project website[5].

An exception was made for the Pb emissions from gasoline combustion. It was decided to accept the EMEP emission data for this category within the ESPREME data set with exception of a few countries where emission data were clearly either underestimated or overestimated, in some cases the fading out of lead additives in gasoline was regarded to lead to zero emissions in this field, which was one of the key errors observed.

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[4] http://reports.eea.eu.int/EMEPCORINAIR4/en
[5] http://espreme.ier.uni-stuttgart.de

The information on emissions from non-ferrous metal production, and waste incineration was also accepted from the EMEP data sets. Emission factors used by national emission experts to calculate the emissions from these source categories were observed to be within the ranges of emissions factors proposed in the emission factor guidebooks.

Statistical data used in the estimates are available from various international and national statistical yearbooks. The basis for ESPREME estimates were, however, data produced by the PRIMES model. This model is used to generate information needed within the CAFÉ program. The use of PRIMES within ESPREME was required to build future scenarios for the year 2010 on the same assumptions and projections that were used in the CAFÉ work of the European Commission.

A comparison of the official datasets for emissions of As, Cd, Cr, Ni, and Pb with the ESPREME estimates is shown in Figure 5.1 for emissions from fuel combustion, iron and steel production, other sources, and totals. The largest difference (a factor of more than 2) for totals was noted for Cd. The official Cd emissions from fuel combustion in utility boilers, industrial furnaces and residential and commercial units seem to be underestimated by a factor of more than 3. These emissions from other sources in sets of official data are indicated by a factor of more than 2.2. This indicates that the official data for Cd emissions are most likely incomplete with respect to the inclusion of all important sources of these emissions.

The emissions of Cr in the official data sets are underestimated by a factor ranging from 1.4 to 1.9 depending on the source category. Low emission factors for fuel combustion and iron and steel production, and missing sources within the category *Other sources* are the main reasons for this underestimation.

Emissions of As, Ni, and Pb are generally underestimated in the official datasets by factors ranging from 1.1 to 1.9, exept for Pb emissions from *Other sources*, which is likely by a factor of 3.6. This indicates a major omission of important Pb sources in this category.

A source-sector analysis has been prepared taking into account the ESPREME emission data set. The source-sector analysis is presented in Table 5.1, where the percentage contribution of each sector to the total emissions are in brackets. Combustion of fuels in stationary sources was the main emission source for As, Cd, Cr, and Ni in Europe in 2000 (more than a 50% of the total anthropogenic emissions), while combustion of gasoline remains to be the main source of for Pb emissions overall.

Coal combustion in large combustion plants (LCPs) contributed about 18 % to the total As emissions from anthropogenic sources in Europe in the year 2000, and another 17 % came from coal combustion in industrial boilers and small residential units. These contributions are 17 %, 17 % for Cd, and 15 % and 24 % for Cr.

Oil combustion was the main emission source of Ni, in particular oil combustion in industrial boilers and residential units alone contributed as much as 55 % to the total anthropogenic emissions of this element in Europe in 2000. It should be added that oil combustion in industrial boilers and residential units contributed substantially also to the total As and Cd total anthropogenic emissions, with 15 % and 26 %, respectively.

More than a half of the anthropogenic emissions of Pb in Europe in 2000 stems from the combustion of gasoline. One should be aware of the fact that there are Pb emissions also during the combustion of so called unleaded gasoline. This type of gasoline is defined as the gasoline without lead additives. However, there is lead as an impurity in the gasoline due to the lead content of crude oil. It was assumed that the Pb content in unleaded gasoline is 15 mg/l. It was also assumed that 75 % of lead in gasoline is emitted to the atmosphere during the combustion process.

Iron and steel production, cement production and high-temperature non-ferrous metal manufacturing are the three main industrial processes emitting all 5 heavy metals, particularly the two former industries. The contribution of emissions from these categories to the total anthropogenic emissions in Europe varies from 37 % for As to 11 % for Ni.

Emissions of studied heavy metals from other sources, including waste incineration, contributed to the total anthropogenic emissions in Europe from 3 % for Pb to 14 % for Cr. Therefore, it is important to conclude that the major anthropogenic sources of As, Cd, Cr, Ni, and Pb emissions in Europe in the year 2000 included combustion of coal and oil in utility furnaces, industrial boilers, and residential units, and iron and steel production, and cement production.

Table 5.1. Contribution from various sources to the ESPREME HMs total estimates (Unit: Mg/Year (%)).

	As		Cd		Cr		Ni		Pb	
	EMEP	ESPREME	EMEP	ESPREME	EMEP	ESPREME	EMEP	ESPREME	EMEP	ESPREME
1. Fuel combustion to produce heat and electricity	322 (49)	391(51)	119 (44)	367 (62)	825 (50)	1394 (51)	3403 (85)	3795 (79)	1377 (13)	1623 (12)
2. Non ferrous metal	132 (20)	132 (17)	52 (19)	52 (9)	54 (3)	54 (2)	49 (1)	49 (1)	1471 (13)	1471 (10)
3. Iron and steel production	106 (16)	114 (15)	37 (14)	46 (8)	409 (25)	571 (21)	106 (3)	171 (4)	0 (0)	2282 (16)
4. Waste disposal	2 (0)	2 (0)	9 (3)	9 (2)	0 (0)	0 (0)	13 (0)	13 (0)	116 (1)	116 (1)
5. Cement procuction and othe sources	92 (14)	124 (16)	52 (19)	116 (20)	370 (22)	692 (26)	447 (11)	769 (16)	247 (2)	892 (6)
6. Gasoline combustion									7712 (71)	7712 (55)
Sum	**654**	**763**	**269**	**590**	**1658**	**2711**	**4017**	**4797**	**10923**	**14096**

5.2.2 Emissions of Hg

Two approaches were used for calculation of the European anthropogenic emissions of mercury in the reference year 2000 within the ESPREME project:

- collection of emission data from countries where such data were estimated by national emission experts, and
- estimates of emissions on the basis of emission factors and statistical data on the production of industrial goods and/or the consumption of raw materials. These estimates were carried out for the countries where national estimates were not available.

National estimates of anthropogenic emissions of mercury were provided by national experts from 29 countries in Europe. The reporting of these data has been done within the UN ECE LRTAP convention. Emission experts in other countries might have also estimated their national emissions of mercury but these data were not available to ESPREME.

The emission data received from national authorities have then been checked by ESPREME emission experts for completeness and comparability. The completeness of data regarded mainly the inclusion of all major source categories which may emit mercury to the atmosphere. No major omissions have been detected in the reported data. All major source categories in all countries reporting the emission data were included in this reporting.

It is very difficult to verify the data obtained from national authorities in various countries. The following approach has been undertaken: Information on emissions of mercury from various sources was brought together with statistics on the production of industrial goods and/ or the consumption of raw materials, and these two sets of data were used to calculate emission factors. Emission factors calculated in such way were then compared with emission factors reported in the Joint EMEP/ CORINAIR Atmospheric Emission Inventory Guidebook (http://reports.eea.eu.int/EMEPCORINAIR3/en/) (UN ECE, 2000). In a majority of the cases, emission factors estimated on the basis of national emission data reported to the project were within the range of emission factors proposed in the Guidebook.

Emission estimates have been performed within ESPREME for the countries where national emission data were not available. These estimates were performed using the information on:

– Statistical information on the consumption of raw materials and the production of industrial goods in 2000, using the following references for:
    - energy production: UN Statistical Yearbook,
    - non-ferrous metal production: the World Bureau of Metal Statistics and Industrial Commodity Statistics Yearbook,
    - iron and steel production and cement production: UN Statistical Yearbook, and
    - waste disposal: UNEP Environmental Data Report, and the OECD Environmental Data Compendium, and

– Emission factors of Hg, estimated for the UN ECE *Task Force on Emission Inventories* in the period from 1997 through 1999 and presented in the Atmospheric Emission Inventory Guidebook (http://reports.eea.eu.int/EMEPCORINAIR4/en).

Emission factors were multiplied by statistical data in order to obtain emission data.

Hg emission data are presented in *Annex 1*. The emission data received from national experts are marked in these data. *Combustion of coal in power plants and residential furnaces* generates about half of the European emissions in the year 2000 (approx. 239 t). Coal combustion is followed by *the production of caustic soda* using Hg cell process (17 %). Major sources of mercury emissions within the mercury cell process include: by-product hydrogen stream, end box ventilation air, and cell room ventilation air. This technology is currently being replaced by other caustic soda production technologies and further reductions of Hg emissions can be expected in this context. The third category on the list of the largest Hg emitters in Europe is *cement production* (about 13 %).

Information on emissions of various chemical forms is also presented in *Annex 1*. The major chemical form of mercury emitted from the anthropogenic sources in Europe to the atmosphere is gaseous elemental mercury, contributing with about 146 tonnes in 2000 (about 61 %). Gaseous bivalent mercury contributed about 76 tonnes (about 32 % of the total), and the emissions of Hg on particles were about 17 tonnes (7 % of the total). Gaseous elemental mercury contributes the most to the total emissions of Hg from all source categories, except for waste disposal. In the latter case, the contribution of gaseous bivalent mercury presents the highest share. This is probably because of the high content of chlorine in wastes thus resulting in the formation of chlorides of mercury.

5.2.3 Wind re-suspension of heavy metals

Other processes responsible for input of heavy metals to the atmosphere are natural emissions and re-suspension of historical depositions of these pollutants accumulated in soil and water bodies. Indeed, relatively high natural content of such metals as Cr and Ni in the Earth's crust can account for significant contribution of emission from natural sources. Besides, elevated airborne depositions of some metals like Pb comparing to the pre-industrial period were recorded in ice cores, freshwater sediments and peat bogs for the last century (e.g. *Candelone and Hong*, 1995; *Farmer et al*., 1997; *Coggins et al*., 2006). Re-suspension of the accumulated material can also significantly contribute to emission of these metals to the atmosphere. These unaccounted processes can be also partly responsible for inconsistencies between measured and modelled ambient concentrations of heavy metals [*Ilyin and Travnikov*, 2005].

Following recommendations of the EMEP/TFMM Workshop on the review of the EMEP HM and POP models [*TFMM Workshop minutes*, 2005] MSC-E within a framework of the ESPREME project has developed a tentative parameterisation for the wind re-suspension of particle-bound heavy metals (Pb, Cd, As, Cr, Ni) from soil and seawater. Pilot calculations evaluating contribution of the wind re-suspension to total emission of heavy metals to the atmosphere are presented below.

The process of wind erosion and suspension of dust aerosol from the ground was incorporated to the MSCE-HM model as combination of two major processes: saltation and sandblasting. The first process (saltation) presents horizontal movement of large soil aggregates driven by wind stress. Indeed, in natural soils small particles (below 20 µm) never occur in free state, but are embedded in larger soil aggregates by cohesion forces (up to a few centimeters). These aggregates are too heavy to be directly suspended by wind in usual conditions. Instead, they are moved by wind stress close to the surface jumping from one place to another. When the saltating aggregates impact the ground they can eject much smaller particles (few micrometers), which can be easily suspended by wind and transported far away from the source region. This process is called the sandblasting.

Parameterization of mentioned above processes are based on approaches applied in contemporary mineral dust production models [e.g. Gomes et al., 2003; Zender et al., 2003; Gong et al., 2003]. The dust suspension was estimated for the following types of non-vegetated land cover:

– deserts and bare soils;
– agricultural soils (during the cultivation period);
– urban areas.

For estimation of heavy metal emission with dust suspension from soils detailed measurement data on heavy metals concentration in topsoil from the Geochemical Atlas of Europe developed under the auspices of the Forum of European Geological Surveys (FOREGS) [www.gtk.fi/publ/foregsatlas/] were used. The data cover most parts of Europe (excluding Eastern European countries) with more than 2000 measurement sites. The kriging interpolation was applied to obtain spatial distribution of heavy metal concentration in soil. For Eastern Europe as well as for the rest of the model domain (Africa, Asia) we used default concentration values based on the literature data.

In order to estimate heavy metal re-suspension from seawater with sea-salt aerosol the empirical Gong-Monahan parameterization was applied [*Gong*, 2003] along with the emission factors derived from the literature. More detailed description of heavy metal re-suspension from soil and seawater is available in [*Gusev et al.*, 2006].

Aggregated values of estimated re-suspension of Pb from soil in different European countries are presented in Figure 5.2a along with total anthropogenic emissions based on ESPREME data. As seen the estimated contribution of Pb re-suspension is comparable or even higher than anthropogenic emissions in such countries as Italy, France, Germany, Greece, Spain, the United Kingdom etc., where observed concentration of this metal in soil considerably exceeds its natural content in the Earth's crust (Figure 5.2b). The most probable reason for this is long-term accumulation of historical depositions.

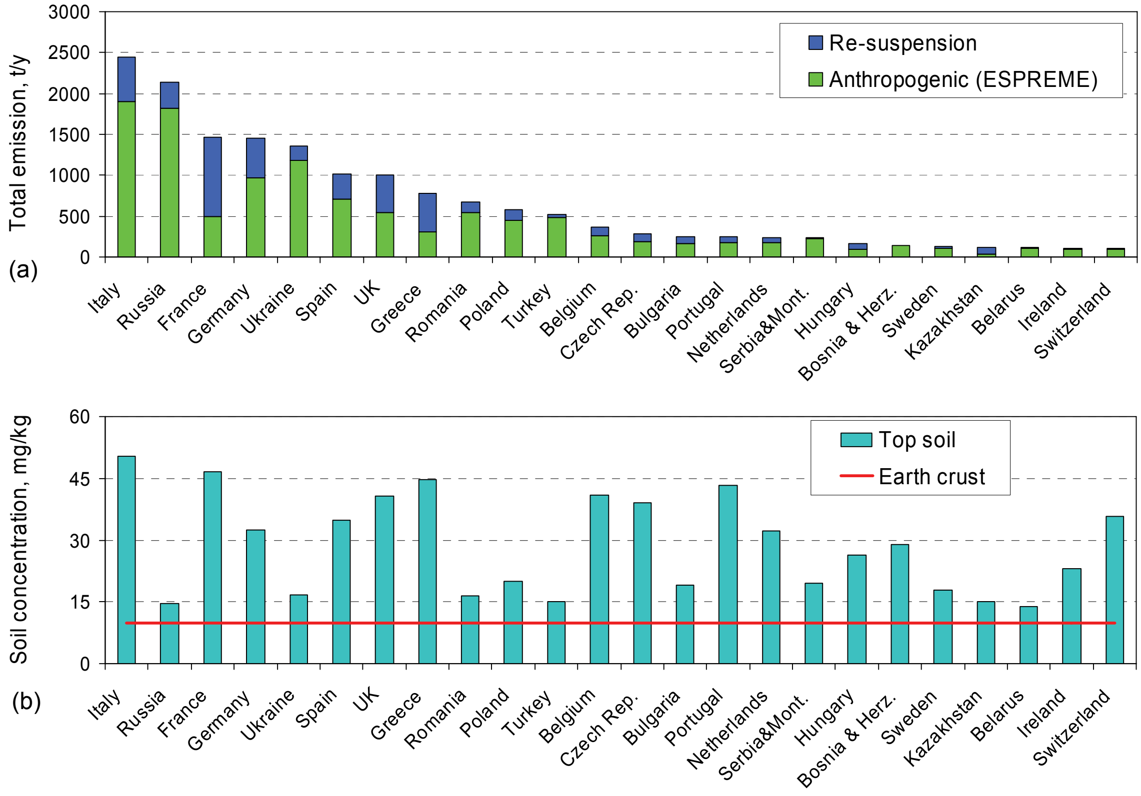


Figure 5.2. Lead total anthropogenic emission (ESPREME data) and re-suspension from soil in Europe (a) and average topsoil concentration in some European countries

Contrary to Pb, re-suspension of Cd from soil insignificantly contributes to total emission of this metal in most European countries (Figure 5.3a). The reason for this is the relatively low cadmium concentrations measured in European soils. Only in a few countries of Europe (Italy, France, Belgium, Greece etc.) mean topsoil concentration noticeably exceeds cadmium natural content in the crust (Figure 5.3b).

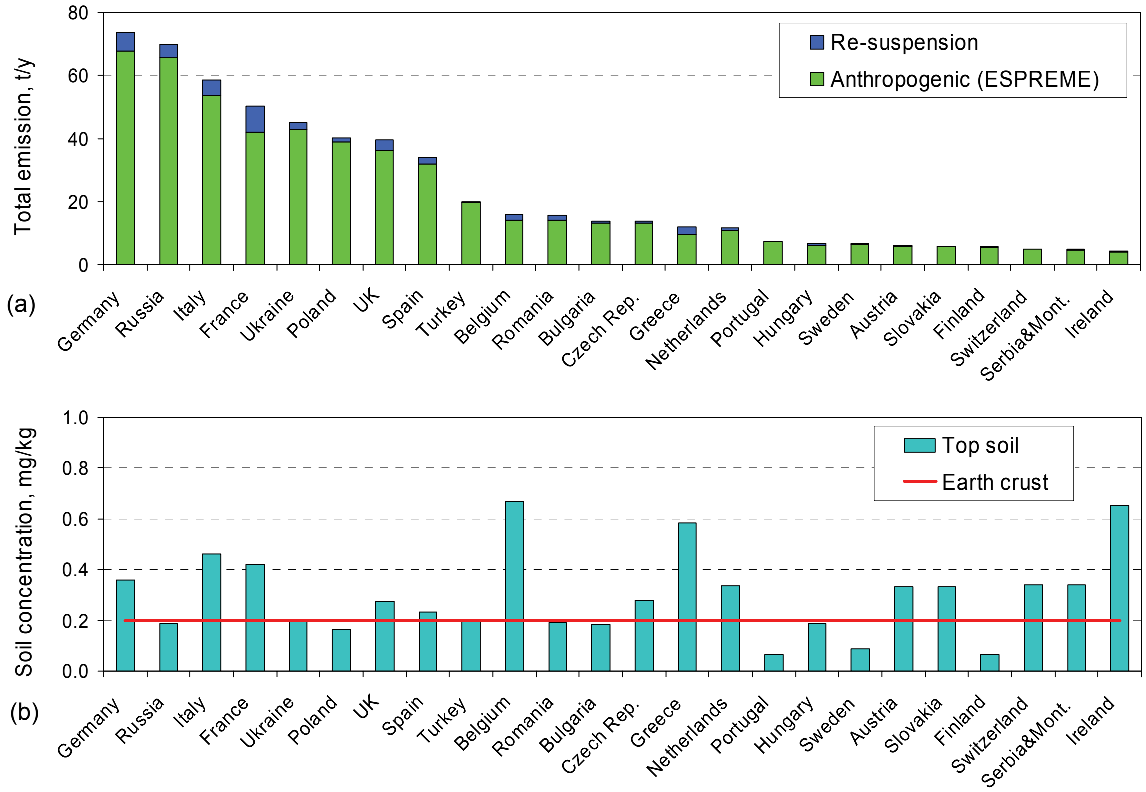


Figure 5.3. Cadmium total anthropogenic emission (ESPREME data) and re-suspension from soil in Europe (a) and average topsoil concentration in some European countries (b).

The results presented above can hardly be considered as final taking into account essential uncertainties in current knowledge of the re-suspension process including parameterization of wind erosion, available data on soil properties, enrichment of mineral dust with heavy metals etc.

5.2.4 Evaluation of HM modelling results based on official and ESPREME emission data

In order to compare modelled pollution levels based on official and ESPREME emission data one-year calculations of heavy metal transport and deposition in Europe were performed with the MSCE-HM model for the year 2000. Detailed description of the Eulerian 3D chemical transport model MSCE-HM is available in [Travnikov and Ilyin, 2005]. The model formulation and performance was thoroughly evaluated within the EMEP/TFMM Workshop on the model review, which concluded that “the MSCE-HM model is suitable for the evaluation of the long-range transboundary transport and deposition of HMs in Europe” [TFMM Workshop minutes, 2005].

Comparison of modelled results based on different emission estimates with observations is illustrated in Figure 5.4 and Figure 5.5. Figure 5.4 shows calculated vs. observed Pb concentration in precipitation for the official emissions data (Figure 5.4a), the ESPREME estimates (Figure 5.4b) and the ESPREME data supplemented with the wind re-suspension. As seen from the figure the modelling results based on official emissions data demonstrate significant (up to 65%) underestimation of the observed values, whereas correlation between modelled and measured concentrations is satisfactory. Using the ESPREME emission data results in considerably better correspondence between calculated values and observations. And finally, the best agreement (with only 20% discrepancy) is achieved when combination of the ESPREME data and the wind re-suspension is used.

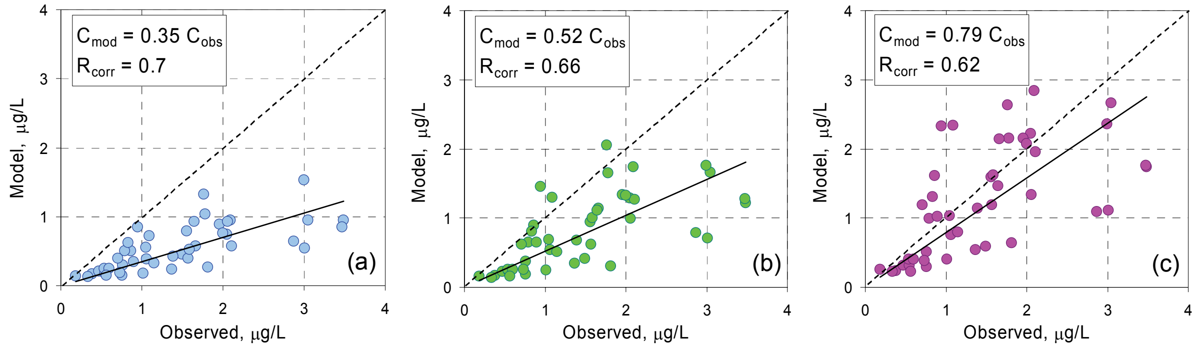


Figure 5.4. Comparison of observed Pb concentration in precipitation with modelling results based on official emissions data (a), ESPREME data (b), and ESPREME data along with re-suspension (c). Solid line depicts the linear regression, dashed line – 1:1 ratio of modelled to observed values

The model underprediction of measured concentration in precipitation is even more noticeable for Cd (up to 75%) when the official emissions are used (Figure 5.5a). As was mentioned previously, the discrepancy between the official data and the ESPREME estimates is largest for this metal (up to a factor of 2). Therefore utilizing the ESPREME estimates leads to essential improvement of the modelling results in comparison with observations (Figure 5.5b). However, the model-to-measurement correlation somewhat decreases, possibly, because of uncertainties of the spatial distribution of emissions. Addition of the re-suspension slightly improves the comparison since, according to the current estimates, contribution this process for Cd is insignificant comparing to anthropogenic emissions.

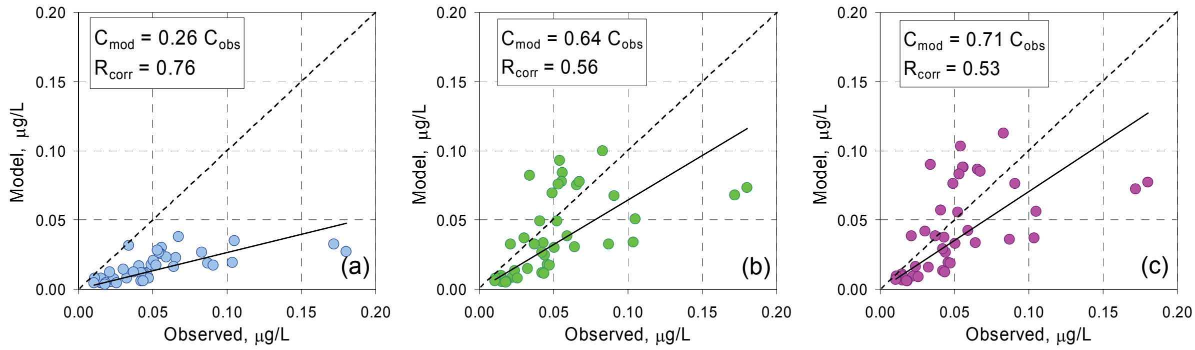


Figure 5.5. Comparison of observed Cd concentration in precipitation with modelling results based on official emissions data (a), ESPREME data (b), and ESPREME data along with re-suspension (c). Solid line depicts the linear regression, dashed line – 1:1 ratio of modelled to observed values

5.2.5 Conclusions

The in-depth analysis of HM emissions in the frame of the ESPREME project has resulted in two main conclusions, one being, that official Hg emission estimates seem to be quite robust and on the other hand, significant gaps and missing sources for other HMs introduce considerable uncertainties in the modelling and assessment of their environmental fate and thus, finally, their impacts on human health.

As Figure 5.6 indicates, in most cases stationary sources, in particular industrial production processes, show differences in emission estimates comparing officially reported and expert estimates. In some countries, for instance, obviously existing production of iron & steel or other metals seem to result in zero emissions from this sector (probably not estimated or omitted?) and in other countries, declining activity rates have not resulted in equally declining emissions (probably retaining of old emission figures?).

Furthermore, Figure 5.7 shows a comparison of estimates both of the ESPREME project and results of a recent study by TNO (Denier van der Gon et al, 2005a) based on emissions officially reported to EMEP complemented with default TNO estimates to obtain completeness. For Cd, Cr and Ni, expert estimates are varying, but in general are (much) larger than official emission reports. . In general TNO data are expected to be slightly higher than the EMEP data with (ESPREME) gap filling because five countries more are included in the TNO figures shown in Table 5.7 (Azerbaijan, Armenia, Georgia, Kazakhstan and Kyrgyzstan).

However, in the case of As, the TNO estimates are lower than official EMEP data with gap filling. This indicates differences in the defaults used for gap filling in these two data sets. ESPREME assumes higher emissions, which is most likely due to different assumptions regarding coal qualities in fossil fuel combustion in the energy sector. For lead, finally, both expert estimates are considerably higher than official emissions reported, which could account for a large part of the gaps between modelled and measured ambient levels of Pb.

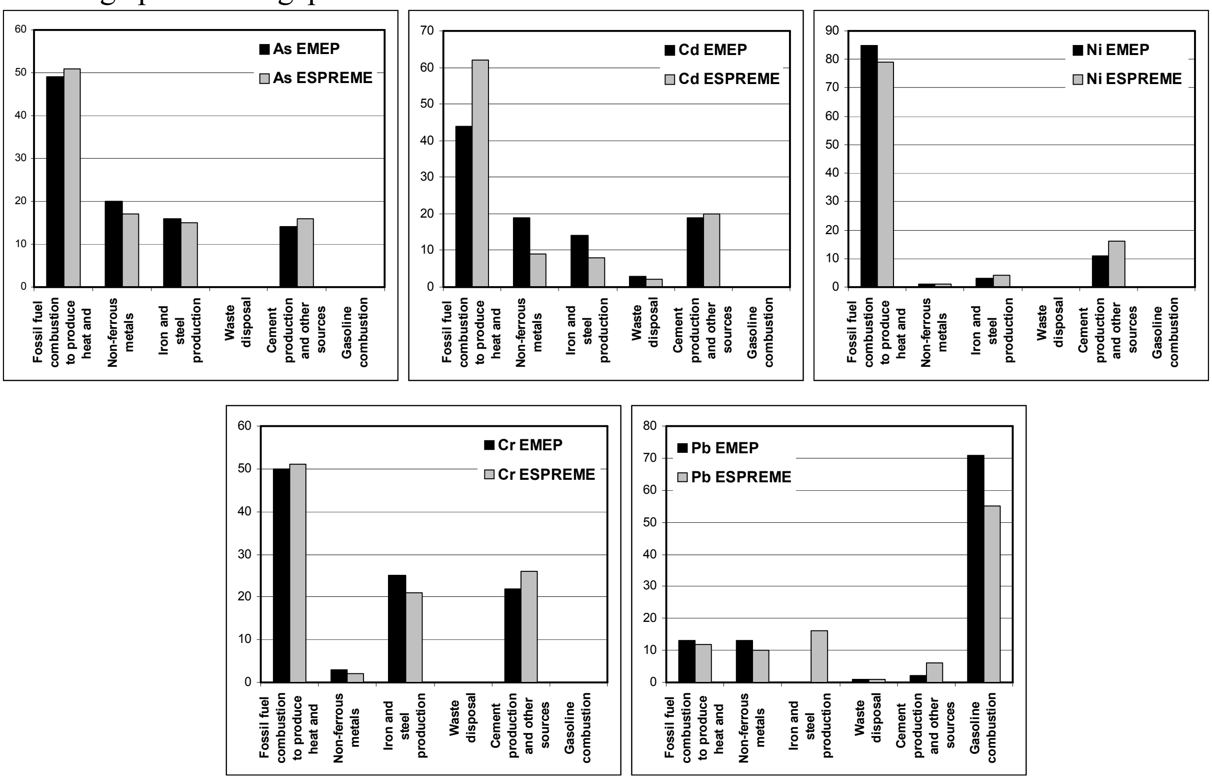
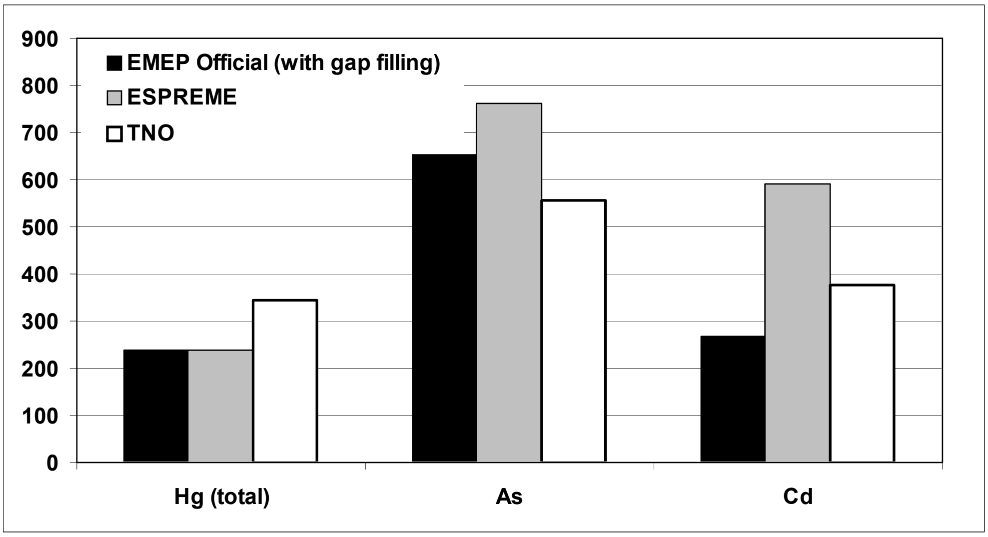


Figure 5.6. Key source analysis indicating different shares of sectoral emissions



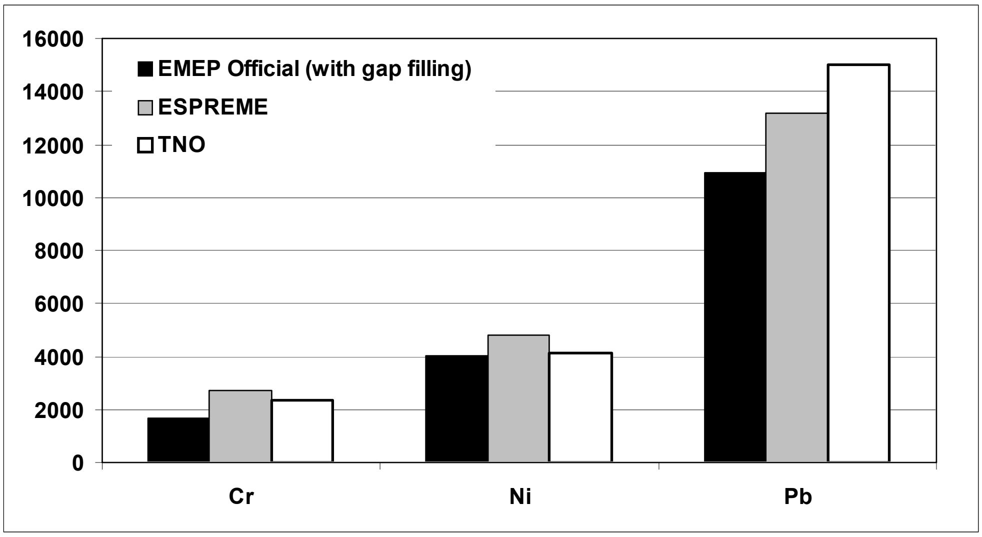


Figure 5.7. Comparison of estimates for the year 2000 and the UNECE Europe countries for EMEP officially reported emissions, ESPREME estimates and TNO[6] estimates

5.2.6 Critical review

It is impossible at this stage to derive a final conclusion on the 'correct' amounts of HM emissions, but the investigation has clearly indicated that official reporting of HM emissions needs improvement. This can mainly be achieved by updating – and in some cases creating even – the relevant documentation for the calculation of HM emissions, data on emission factors and functions in the EMEP/CORINAIR Emission Inventory Guidebook, where the texts on HM emissions are at this stage outdated and incomplete. New findings of ongoing measurement activities, for instance on combustion plants in BELARUS and small combustion of wood in GERMANY and other countries need to be integrated as soon as they are available, as the latter in particular could help to reduce uncertainties in small combustion emissions drastically. The results, however, indicate clearly as well the need for both individual national emission reporting, supported by centralised studies and projects

[6] TNO-report B&P-A R2005/193, Study on the effectiveness of the UNECE Heavy Metals Protocol and costs of possible additional measures.

supporting the continuous improvement of the knowledge on emission factors, activities and parameters for the validation and verification of inventories.

With regard to Figure 5.7, a note of caution has to be added, as the comparison is made with keeping in mind, that the EMEP officially reported emissions were gap-filled with EMEP expert estimates (see http://webdab.emep.int for access to data), hence differences between the TNO estimates (based on official emission data submitted) and the thus enhanced EMEP dataset occur. The only way to analyze both the differences between expert estimates and the reasons for expert estimates arriving at higher emissions in most cases (e.g. missing sources, usage of outdated emission factors etc.) would be to conduct an in-depth inventory review. At this stage, neither funding nor time is available to achieve this, but it is important to note, that even this coarse investigation has identified a clear need for a thorough assessment of HM emissions by country and source sector to develop emission datasets for modelling that are complete, comprehensive and robust enough to evaluate model results vs. measured concentrations and depositions of HM to support the development of HM abatement strategies. Both the TNO and the ESPREME review of currently available emission data of priority metals have contributed to a better understanding of the gaps and the identification of the next steps in this process.

Along with an improvement of the anthropogenic emissions inventory heavy metal emission from natural sources and re-suspension of historical depositions should be further investigated since their contribution to the total emission can be significant. Particularly, this concerns the dust suspension processes, heavy metal accumulation in soil and other compartments, dynamical redistribution between the surface and subsoil layers, and availability for the wind erosion.

5.3 PERSISTENT ORGANIC POLLUTANTS

5.3.1 Emissions of Persistent Organic Pollutants in 2000 and projected emission data for 2010-2020

The starting point of the POP inventory for the year 2000 by Denier van der Gon et al. (2005b) are the submissions of emission data from the Parties to the Convention on LRTAP. For the countries, sources or compounds lacking in official submissions, default emission estimates have been prepared and applied to complete the inventory (Table 5.2). Several POPs are thought to be no longer emitted in Europe and these substances (aldrin, chlordane, chlordecone, dieldrin, endrin, hexabromo-biphenyl, mirex, toxaphene, DDT, and heptachlor) are not further addressed. An overview of the emission sources considered in the study by POP is presented in Annex 3. It is essential to have all relevant source categories covered for all countries to have comparable emission data. Therefore, only official data which have a split at the sector level (e.g. NFR level 1 or SNAP level 1) are used in the compilation of Table 5.2 because otherwise no indication of completeness of the inventory can be obtained. The origin of the national emission data in Table 5.2 is indicated by the formatting. A national total emission reported in Table 5.2 may consist of a mix of official data and TNO expert estimates. If the national official emission data do not cover all relevant source categories they have been complemented by TNO default estimates to achieve completeness.

The data compilation in Table 5.2 indicates that official data cover PCDD/F emissions relatively well but for all other substances the coverage is poor. Again, as outlined above, official emission data reported at the national level only (e.g., no sectoral split provided) are not considered because no assessment of the completeness of such a national estimate could be made. Please note that this does not necessarily mean that the national submission truly was incomplete, it was just not possible to clearly ascertain this. Furthermore, emissions no longer occurring (e.g. HCH) are often not reported or only at the national level and iii) countries often report PAH as a group (e.g., Bornheff-6) but not the individual PAH indicator compounds requested by the POP protocol. So, at first glance Table 5.2 paints a somewhat bleaker picture of the coverage of national emission reporting than fair. Nevertheless, a first clear conclusion from Table 5.2 is that a major improvement in POP emission reporting by countries can be made. The source categories identified in Denier van der Gon et al. 2005b and their respective default emission factors provide the means to make a first step and should subsequently be improved by national experts and/or source-specific local knowledge. Again, it is of utmost importance that official inventories provide insight in the sources covered by the reporting to assess completeness of the reporting and maintain comparability with other national reporting.

The aggregated 1990, 2000 and projected emissions for the years 2010 and 2020 for UNECE-Europe are presented in Table 5.3. The presented 1990 emissions are conservative estimates and may be underestimated. For a description of the limitations of the projection data and the compatibility of the 1990 and 2000 data we refer to Denier van der Gon et al. (2005b, 2006). The comparison of the 1990 and 2000 emission data indicates that the emissions of PCDD/F and HCH decreased with 10% and 82%, respectively (Table 5.3). PCB emissions change little between 1990 and 2000. Remarkably, HCB emissions increase strongly going from 1990 – 2000. However, this is at least partly an artefact because unlike the inventory by Denier van der Gon et al. (2005b), Berdowski et al. (1997) did not include production of secondary Aluminium as a HCB source. It is anticipated that the increase in HCB from 1990 – 2000 is not a real trend.

Compared to the period 1990-2000, over the next decade (2000-2010) and current ratification a large emission reduction is foreseen for PCB (-80%), HCB (-56%) and to a lesser extend also for PCDD/F (-27%). Full implementation of the POP protocol by all UNECE-Europe countries brings about considerable POP emission reductions with the exception of HCH.

Important observations from the projected POP emissions in UNECE Europe for 2010, 2015 and 2020 following two policy scenarios (Table 5.3) are:

- HCB emissions are reduced from 2000 to 2010 but implementation of the POP Protocol by all countries results in only limited further reduction.
- HCH emissions do not change much over time because HCH use has been reduced already before 2000 and other measures are not affecting the currently allowed use of HCH.
- PCB emissions strongly decline from 2000 to 2010. If all countries implement the POP Protocol emissions will decline further and emission reductions that is otherwise achieved by 2020 may already be reached by 2010.
- Dioxin and furan emissions decline slightly under current legislation and autonomous measures but considerable additional reduction would result from full implementation of the POP Protocol.
- PAH indicator compound emissions are only slightly reduced going from 2000 to 2010 but a considerable further reduction (30-50%) is possible if the POP Protocol is implemented by all countries.

Table 5.2. National emissions[a)] of POPs and PAH indicator compounds in UNECE-Europe in 2000 (Denier van der Gon et al. 2006).

Country	ISO3	HCB	HCH	PCB	PCDD/F	PAH indicator compounds			
						BaP	BbF	BkF	Indeno
		kg/yr			kg Teq/yr	kg/yr			
Albania	ALB	0	123	26	0.043	2646	3471	1166	1928
Armenia	ARM	0	0	405	0.047	1997	2609	896	1408
Austria	AUT	**42**	0	948	**0.050**	24436	30394	9781	18099
Azerbaijan	AZE	0	0	810	0.098	4207	5548	1918	3013
Belgium	BEL	**28**	167	3698	**0.114**	7518	6394	2161	5541
Bulgaria	BGR	*54*	0	*229*	**0.233**	7803	7843	3230	5179
Bosnia-Herzegovina	BIH	0	115	187	0.067	4799	6440	2707	5073
Belarus	BLR	0	0	1147	*0.018*	7188	9300	3050	6380
Switzerland	CHE	31	0	1154	0.017	2245	2925	871	1726
Cyprus	CYP	1	0	45	0.011	480	655	175	380
Czech Republic	CZE	202	0	*2091*	**0.744**	13644	13319	4389	12555
Germany	DEU	2870	0	29887	0.406	50944	56876	18411	38537
Denmark	DNK	*162*	*0*	695	**0.078**	*2831*	*3740*	*1355*	*2074*
Spain	ESP	**6082**	**9962**	5868	**0.143**	27335	36905	15811	19997
Estonia	EST	0	0	223	**0.003**	2427	3149	1022	1949
Finland	FIN	226	0	1917	**0.031**	10203	12318	4162	7157
France	FRA	**1800**	39859	13380	**0.560**	83458	103070	31964	61657
United Kingdom	GBR	**595**	**30308**	**1643**	**0.346**	**6692**	**5938**	**3176**	**4268**
Georgia	GEO	0	0	582	0.067	2981	3897	1307	2144
Greece	GRC	2	2431	168	0.279	6163	8099	2689	4613
Croatia	HRV	**0**	**6983**	135	**0.109**	2821	3711	1236	2116
Hungary	HUN	279	0	323	0.687	8582	10967	4729	6398
Ireland	IRL	0	0	49	0.030	2468	3128	759	3399
Iceland	ISL	0	0	34	0.002	398	457	280	175
Italy	ITA	2863	143856	3648	*0.245*	53145	63830	20483	37492
Kazakhstan	KAZ	1	0	1202	0.288	14473	19585	7146	10857
Kyrgyzstan	KGZ	1	0	244	0.062	4055	5338	1831	2887
Lithuania	LTU	0	0	406	*0.088*	2518	3225	945	2316
Luxembourg	LUX	0	0	68	0.010	514	644	93	429
Latvia	LVA	0	0	267	0.054	1790	2293	687	1629
Rep.of Moldova	MDA	**66**	0	**194**	**0.004**	*510*	*602*	*296*	*1219*
Form. Yug. Rep. of Macedonia	MKD	0	87	86	0.028	1176	1551	520	869
Netherlands	NLD	598	0	164	**0.031**	6175	5458	2175	4077
Norway	NOR	1273	0	275	**0.034**	11925	33618	30190	6630
Poland	POL	**46**	0	**2265**	**0.334**	37420	35066	9977	46101
Portugal	PRT	96	7729	385	0.844	10105	12929	3994	7386
Romania	ROM	14	1052	496	0.400	10960	10513	4585	7165
Russia	RUS	8	0	31016	2.732	301794	362098	196248	232801
Slovak Republic	SVK	1	0	**133**	**0.146**	4591	4010	1856	3214
Slovenia	SVN	0	0	*143*	*0.027*	1317	1719	536	1020
Sweden	SWE	152	0	1373	**0.028**	10364	11964	4143	7049
Turkey	TUR	2	11806	326	1.012	47399	59546	22155	39484
Ukraine	UKR	655	0	24436	1.022	94286	54052	30005	64001
Federal Rep. of Yugoslavia	YUG	0	510	552	0.172	8526	11242	4019	7789
UNECE-Europe Total[b)]		***18.2***	***255***	***133***	***11.7***	***907***	***1040***	***459***	***700***

[a)] Origin of national emission data; official emission data in bold, TNO expert estimates are shaded, mixed official data and expert estimates in italics. Detailed emission data by source category and fuel type are available upon request. [b)] Total emissions in tonnes/yr, PCDD/F in kg TEQ/yr

Table 5.3. Emissions of POP in UNECE Europe for 1990, 2000 and projected emissions for 2010, 2015 and 2020 following two policy scenarios (Tonnes/yr, PCDD/f in kg Teq/yr).

Year_policy scenario[a)]	HCB	HCH	PCB	PCDD/F	PAH indicator compounds			
					BaP	BbF	BkF	Indeno
1990[b)]	8.0	1326	122	12.9	NA [c)]	NA [c)]	NA [c)]	NA [c)]
2000	18.2	255	133	11.7	907	1040	459	700
2010_BL_CLE_CRPOP	8.0	255	26.5	8.63	869	1006	434	657
2020_BL_CLE_CRPOP	8.4	255	8.1	8.32	817	930	448	578
2010_BL_CLE_FIPOP	1.2	255	9.4	4.29	682	803	246	566
2020_BL_CLE_FIPOP	1.5	255	7.4	3.79	597	678	222	460

a) BL_CLE_CRPOP: Base Line scenario with Current LEgislation and Current Ratification of the UNECE POP Protocol; BL_CLE_FIPOP: Base Line scenario with Current LEgislation and Full Implementation of the UNECE POP Protocol.

b) 1990 data taken from Berdowski et al. (1997) for indicative comparison. Countries not covered by Berdowski et al. are represented by their year 2000 emissions

c) NA = Not Available

The results show that full implementation (all UNECE-Europe countries) of the POP protocol would result in an important further reduction of HCB, PAHs and PCDD/F emissions and will effectively address the still remaining PCB emissions (Table 5.3). For PCB it should be noted that the autonomous replacement of PCB containing equipment which is incorporated in our scenario is an important cause of the strong reductions that are foreseen in the year 2010 and onwards. The POP Protocol is effective in addressing the still remaining emissions and full implementation of the POP Protocol is an important step in POP emission reduction. Only HCH emissions do not change much upon full implementation because HCH use has been reduced already before 2000 and other measures are not affecting the currently allowed use of HCH.

A key source analysis of the projected emissions assuming full implementation of the UNECE POP Protocol identifies the remaining source strengths and a number of potential measures to achieve further reduction of POP can be suggested (Denier van der Gon et al. 2005). Examples of suggested measures are the use of cleaner fuels and/or ban of specific fuels in small combustion units (Capacity < 5 MWth) (addressing PCDD/F, PAH), replacement of chlorine and chlorine compound additives in the Secondary aluminium production (addressing HCB), further tightening of existing limit value for incineration of hazardous waste (addressing PCCD/F) and further restriction of the use of Lindane.

It is important to note that inventory methodologies for POP are under constant development and are subject to a considerable uncertainty; any observed trend may well be an artefact caused by an improved methodology rather than actual changes in emissions. Important improvements in the quality of the POP emission inventories can be made through more detailed country usage data (e.g., for pesticides) and determination of emission factors. The present emission estimation methodologies are often too simple and appropriate emission factor data are too limited.

5.3.2 Uncertainties in Dioxin Emission Estimates for Central Europe

Pulles et al. (2005; 2006) use an improved emission inventory model to assess the uncertainties in emissions of dioxins and furans associated with both knowledge on the exact technologies and processes used and with the uncertainties of both activity data and emission factors. The annual total emissions for the year 2000 in thirteen countries in Central and Eastern Europe can be estimated with 90 % confidence within a range that is about a factor of 2 to 3 lower to a factor of 3 to 5 higher than a point value obtained from a more classical approach. The total emissions of dioxins and furans in the thirteen countries in this study are estimated to be 3.3 kg I-TEQ per annum, applying the information obtained from the participating countries where-ever possible and applying the "best" choice of emission factors from the UNEP Chemicals Toolkit as determined basically by means of expert judgement (Table 5.4).

The importance of the selection of emission factors is confirmed by the Monte Carlo analysis taking into account the uncertainties in all parameters and variables, used in the emission inventory. The 90 % confidence interval for the total emissions in the area is as wide as 1.2 to 7.4 kg I-TEQ per annum (Table 5.5). The highest contributions to this uncertainty range are due to the uncertainties in emission factors for incineration of hospital waste, open burning of domestic waste and iron sintering (Pulles et al., 2006)

Table 5.4. Dioxin emissions by sector in 13 countries as estimated by Pulles et al (2005). Numbers are rounded to two significant digits (in g I-TEQ for the year 2000).

Country	Waste incineration and burning	Metal industry	Cement production	Preservation of wood and accidental fires	Residential heating	Other combustion	Other sources	Country Total
Bulgaria	150	56	11	16	4	3	45	**290**
Cyprus	4.2	0.01	0.84	1.4	0.06	0.09	0	**6.6**
Czech Republic	37	200	24	20	21	7.8	13	**320**
Estonia	0.52	0	0.24	2.8	1.5	3.5	0.12	**8.7**
Hungary	33	27	2.1	20	16	18	6	**120**
Latvia	8.1	0	0.05	4.8	3.1	1.5	0.14	**18**
Lithuania	37	0	0.39	7	2.5	0.95	0.88	**48**
Malta	2.9	0	0	0.78	0.1	0.06	0.05	**3.9**
Poland	310	110	0.98	78	210	32	47	**790**
Romania	270	95	29	44	9.2	8.7	32	**490**
Slovak Republic	53	80	15	11	2.8	2.3	14	**180**
Slovenia	17	5.6	5	4	1.2	2	1.5	**36**
Turkey	470	130	170	130	26	10	29	**960**
Sector total	**1 400**	**700**	**250**	**340**	**300**	**90**	**190**	**3 300**
Share in total	**43%**	**21%**	**8%**	**11%**	**9%**	**3%**	**6%**	

Table 5.5. National total emissions (g I-TEQ/year): point estimate and boundaries of the 90-% confidence intervals. The percentiles are not additive, so the value for the 13 countries does not equal the sum of the values for each country separately.

	point estimate	**5 %-ile**	**95 %-ile**
Bulgaria	290	66	790
Cyprus	6.6	0.8	20
Czech Republic	320	72	880
Estonia	8.7	1.6	25
Hungary	120	35	300
Latvia	18	2.4	54
Lithuania	48	7.1	140
Malta	3.9	0.34	13
Poland	790	220	2 000
Romania	490	110	1 300
Slovak Republic	180	36	500
Slovenia	36	8.2	97
Turkey	960	190	2 600
13 country total	**3 300**	**1 200**	**7 400**

Source: Pulles et al. (2006)

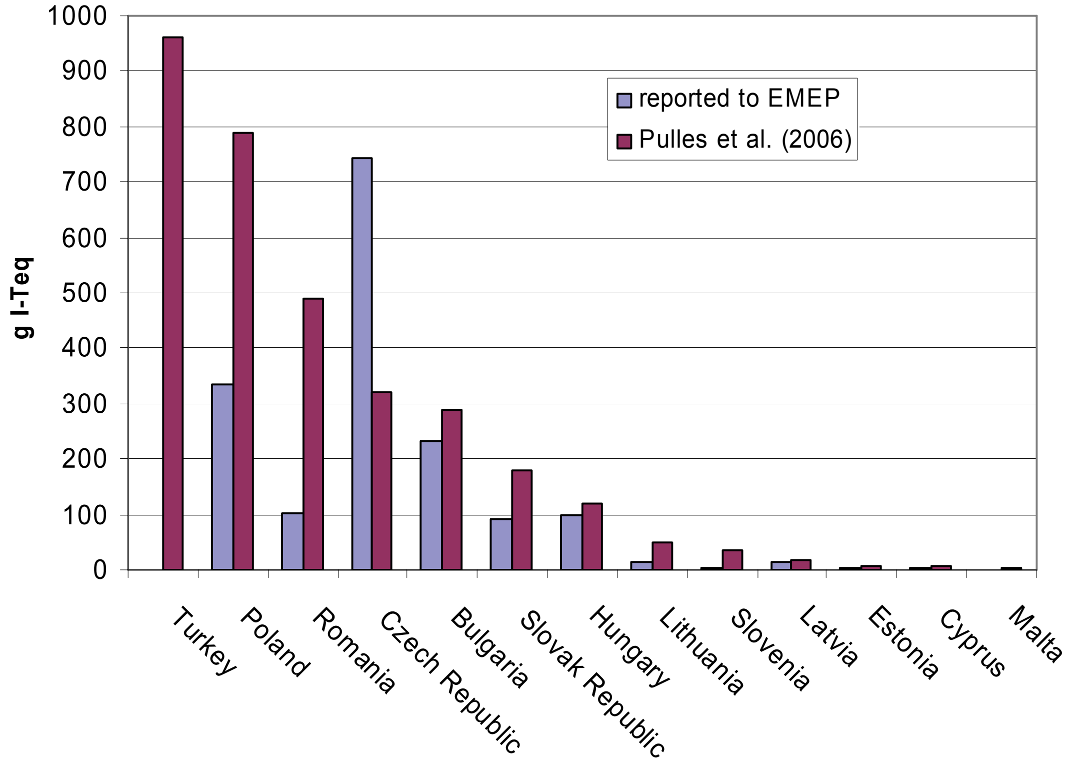


Figure 5.8. Comparison of national total emissions between expert emissions and official reported data for year 2000 or closest year if 2000 emission data not available; CY - 2003, EE - 2002 and LT -2003.

The year 2000 PCDD/F emissions estimated by Pulles et al. (2006) can be compared with the official reported PCDD/F emissions to EMEP (Figure 5.8). If no year 2000 emission data are reported the closest reported year was taken from Vestreng et al. (2006). The expert estimates are consistently higher than the officially submitted data with the exception of the Czech Republic. It can be noted that reported emissions by the Czech Republic in 2002 and beyond are below 200 g Teq /yr, which is considerably below the expert estimates but also within the uncertainty boundaries. Over all, it is important to note that all country estimates are within the expert estimate uncertainty boundaries (Figure 5.8), with the exception of Romania and Slovenia. A review of the sources covered by the national reporting and a comparison with the source coverage by Pulles et al. (2006) is outside the scope of the present chapter but will most likely result in a clear identification of the sources that are either omitted or where a single large discrepancy can be identified.

Despite the considerable variation between the estimates as well as uncertainty in emission factors, the inventory can reliably be used to gain insight into i) what sources are important and ii) what reduction options are available. In the case of dioxins and furans, it is clear that significant contributions are caused by some industrial processes and by residential combustion in small stoves and the open burning of wastes. A final and important conclusion from the study is that on a global and per capita basis the amount of dioxins emitted to air in the new Member States is at the same level as in the old Member States. As for the releases to land, the estimated total releases are considerably smaller in the new Member States.

5.4 SUBSTANCES PROPOSED FOR POSSIBLE ADDITION TO THE POPS PROTOCOL

According to article 14.6 of the 1998 UNECE POP protocol, Parties to the protocol can propose new substances which can be added to annex I, II or III of the protocol. This makes identification and proposal of substances for addition to the POP Protocol a continuous process and a number of chemicals are currently being investigated for inclusion on the UN/ECE POP protocol list of priority compounds. A preliminary year 2000 emission inventory for eight substances that have or may be proposed for addition to the protocol (Dicofol, Edosulfan, Hexachlorobutadiene (HBU or HCBD), Pentabromodiphenyl ether (PeDBE, PDBE), Pentachlorobenzene (PCBe), Pentachlorophenol (PCP), Polychlorinated naftalenes (PCN) and Short chained chlorinated paraffin's (SCCP's)) has recently been published (Denier van der Gon et al., 2005). Since identification and proposal of substances as candidates for inclusion in the POP protocol is a dynamic process, this inventory does not cover all substances under discussion at the moment. For example, PerFluoroOctane Sulphonate (PFOS) and OctaBDE have also recently been proposed for addition to the UNECE POP Protocol but are not addressed by Denier van der Gon et al (2005b). A first (preliminary) UNECE-wide emission inventory for these substances is not yet available. Construction of inventories (by one of the Parties) for any substance that is proposed for addition is highly recommended to have better appreciation of the emissions and possible emission reduction measures.

Since countries have no obligation to report emissions of substances possibly proposed for addition to the POP protocol, these preliminary emission inventories will be almost exclusively filled with expert estimates. The estimation methodology for the substances is described in detail by Denier van der Gon et al. (2005; 2006). The estimated annual emissions of selected substances in UNECE-Europe per source category for the year 2000 are presented in Table 5.6. Emissions of the substances mostly originate from one major source category, a more detailed overview of the sources considered for each substance is given in annex 3. The exception is PCN which, like PCDD/F, is mostly emitted as an unwanted by-product and can be released from a large number of sources. The national emissions estimated for the year 2000 are presented in Table 5.7. The complete calculated figures are represented in Table 5.7 because this may facilitate discussion and cross-checking of data, however, the accuracy is at most two significant digits. Uncertainties in the emission estimates for these substances are large and this inventory should be seen as a first step towards a reliable emission inventory.

The most effective improvements vary by substance and no generic approach can be given but we conclude that emissions from in-use products are especially uncertain due to a lack of emission and/or usage data. For example, national usage/sales data for the pesticides Dicofol and Endosulfan for all UNECE countries would greatly improve the inventory. Provided that some of these substances may be added to the POP protocol in the near future, an investment in research to improve the quality of our knowledge on emissions, sources and measures is highly recommended.

Table 5.6. Annual emissions of selected substances possibly proposed for addition to the POP Protocol in UNECE-Europe per source category for year 2000 (Tonnes/yr).

Source sector	Dicofol	Endosulfan	HBU	PBDE	PCN	PCP	PeCB	SCCP
Public power and heat					0.01	0.1		
Residential combustion					0.10			
Industrial combustion and processes			2.53	0.33	0.11	0.1		
Solvent and Product use			0.07	9.41	0.06	705		114
Road transport								
Non-road transport								
Waste incineration				0.05	0.74			
Agriculture	32	775						
Grand Total	***32***	***775***	***2.6***	***9.8***	***1.0***	***705***	***0.0***	***114***

Table 5.7. National emissions a) of eight candidate POPs in UNECE-Europe in 2000.

Country	ISO3	Dicofol	Endosulfan	HBU	PBDE	PCN	PCP	PeCB	SCCP
		Kg/yr							
Albania	ALB	38	1254		41	2	1308	0	869
Armenia	ARM	87	173		39	3	1259	0	837
Austria	AUT	0	750		95	5	1074	0	92
Azerbaijan	AZE	123	3640		91	5	2917	0	1939
Belgium	BEL	20	9050		121	8	**8**	0	116
Bulgaria	BGR	883	4204		92	26	*2946*	0	1957
Bosnia-Herzegovina	BIH	22	1168		45	3	1444	0	960
Belarus	BLR	0	14956		122	8	3903	0	2595
Switzerland	CHE	0	3800		86	1	963	0	82
Cyprus	CYP	142	2543		9	1	286	0	190
Czech Republic	CZE	76	1272	8	121	23	3867	0	2570
Germany	DEU	0	0	236	967	35	10885	0	932
Denmark	DNK	0	0		63	5	707	0	61
Spain	ESP	12500	110500	8	471	48	**102**	0	0
Estonia	EST	2	26		17	1	539	0	358
Finland	FIN	0	0		61	13	685	0	59
France	FRA	1400	35400	338	699	269	19806	0	673
United Kingdom	GBR	100	500	18	700	19	**449211**	0	675
Georgia	GEO	0	1882		59	4	1890	0	1256
Greece	GRC	0	36900		124	14	3976	0	120
Croatia	HRV	0	1280		50	25	1613	0	1072
Hungary	HUN	532	3356		119	35	3817	0	2537
Ireland	IRL	0	0		45	2	275	0	43
Iceland	ISL	0	9		3	0	104	0	69
Italy	ITA	9524	45300	8	679	31	7643	0	654
Kazakhstan	KAZ	69	7076	208	197	15	6300	0	4188
Kyrgyzstan	KGZ	43	3538		55	3	1764	0	1173
Lithuania	LTU	0	61		43	5	1363	0	906
Luxembourg	LUX	8	65		5	1	165	0	5
Latvia	LVA	0	26		28	3	906	0	0
Rep.of Moldova	MDA	0	4939		52	3	1668	0	1109
Form. Yug. Rep. of Macedonia	MKD	159	891		24	1	769	0	511
Netherlands	NLD	0	0		187	2	**24000**	0	180
Norway	NOR	0	0	828	53	3	595	0	0
Poland	POL	0	4939		455	38	14551	0	9672
Portugal	PRT	486	1500		118	42	17054	0	114
Romania	ROM	1469	10717		264	20	8454	0	5619
Russia	RUS	368	212704	908	1718	152	54973	0	36540
Slovak Republic	SVK	105	1133		64	10	2033	0	1352
Slovenia	SVN	92	856		23	2	726	0	482
Sweden	SWE	0	0		105	15	1183	0	101
Turkey	TUR	2476	120322		773	51	24725	0	16435
Ukraine	UKR	596	123219	8	578	63	18507	0	12302
Federal Rep. of Yugoslavia	YUG	382	5199	24	125	9	4015	0	2669
UNECE-Europe Total b)		***32***	***775***	***2.6***	***9.8***	***1.0***	***705***	***0***	***114***

a) Origin of emission data; official emission data in bold is; mixed official data and expert estimates in italics; TNO expert estimates are shaded. Detailed emission data by source category and fuel type are available upon request.
b) Total emissions in tonnes/yr

5.5 REFERENCES

Berdowski J.J.M., J. Baas, J.P.J. Bloos, A.J.H. Visschedijk and P.Y.J. Zandveld, 1997. The European Inventory of Heavy Metals and Persistent Organic Pollutants for 1990, TNO Institute of Environmental Sciences, Energy Research and Process Innovation (MEP), UBA FB, June 1997.

Candelone, J.-P., Hong, S. (1995): Post-industrial revolution changes in large-scale atmospheric pollution of the northern hemisphere by heavy metals as documented in central Greenland snow and ice. *Journal of Geophysical Research*, 100(D8): 16605-16616

Coggins A.M., Jennings S.G., Ebinghaus R. (2006): Accumulation rates of the heavy metals lead, mercury and cadmium in ombrotrophic peatlands in the west of Ireland. *Atmospheric Environment* 40(2): 260-278

Denier van der Gon, H.A.C., M. van het Bolscher A.J.H. Visschedijk P.Y.J. Zandveld, Study to the effectiveness of the UNECE Heavy Metals Protocol and costs of possible additional measures Phase I: Estimation of emission reduction resulting from the implementation of the HM Protocol, TNO report B&O-A R 2005/193, 2005a.

Denier van der Gon, H.A.C., M. van het Bolscher A.J.H. Visschedijk P.Y.J. Zandveld, Study to the effectiveness of the UNECE Persistent Organic Pollutants Protocol and costs of possible additional measures Phase I: Estimation of emission reduction resulting from the implementation of the POP Protocol, TNO report B&O-A R 2005/194, 2005b.

Denier van der Gon, H.A.C., M. van het Bolscher A.J.H. Visschedijk P.Y.J. Zandveld, 2006, Emissions of Persistent Organic Pollutants and eight candidate POPs from UNECE-Europe in 2000, 2010 and 2020 and the emission reduction resulting from the implementation of the UNECE POP Protocol (submitted)

Farmer, J.G., Mackenzie, A.B., Sugden, C.L., Edgar, P.J., Eades, L.J. (1997): A comparison of the historical lead pollution records in peat and freshwater lake sedimants from central Scotland. *Water, Air and Soil Pollution*, 100: 253-270

Gomes L., Rajot J.L., Alfaro S.C. and A. Gaudichet [2003] Validation of a dust production model from measurements performed in semi-arid agricultural areas of Spain and Niger. *Catena* 52, 257 – 271

Gong S.L. [2003] A parameterization of sea-salt aerosol source function for sub- and super-micron particles. *Global Biogeochemical Cycles* 17(4), 1097-1103

Gong S.L., Zhang X.Y., Zhao T.L., McKendry I.G., Jaffe D.A., Lu N.M. [2003] Characterization of soil dust aerosol inChina and its transport and distribution during 2001 ACE-Asia: 2. Model simulation and validation. *Journal of Geophysical Research,* 108(D9), 4262

Gusev A., Ilyin I., Mantseva L., Rozovskaya O., Shatalov V., Travnikov O. [2006] Progress in further development of MSCE-HM and MSCE-POP models. EMEP/MSC-E Technical Report 4/2006. Meteorological Synthesizing Centre – East of EMEP, Moscow, Russia. Available at: http://www.msceast.org/publications.html

Ilyin, I., Travnikov, O. (2005): Modelling of heavy metal airborne pollution in Europe: Evaluation of the model performance. EMEP/MSC-E Technical Report 8/2005. Meteorological Synthesizing Centre – East of EMEP, Moscow, Russia. Available at: http://www.msceast.org/publications.html

Kakareka S., Gromov S., Pacyna J.M. and T. Kukharchyk. Estimation of heavy metal emission fluxes on the territory of the NIS. (2004) *Atmospheric Environment*, 38, 7101-7109.

Pacyna J.M. and E.G. Pacyna. (2001) Assessment of global and regional emissions of trace metals to the atmosphere from anthropogenic sources worldwide. *Canadian Journal of Environmental Reviews*, 9, 269-298.

Pacyna E.G. and J.M. Pacyna. (2002) Global emission of mercury from anthropogenic sources in 1995. *Water, Air and Soil Pollution,* 137, 149-165.

Storch van H., Costa-Cabral M., Hagner, C., Feser F., Pacyna J.M., and E.G. Pacyna E. (2003) Four decades of gasoline lead emissions and control policies in Europe: a retrospective assessment. *The Science of the Total Environment,* 311, 151-176.

Pacyna J.M., Pacyna E.G., Steenhuisen F. and S. Wilson. Mapping 1995 global anthropogenic emissions of mercury (2003). *Atmospheric Environment,* 37, Supplement No. 1, 109-117.

Pacyna E.G., Pacyna J.M., Steenhuisen F. and S.J. Wilson. Global anthropogenic mercury emission inventory for 2000. *Atmospheric Environment,* (in print).

Pacyna E.G., Pacyna J.M. Fudala J., Strzelecka-Jastrzab E., Hlawiczka S. and D. Panasiuk. Mercury emissions from anthropogenic sources in Europe in 2000 and their scenarios until 2020. *The Science of the Total Environment* (submitted)

Pulles, T, H Kok, U. Quass, C. Juéry and J Matejovicova (2005), Dioxin emissions in Candidate Countries, TNO Report R&I-A R 2005/054, http://europa.eu.int/comm/environment/dioxin/pdf/rapport_2005.pdf

Pulles, T, H Kok, U. Quass, 2006, Application of the emission inventory model TEAM : Uncertainties in dioxin emission estimates for central Europe, *Atmospheric environment*, 40, 2321-2332.

Ryaboshapko A., Bullock O.R., Christensen J., Cohen M., Dastoor, A., Ilyin I., Petersen G., Syrakov D., Travnikov O., Artz R.S., Davignon, D., Draxler R.R., Munthe J. and J. M. Pacyna. Intercomparison study of atmospheric mercury models: Modelling results vs. long-term observations and comparison of country atmospheric balances. *Atmospheric Environment*, (submitted).

TFMM Workshop Minutes [2005]. Minutes of Workshop on the review of the EMEP Models on Heavy Metals and Persistent Organic Pollutants, Moscow, 13 – 14 October 2005. Available at: www.msceast.org/events/review.html

Vestreng, V., Rigler E., Adams, M., Kindbom, K., Pacyna, J.M., Denier van der Gon, H., Reis, S., Travnikov, O, Inventory review 2006, Emission data reported to LRTAP and NEC Directive, Stage 1, 2 and 3 review and Evaluation of inventories of HM and POPs. EMEP/MSC-W Technical Report 2006, ISSN 1504-6179. Available from http://www.emep.int

Wilson S.J., Steenhuisen F., Pacyna J.M. and E.G. Pacyna Mapping the spatial distrubution of global anthropogenic mercury atmospheric emission inventories. *Atmospheric Environment,* (in print).

Zender C. S., Bian H. and D. Newman [2003] Mineral dust entrainment and deposition (DEAD) model: description and 1990s dust climatology. *Journal of Geophysical Research* 108(D14), 4416

Total Hg Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Coal Combustion		Oil	Cement	Non-ferrous Metals		Iron & Steel	Caustic	Waste	Other	Total	Information
	Power Plants	Residential heat	Combustion	Production	Lead	Zinc	Production	Soda	Disposal	Sources		Source 2000
Albania	0.07									0.10	0.17	JP/EP
Austria	0.10	0.57	0.10	0.13			0.10	0.03	0.07		1.10	EMEP 1/2002
Belarus	0.02	0.32	0.01	0.01							0.36	National
Belgium	1.06			0.13	0.06	0.25	0.06	0.44	0.06		2.06	EMEP 1/2002 (1), JP/EP
Bosnia-Herzegovina	0.22										0.22	JP/EP
Bulgaria	1.64	1.64	0.06	0.06	0.06	0.06	0.06	0.49		0.12	4.19	EMEP 1/2002
Croatia										0.31	0.31	EMEP 1/2002 (1),
Cyprus										0.10	0.10	JP/EP
Czech Republic	1.71	1.71	0.02	0.05			0.07	0.28			3.84	EMEP 1/2002,JP/EP
Denmark	0.60	0.17		0.17					0.85	0.26	2.05	EMEP 1/2002
Estonia	0.40	0.10		0.02			0.03				0.55	National
Finland	0.05	0.21		0.05		0.16	0.05	0.03		0.05	0.60	EMEP 1/2002,JP/EP
France	2.06	0.14		3.44	0.69	1.79	1.37	0.70	2.61	2.20	15.00	EMEP 1/2002
Germany	5.24	4.05	1.19	5.49		2.00	1.24	1.19	3.00		23.40	JP/EP
Greece	0.73	0.63		1.56	0.10		0.20	0.03	0.20		3.45	JP/EP
Hungary	1.00	1.11	0.10	0.30			0.10	0.20	1.04	0.36	4.21	National
Iceland											0.00	
Ireland	0.20			0.12	0.11						0.43	JP/EP
Italy	0.46	2.54		3.27	0.10	0.70	0.56	0.65	1.00	0.50	9.78	JP/EP
Latvia	0.08			0.07							0.15	National
Lithuania										0.25	0.25	EMEP 1/2002
Luxemburg	0.14						0.13				0.27	EMEP 1/2002
Monaco	0.04	0.04									0.08	National
Netherlands	0.05	0.05		0.15			0.15	0.03	0.10		0.53	EMEP 1/2002 (1), JP/EP
Norway		0.24		0.24			0.24		0.24		0.96	EMEP 1/2002,JP/EP
Poland	10.20	12.84		0.10		0.10	0.90	0.10	0.57	0.79	25.60	National
Portugal	0.17			0.88				0.03			1.08	JP/EP
Republic of Moldova	0.06	0.07								0.05	0.18	EMEP 1/2002 (1), INTAS
Romania	2.10	2.70		0.05			0.05		0.10		5.00	National
Russian Federation	15.50	11.00		3.70	5.90		1.90	28.00	0.10		66.10	INTAS/JP,EP
Slovakia	1.09	1.09		0.27			0.27	0.11		1.62	4.45	EMEP 1/2002
Slovenia	0.29									0.29	0.58	EMEP 1/2002
Spain	5.39	4.35		5.60	0.42	2.49	1.04	0.61		3.10	23.00	EMEP 1/2002
Sweden	0.06	0.06					0.06	0.04	0.25	0.07	0.54	EMEP 1/2002 (1),
Switzerland	0.10	0.10		0.20			0.80	0.10	1.30	0.03	2.63	National
TFYR of Macedonia				0.04						0.01	0.05	National
Turkey				2.69			1.17			0.20	4.06	JP/EP
Ukraine	5.70	1.71		0.85			1.69	6.26	0.08		16.29	INTAS
United Kingdom	3.42	0.62		0.26	0.09	0.09	0.13	0.68		3.25	8.54	EMEP 1/2002
Yugoslavia	3.52	0.66	0.21	0.28	0.10	0.20	0.12	0.40		1.60	7.09	JP/EP
EUROPE	**63.47**	**48.72**	**1.69**	**30.18**	**7.63**	**7.84**	**12.49**	**40.40**	**11.57**	**15.26**	**239.25**	

(1) 1999 year

Hg0 Emissions from Anthropogenic Sources in Europe, 2000 (in Tons / Year)

Country	Coal Combustion		Oil	Cement	Non-ferrous Metals		Iron & Steel	Caustic	Waste	Other	Total	Information
	Power Plants	Residential heat	Combustion	Production	Lead	Zinc	Production	Soda	Disposal	Sources		Source 2000
Albania	0.03									0.08	0.11	JP/EP
Austria	0.05	0.28	0.05	0.10			0.08	0.02	0.01		0.59	EMEP 1/2002
Belarus	0.01	0.16	0.01	0.01							0.19	National
Belgium	0.53			0.10	0.05	0.20	0.05	0.31	0.01		1.25	EMEP 1/2002 (1), JP/EP
Bosnia-Herzegovina	0.11										0.11	JP/EP
Bulgaria	0.82	0.82	0.03	0.05	0.05	0.05	0.05	0.34		0.09	2.30	EMEP 1/2002
Croatia										0.24	0.24	EMEP 1/2002 (1),
Cyprus										0.07	0.07	JP/EP
Czech Republic	0.86	0.86	0.01	0.04			0.06	0.20			2.03	EMEP 1/2002,JP/EP
Denmark	0.30	0.08		0.13					0.17	0.21	0.89	EMEP 1/2002
Estonia	0.20	0.05		0.02			0.02				0.29	National
Finland	0.03	0.11		0.04		0.13	0.04	0.02		0.04	0.41	EMEP 1/2002,JP/EP
France	1.03	0.08		2.75	0.56	1.43	1.10	0.49	0.52	1.76	9.72	EMEP 1/2002
Germany	2.62	2.03	0.60	4.40		1.60	0.99	0.83	0.60		13.67	JP/EP
Greece	0.37	0.32		1.25	0.08		0.16	0.02	0.04		2.24	JP/EP
Hungary	0.50	0.56	0.05	0.23			0.07	0.14	0.21	0.29	2.05	National
Iceland											0.00	
Ireland	0.10			0.09	0.08						0.27	JP/EP
Italy	0.23	1.27		2.62	0.08	0.55	0.45	0.45	0.20	0.39	6.24	JP/EP
Latvia	0.04			0.06							0.10	National
Lithuania										0.20	0.20	EMEP 1/2002
Luxembourg	0.07						0.10				0.17	EMEP 1/2002
Monaco	0.02	0.02									0.04	National
Netherlands	0.03	0.03		0.12			0.12	0.02	0.02		0.34	EMEP 1/2002 (1), JP/EP
Norway		0.12		0.19			0.19		0.05		0.55	EMEP 1/2002,JP/EP
Poland	5.10	6.42		0.08		0.08	0.72	0.07	0.11	0.63	13.21	National
Portugal	0.09			0.71				0.02			0.82	JP/EP
Republic of Moldova	0.03	0.04								0.04	0.11	EMEP 1/2002 (1), INTAS
Romania	1.05	1.35		0.04			0.04		0.02		2.50	National
Russian Federation	7.75	5.50		2.96	4.72		1.52	19.60	0.02		42.07	INTAS/JP,EP
Slovakia	0.54	0.54		0.22			0.22	0.08		1.30	2.90	EMEP 1/2002
Slovenia	0.14									0.24	0.38	EMEP 1/2002
Spain	2.69	2.17		4.48	0.34	2.00	0.83	0.43		2.47	15.41	EMEP 1/2002
Sweden	0.03	0.03					0.05	0.03	0.05	0.05	0.24	EMEP 1/2002 (1),
Switzerland	0.05	0.05		0.16			0.64	0.07	0.26	0.02	1.25	National
TFYR of Macedonia				0.03						0.01	0.04	National
Turkey				2.16			0.93			0.16	3.25	JP/EP
Ukraine	2.85	0.86		0.68			1.36	4.38	0.02		10.15	INTAS
United Kingdom	1.71	0.31		0.21	0.07	0.07	0.11	0.48		2.60	5.56	EMEP 1/2002
Yugoslavia	1.76	0.33	0.11	0.23	0.08	0.16	0.09	0.28		1.28	4.32	JP/EP
EUROPE	**31.74**	**24.39**	**0.86**	**24.16**	**6.11**	**6.27**	**9.99**	**28.28**	**2.31**	**12.17**	**146.28**	

(1) 1999 year

Hg2+ Emissions from Anthropogenic Sources in Europe, 2000 (in Tons / Year)

Country	Coal Combustion		Oil Combustion	Cement Production	Non-ferrous Metals		Iron & Steel Production	Caustic Soda	Waste Disposal	Other Sources	**Total**	Information Source 2000
	Power Plants	Residential heat			Lead	Zinc						
Albania	0.03									0.02	0.05	JP/EP
Austria	0.04	0.23	0.04	0.02			0.01	0.01	0.05		0.40	EMEP 1/2002
Belarus	0.01	0.13									0.14	National
Belgium	0.42			0.02	0.01	0.04	0.01	0.13	0.04		0.67	EMEP 1/2002 (1), JP/EP
Bosnia-Herzegovina	0.09										0.09	JP/EP
Bulgaria	0.66	0.66	0.02	0.01	0.01	0.01	0.01	0.15		0.02	1.55	EMEP 1/2002
Croatia										0.05	0.05	EMEP 1/2002 (1),
Cyprus										0.02	0.02	JP/EP
Czech Republic	0.68	0.68	0.01	0.01			0.01	0.08			1.47	EMEP 1/2002,JP/EP
Denmark	0.24	0.07		0.03					0.51	0.04	0.89	EMEP 1/2002
Estonia	0.16	0.04					0.01				0.21	National
Finland	0.02	0.08		0.01		0.02	0.01	0.01		0.01	0.16	EMEP 1/2002,JP/EP
France	0.82	0.05		0.52	0.10	0.27	0.20	0.21	1.57	0.33	4.07	EMEP 1/2002
Germany	2.10	1.62	0.47	0.82		0.30	0.19	0.36	1.80		7.66	JP/EP
Greece	0.29	0.25		0.23	0.02		0.03	0.01	0.12		0.95	JP/EP
Hungary	0.40	0.44	0.04	0.05			0.02	0.06	0.62	0.05	1.68	National
Iceland											0.00	
Ireland	0.08			0.02	0.02						0.12	JP/EP
Italy	0.18	1.02		0.49	0.02	0.11	0.08	0.20	0.60	0.08	2.78	JP/EP
Latvia	0.03			0.01							0.04	National
Lithuania										0.04	0.04	EMEP 1/2002
Luxembourg	0.06						0.02				0.08	EMEP 1/2002
Monaco	0.02	0.02									0.04	National
Netherlands	0.02	0.02		0.02			0.02	0.01	0.06		0.15	EMEP 1/2002 (1), JP/EP
Norway		0.10		0.04			0.04		0.14		0.32	EMEP 1/2002,JP/EP
Poland	4.08	5.14		0.02		0.02	0.14	0.03	0.35	0.12	9.90	National
Portugal	0.07			0.13				0.01			0.21	JP/EP
Republic of Moldova	0.02	0.03								0.01	0.06	EMEP 1/2002 (1), INTAS
Romania	0.84	1.08		0.01			0.01		0.06		2.00	National
Russian Federation	6.20	4.40		0.56	0.89		0.29	8.40	0.06		20.80	INTAS/JP,EP
Slovakia	0.44	0.44		0.04			0.04	0.03		0.23	1.22	EMEP 1/2002
Slovenia	0.12									0.04	0.16	EMEP 1/2002
Spain	2.16	1.74		0.84	0.06	0.37	0.16	0.18		0.47	5.98	EMEP 1/2002
Sweden	0.03	0.03					0.01	0.01	0.15	0.01	0.24	EMEP 1/2002 (1),
Switzerland	0.04	0.04		0.03			0.12	0.03	0.78	0.01	1.05	National
TFYR of Macedonia				0.01							0.01	National
Turkey				0.40			0.18			0.03	0.61	JP/EP
Ukraine	2.28	0.68		0.13			0.25	1.88	0.04		5.26	INTAS
United Kingdom	1.37	0.25		0.04	0.01	0.01	0.02	0.20		0.49	2.39	EMEP 1/2002
Yugoslavia	1.41	0.26	0.08	0.04	0.01	0.03	0.02	0.12		0.24	2.21	JP/EP
EUROPE	**25.41**	**19.50**	**0.66**	**4.55**	**1.15**	**1.18**	**1.90**	**12.12**	**6.95**	**2.31**	**75.73**	

(1) 1999 year

Particulate Hg Emissions from Anthropogenic Sources in Europe, 2000 (in Tons / Year)

Country	Coal Combustion		Oil	Cement	Non-ferrous Metals		Iron & Steel	Caustic	Waste	Other	Total	Information
	Power Plants	Residential heat	Combustion	Production	Lead	Zinc	Production	Soda	Disposal	Sources		Source 2000
Albania	0.01										0.01	JP/EP
Austria	0.01	0.06	0.01	0.01			0.01		0.01		0.11	EMEP 1/2002
Belarus		0.03									0.03	National
Belgium	0.11			0.01		0.01			0.01		0.14	EMEP 1/2002 (1), JP/EP
Bosnia-Herzegovina	0.02										0.02	JP/EP
Bulgaria	0.16	0.16	0.01							0.01	0.34	EMEP 1/2002
Croatia										0.02	0.02	EMEP 1/2002 (1),
Cyprus										0.01	0.01	JP/EP
Czech Republic	0.17	0.17									0.34	EMEP 1/2002,JP/EP
Denmark	0.06	0.02		0.01					0.17	0.01	0.27	EMEP 1/2002
Estonia	0.04	0.01									0.05	National
Finland		0.02				0.01					0.03	EMEP 1/2002,JP/EP
France	0.21	0.01		0.17	0.03	0.09	0.07		0.52	0.11	1.21	EMEP 1/2002
Germany	0.52	0.40	0.12	0.27		0.10	0.06		0.60		2.07	JP/EP
Greece	0.07	0.06		0.08			0.01		0.04		0.26	JP/EP
Hungary	0.10	0.11	0.01	0.02			0.01		0.21	0.02	0.48	National
Iceland											0.00	
Ireland	0.02			0.01	0.01						0.04	JP/EP
Italy	0.05	0.25		0.16		0.04	0.03		0.20	0.03	0.76	JP/EP
Latvia	0.01										0.01	National
Lithuania										0.01	0.01	EMEP 1/2002
Luxembourg	0.01						0.01				0.02	EMEP 1/2002
Monaco											0.00	National
Netherlands				0.01			0.01		0.02		0.04	EMEP 1/2002 (1), JP/EP
Norway		0.02		0.01			0.01		0.05		0.09	EMEP 1/2002,JP/EP
Poland	1.02	1.28					0.04		0.11	0.04	2.49	National
Portugal	0.01			0.04							0.05	JP/EP
Republic of Moldova	0.01										0.01	EMEP 1/2002 (1), INTAS
Romania	0.21	0.27							0.02		0.50	National
Russian Federation	1.55	1.10		0.18	0.29		0.09		0.02		3.23	INTAS/JP,EP
Slovakia	0.11	0.11		0.01			0.01			0.09	0.33	EMEP 1/2002
Slovenia	0.03									0.01	0.04	EMEP 1/2002
Spain	0.54	0.44		0.28	0.02	0.12	0.05			0.16	1.61	EMEP 1/2002
Sweden									0.05	0.01	0.06	EMEP 1/2002 (1),
Switzerland	0.01	0.01		0.01			0.04		0.26		0.33	National
TFYR of Macedonia											0.00	National
Turkey				0.13			0.06			0.01	0.20	JP/EP
Ukraine	0.57	0.17		0.04			0.08		0.02		0.88	INTAS
United Kingdom	0.34	0.06		0.01	0.01	0.01				0.16	0.59	EMEP 1/2002
Yugoslavia	0.35	0.07	0.02	0.01	0.01	0.01	0.01			0.08	0.56	JP/EP
EUROPE	**6.32**	**4.83**	**0.17**	**1.47**	**0.37**	**0.39**	**0.60**	**0.00**	**2.31**	**0.78**	**17.24**	

(1) 1999 year

Total As Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Coal Combustion: Power Plants	Coal Combustion: Residential Heat	Non-ferrous Metal Manufacturing	Iron & Steel Production	Waste Disposal	Other Sources	**Total**	References
Albania	0.1		0.1				**0.2**	JP/EP
Austria	0.1	0.4	2.5	0.5		0.4	**3.9**	JP/EP
Belarus	0.2	3.0				0.1	**3.3**	EMEP-W, July 2003
Belgium	1.5		0.5	0.3		0.6	**2.9**	EMEP-W, July 2003
Bosnia-Herzegovina	0.2						**0.2**	JP/EP
Bulgaria	0.5	0.5	1.8				**2.8**	JP/EP
Croatia	0.2	0.3				0.6	**1.1**	EMEP-W, July 2003
Cyprus						0.1	**0.1**	JP/EP
Czech Republic	0.9	0.8	0.7	0.7		0.4	**3.5**	EMEP-W, July 2003 (1)
Denmark	0.6	0.2				0.1	**0.9**	EMEP-W, July 2003
Estonia	4.2	1.1		0.4		4.0	**9.7**	EMEP-W, July 2003
Finland	0.2	0.7	1.7	2.0			**4.6**	EMEP-W, July 2003
France	18.7	1.3	0.8	0.8	0.6		**22.2**	EMEP-W, July 2003
Germany	10.7	8.3				4.2	**23.2**	JP/EP
Greece	1.1	0.9	1.5			0.5	**4**	EMEP-W, July 2003 (3)
Hungary	1.3	1.4	1.0	1.0		1.0	**5.7**	EMEP-W, July 2003
Iceland							**0**	JP/EP
Ireland	0.5		0.1				**0.6**	JP/EP
Italy	2.1	11.7			0.2	1.0	**15**	JP/EP
Latvia	0.5					0.1	**0.6**	EMEP-W, July 2003
Lithuania	0.3	0.2		0.2		0.1	**0.8**	EMEP-W, July 2003
Luxemburg	0.1						**0.1**	EMEP-W, July 2003
Monaco	0.0	0.1					**0.1**	JP/EP
Netherlands	0.1	0.1	0.2	0.6	0.1	0.2	**1.3**	EMEP-W, July 2003
Norway		0.2		0.3	0.3	1.7	**2.5**	EMEP-W, July 2003
Poland	11.1	13.9	12.0	12.0		1.4	**50.4**	EMEP-W, July 2003
Portugal	0.4					1.1	**1.5**	JP/EP
Republic of Moldova	0.1	0.1					**0.2**	EMEP-W, July 2003 (2)
Romania	3.1	3.9	2.0	1.0			**10**	JP/EP
Russian Federation	23.4	16.6	33.0	20.0		40.1	**133.1**	JP/EP
Slovakia	2.6	2.6	2.0	2.0		2.0	**11.2**	EMEP-W, July 2003
Slovenia	0.5		0.2	0.2		0.3	**1.2**	JP/EP
Spain	11.1	8.9	17.0	12.0		8.3	**57.3**	EMEP-W, July 2003
Sweden	0.1	0.2	0.7			0.1	**1.1**	EMEP-W, July 2003
Switzerland	0.7	0.7		1.4			**2.8**	JP/EP
TFYR of Macedonia	0.1	0.0					**0.1**	JP/EP
Turkey	1.5	1.5	1.0	1.0		1.0	**6**	JP/EP
Ukraine	79.2	23.8	50.0	48.0		20.1	**221.1**	EMEP-W, July 2003 (1)
United Kingdom	27.3	4.9	3.0	1.5	0.3	1.0	**38**	EMEP-W, July 2003
Yugoslavia	6.7	1.3	0.5	0.5		1.5	**10.5**	JP/EP
EUROPE	**212**	**109.6**	**132.3**	**106.4**	**1.5**	**92.0**	**653.8**	

(1) 2001 year (2) 1999 year (3) 1996 year

Total Cd Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Coal Combustion		Non-ferrous Metal Manufacturing	Iron &Steel Production	Waste Disposal	Other Sources	**Total**	References
	Power Plants	Residential Heat						
Albania	0.5					0.1	0.6	EMEP-E 3/2002
Austria	0.1	0.5	0.1	0.1		0.6	1.4	EMEP-W, July 2003
Belarus	0.1	1.2				0.1	1.4	EMEP-W, July 2003
Belgium	0.6		0.6	0.2	0.5	0.4	2.3	EMEP-W, July 2003
Bosnia-Herzegovina	0.3						0.3	EMEP-E 3/2002
Bulgaria	1.2	1.2	8.3	0.1	0.2		11.0	EMEP-W, July 2003
Croatia	0.3	0.2				0.5	1.0	EMEP-W, July 2003
Cyprus	0.0	0.1				0.1	0.2	EMEP-E 3/2002
Czech Republic	1.3	1.3		0.2		0.1	2.9	EMEP-W, July 2003
Denmark	0.2	0.1		0.1		0.3	0.7	EMEP-W, July 2003
Estonia	0.3	0.1		0.1		0.2	0.7	EMEP-W, July 2003
Finland	0.1	0.2	1.0	0.1			1.4	EMEP-W, July 2003
France	0.7	0.1	2.2	0.9	3.9	3.7	11.5	EMEP-W, July 2003
Germany	0.8	0.6	4.6	1.4	0.2	3.4	11.0	EMEP-W, July 2003 (3)
Greece	0.8	0.7	0.1	0.1		1.3	3.0	EMEP-W, July 2003 (2)
Hungary	0.6	0.7		0.5		0.9	2.7	EMEP-W, July 2003
Iceland	0.1	0.1					0.2	EMEP-E 3/2002
Ireland	0.7			0.2		1.1	2.0	EMEP-E 3/2002
Italy	1.3	7.2	8.2	3.2	3.1	6.9	29.9	EMEP-E 3/2002
Latvia	0.5					0.1	0.6	EMEP-W, July 2003
Lithuania	0.4	0.4		0.4		0.2	1.4	EMEP-W, July 2003
Luxemburg	0.1						0.1	EMEP-W, July 2003
Monaco							0.0	EMEP-W, July 2003
Netherlands	0.4	0.3	0.1	0.1		0.3	1.2	EMEP-W, July 2003
Norway			0.3	0.3	0.1		0.7	EMEP-W, July 2003
Poland	20.1	25.4	1.4	1.5		2.0	50.4	EMEP-W, July 2003
Portugal	1.5		1.1	0.1		0.3	3.0	EMEP-E 3/2002
Republic of Moldova	0.0	0.1					0.1	EMEP-E 3/2002
Romania	4.4	5.6	3.7	4.8		2.5	21.0	EMEP-E 3/2002
Russian Federation	9.4	6.6	10.3	7.7		16.5	50.5	EMEP-W, July 2003
Slovakia	0.7	0.7		3.0	0.1	2.7	7.2	EMEP-W, July 2003
Slovenia	0.6		0.3	0.3		0.3	1.5	EMEP-W, July 2003
Spain	2.7	2.2	3.8	7.5		3.6	19.8	EMEP-W, July 2003
Sweden	0.1	0.2	0.5	0.1			0.9	EMEP-W, July 2003
Switzerland	0.4	0.3	1.2	0.3			2.2	EMEP-W, July 2003
TFYR of Macedonia	0.1	0.1					0.2	EMEP-W, July 2003
Turkey	0.1	0.1					0.2	EMEP-E 3/2002
Ukraine	2.7	1.8	2.5	2.5		1	10.5	EMEP-W, July 2003 (1)
United Kingdom	2.4	0.4	1.0	0.5	1.1	1.8	7.2	EMEP-W, July 2003
Yugoslavia	3.4	0.6	0.5	0.5		1	6.0	EMEP-E 3/2002
EUROPE	**60**	**59.1**	**51.8**	**36.8**	**9.2**	**52.0**	**268.9**	

(1) 2001 year (2) 1996 year (3) 1995 year

Total Cr Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Coal Combustion		Non-ferrous Metal Manufacturing	Iron &Steel Production	Waste Disposal	Other Sources	**Total**	References
	Power Plants	Residential Heat						
Albania	0.5						**0.5**	JP/EP
Austria	0.1	0.3		0.4		0.1	**0.9**	JP/EP
Belarus	0.3	4		1.5		0.5	**6.3**	EMEP-W, July 2003
Belgium	10.0			4.7		3.0	**17.7**	EMEP-W, July 2003
Bosnia-Herzegovina	0.8					0.2	**1**	JP/EP
Bulgaria	5.5	5.5		6.0		4.0	**21**	JP/EP
Croatia	1.1	1.2				2.0	**4.3**	EMEP-W, July 2003
Cyprus						0.5	**0.5**	JP/EP
Czech Republic	3.2	3.2		4.0		2.0	**12.4**	EMEP-W, July 2003 (1)
Denmark	1.4	0.4		0.4		0.1	**2.3**	EMEP-W, July 2003
Estonia	4.6	1.1		3.0		1.0	**9.7**	EMEP-W, July 2003
Finland	2.7	11.3	1.0	7.0		6.0	**28**	EMEP-W, July 2003
France	115.2	7.8	2.0	60.0		58.6	**243.6**	EMEP-W, July 2003
Germany	33.8	26.2	2.0	30.0		23.0	**115**	EMEP-W, July 2003 (4)
Greece	3.2	2.8		2.0		2.0	**10**	EMEP-W, July 2003 (3)
Hungary	1.8	1.9	1.0	1.0		1.0	**6.7**	EMEP-W, July 2003
Iceland	0.3	0.2					**0.5**	JP/EP
Ireland	1.1			0.5		0.5	**2.1**	JP/EP
Italy	2.8	15.2	2.0	15.0		14.0	**49**	JP/EP
Latvia	2.8			2.0		1.0	**5.8**	EMEP-W, July 2003
Lithuania	0.6	0.7		0.5		0.5	**2.3**	EMEP-W, July 2003
Luxemburg	0.1			0.2			**0.3**	EMEP-W, July 2003
Monaco							**0**	EMEP-W, July 2003
Netherlands	1.3	1.3		2.0		1.0	**5.6**	EMEP-W, July 2003
Norway		4.8		3.0		1.0	**8.8**	EMEP-W, July 2003
Poland	18.6	23.4	3.0	18.0		21.3	**84.3**	EMEP-W, July 2003
Portugal	3.1			1.0		1.0	**5.1**	JP/EP
Republic of Moldova	0.2	0.3					**0.5**	EMEP-W, July 2003 (2)
Romania	5.3	6.7	2.0	6.0		5.0	**25**	JP/EP
Russian Federation	93.6	66.4	20.0	60.0		90.5	**330.5**	JP/EP
Slovakia	2.0	2.0		2.1		2.0	**8.1**	EMEP-W, July 2003
Slovenia	1.9			0.5		0.5	**2.9**	JP/EP
Spain	14.4	11.6	2.0	13.0		9.1	**50.1**	EMEP-W, July 2003
Sweden	0.5	0.5		3.9		2.0	**6.9**	EMEP-W, July 2003
Switzerland	3.5	3.5		5.0		1.0	**13**	JP/EP
TFYR of Macedonia	0.2	0.1					**0.3**	JP/EP
Turkey	5.2	5.3		6.0		4.0	**20.5**	JP/EP
Ukraine	169.2	50.8	14.0	120.0		97.4	**451.4**	EMEP-W, July 2003 (1)
United Kingdom	33.0	6.0	3.0	20.0		7.4	**69.4**	EMEP-W, July 2003
Yugoslavia	14.3	2.7	2.0	10.0		6.5	**35.5**	JP/EP
EUROPE	**558.2**	**267.2**	**54.0**	**408.7**	**0.0**	**369.7**	**1,657.8**	

(1) 2001 year (2) 1999 year (3) 1996 year (4) 1995 year

Total Ni Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Coal Combustion		Non-ferrous Metal Manufacturing	Iron &Steel Production	Waste Disposal	Other Sources	**Total**	References
	Power Plants	Residential Heat						
Albania	7.0					1.0	**8.0**	JP/EP
Austria	2.4	4.9		0.2		7.5	**15.0**	JP/EP
Belarus	5.5	88.7				0.2	**94.4**	EMEP-W, July 2003
Belgium	44.9		0.5	2.5	0.1	1.6	**49.6**	EMEP-W, July 2003
Bosnia-Herzegovina	0.2						**0.2**	JP/EP
Bulgaria	80.7	80.6		3.7		12.0	**177.0**	JP/EP
Croatia	11.1	11.2	0.3			4.0	**26.6**	EMEP-W, July 2003
Cyprus	5.0	5.0					**10.0**	JP/EP
Czech Republic	6.0	6.0		2.0		1.5	**15.5**	EMEP-W, July 2003 (1)
Denmark	10.2	2.9		0.1		0.7	**13.9**	EMEP-W, July 2003
Estonia	4.7	1.2				2.0	**7.9**	EMEP-W, July 2003
Finland	4.7	19.8		8.8			**33.3**	EMEP-W, July 2003
France	191.3	13.0		9.4	2.9	3.5	**220.1**	EMEP-W, July 2003
Germany	77.7	60.1				20.2	**158.0**	EMEP-W, July 2003 (4)
Greece	43.6	37.6	1.5	0.3		18.0	**101.0**	EMEP-W, July 2003 (3)
Hungary	13.8	15.3	0.4	1.7		6.0	**37.2**	EMEP-W, July 2003
Iceland	1.1	1.2				2.4	**4.7**	JP/EP
Ireland	15.5					2.5	**18.0**	JP/EP
Italy	70.4	388.8		2.4	8.4	70.0	**540.0**	JP/EP
Latvia	10.1					1.0	**11.1**	EMEP-W, July 2003
Lithuania	12.1	12.0				2.5	**26.6**	EMEP-W, July 2003
Luxemburg	0.6					0.1	**0.7**	EMEP-W, July 2003
Monaco							**0.0**	EMEP-W, July 2003
Netherlands	21.8	21.9	0.4	1.0	0.1	8.0	**53.2**	EMEP-W, July 2003
Norway		7.0	4.0			7.0	**18.0**	JP/EP
Poland	101.6	127.8		2.0		20.0	**251.4**	EMEP-W, July 2003
Portugal	57.0			1.0		12.0	**70.0**	JP/EP
Republic of Moldova	1.9	2.3				0.2	**4.4**	EMEP-W, July 2003 (2)
Romania	16.6	21.4	25.0			1.0	**64.0**	JP/EP
Russian Federation	482.5	342.5	5.0	20.0		100.0	**950.0**	JP/EP
Slovakia	5.8	5.8	7.0	2.5		2.5	**23.6**	EMEP-W, July 2003
Slovenia	8.5		0.8			2.0	**11.3**	JP/EP
Spain	119.9	96.7	1.0	5.0		100.0	**322.6**	EMEP-W, July 2003
Sweden	4.8	4.8		4.0		2.2	**15.8**	EMEP-W, July 2003
Switzerland	4.9	4.8		0.8		3.5	**14.0**	JP/EP
TFYR of Macedonia	3	3.0				1.0	**7.0**	JP/EP
Turkey	101.3	101.3	0.4	15.0		12.0	**230.0**	JP/EP
Ukraine	161.7	48.5	0.4	15.0		12.0	**237.6**	EMEP-W, July 2003 (1)
United Kingdom	101.0	18.3	1.0	4.0	1.0		**125.3**	EMEP-W, July 2003
Yugoslavia	31.6	5.9	1.2	4.3		7.0	**50.0**	JP/EP
EUROPE	**1842.5**	**1,560.3**	**48.9**	**105.7**	**12.5**	**447.1**	**4,017.0**	

(1) 2001 year (2) 1999 year (3) 1996 year (4) 1995 year

Total Pb Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Coal Combustion		Non-ferrous Metal Manufacturing	Iron & Steel Production	Waste Disposal	Gasoline Combustion	Cement Production	Other Sources	Total	References
	Power Plants	Residential Heat								
Albania	1.5		0.9		0.2	21.4			24.0	EMEP-E 3/2002
Austria	0.5	3.0	2.7		0.1	7.5		0.1	13.9	EMEP-W, July 2003
Belarus	0.5	8.1				10.9		26.6	46.1	EMEP-W, July 2003
Belgium	22.4		5.7		12.4	77.1		5.4	123.0	EMEP-W, July 2003
Bosnia-Herzegovina					0.1	4.9			5.0	EMEP-E 3/2002
Bulgaria	46.3	46.4			4.3	116.2		0.2	213.4	EMEP-W, July 2003
Croatia	1.5	1.4				143.4		0.6	146.9	EMEP-W, July 2003
Cyprus						50.0		24.0	74.0	EMEP-W, July 2003
Czech Republic	8.8	8.8	35.2			54.9			107.7	EMEP-W, July 2003
Denmark	3.4	0.9				2.3		0.4	7.0	EMEP-W, July 2003
Estonia	0.6	0.1				39.3		0.7	40.7	EMEP-W, July 2003
Finland	0.4	1.9	9.0		0.1	21.4		4.7	37.5	EMEP-W, July 2003
France	17.4	1.2	10.7		9.3	157.4			196.0	EMEP-W, July 2003
Germany	38	29.4	144.7		12.6	337.1		70.2	632.0	EMEP-W, July 2003 (5)
Greece	17.4	15.0	29.5			383.0		25.1	470.0	EMEP-W, July 2003 (4)
Hungary	3.8	4.2	0.5		0.8	27.7			37.0	EMEP-W, July 2003
Iceland						0.4			0.4	EMEP-W, July 2003 (3)
Ireland	3.5		12.9			66.6			83.0	EMEP-E 3/2002
Italy	19.1	105.7	305.9		60.4	1,682.7			2173.8	EMEP-W, July 2003 (6)
Latvia	0.2					8.1		0.1	8.4	EMEP-W, July 2003
Lithuania	1.2	1.1				13.4		0.2	15.9	EMEP-W, July 2003
Luxemburg	0.1				0.1	0.3		1.1	1.6	EMEP-W, July 2003
Monaco								0.1	0.1	EMEP-W, July 2003
Netherlands	2.6	2.7	0.1		0.6	37.4		0.7	44.1	EMEP-W, July 2003
Norway		0.4				5.6			6.0	EMEP-W, July 2003
Poland	225.4	283.7	32.5		0.5	105.4			647.5	EMEP-W, July 2003
Portugal	25.2		14.4			305.6		19.8	365.0	EMEP-E 3/2002
Republic of Moldova	0.8	1.0				9.4			11.2	EMEP-W, July 2003 (2)
Romania	23.8	30.6	95.4			350.2		10.0	510.0	EMEP-E 3/2002
Russian Federation	58.3	41.3	244.4			1,996.0		12.0	2352.0	EMEP-W, July 2003
Slovakia	13.6	13.6	10.0			37.1			74.3	EMEP-W, July 2003
Slovenia	0.4					34.8		2.0	37.2	EMEP-W, July 2003
Spain	14.9	12.0	274.5			355.3		15.8	672.5	EMEP-W, July 2003
Sweden	0.4	0.4	1.1			13.3		0.2	15.4	EMEP-W, July 2003
Switzerland	17.4	17.4	18.6		3.5	52.1		4.6	113.6	EMEP-W, July 2003
TFYR of Macedonia			0.4			2.6			3.0	EMEP-W, July 2003
Turkey	26.9	26.9	57.5		4.5	301.5		9.7	427.0	EMEP-E 3/2002
Ukraine	61.4	18.4				581.3		2.0	663.1	EMEP-W, July 2003 (1)
United Kingdom	26.8	4.8	28.6		6.7	117.5		8.4	192.8	EMEP-W, July 2003
Yugoslavia	9.9	1.9	136.2			180.4		2.6	331.0	EMEP-E 3/2002
EUROPE	**694.4**	**682.3**	**1,471.4**	**0.0**	**116.2**	**7,711.5**	**0.0**	**247.3**	**10,923.1**	

(1) 2001 year (2) 1999 year (3) 1998 year (4) 1996 year (5) 1995 year (6) 1994 year

Total As Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Fuel Combastion		Ind. Resid.&Com.boilers		Iron & Steel Production	Cement Production	Non-ferrous Metal	Waste Disposal	Other Sources	Total
	Coal	Oil	Coal	Oil						
Albania	0.09	0.01	0.04	0.09	0.04	0.02	0.10			0.39
Austria	0.25	0.06	1.84	1.68	0.71	0.38	2.50		0.40	7.82
Belarus	0.36	0.03	0.24	0.81	0.75	0.19			0.10	2.48
Belgium	0.61	0.04	4.13	3.26	5.82	0.80	0.50		0.60	15.76
Bosnia-Herzegovina	1.32	0.02	0.88	0.09	0.04	0.03				2.38
Bulgaria	2.52	0.03	1.68	0.44	1.01	0.22	1.80			7.70
Croatia	0.18	0.09	0.16	0.45	0.04	0.29			0.60	1.81
Cyprus	0.00	0.13	0.03	0.22	0.00	0.14			0.10	0.62
Czech Republic	8.42	0.03	6.09	1.11	1.31	0.41	0.70		0.40	18.47
Denmark	0.74	0.20	0.26	1.16	0.01	0.26			0.10	2.73
Estonia	1.32	0.00	0.62	0.08	0.00	0.03			4.00	6.05
Finland	0.63	0.02	1.50	1.38	2.05	0.14	1.70			7.42
France	1.27	0.24	7.05	13.01	10.50	2.00	0.80	0.60		35.47
Germany	13.05	0.26	12.56	19.22	4.94	3.81			4.20	58.04
Greece	1.65	0.32	0.65	2.07	0.53	1.42	1.50		0.50	8.64
Hungary	1.72	0.16	0.88	0.88	0.99	0.33	1.00		1.00	6.96
Iceland	0.00	0.00	0.05	0.09	0.00	0.01				0.15
Ireland	0.38	0.16	0.58	1.00	0.19	0.26	0.10			2.67
Italy	1.17	3.02	5.46	10.32	13.31	3.83		0.20	1.00	38.31
Latvia	0.02	0.01	0.10	0.17	0.25				0.10	0.65
Lithuania	0.00	0.02	0.08	0.33	0.00	0.06			0.10	0.59
Luxemburg	0.00	0.00	0.10	0.34	1.29	0.08				1.81
Monaco										0.00
Netherlands	1.03	0.14	2.26	4.12	2.84	0.35	0.20	0.10	0.20	11.24
Norway	0.00	0.00	0.72	1.77	0.00	0.19		0.30	1.70	4.68
Poland	20.87	0.03	17.25	3.00	5.25	1.51	12.00		1.40	61.31
Portugal	0.64	0.30	0.48	1.96	0.00	1.01			1.10	5.49
Republic of Moldova	0.04	0.02	0.02	0.05	0.00	0.02				0.15
Romania	2.76	0.35	1.76	0.90	2.34	0.84	2.00			10.95
Russian Federation	35.02	0.73	28.94	14.25	27.76	3.24	33.00		40.10	183.04
Slovakia	0.81	0.01	2.32	0.64	0.01	0.31	2.00		2.00	8.10
Slovenia	0.75	0.00	0.07	0.35	0.00	0.13	0.20		0.30	1.80
Spain	3.66	0.78	1.89	8.70	0.01	3.82	17.00		8.30	44.16
Sweden	0.10	0.04	1.69	2.11	1.79	0.26	0.70		0.10	6.79
Switzerland	0.06	0.37	0.64	1.20	0.57	0.36				3.20
TFYR of Macedonia	0.09	0.02	0.56	0.11	0.08	0.08				0.94
Turkey	9.60	1.01	6.40	3.00	6.34	3.62	1.00		1.00	31.97
Ukraine	16.25	0.17	13.42	1.20	15.89	0.53	50.00		20.10	117.56
United Kingdom	5.54	0.17	6.58	11.93	7.51	1.28	3.00	0.30	1.00	37.31
Yugoslavia	3.00	0.08	2.00	0.30			0.50		1.50	7.38
TOTAL EUROPE	**135.92**	**9.07**	**131.98**	**113.79**	**114.17**	**32.26**	**132.30**	**1.50**	**92.00**	**762.99**

Total Cd Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Fuel Combastion		Ind. Resid.&Com.boilers		Iron & Steel Production	Cement Production	Non-ferrous Metal	Waste Disposal	Other Sources	Total
	Coal	Oil	Coal	Oil						
Albania	0.06	0.01	0.03	0.12	0.01	0.04			0.10	0.37
Austria	0.25	0.10	1.38	2.23	0.28	0.76	0.10		0.60	5.70
Belarus	0.24	0.06	0.18	1.08	0.30	0.37			0.10	2.33
Belgium	0.61	0.06	3.10	4.34	2.33	1.60	0.60	0.50	0.40	13.54
Bosnia-Herzegovina	0.88	0.03	0.66	0.12	0.02	0.06				1.77
Bulgaria	1.68	0.05	1.26	0.58	0.40	0.44	8.30	0.20		12.91
Croatia	0.12	0.15	0.12	0.60	0.01	0.57			0.50	2.07
Cyprus	0.00	0.22	0.02	0.29	0.00	0.28			0.10	0.91
Czech Republic	5.61	0.05	4.57	1.48	0.52	0.82			0.10	13.15
Denmark	0.74	0.34	0.19	1.54	0.00	0.53			0.30	3.64
Estonia	0.88	0.00	0.46	0.10	0.00	0.07			0.20	1.71
Finland	0.63	0.04	1.13	1.84	0.82	0.28	1.00			5.74
France	1.27	0.40	5.29	17.35	4.20	4.00	2.20	3.90	3.70	42.31
Germany	13.05	0.43	9.42	25.63	1.98	7.62	4.60	0.20	3.40	66.33
Greece	1.65	0.54	0.49	2.75	0.21	2.83	0.10		1.30	9.87
Hungary	1.14	0.26	0.66	1.18	0.39	0.67			0.90	5.20
Iceland	0.00	0.00	0.04	0.11	0.00	0.03				0.18
Ireland	0.38	0.26	0.44	1.33	0.08	0.52			1.10	4.11
Italy	1.17	5.03	4.10	13.76	5.32	7.66	8.20	3.10	6.90	55.24
Latvia	0.02	0.02	0.08	0.23	0.10				0.10	0.55
Lithuania	0.00	0.04	0.06	0.43	0.00	0.11			0.20	0.84
Luxemburg	0.00	0.00	0.08	0.46	0.51	0.15				1.20
Monaco										0.00
Netherlands	1.03	0.23	1.70	5.50	1.13	0.69	0.10		0.30	10.68
Norway	0.00	0.00	0.54	2.36	0.00	0.37	0.30	0.10		3.67
Poland	13.92	0.06	12.94	4.00	2.10	3.01	1.40		2.00	39.43
Portugal	0.64	0.51	0.36	2.61	0.00	2.02	1.10		0.30	7.54
Republic of Moldova	0.02	0.03	0.02	0.06	0.00	0.04				0.17
Romania	1.84	0.59	1.32	1.20	0.93	1.68	3.70		2.50	13.76
Russian Federation	23.34	1.22	21.70	19.00	11.10	6.48	10.30		16.50	109.64
Slovakia	0.54	0.01	1.74	0.85	0.00	0.61		0.10	2.70	6.55
Slovenia	0.50	0.01	0.05	0.47	0.00	0.25	0.30		0.30	1.88
Spain	3.66	1.30	1.42	11.60	0.00	7.63	3.80		3.60	33.01
Sweden	0.10	0.07	1.27	2.81	0.71	0.52	0.50			5.98
Switzerland	0.06	0.62	0.48	1.60	0.23	0.72	1.20			4.91
TFYR of Macedonia	0.06	0.04	0.42	0.14	0.03	0.16				0.85
Turkey	6.40	1.68	4.80	4.00	2.54	7.25				26.67
Ukraine	10.83	0.28	10.07	1.60	6.36	1.06	2.50		1.00	33.70
United Kingdom	5.54	0.29	4.94	15.91	3.00	2.56	1.00	1.10	1.80	36.14
Yugoslavia	2.00	0.13	1.50	0.40			0.50		1.00	5.53
TOTAL EUROPE	**100.86**	**15.16**	**99.03**	**151.66**	**45.61**	**64.46**	**51.80**	**9.20**	**52.00**	**589.78**

Total Cr Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Fuel Combastion		Ind. Resid.&Com.boilers		Iron & Steel Production	Cement Production	Non-ferrous Metal	Waste Disposal	Other Sources	Total
	Coal	Oil	Coal	Oil						
Albania	0.24	0.02	0.20	0.24	0.18	0.18				1.06
Austria	1.01	0.18	9.20	4.47	3.55	3.80			0.10	22.31
Belarus	0.96	0.10	1.20	2.16	3.75	1.85			0.50	10.52
Belgium	2.43	0.11	20.64	8.68	29.10	8.00			3.00	71.96
Bosnia-Herzegovina	3.52	0.05	4.40	0.24	0.20	0.30			0.20	8.91
Bulgaria	6.72	0.09	8.40	1.16	5.05	2.21			4.00	27.63
Croatia	0.48	0.27	0.80	1.20	0.18	2.85			2.00	7.78
Cyprus	0.00	0.39	0.16	0.58	0.00	1.40			0.50	3.03
Czech Republic	22.45	0.09	30.44	2.95	6.53	4.09			2.00	68.55
Denmark	2.96	0.60	1.28	3.08	0.03	2.64			0.10	10.69
Estonia	3.52	0.00	3.08	0.20	0.00	0.33			1.00	8.13
Finland	2.54	0.07	7.52	3.68	10.23	1.42	1.00		6.00	32.46
France	5.10	0.72	35.24	34.70	52.50	20.00	2.00		58.60	208.86
Germany	52.20	0.77	62.80	51.26	24.70	38.09	2.00		23.00	254.82
Greece	6.58	0.97	3.24	5.51	2.65	14.15			2.00	35.10
Hungary	4.58	0.47	4.40	2.35	4.93	3.33	1.00		1.00	22.06
Iceland	0.00	0.00	0.24	0.23	0.00	0.14				0.61
Ireland	1.54	0.47	2.92	2.66	0.95	2.62			0.50	11.66
Italy	4.66	9.05	27.32	27.51	66.55	38.30	2.00		14.00	189.39
Latvia	0.06	0.03	0.52	0.45	1.25				1.00	3.31
Lithuania	0.00	0.07	0.40	0.87	0.00	0.57			0.50	2.41
Luxemburg	0.00	0.00	0.52	0.91	6.43	0.75				8.61
Monaco										0.00
Netherlands	4.12	0.41	11.32	11.00	14.18	3.45			1.00	45.48
Norway	0.00	0.00	3.60	4.72	0.00	1.85			1.00	11.17
Poland	55.66	0.10	86.24	8.00	26.25	15.05	3.00		21.30	215.60
Portugal	2.56	0.91	2.40	5.22	0.00	10.08			1.00	22.17
Republic of Moldova	0.10	0.05	0.12	0.12	0.00	0.22				0.61
Romania	7.36	1.06	8.80	2.40	11.68	8.41	2.00		5.00	46.71
Russian Federation	93.38	2.19	144.68	38.00	138.80	32.39	20.00		90.50	559.94
Slovakia	2.16	0.02	11.60	1.70	0.05	3.05			2.00	20.58
Slovenia	2.00	0.01	0.36	0.94	0.00	1.25			0.50	5.06
Spain	14.62	2.34	9.44	23.21	0.05	38.15	2.00		9.10	98.91
Sweden	0.38	0.12	8.44	5.62	8.93	2.61			2.00	28.10
Switzerland	0.25	1.12	3.20	3.20	2.85	3.60			1.00	15.22
TFYR of Macedonia	0.24	0.07	2.80	0.28	0.40	0.80				4.59
Turkey	25.60	3.02	32.00	8.00	31.70	36.24			4.00	140.56
Ukraine	43.33	0.50	67.12	3.20	79.45	5.31	14.00		97.40	310.31
United Kingdom	22.18	0.52	32.92	31.81	37.55	12.80	3.00		7.40	148.18
Yugoslavia	8.00	0.23	10.00	0.80			2.00		6.50	27.53
TOTAL EUROPE	**403.49**	**27.19**	**659.96**	**303.31**	**570.65**	**322.28**	**54.00**	**0.00**	**369.70**	**2,710.58**

Total Ni Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Fuel Combastion		Ind. Resid.&Com.boilers		Iron & Steel Production	Cement Production	Non-ferrous Metal	Waste Disposal	Other Sources	Total
	Coal	Oil	Coal	Oil						
Albania	0.24	0.14	0.15	2.10	0.05	0.18			1.00	3.86
Austria	1.26	1.44	6.90	39.10	1.07	3.80			7.50	61.07
Belarus	0.96	0.81	0.90	18.90	1.13	1.85			0.20	24.75
Belgium	3.04	0.88	15.48	75.95	8.73	8.00	0.50	0.10	1.60	114.28
Bosnia-Herzegovina	3.52	0.35	3.30	2.10	0.06	0.30				9.63
Bulgaria	6.72	0.70	6.30	10.15	1.52	2.21			12.00	39.60
Croatia	0.48	2.10	0.60	10.50	0.05	2.85	0.30		4.00	20.88
Cyprus	0.00	3.01	0.12	5.08	0.00	1.40				9.61
Czech Republic	22.45	0.70	22.83	25.83	1.96	4.09			1.50	79.36
Denmark	3.70	4.69	0.96	26.95	0.01	2.64			0.70	39.65
Estonia	3.52	0.04	2.31	1.75	0.00	0.33			2.00	9.95
Finland	3.17	0.53	5.64	32.17	3.07	1.42				46.00
France	6.37	5.64	26.43	303.66	15.75	20.00		2.90	3.50	384.25
Germany	65.25	5.95	47.10	448.56	7.41	38.09			20.20	632.56
Greece	8.23	7.56	2.43	48.20	0.80	14.15	1.50		18.00	100.87
Hungary	4.58	3.68	3.30	20.58	1.48	3.33	0.40		6.00	43.35
Iceland	0.00	0.00	0.18	2.00	0.00	0.14			2.40	4.72
Ireland	1.92	3.64	2.19	23.24	0.29	2.62			2.50	36.40
Italy	5.83	70.42	20.49	240.73	19.97	38.30		8.40	70.00	474.14
Latvia	0.06	0.25	0.39	3.96	0.38				1.00	6.04
Lithuania	0.00	0.56	0.30	7.60	0.00	0.57			2.50	11.53
Luxemburg	0.00	0.04	0.39	7.98	1.93	0.75			0.10	11.19
Monaco										0.00
Netherlands	5.15	3.22	8.49	96.22	4.25	3.45	0.40	0.10	8.00	129.28
Norway	0.00	0.00	2.70	41.30	0.00	1.85	4.00		7.00	56.85
Poland	55.66	0.81	64.68	69.97	7.88	15.05			20.00	234.05
Portugal	3.20	7.07	1.80	45.71	0.00	10.08			12.00	79.86
Republic of Moldova	0.10	0.35	0.09	1.05	0.00	0.22			0.20	2.01
Romania	7.36	8.23	6.60	21.00	3.50	8.41	25.00		1.00	81.10
Russian Federation	93.38	17.05	108.51	332.50	41.64	32.39	5.00		100.00	730.47
Slovakia	2.16	0.14	8.70	14.91	0.02	3.05	7.00		2.50	38.48
Slovenia	2.00	0.07	0.27	8.23	0.00	1.25	0.80		2.00	14.62
Spain	18.28	18.17	7.08	203.07	0.02	38.15	1.00		100.00	385.77
Sweden	0.48	0.95	6.33	49.14	2.68	2.61			2.20	64.39
Switzerland	0.31	8.68	2.40	28.00	0.86	3.60			3.50	47.35
TFYR of Macedonia	0.24	0.53	2.10	2.45	0.12	0.80			1.00	7.24
Turkey	25.60	23.45	24.00	70.00	9.51	36.24	0.40		12.00	201.20
Ukraine	43.33	3.92	50.34	28.00	23.84	5.31	0.40		12.00	167.14
United Kingdom	27.72	4.06	24.69	278.36	11.27	12.80	1.00	1.00		360.90
Yugoslavia	8.00	1.75	7.50	7.00			1.20		7.00	32.45
TOTAL EUROPE	**434.27**	**211.58**	**494.97**	**2,654.00**	**171.25**	**322.28**	**48.90**	**12.50**	**447.10**	**4,796.85**

Total Pb Emissions from Anthropogenic Sources in Europe, 2000 (in Tons/Year)

Country	Fuel Combastion		Ind. Resid.&Com.boilers		Iron & Steel Production	Cement Production	Non-ferrous Metal	Waste Disposal	Gasoline Combustion	Other Sources	Total
	Coal	Oil	Coal	Oil							
Albania	0.30	0.02	0.19	0.36	0.70	0.36	0.90	0.20	21.40		24.43
Austria	1.26	0.25	8.74	6.70	14.20	7.60	2.70	0.10	22.40	0.10	64.05
Belarus	1.20	0.14	1.14	3.24	15.00	3.70			95.70	26.60	146.72
Belgium	3.04	0.15	19.61	13.02	116.40	16.00	5.70	12.40	77.10	5.40	268.82
Bosnia-Herzegovina	4.40	0.06	4.18	0.36	0.80	0.60		0.10	4.90		15.40
Bulgaria	8.40	0.12	7.98	1.74	20.20	4.42		4.30	116.20	0.20	163.56
Croatia	0.60	0.36	0.76	1.80	0.70	5.70			143.40	0.60	153.92
Cyprus	0.00	0.52	0.15	0.87	0.00	2.80			12.30	24.00	40.64
Czech Republic	28.06	0.12	28.92	4.43	26.10	8.18	35.20		54.90		185.91
Denmark	3.70	0.80	1.22	4.62	0.10	5.28			22.40	0.40	38.52
Estonia	4.40	0.01	2.93	0.30	0.00	0.66			12.30	0.70	21.30
Finland	3.17	0.09	7.14	5.51	40.90	2.84	9.00	0.10	21.40	4.70	94.85
France	6.37	0.97	33.48	52.06	210.00	40.00	10.70	9.30	157.40		520.28
Germany	65.25	1.02	59.66	76.90	98.80	76.18	144.70	12.60	337.10	70.20	942.41
Greece	8.23	1.30	3.08	8.26	10.60	28.30	29.50		196.80	25.10	311.17
Hungary	5.72	0.63	4.18	3.53	19.70	6.66	0.50	0.80	27.70		69.42
Iceland	0.00	0.00	0.23	0.34	0.00	0.28			0.40		1.25
Ireland	1.92	0.62	2.77	3.98	3.80	5.24	12.90		66.60		97.83
Italy	5.83	12.07	25.95	41.27	266.20	76.60	305.90	60.40	1,125.00		1919.22
Latvia	0.08	0.04	0.49	0.68	5.00				8.10	0.10	14.49
Lithuania	0.00	0.10	0.38	1.30	0.00	1.14			13.40	0.20	16.52
Luxemburg	0.00	0.01	0.49	1.37	25.70	1.50		0.10	0.30	1.10	30.57
Monaco										0.10	0.10
Netherlands	5.15	0.55	10.75	16.49	56.70	6.90	0.10	0.60	85.10	0.70	183.04
Norway	0.00	0.00	3.42	7.08	0.00	3.70			19.00		33.20
Poland	69.58	0.14	81.93	11.99	105.00	30.10	32.50	0.50	105.40		437.14
Portugal	3.20	1.21	2.28	7.84	0.00	20.16	14.40		129.20	19.80	198.09
Republic of Moldova	0.12	0.06	0.11	0.18	0.00	0.44			9.40		10.31
Romania	9.20	1.41	8.36	3.60	46.70	16.82	95.40		350.20	10.00	541.69
Russian Federation	116.72	2.92	137.45	57.00	555.20	64.78	244.40		1996.00	12.00	3186.47
Slovakia	2.70	0.02	11.02	2.56	0.20	6.10	10.00		37.10		69.70
Slovenia	2.50	0.01	0.34	1.41	0.00	2.50			34.80	2.00	43.56
Spain	18.28	3.11	8.97	34.81	0.20	76.30	274.50		355.30	15.80	787.27
Sweden	0.48	0.16	8.02	8.42	35.70	5.22	1.10		45.90	0.20	105.20
Switzerland	0.31	1.49	3.04	4.80	11.40	7.20	18.60	3.50	52.10	4.60	107.04
TFYR of Macedonia	0.30	0.09	2.66	0.42	1.60	1.60	0.40		2.60		9.67
Turkey	32.00	4.02	30.40	12.00	126.80	72.48	57.50	4.50	301.50	9.70	650.90
Ukraine	54.16	0.67	63.76	4.80	317.80	10.62			287.10	2.00	740.91
United Kingdom	27.72	0.70	31.27	47.72	150.20	25.60	28.60	6.70	244.20	8.40	571.11
Yugoslavia	10.00	0.30	9.50	1.20			136.20		180.40	2.60	340.20
TOTAL EUROPE	**504.35**	**36.26**	**626.95**	**454.96**	**2,282.40**	**644.56**	**1,471.40**	**116.20**	**6,772.50**	**247.30**	**13,156.88**

Annex 3

Table A3-1 Source categories addressed in inventorying POP emissions in UNECE-Europe

Common Format	Source Category	Fuel	POPs				PAH indicator compounds			
			HCB	HCH	PCB	PCDD/F	BaP	BbF	BkF	Indeno
Public heat and power; Excludes refineries	Heat / Power Plants	Brown Coal			X	X	X	X	X	X
		Diesel				X	X	X	X	X
		Gasoline				X	X	X	X	X
		Hard Coal			X	X	X	X	X	X
		Heavy Fuel Oil				X	X	X	X	X
		Peat				X	X	X	X	X
	Unidentified Source / other		X							
Residential, commercial and other; Includes combustion in agriculture	Residential, commercial and other combustion	Brown Coal			X	X	X	X	X	X
		Diesel				X	X	X	X	X
		Gasoline				X	X	X	X	X
		Hard Coal			X	X	X	X	X	X
		Heavy Fuel Oil				X	X	X	X	X
		Kerosines				X	X	X	X	X
		Peat				X	X	X	X	X
		Wood and Wood Waste				X	X	X	X	X
Industry; Includes both combustion and process emission, and refineries and fossil fuel production	Coke Ovens	-					X	X	X	X
	Industrial Combustion	Brown Coal			X	X	X	X	X	X
		Diesel				X	X	X	X	X
		Gasoline				X	X	X	X	X
		Hard Coal			X	X	X	X	X	X
		Heavy Fuel Oil				X	X	X	X	X
		Kerosines				X	X	X	X	X
		Peat				X	X	X	X	X
	Iron & Steel, Electric Arc Furnace	-				X	X			
	Iron & Steel, Open Hearth Furnace	-			X					
	Iron & Steel, Oxygen Furnace	-			X					
	Iron & Steel, Sinter Production	-	X		X	X				
	Oil and Gas Extraction	Diesel				X	X	X	X	X
		Gasoline				X	X	X	X	X
		Heavy Fuel Oil				X	X	X	X	X
	Oil Refineries	Diesel				X	X	X	X	X
		Gasoline				X	X	X	X	X
		Hard Coal			X	X	X	X	X	X
		Heavy Fuel Oil				X	X	X	X	X
	Pre-baked Aluminium	-					X	X	X	X
	Secondary Aluminium Production	-	X							
	Secondary Copper Production	-				X				
	Secondary Lead Production	-				X				
	Soederberg Aluminium	-					X	X	X	X
	Solid Fuel Production	Brown Coal			X	X	X	X	X	X
		Diesel				X	X	X	X	X
		Hard Coal			X	X	X	X	X	X
		Heavy Fuel Oil				X	X	X	X	X
		Peat				X	X	X	X	X
	Other (e.g., Mg prodcution, PUR prodcution)									
Solvent and product use; New and existing stocks; Includes wood preservation	Electrical Equipment / large_capacitors	-			X					
	Electrical Equipment / small_capacitors	-			X					
	Electrical Equipment / transformers	-			X					
	Solvent and product use / fungicide use	-	X							
	Solvent and product use / wood preservation	-		X			X	X	X	X
	Other incl. releases from in-use prodcuts	-				X				
Road transport	Road Transport (Exhaust)	Diesel				X	X	X	X	X
		Gasoline				X	X	X	X	X
Non-Road transport	Domestic Air Transport	Gasoline				X	X	X	X	X
		Kerosines				X	X	X	X	X
	Internal Navigation	Diesel	X			X	X	X	X	X
		Gasoline				X	X	X	X	X
		Heavy Fuel Oil	X			X	X	X	X	X
		Kerosines					X	X	X	X
	Non-specified Transport	Diesel				X	X	X	X	X
		Gasoline				X	X	X	X	X
		Heavy Fuel Oil				X	X	X	X	X
		Kerosines				X	X	X	X	X
	Rail Transport	Brown Coal				X	X	X	X	X
		Diesel				X	X	X	X	X
		Hard Coal				X	X	X	X	X
		Heavy Fuel Oil				X	X	X	X	X
		Kerosines				X	X	X	X	X
Waste disposal	Clinical Waste Incineration	-	X		X	X				
	Hazardous Waste Incineration	-	X		X	X				
	Industrial Waste Incineration	-	X		X	X				
	Municipal Waste Incineration	-	X		X	X				
	Other incl. MSW & small scale incineration, releases from landfils	-					X	X	X	X
Agriculture; Excludes combustion emission in agriculture	Various incl. Pesticide use; Seed dressing	-	X	X						

Table A3-2. Source categories addressed in inventorying substances possibly proposed for addition to the POP Protocol emissions in UNECE-Europe.

Common Format	Source Category	Fuel	Substances possibly proposed for addition to the POP Protocol							
			Dicofol	Endosulfa	HBU	PBDE	PCN	PCP	PeCB	SCCP
	Heat / Power Plants	Brown Coal					X			
		Diesel					X			
Public heat and power; Excludes refineries		Gasoline					X			
		Hard Coal					X			
		Heavy Fuel Oil					X			
		Peat					X			
	Unidentified Source / other							X		
	Residential, commercial and other combustion	Brown Coal					X			
Residential, commercial and other; Includes combustion in agriculture		Diesel					X			
		Gasoline					X			
		Hard Coal					X			
		Heavy Fuel Oil					X			
		Kerosines					X			
		Peat					X			
		Wood and Wood Waste					X			
	Coke Ovens	-								
	Industrial Combustion	Brown Coal					X			
		Diesel					X			
		Gasoline					X			
		Hard Coal					X			
		Heavy Fuel Oil					X			
		Kerosines					X			
		Peat					X			
	Iron & Steel, Electric Arc Furnace	-					X			
	Iron & Steel, Open Hearth Furnace	-					X			
	Iron & Steel, Oxygen Furnace	-					X			
	Iron & Steel, Sinter Production	-					X			
	Oil and Gas Extraction	Diesel					X			
Industry; Includes both combustion and process emission, and refineries and fossil fuel production		Gasoline					X			
		Heavy Fuel Oil					X			
	Oil Refineries	Diesel					X			
		Gasoline					X			
		Hard Coal					X			
		Heavy Fuel Oil					X			
	Pre-baked Aluminium	-								
	Secondary Aluminium Production	-								
	Secondary Copper Production	-					X			
	Secondary Lead Production	-					X			
	Soederberg Aluminium	-								
	Solid Fuel Production	Brown Coal					X			
		Diesel					X			
		Hard Coal					X			
		Heavy Fuel Oil					X			
		Peat					X			
	Other (e.g., Mg prodcution, PUR prodcution)				X	X				
	Electrical Equipment / large_capacitors	-					X			
	Electrical Equipment / small_capacitors	-					X			
Solvent and product use; New and existing stocks; Includes wood preservation	Electrical Equipment / transformers	-					X			
	Solvent and product use / fungicide use	-								
	Solvent and product use / wood preservation	-						X		
	Other incl. releases from in-use prodcuts	-			X	X		X		X
Road transport	Road Transport (Exhaust)	Diesel								
		Gasoline								
	Domestic Air Transport	Gasoline					X			
		Kerosines					X			
	Internal Navigation	Diesel					X			
		Gasoline					X			
		Heavy Fuel Oil					X			
		Kerosines					X			
	Non-specified Transport	Diesel					X			
Non-Road transport		Gasoline					X			
		Heavy Fuel Oil					X			
		Kerosines					X			
	Rail Transport	Brown Coal					X			
		Diesel					X			
		Hard Coal					X			
		Heavy Fuel Oil					X			
		Kerosines					X			
	Clinical Waste Incineration	-					X	X		
	Hazardous Waste Incineration	-					X	X		
Waste disposal	Industrial Waste Incineration	-					X	X		
	Municipal Waste Incineration	-					X	X		
	Other incl. MSW & small scale incineration, releases from landfils	-				X				
Agriculture; Excludes combustion emission in agriculture	Various incl. Pesticide use; Seed dressing	-	X	X						

6 APPENDICES

Appendix 1: Overview of LRTAP submissions

Appendix 2: Explanation of NFR sector codes

Appendix 3: Overview of LRTAP Recalculations

Appendix 4: Overview of inventory comparisons

Appendix 5 Tables 1-7: Overview of national total emissions in EMEP 1990-2004

Appendix 6: Example of a country-specific Synthesis and Assessment report provided to countries in 2006.

Appendix 1 - Overview of reporting under the Convention on LRTAP

PARTY	Date Rec'd yyyy-mm-dd	Re-submission yyyy-mm-dd	NFR template format Version 2004-1	NFR template format Version 2002-2	Own format	Informative Inventory Report (IIR)	Reply Stage 2 review reports	Footnotes	Extensions	Main (NEC) SO2 NOx NH3 NMVOC	CO	Cd	Hg	Pb	PM2.5	PM10	TSP	POPs (PAH DIOX HCB)	Projections	Gridded data tables and years	Activity data	Time series provided
Summary	Total: 35 (71%). Within deadline: 27 (55%).	15 (43%)	28 (80%)	5 (14%) in old format only	2 (6%) in own format only	17 (35%)	21 (43% of total or 60% of those reporting)	11 (31%)														
Armenia																						
Austria	2006-02-15		X	X (proj, activity)		X	X	no	X	X	X	X	X	X	X	X	X	X	X		X	Main:1980-2004, HM+POP: 1985-2004, PM: 1990-2004
Azerbaijan																						
Belarus	2006-02-15	2006-02-22	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X				2004, nh3: 1990-1999
Belgium	2006-03-07		X			X	X	no	no	X	X	X	X	X	X	X	X	X				1990, 1995, 2000-2004
Bosnia and Herzegovina																						
Bulgaria	2006-02-03	2006-02-07	X			X	X	X	X	X	X	X	X	X				X				2004
Canada	2006-02-15		X		X			no	no	X	X	X	X	X	X	X	X	X	X			Main+PMs: 1985-2004, nh3: 1995-2004, POPs/HMs: 1990-2004, CLE: 2010, 2015, 2020
Croatia																						
Cyprus	2006-04-05		X			X				X	X	X	X	X	X	X	X	X				2004
Czech Republic	2006-02-15		X			X	X	no	no	X	X	X	X	X	X	X	X	X				2004
Denmark	2006-02-15			X		X		no	no	X	X	X	X	X	X	X	X	X	X		X	SO2: 1980-2004, other main: 1985-2004, PMs:2000-2004, HMs and PAH: 1990-2004, CLE: 2010, 2015, 2020
Estonia	2006-02-15	2006-03-27	X				X	no	no	X	X	X	X	X	X	X	X	X				2004, 1990-1999
Finland	2006-02-15	2006-02-23	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	3a,b: 2003+2004	X	
France	2005-12-23	2006-02-14	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	Main:1980-2004, NMVOC:1988-2004, HM/POP/PM:1990-2004, CLE+CRP: 2010
Georgia																						
Germany	2006-01-03		X				X	X	X	X	X	X	X	X	X	X	X	X	X		X	
Greece	2006-02-15	2006-02-20	X					no	no	X	X											2004:sox, nox, nmvoc, co
Hungary	2006-02-14	2006-02-22	X		X	X	X	no	no	X	X	X	X	X	X	X	X	X				2004
Iceland	2006-03-15		X					no	no									X				1990-2004: DIOX, PAH
Ireland	2006-01-03			X			X	no	no	X	X	X	X	X	X	X	X	X				HMs: 1990-2004, Other pollutants: 2004
Italy																						
Kazakhstan																						
Kyrgyzstan																						
Latvia	2006-02-15		X			X		X	no	X	X	X	X	X	X	X	X	X	X	3c: 2000	X	1990-2004, 2010, 2015,2020. All activity data.
Liechtenstein																						
Lithuania	2006-02-14		X				X	X	X	X	X	X	X	X	X	X	X	X	X	3a,b,c: 2004	X	
Luxembourg							X															
Malta	2006-04-05		X							X												2003, 2004 data
Moldova	2006-01-31	2006-02-07/ 2006-02-22	X	X				no	X	X	X	X	X	X	X	X	X	X				1990, 2004
Monaco	2006-02-10	2006-02-24		X			X	no	no	X	X	X	X	X			X	X	X	3c:2004	X	
Netherlands	2006-03-03		X					no	no	X	X	X	X	X	X	X	X	X	X			1990, 1995, 2000-2004, CLE:2010, 2015, 2020
Norway	2006-02-15		X			X	X	X	no	X	X	X	X	X	X	X	X	X	X		X	1980, 1987, 1989-2004, CLE: 2010, 2020, AD: required yrs
Poland	2006-02-16	2006-03-02	X			X	X	no	no	X	X	X	X	X	X	X	X	X				2004
Portugal	2006-03-24			X			X	no	no	X	X	X	X	X	X	X	X				X	
Romania																						
Russian Federation	2005-12-15	2006-02-12 / 2006-02-22/ 2006-02-28/2006-03-03	X					no	no	X	X	X	X	X	X	X	X					2002, 2003, NO POPs
Serbia and Montenegro	2006-02-14	2006-02-24	X			X		no	no	X												2004: Nox, Sox
Slovakia	2006-02-07	2006-02-23	X		X	X	X	X	no	X	X	X	X	X	X	X	X	X	X	3a:90,95,00. 3c: 2000		2000-2004, CLE: 2010, 2015, 2020
Slovenia	2006-02-15	2006-02-23	X		X	X	X	no	no	X	X	X	X	X	X	X	X	X	X			2000-2004, CLE: 2010, 2015, 2020
Spain																						
Sweden	2006-02-10		X (2004)	X (other yrs)		X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	1980-2004, 2010 (CLE, CRP)
Switzerland	2006-02-17		X		X			no	no	X	X	X	X	X	X	X	X	X	X			90,95,00,04, 10, 15, 20. Totals each year from 1990-2004, 2010, 2015, 2020
TFYR of Macedonia	2006-02-10			X				no	no	X	X						X				X	
Turkey																						
Ukraine	2006-02-14				X			no	no	X	X	X	X	X	X	X	X					2004
United Kingdom	2006-02-15	2006-02-24	X				X	X	no	X	X	X	X	X	X	X		X				Main, pm, hm: 1980-2004, nh3: 1990-2004, pop: 1990-2004
United States	2006-02-15				X					X	X	X		X	X	X		X (HCB only)				2002,03,04. National totals
European Community																						

Appendix 2: Explanation of NFR02 sector codes

1 A 1 a Public Electricity and Heat Production
1 A 1 b Petroleum refining
1 A 1 c Manufacture of Solid fuels and Other Energy Industries
1 A 2 Manufacturing Industries and Construction
1 A 2 a Iron and Steel
1 A 2 b Non-ferrous Metals
1 A 2 c Chemicals
1 A 2 d Pulp, Paper and Print
1 A 2 e Food Processing, Beverages and Tobacco
1 A 2 f Other, Manufacturing Industries and Construction
1 A 3 a ii (i) Civil Aviation (Domestic, Cruise)
1 A 3 a ii (ii) Civil Aviation (Domestic, LTO)
1 A 3 b Road Transport
1 A 3 b i Road Transport, Passenger cars
1 A 3 b ii Road Transport, Light duty vehicles
1 A 3 b iii Road Transport, Heavy duty vehicles
1 A 3 b iv Road Transport, Mopeds & Motorcycles
1 A 3 b v Road Transport, Gasoline evaporation
1 A 3 b vi Road Transport, Automobile tyre and brake wear
1 A 3 b vii Road Transport, Automobile road abrasion
1 A 3 c Railways
1 A 3 d ii National Navigation
1 A 3 e Other, Transport below 1000 (please specify)
1 A 3 e i Pipeline compressors
1 A 3 e ii Other mobile sources and machinery
1 A 4 a Commercial / Institutional
1 A 4 b Residential
1 A 4 b i Residential plants
1 A 4 b ii Household and gardening (mobile)
1 A 4 c Agriculture / Forestry / Fishing
1 A 4 c i Stationary (A,F,F)
1 A 4 c ii Off-road Vehicles and Other Machinery (A,F,F)
1 A 4 c iii National Fishing
1 A 5 a Other, Stationary (including Military)
1 A 5 b Other, Mobile (including military)
1 B 1 a Coal Mining and Handling
1 B 1 b Solid fuel transformation
1 B 1 c Other, Fugitive Emissions from Solid Fuels
1 B 1 Fugitive Emissions from Solid Fuels
1 B 2 a Oil
1 B 2 a i Exploration, Production, Transport (Oil)
1 B 2 a iv Refining, Storage (Oil)
1 B 2 a v Distribution of oil products
1 B 2 a vi Other, Oil
1 B 2 b Natural Gas
1 B 2 c Venting and flaring (Oil and Gas)
1 B 2 Oil and natural gas
2 A Mineral Products
2 A 1 Cement Production
2 A 2 Lime Production
2 A 3 Limestone and Dolomite Use
2 A 4 Soda Ash Production and Use
2 A 5 Asphalt Roofing

2 A 6 Road Paving with Asphalt
2 A 7 Other, Mineral Products (including Non Fuel Mining & Construction)
2 B Chemical Industry
2 B 1 Ammonia Production
2 B 2 Nitric Acid Production
2 B 3 Adipic Acid Production
2 B 4 Carbide Production
2 B 5 Other, Chemical Industry
2 C Metal Production
2 D Other Production
2 D 1 Pulp and Paper Production
2 D 2 Food and Drink Production
2 G Other Industrial Processes
3 A Paint Application
3 B Degreasing and Dry Cleaning
3 C Chemical Products, Manufacture and Processing
3 D Other, Solvent and other Product Use (including products containing Hms and POPs)
4 B Manure Management
4 B 1 a Dairy
4 B 1 b Non-Dairy
4 B 1 Cattle
4 B 13 Other, Manure Management
4 B 2 Buffalo
4 B 3 Sheep
4 B 4 Goats
4 B 5 Camels and Llamas
4 B 6 Horses
4 B 7 Mules and Asses
4 B 8 Swine
4 B 9 Poultry
4 C Rice Cultivation
4 D Agricultural Soils
4 D 1 Direct Soil Emission
4 F Field Burning of Agricultural Wastes
4 G Other, Agriculture
5 B Forest and Grassland Conversion
5 E Other (not included in National Total)
6 A Solid Waste Disposal
6 B Waste-Water Handling
6 C Waste Incineration
6 D Other, Waste
7 Other (included in National Total)
1 A 3 a i (i) International Aviation (LTO)
1 A 3 a i (ii) International Aviation (Cruise)
1 A 3 d i (i) International maritime Navigation
1 A 3 d i (ii) International inland waterways (Included in NEC totals only)
SNAP NATIONAL National Total for the entire territory (1997 Guidelines)
GRID TOTAL National Total for the EMEP grid domain
X (11 08 Volcanoes)

Appendix 3: Overview of LRTAP Recalculations

The aim of this test is to identify differences between national totals reported by Parties between the 2006 and 2005 reporting years (100*[(X2006 – X2005)/ X2005]). Recalculations larger than ± 10% are flagged

Summary showing results of the recalculation check performed for officially reported data to LRTAP showing changes larger than ± 10% made to emission values reported in 2006 compared to 2005. The highest percentage per component is listed. The years with recalculations (also those smaller than ± 10%) are listed in brackets. IIR=Informative Inventory Report, RR= Stage 2 country specific Review Report.

Party/Component	SOx	NOx	NMVOC	NH3	CO	PM2.5	PM10	Pb	Hg	Cd	PCDD/F	PAH	HCB	Explained
Armenia	na	na	na	na	na	na	na	na	na	na	na	na	na	
Austria				24 (1980-2003)										IIR
Azerbaijan	na	na	na	na	na	na	na	na	na	na	na	na	na	
Belarus														
Belgium						-13 (2000-2003)			16 (2000- 2003)	45 (2000- 2003)	403 (2000-2003)	-43 (2000-2003)		RR
Bosnia and Herzegovina	na	na	na	na	na	na	na	na	na	na	na	na	na	
Bulgaria	na	na	na	na	na	na	na	na	na	na	na	na	na	RR
Canada		-13 (1985-2003)	-11 (1985-2003)			17 (1995-2003)			-28 (2003)			-84 (1990-2003)		
Croatia	na	na	na	na	na	na	na	na	na	na	na	na	na	
Cyprus														
Czech Republic														
Denmark			- 31 (1985-2003)									11 (1990-2003)		IIR
Estonia														
Finland												19.18 (2003)		RR
France						21.8 (1990-2003)							-30.4 (1990-2003)	IIR
Georgia	na	na	na	na	na	na	na	na	na	na	na	na	na	
Germany	15 (1990-2000)	13 (1990-2000)	13 (1990-2000)			3107 (1990-2000)	6504 (1990-2000)	1328 (1990-1997)			- 15 (1990-1995)	- 58 (1990-2000)		RR
Greece														
Hungary														
Iceland														
Ireland								-40 (2003)	-76 (2003)	117 (20039				RR
Italy	na	na	na	na	na	na	na	na	na	na	na	na	na	
Kazakhstan	na	na	na	na	na	na	na	na	na	na	na	na	na	
Kyrgyzstan	na	na	na	na	na	na	na	na	na	na	na	na	na	
Latvia	-38 (1990.2003)		-33 (1990-2003)		-48 (1990-2003)	268 (2000-2003)	215 (2000-2003)	2542 (1990-2003)	-75 (1990-2003)	65 (1990-2003)	- 19 (2000)			RR
Liechtenstein	na	na	na	na	na	na	na	na	na	na	na	na	na	
Lithuania														
Luxembourg	na	na	na	na	na	na	na	na	na	na	na	na	na	
Malta	na	na	na	na	na	na	na	na	na	na	na	na	na	
Moldova														
Monaco														
Netherlands														
Norway										35 (1990-2003)				
Poland														
Portugal				-21 (1990-2003)		error in 2005 corrected	error in 2005 corrected	error in 2005 corrected	error in 2005 corrected	error in 2005 corrected				RR
Romania	na	na	na	na	na	na	na	na	na	na	na	na	na	
Russian Federation														
Serbia and Montenegro														
Slovakia											-50 (2000-2003)	-25 (2000-2003)		IIR/RR
Slovenia											13 (2003)			RR
Spain	na	na	na	na	na	na	na	na	na	na	na	na	na	
Sweden			14 (1990-2003)					-44 to + 40 (1990-2003)				10 (1994)		IIR/RR
Switzerland				15 (2000)		-26 (2000)		- 68 (2000)	-15 (2000)		2094 (2000)			
TFYR of Macedonia														
Turkey	na	na	na	na	na	na	na	na	na	na	na	na	na	
Ukraine														
United Kingdom					12 (1980-2003)	15 (1980- 2003)	10 (1980-2003)					21 (1980-2003)	-91 (1980-2003)	RR
United States														
European Community	na	na	na	na	na	na	na	na	na	na	na	na	na	

Appendix 4: Overview of inventory comparisons

Inventory comparison. The aim of this test is to compare national totals reported to NEC, LRTAP and under the EU Monitoring Mechanism reported within 10th March 2006 (LRTAP), 28th February 2006 (NEC) and 8th April 2006 (EU Monitoring Mechanism).

Summary showing results of the EU25 comparison performed between officially reported data to NEC-LRTAP-EU MM for the most recent reporting year (2004). Differences are expressed as percentages (%). Explanations for the noted differences noted are provided where these have been received in response to the review or were already documented by the respective country. Flagged values indicate differences of greater than 0.1% between the respective national totals (NEC-LRTAP-EU MM). IIR=Informative Inventory Report, RR= Stage 2 country specific Review Report

Country	**Comparison**	**SOx**	**NOx**	**NH3**	**NMVOC**	**CO**	**Explanation**	**Notes & country explanations to explain differences**
Austria	NEC-LRTAP	0.00	0.00	0.00	0.00	N/A		
Austria	LRTAP-EU MM	0.00	0.00	N/A	0.00	0.00		
Austria	NEC-EU MM	0.00	0.00	N/A	0.00	N/A		
Belgium	NEC-LRTAP	0.04	-0.01	-0.03	-3.51	N/A	RR/IIR	SOx: emission factors of the Brussels coke plant have been reviewed after the NEC-submission. NMVOC: Flemish emission inventory revised based on studies
Belgium	LRTAP-EU MM	6.26	8.15	N/A	25.01	18.59	RR	
Belgium	NEC-EU MM	6.22	8.16	N/A	27.65	N/A	RR	In 2004, inventory of the Wallon region was provisional and still incomplete; some errors in CRF
Cyprus	NEC-LRTAP							NEC Data not available to allow comparison
Cyprus	LRTAP-EU MM							CLRTAP data not available to allow comparison for 2004
Cyprus	NEC-EU MM							NEC Data not available to allow comparison
Czech Republic	NEC-LRTAP							NEC Data not available to allow comparison
Czech Republic	LRTAP-EU MM	-1.48	1.00	N/A	-0.10	-5.50	RR	NOx and CO: differences in LULUCF sector (emissions from on-site combustion are included in CRF, but not in NFR)
Denmark	NEC-LRTAP							NEC Data not available to allow comparison
Denmark	LRTAP-EU MM	0.00	0.00	N/A	0.00	5.13		

Country	Comparison	SOx	NOx	NH3	NMVOC	CO	Explanation	Notes & country explanations to explain differences
Estonia	NEC-LRTAP	-0.02	-2.36	0.73	-1.37	N/A	RR	The difference in NOx and NMVOC emission was as result of emission correction from road transport. Some corrections were made also in NH3.
Estonia	LRTAP-EU MM	-2.37	-33.56	N/A	-15.19	-21.22	RR	Two different databases are available for air pollution and GHGs as well as two different approaches to inventories SOx, NOx: mainly differences in emissions from oilshale combustion NMVOC: differences in transport; different emission factor for wood combustion in domestic sector CO: difference in emission factor for fuel combustion and for road transport
Estonia	NEC-EU MM	-2.35	-30.41	N/A	-13.60	N/A		
Finland	NEC-LRTAP							NEC Data not available to allow comparison
Finland	LRTAP-EU MM	0.00	0.00	N/A	-0.52	1.42	RR	Air emissions and GHG emissions from the energy sector are calculated by two different institutes. Data submitted under CLRTAP are the official data, whereas emissions reported under the EU MM are preliminary.
Finland	NEC-EU MM							NEC Data not available to allow comparison
France	NEC-LRTAP	0.00	0.00	0.00	0.00	N/A		
France	LRTAP-EU MM	-13.69	-2.69	N/A	-93.70	-9.30	RR	Differences in reporting requirements under LRTAP and EU MM (LULUCF, overseas territories)
France	NEC-EU MM	-13.69	-2.69	N/A	-93.70	N/A	RR	See above
Germany	NEC-LRTAP							NEC Data not available to allow comparison
Germany	LRTAP-EU MM	0.03	-0.05	N/A	-3.20	10.52	RR	NMVOC: new information was included in sector 4 in the CRF
Greece	NEC-LRTAP	0	0	N/A	0	N/A		
Greece	LRTAP-EU MM	-3.57	0.00	N/A	-0.02	-81.31		
Greece	NEC-EU MM	-3.57	0.00	N/A	-0,02	N/A		
Hungary	NEC-LRTAP	-0.75	-0.73	11.75	2.06	N/A	RR	There are differences in the reporting methods, some earlier publication have been recalculated some remained intact. In the next reporting all submissions will be recalculate. It should be mentioned when making reports till 15th February, some statistical publications are not available in our country, and thus

Country	Comparison	SOx	NOx	NH3	NMVOC	CO	Explanation	Notes & country explanations to explain differences
								the data reported are preliminary.
Hungary	LRTAP-EU MM	0.00	0.00	N/A	-0.32	0.25	RR	See above
Hungary	NEC-EU MM	0.75	0.73	N/A	-2.39	N/A	RR	See above
Ireland	NEC-LRTAP	0.00	0.00	0.00	0.00	N/A		
Ireland	LRTAP-EU MM	0.89	2.57	N/A	5.64	0.80	RR	Non-GHG data reported under the EU MM do not undergo the same QA/QC and revision/recalculation checks as it would before reporting to NEC or UNECE.
Ireland	NEC-EU MM	0.89	2.57	N/A	5.64	N/A	RR	See above
Italy	NEC-LRTAP							Data not available to allow comparison for 2004
Latvia	NEC-LRTAP	1.07	0.004	-0.14	-3.82	N/A	RR	Calculations, activity data and emission factors were improved from submission to submission.
Latvia	LRTAP-EU MM	1.92	-0.58	N/A	6.23	-0.03	RR	Calculations, activity data and emission factors were improved from submission to submission. No significant differences were observed between the resubmissions to CLRTAP and UNFCCC by 15th May 2006.
Latvia	NEC-EU MM	0.87	-0.59	N/A	9.81	N/A	RR	See above
Lithuania	NEC-LRTAP	13.91	13.42	-0.01	63.04	N/A	RR	Emission inventory reported to LRTAP is more complete then it reported earlier to NEC (more emission sources estimated).
Lithuania	LRTAP-EU MM	15.55	15.15	N/A	47.07	1.61	RR	Emissions reported under the EU MM were not complete.
Lithuania	NEC-EU MM	3.81	3.76	N/A	13.70	N/A	RR	See above
Luxembourg	NEC-LRTAP							Data not available to allow comparison for 2004
Malta	NEC-LRTAP	0.00	0.00	0.00	0.00	N/A		Same submission to both NEC and LRTAP
Malta	LRTAP-EU MM							No CRF available to allow comparison for 2004
Malta	NEC-EU MM							No CRF available to allow comparison for 2004
Netherlands	NEC-LRTAP	-2.37	-6.61	-0.005	-0.77	N/A		Guidelines differences for 1 A 3 d ii National Navigation and 1 A 3 a ii (i) Civil Aviation (Domestic, LTO).
Netherlands	LRTAP-EU MM	3.75	1.32	N/A	16.78	-0.79		SOx: differences occur in various sectors NMVOC: differences occur mainly in 1A3b
Netherlands	NEC-EU MM	5.99	7.84	N/A	17.42	N/A		See above
Poland	NEC-LRTAP							NEC Data not available to allow comparison

Country	Comparison	SOx	NOx	NH3	NMVOC	CO	Explanation	Notes & country explanations to explain differences
Poland	LRTAP-EU MM	0.00	0.01	N/A	0.00	0.00		
Poland	NEC-EU MM							NEC Data not available to allow comparison
Portugal	NEC-LRTAP							NEC Data not available to allow comparison
Portugal	LRTAP-EU MM	-0.02	-0.04	N/A	-3.33	-9.80	RR	The UNFCCC totals considered include emissions from forest fires which are not included in the CLRTAP totals. Also emissions from wildfires differ as under CLRTAP, emissions from bushland biomass burnt are considered, and in the UNFCCC only forest land is taken into account.
Portugal	NEC-EU MM							NEC Data not available to allow comparison
Slovakia	NEC-LRTAP	0.00	0.00	0.00	0.00	N/A		
Slovakia	LRTAP-EU MM	0.00	0.00	N/A	-0.01	0.00		
Slovakia	NEC-EU MM	0.00	-0.09	N/A	-0.01	N/A		
Slovenia	NEC-LRTAP	-4.03	1.34	0	-0.46	N/A	RR	Report for NEC is provisional and not complete, because of missing data at the end of the year. There is no legal obligation that data should be updated after 15th of February, when the data for CLRTAP report are completed and reported. By the requirements for NEC reporting data for NEC aren't updated earlier than in next reporting year.
Slovenia	LRTAP-EU MM	91.83	99.49	N/A	50.46	80.30		Because of difficulties with the new reporting format for UNFCCC (CRF reporter) wrong data were reported for UNFCCC report
Slovenia	NEC-EU MM	92.16	99.48	N/A	50.69	N/A		See above
Spain	NEC-LRTAP							Data not available to allow comparison for 2004
Spain	LRTAP-EU MM							Data not available to allow comparison for 2004
Spain	NEC-EU MM							Data not available to allow comparison for 2004
Sweden	NEC-LRTAP	0.00	0.00	0.00	0.00	N/A		
Sweden	LRTAP-EU MM	0.00	0.00	N/A	0.00	0.00		
Sweden	NEC-EU MM	0.00	0.00	N/A	0.00	N/A		
United Kingdom	NEC-LRTAP	0	0	-0.0001	0	N/A	RR	NEC-LRTAP are very small rounding errors.
United Kingdom	LRTAP-EU MM	0.00	0.02	N/A	0.17	0.39	RR	UNFCCC-LRTAP/NEC are known differences to arise from the different reporting formats i.e. some missions are included in one format, but not the other
United Kingdom	NEC-EU MM	0.00	0.02	N/A	0.17	N/A	RR	See above

Appendix 5: Tables 1-5: Overview of national total emissions in EMEP 1990-2004

Table 1: National total emission trends
Emissions of sulphur (1990-2004) used for modelling at the MSC-W (Gg of SO_2 per year)[a]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Albania	74	62	50	38	26	14	17	21	25	29	32	32	32	32	32
Armenia	***86***	***72***	***58***	***44***	***29***	***15***	***14***	***14***	***13***	***12***	***11***	***11***	***9.6***	8.6	7.7
Austria	74	71	55	53	48	47	45	40	36	34	32	33	33	33	29
Azerbaijan	615	544	473	403	332	262	242	222	202	182	162	***154***	146	138	130
Belarus	***888***	***779***	***670***	***561***	***452***	***344***	***307***	***271***	***235***	***198***	***162***	126	117	107	***97***
Belgium	361	***340***	***320***	***300***	***280***	262	***242***	***223***	204	***186***	171	169	150	147	154
Bosnia and Herzegovina	***484***	459	434	410	385	360	372	384	396	408	420	422	423	425	427
Bulgaria	2007	1665	***1116***	1426	1479	***1477***	***1420***	1365	1251	943	918	***969***	964	***994***	929
Croatia	178	106	105	112	88	70	66	80	89	90	***60***	63	68	75	85
Cyprus	***46***	33	***39***	***43***	***42***	***41***	***45***	***48***	49	***51***	***51***	47	51	46	45
Czech Republic	1876	1775	1537	1418	1269	***1090***	***946***	***700***	***443***	***269***	264	248	235	232	227
Denmark	176	235	180	145	143	133	168	95	73	53	27	24	24	30	23
Estonia	***274***	***251***	***192***	***156***	***152***	***117***	***126***	***117***	***103***	***97***	***96***	***92***	***88***	***101***	***90***
Finland	259	194	140	122	114	95	***105***	***99***	90	87	***74***	85	79	98	83
France	1333	1438	1256	1099	1033	968	944	796	817	705	613	550	510	505	484
Georgia	43	35	28	21	13	5.7	5.9	6.2	6.4	6.7	***7.0***	***6.5***	6.0	5.5	4.9
Germany	5289	3920	3222	2859	2401	1708	1426	1197	956	776	630	628	588	595	559
Greece	487	525	544	542	513	536	***523***	***518***	527	544	***493***	502	517	554	537
Hungary	***1011***	***914***	***828***	757	741	705	673	659	592	590	486	***400***	***360***	339	240
Iceland	8.7	8.8	9.0	9.1	9.3	9.4	9.4	9.3	9.2	9.2	9.1	9.1	9.1	9.0	9.0
Ireland	186	180	172	161	175	161	147	166	176	157	131	126	96	76	71
Italy	1795	1677	1578	1477	1387	1320	1209	1132	995	899	752	708	632	506	418
Kazakhstan	***651***	***626***	***602***	***577***	***553***	***528***	***524***	***519***	***515***	***510***	***506***	486	466	445	425
Latvia	97	82	66	65	65	47	53	38	35	29	10	7.9	6.0	4.7	4.0
Lithuania	***263***	229	***194***	***160***	***126***	92	82	72	63	53	43	45	43	39	40
Luxembourg	***26***	22	18	15	11	7.3	6.7	***6.1***	***5.7***	***4.9***	***4.3***	4.2	***4.0***	***3.9***	3.7
Macedonia. TFYR of	110	107	103	100	97	93	93	***92***	91	91	90	89	88	88	87
Malta	29	41	34	30	31	33	30	27	27	25	26	29	29	33	17
Moldova. Republic of	175	159	143	126	***110***	***94***	***78***	***61***	***45***	***29***	13	12	15	21	15
Monaco	***0.078***	0.091	0.094	0.100	0.089	0.084	0.076	0.073	***0.072***	***0.076***	0.067	0.065	0.066	0.076	0.074
Netherlands	189	***176***	164	152	139	127	117	109	98	91	72	73	65	63	66
Norway	53	44	37	35	35	34	33	31	30	29	27	25	23	23	25
Poland	***3278***	***3019***	***2835***	***2730***	***2610***	***2381***	***2373***	***2185***	***1902***	***1724***	1507	1564	1455	1375	***1286***
Portugal	317	308	370	316	296	332	270	292	341	341	306	294	294	200	203
Romania	1310	1040	945	921	906	882	859	835	811	689	727	832	783	734	685
Russian Federation	***6113***	***5510***	***4908***	***4306***	***3704***	***3101***	***2934***	***2766***	***2599***	***2431***	***2263***	***2162***	2061	1960	1858
Serbia and Montenegro	***593***	***560***	***527***	***494***	***461***	428	421	415	409	***402***	***396***	382	368	355	341
Slovakia	***542***	445	380	325	238	239	227	202	179	171	127	131	103	106	97
Slovenia	***198***	***182***	***188***	***185***	***179***	***127***	***114***	***120***	***125***	***107***	***99***	***68***	***71***	***64***	***55***
Spain	2166	2167	2133	1999	1947	1795	1566	1748	1597	1607	1489	1446	1550	1352	1172
Sweden	117	114	109	96	93	79	77	70	67	54	52	51	51	52	47
Switzerland	42	39	37	34	31	28	26	24	22	20	19	***18***	***18***	18	17
Turkey	***1519***	***1495***	***1470***	***1446***	***1421***	***1397***	***1542***	***1687***	***1832***	1977	***2122***	2039	1957	***1875***	1792
Ukraine	***3921***	***3605***	***3289***	***2974***	***2658***	***2342***	***2193***	***2045***	***1896***	***1748***	1599	1461	1324	1232	***1145***
United Kingdom	3699	3522	3430	3085	2649	2343	1999	1635	1591	1202	1173	1111	994	973	833

[a] Reported values with white background, expert estimates replacing gaps in grey. Values in bold italic show replacement of reported data by expert estimates.

Table 2: National total emission trends
Emissions of nitrogen oxides (1990-2004) used for modelling at the MSC-W (Gg of NO_2 per year)[a]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Albania	23	21	20	18	17	16	17	18	19	20	22	22	23	24	25
Armenia	**60**	**51**	**43**	**35**	**26**	**18**	**21**	**23**	**26**	**28**	**31**	**32**	**33**	**38**	38
Austria	212	223	210	203	195	193	212	200	212	199	204	213	220	230	227
Azerbaijan	171	153	136	119	101	85	83	80	78	76	76	**77**	80	**86**	85
Belarus	**379**	**350**	**320**	**291**	**262**	**232**	**228**	**223**	**218**	**213**	**208**	**204**	**205**	**209**	**213**
Belgium	382	**380**	**378**	**376**	**374**	372	**363**	**355**	**347**	**338**	330	316	**300**	**298**	**298**
Bosnia and Herzegovina	73	68	64	60	55	51	51	52	52	52	53	53	52	52	52
Bulgaria	**363**	**260**	**235**	**247**	230	264	259	225	223	**202**	184	**192**	197	202	216
Croatia	**88**	**65**	56	59	65	**66**	69	73	76	**77**	**77**	70	69	69	70
Cyprus	**19**	**17**	**20**	**21**	**21**	**20**	**22**	**22**	**23**	**23**	**25**	**19**	**23**	**22**	**19**
Czech Republic	**742**	**724**	**697**	**573**	**435**	**413**	**432**	**423**	**413**	**391**	**398**	332	316	324	328
Denmark	266	315	271	270	268	253	290	244	221	205	188	184	181	189	171
Estonia	74	69	43	40	43	38	41	40	39	35	37	38	40	39	37
Finland	299	290	284	**282**	281	258	**268**	259	251	247	235	220	208	218	205
France	1829	1888	1852	1739	1694	1643	1616	1551	1532	1461	1390	1335	1282	1243	1218
Georgia	64	54	44	**33**	**23**	13	16	20	23	27	30	30	31	32	32
Germany	2878	2648	2492	2383	2236	2131	2050	1976	1940	1916	1855	1763	1674	1605	1554
Greece	299	312	**314**	313	320	320	**325**	332	**348**	337	328	343	318	343	317
Hungary	**276**	**237**	**213**	**199**	**198**	**193**	**197**	**200**	**204**	**205**	**194**	**192**	**196**	**192**	**190**
Iceland	8.7	8.7	8.6	8.6	8.5	8.5	8.6	8.7	8.8	8.9	9.0	9.2	9.4	11	11
Ireland	119	122	133	121	120	120	124	122	126	123	129	132	122	**117**	**116**
Italy	1945	2000	2019	1919	1840	1808	1731	1653	1552	1456	1377	1366	1275	1259	1244
Kazakhstan	179	176	172	169	165	162	153	145	136	127	119	127	135	151	151
Latvia	69	**64**	**53**	46	41	41	43	41	39	37	34	38	37	38	39
Lithuania	158	166	98	78	77	65	64	**63**	**65**	**57**	**49**	47	51	53	55
Luxembourg	20	23	25	**28**	**30**	**32**	**33**	**33**	**33**	**33**	**33**	32	**31**	**30**	29
Macedonia, TFYR of	46	44	42	40	38	35	36	**37**	**37**	38	**39**	**41**	**42**	43	**42**
Malta	14	13	13	13	12	13	13	12	12	12	12	12	11	12	12
Moldova, Republic of	131	**120**	**110**	**100**	**89**	**79**	**69**	**58**	**48**	**37**	27	23	25	30	38
Netherlands	549	532	515	498	481	464	443	428	402	397	**389**	381	368	**367**	**360**
Norway	224	214	212	222	220	221	231	233	235	238	224	220	212	215	215
Poland	**1581**	**1419**	**1329**	**1224**	**1204**	**1121**	**1155**	1114	991	**953**	838	**848**	796	808	804
Portugal	243	257	277	266	265	274	268	267	278	287	285	286	294	271	271
Romania	527	**501**	**476**	**451**	**425**	400	386	372	**358**	**345**	**331**	335	338	342	346
Russian Federation	3600	3435	3123	3054	2667	2570	**2477**	**2423**	**2542**	**2577**	**2457**	2582	**2698**	**3105**	**3093**
Serbia and Montenegro	**165**	**152**	**140**	**136**	**134**	**133**	**133**	**148**	**146**	**131**	**137**	**140**	**141**	**146**	**149**
Slovakia	215	194	182	174	165	174	132	125	130	118	109	109	101	98	98
Slovenia	**63**	58	**58**	**63**	66	67	69	71	64	**58**	60	59	58	56	58
Spain	1247	1293	1325	1300	1329	1351	1317	1365	1376	1447	1477	1459	1522	1519	1519
Sweden	306	295	293	281	283	271	261	250	242	230	217	211	206	203	197
Switzerland	156	148	141	134	127	119	116	112	**109**	**105**	101	**97**	92	88	87
Turkey	**691**	**711**	**730**	**750**	**769**	789	819	850	**881**	912	942	**940**	937	934	932
Ukraine	**1753**	**1652**	**1550**	**1448**	**1346**	**1245**	**1168**	**1091**	**1015**	**938**	**861**	886	**911**	**936**	**960**
United Kingdom	2932	2803	2719	2546	2456	2355	2277	2121	2052	1936	1857	1799	1693	1685	1621

[a] All years: Reported values with white background, expert estimates replacing gaps in grey. Values in bold italic show replacement of reported data by expert estimates.

Table 3: National total emission trends
Emissions of ammonia (1990-2004) used for modelling at the MSC-W (Gg of NH_3 per year)[a]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Albania	23	22	21	20	20	19	19	20	21	21	22	22	23	23	23
Armenia	24	***24***	***23***	***22***	***18***	***15***	***16***	***15***	***15***	***14***	***13***	***13***	12	15	17
Austria	69	70	68	68	69	70	69	69	69	67	66	65	64	65	64
Azerbaijan	68	68	65	61	50	41	45	41	41	38	37	36	35	41	48
Belarus	215	208	192	181	165	154	153	152	150	143	142	134	128	120	121
Belgium	112	***110***	***108***	***107***	***105***	103	***100***	96	93	90	87	84	82	79	74
Bosnia and Herzegovina	21	20	19	19	18	17	17	17	17	17	17	17	17	17	17
Bulgaria	144	124	111	109	101	99	83	77	66	60	56	56	56	52	54
Croatia	***53***	***52***	***52***	***52***	***52***	***52***	***52***	***53***	***54***	***55***	***53***	52	***53***	53	53
Cyprus	5	5	5	5	5	5	6	6	6	6	6	7	5	6	6
Czech Republic	***157***	***136***	113	96	88	***87***	***83***	***83***	***82***	***77***	***76***	***81***	***74***	82	69
Denmark	134	130	128	125	121	114	110	110	111	106	105	104	102	98	98
Estonia	26	23	19	15	14	12	11	11	11	10	9	9	9	10	10
Finland	38	37	37	36	35	35	***36***	38	35	33	33	33	33	33	33
France	787	772	777	757	766	772	775	789	788	780	789	775	778	750	742
Georgia	36	36	35	33	27	22	24	22	22	20	20	19	19	22	26
Germany	758	670	653	654	633	642	645	636	644	650	646	659	649	648	***641***
Greece	79	77	74	74	72	81	72	70	73	73	73	73	72	72	72
Hungary	124	93	84	77	76	77	78	76	74	***72***	***71***	***67***	65	67	74
Iceland	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Ireland	***114***	***116***	***119***	***119***	***120***	***121***	***123***	***125***	***128***	***128***	123	123	119	116	113
Italy	405	417	411	420	416	417	411	426	428	436	424	433	435	423	412
Kazakhstan	***664***	***621***	***578***	***535***	***492***	***449***	***453***	***457***	***462***	***466***	***470***	487	503	520	537
Latvia	47	44	32	20	17	15	14	14	13	12	12	14	13	14	13
Lithuania	82	73	63	54	44	34	36	***38***	***40***	***41***	***43***	45	46	***47***	***49***
Luxembourg	7	7	7	7	7	7	7	7	7	7	7	7	***7***	***7***	7
Macedonia, TFYR of	15	15	15	15	14	14	14	14	14	14	14	14	14	14	***14***
Malta	0.7	0.7	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0	1.0	0.8	0.9	0.9
Moldova, Republic of	61	***58***	***54***	***51***	***48***	***45***	***41***	***38***	***35***	***31***	***28***	***30***	***30***	27	26
Netherlands	249	***238***	***227***	***216***	***204***	193	***186***	180	***173***	167	152	143	136	130	134
Norway	20	21	22	22	22	23	24	23	23	23	23	23	23	23	23
Poland	***511***	442	416	381	383	378	363	349	369	340	321	328	325	323	317
Portugal	55	60	61	60	63	63	63	66	65	65	64	66	64	64	64
Romania	289	267	250	***230***	211	193	203	213	***223***	***237***	***252***	***253***	257	261	266
Russian Federation	***1204***	***1174***	***1097***	***916***	***785***	***837***	***762***	***743***	***688***	***670***	***663***	638	***613***	***613***	***621***
Serbia and Montenegro	74	72	70	68	65	63	63	64	64	64	65	65	65	66	66
Slovakia	***66***	***59***	***50***	***44***	***41***	***42***	***41***	***39***	***34***	***32***	***32***	***33***	***33***	***31***	***28***
Slovenia	***25***	***24***	24	***24***	***23***	22	22	***20***	20	20	20	20	20	19	17
Spain	329	318	316	297	317	306	340	339	358	370	388	384	385	399	413
Sweden	55	55	55	62	62	64	61	62	61	59	58	57	57	56	56
Switzerland	68	67	66	65	64	63	62	62	61	61	60	57	55	52	58
Turkey	373	376	379	382	385	***387***	***390***	***394***	***397***	***400***	***403***	404	405	406	407
Ukraine	682	638	594	550	506	463	467	472	***476***	***481***	***485***	***500***	***517***	***533***	***550***
United Kingdom	382	382	368	365	368	359	362	364	361	358	337	330	319	308	336

[a] All years: Reported values with white background, expert estimates replacing gaps in grey. Values in bold italic show replacement of reported data by expert estimates.

Table 4: National total emission trends
Emissions of non-methane volatile organic compounds (1990-2004) used for modelling at the MSC-W (Gg of NMVOC per year)[a]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Albania	31	31	31	31	31	31	30	30	30	30	29	30	31	31	32
Armenia	***95***	***84***	***72***	***60***	***49***	***37***	***39***	***41***	***43***	***45***	***47***	***47***	***48***	***49***	49
Austria	284	272	243	238	221	221	216	203	190	179	179	182	176	175	172
Azerbaijan	376	341	307	272	237	202	208	215	221	227	233	***233***	233	***234***	234
Belarus	497	473	***449***	***426***	***402***	***378***	***370***	***363***	***355***	***348***	***340***	***320***	***301***	***314***	***326***
Belgium	305	***295***	***285***	***275***	***265***	255	***244***	233	223	212	201	194	181	173	165
Bosnia and Herzegovina	48	46	43	40	38	35	36	37	38	39	40	40	41	41	42
Bulgaria	214	183	176	174	185	192	164	138	144	140	***123***	***128***	123	***121***	***132***
Croatia	105	86	64	69	75	74	81	80	79	77	80	***83***	***91***	104	122
Cyprus	16	16	16	16	16	16	16	16	16	16	16	***16***	16	16	12
Czech Republic	374	337	312	301	302	281	287	***286***	***276***	***264***	***266***	***257***	***238***	***238***	***240***
Denmark	166	167	165	161	156	152	152	144	135	130	127	122	118	116	116
Estonia	***71***	***67***	***43***	***36***	***39***	***47***	***50***	***51***	***43***	***42***	***38***	***34***	***39***	***41***	***41***
Finland	221	208	201	194	192	187	181	175	***171***	***167***	154	157	151	145	***142***
France	2414	2392	2344	2240	2119	2032	1944	1870	1812	1733	1658	1587	1476	1411	1367
Georgia	***151***	***132***	***112***	***92***	***73***	***53***	***64***	***76***	***87***	***99***	***110***	***110***	109	108	107
Germany	3584	3043	2775	2520	2247	2100	1974	1913	1842	1714	1569	1476	1381	1272	1268
Greece	281	***289***	295	301	307	302	306	304	308	303	295	289	261	278	262
Hungary	***252***	***197***	***188***	***195***	***188***	***191***	***191***	***187***	***181***	***184***	***187***	***179***	***176***	***171***	***172***
Iceland	12	12	12	12	12	12	12	11	10	10	9	10	10	11	11
Ireland	111	111	114	109	107	105	112	116	118	98	90	87	81	78	63
Italy	2023	2090	2146	2102	2046	2022	1970	1904	1798	1711	1538	1453	1344	1307	1273
Kazakhstan	***214***	***195***	***177***	***158***	***140***	***122***	***125***	***129***	***133***	***136***	***140***	143	145	147	150
Latvia	73	63	55	51	63	62	64	64	***64***	***64***	***58***	***58***	***59***	***60***	64
Lithuania	***136***	***134***	***95***	***80***	***76***	71	77	***85***	***87***	***82***	***78***	71	***72***	***75***	67
Luxembourg	16	17	18	***19***	***21***	***22***	***20***	***18***	***17***	15	13	12	11	11	10
Macedonia, TFYR of	21	22	24	25	26	27	27	27	26	26	25	26	27	27	***28***
Malta	8	8	8	8	8	8	8	8	8	8	8	8	8	8	7
Moldova, Republic of	123	115	***107***	***99***	***91***	***83***	***75***	67	***59***	***51***	***42***	***44***	***45***	***36***	33
Monaco	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Netherlands	491	***466***	***440***	***415***	389	364	343	***326***	301	***293***	267	242	236	222	216
Norway	295	294	323	340	353	367	369	367	360	368	379	389	343	297	265
Poland	***832***	833	***808***	***758***	***822***	***771***	***768***	***775***	730	731	***606***	***607***	600	***606***	***600***
Portugal	273	277	287	280	287	288	290	293	293	285	282	284	286	287	287
Romania	517	485	453	421	389	357	362	366	370	***374***	***378***	***385***	391	398	404
Russian Federation	3659	3354	3290	3053	2918	2848	2612	2379	2371	2446	2445	2510	2574	***2791***	***2675***
Serbia and Montenegro	158	151	145	138	131	125	128	131	134	138	141	142	144	145	147
Slovakia	122	115	111	108	110	***111***	***108***	***99***	***97***	***90***	***86***	***88***	***84***	***88***	***91***
Slovenia	***53***	***50***	***49***	***52***	***54***	***55***	***59***	***58***	***53***	***51***	51	49	48	46	46
Spain	1135	1177	1189	1119	1142	1093	1112	1126	1184	1181	1162	1147	1139	1146	1153
Sweden	443	428	417	395	373	362	349	330	303	293	282	270	264	265	255
Switzerland	262	245	228	211	194	177	168	158	149	139	130	***126***	***121***	***117***	98
Turkey	***636***	***613***	***591***	***568***	***546***	523	531	539	547	555	563	561	559	***556***	554
Ukraine	1053	992	931	870	809	748	***727***	***705***	***684***	***663***	641	***662***	***683***	***704***	***725***
United Kingdom	2396	2315	2249	2140	2077	1939	1832	1766	1617	1463	1348	1252	1175	1073	1024

[a] All years: Reported values with white background, expert estimates replacing gaps in grey. Values in bold italic show replacement of reported data by expert estimates.

Table 5: National total emission trends
Emissions of particulate matter (2000-2004) used for modelling at the MSC-W (Gg of $PM_{2.5}$ & PM_{10} per year)[a]

	2000		2001		2002		2003		2004	
Country	**PM10**	**PM2.5**	**PM10**	**PM2.5**	**PM10**	**PM2.5**	**PM10**	**PM2.5**	**PM10**	**PM2.5**
Albania	9	7	9	7	9	7	9	7	9	7
Armenia	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.4	0.5	0.4
Austria	44	26	46	27	46	26	46	27	47	27
Azerbaijan	7	6	6	6	6	5	6	5	5	5
Belarus	56	40	56	41	57	41	57	41	***57***	***41***
Belgium	66	35	64	32	63	32	61	30	62	30
Bosnia and Herzegovina	48	20	47	20	46	20	46	20	45	19
Bulgaria	94	59	94	58	93	57	92	56	92	56
Croatia	30	20	***28***	***19***	***27***	***18***	26	17	24	17
Cyprus	1.2	0.7	***1.2***	0.7	1.1	0.7	1.0	0.7	0.9	0.6
Czech Republic	44	28	***47***	31	***50***	35	***56***	***39***	***52***	***36***
Denmark	30	23	31	23	30	22	31	23	31	23
Estonia	51	38	42	31	35	25	30	21	30	22
Finland	***54***	***38***	54	38	55	39	55	38	***58***	***39***
France	549	342	541	337	519	318	531	325	***532***	***325***
Georgia	4	3	3	3	3	3	3	3	3	2
Germany	193	115	187	113	184	109	184	108	173	105
Greece	75	49	78	50	80	52	82	53	84	54
Hungary	***60***	26	***57***	24	***56***	24	***61***	27	***60***	27
Iceland	0.9	0.7	0.8	0.6	0.8	0.6	0.8	0.6	0.8	0.6
Ireland	***20***	13	***19***	12	***18***	11	***18***	13	***18***	12
Italy	***273***	209	***258***	197	***243***	185	***229***	173	214	161
Kazakhstan	56	31	53	30	51	29	48	28	45	27
Latvia	14	11	15	12	14	12	14	11	16	13
Lithuania	21	17	21	17	21	17	21	17	***20***	***17***
Luxembourg	4	3	4	3	4	3	4	3	4	3
Macedonia,TFYR of	21	9	21	9	20	9	20	9	19	9
Malta	0.8	0.6	0.8	0.5	0.7	0.5	0.7	0.5	0.7	0.4
Moldova, Republic of	***41***	***23***	***42***	***23***	***43***	***24***	***45***	***25***	***46***	***25***
Netherlands	48	29	***47***	***28***	***45***	26	41	25	41	24
Norway	64	58	64	57	66	60	62	56	61	55
Poland	279	135	300	142	291	138	***286***	136	280	134
Portugal	119	95	127	97	117	90	118	92	128	101
Romania	171	115	167	112	162	109	157	106	152	103
Russian Federation	1161	694	1220	711	***1268***	***728***	***1336***	***745***	***1366***	***762***
Serbia and Montenegro	93	45	91	44	89	44	88	43	86	43
Slovakia	***45***	26	***46***	26	***41***	27	***38***	25	***41***	28
Slovenia	9	7	9	7	9	7	9	7	9	7
Spain	208	139	209	141	215	144	214	144	213	145
Sweden	68	46	68	46	68	46	70	47	69	47
Switzerland	20	9	19	9	19	9	19	9	18	8
Turkey	436	305	421	295	405	286	390	277	374	268
Ukraine	473	289	469	287	***466***	***284***	462	281	***458***	***278***
United Kingdom	180	108	176	107	160	99	155	96	154	95

[a] All years: Reported values with white background, expert estimates replacing gaps in grey. Values in bold italic show replacement of reported data by expert estimates.

Appendix 6: Example Synthesis and Assessment Report

Review report 2006 for Country XXX

Data included in review:

1. **Emissions reported under the Convention on LRTAP to the UNECE Secretariat by: March 10th 2006**
2. **Emissions reported under the National Emission Ceilings Directive to the European Commission by: February 28th 2006**
3. **Emission and activity data reported to the UNFCCC by: 08th April 2006**

Questions prepared and made available to countries by the Expert Review Team on: May 15th 2006.

Response from Country sent:

Date of your response:

Introduction

This review has been performed in accordance with the methods and procedures for review of emissions data under the LRTAP as outlined in Annex III of EB.AIR/GE.1/2005/7. In addition, efforts have been made to meet the requirements from the Parties following the first annual review in 2005. The 2006 review presents the results of different types of review tests and lists specific questions about your emissions inventory submitted to LRTAP and NEC. We have chosen to focus the tests on main pollutants, PMs and priority HMs and POPs and key sources. This year's review is performed in co-operation with UBA-Vienna and AEAT in the framework of the European Topic Centre on Air and Climate Change (ETC-ACC). We wish to make the review process as easy as possible for you, and we will appreciate any additional feedback on the review process itself.

The review process is aiming at inventory improvements. As part of the Inventory Improvement Programme under the Task Force on Emission Inventories and Projections (TFEIP) Parties are expected to gradually improve the reporting. However, it may not be practical to implement all improvements in the next reporting. We do appreciate ideas for better solutions that may be implemented at a national or international level to improve the reporting and quality over a longer timescale.

The draft review findings will be discussed at the meeting of the TFEIP/Expert Panel on review at its meeting in den Haag 12-14 June 2006. Your response to this summary of Stage 1 and Stage 2 review will serve as input to a possible future Stage 3 review. A trial Stage 3, Centralized review was performed in Copenhagen 27 February-3 March 2006. Last year's country specific review reports (this report) were found useful for the in-depth reviews.

The emission data included in the 2006 review is data reported to the UNECE under the LRTAP Convention or to the European Commission under the NEC Directive, and received before 10th

March 2006/28 February 2006 respectively. The LRTAP data is available through a pre-release of WEBDAB, user: webdab2006, password: wdab06.

We hope that you appreciate the improvements we have introduced to this year's country specific review reports. These are:

- Separate testing and reporting of results for LRTAP and NEC data if the inventories are proved to differ by more than 0.1%
- Improved key source analysis including percentage contribution for each sector
- Introduction of two average reports, one for Eastern Europe and one for Western Europe, in order for you to compare your contribution to the average
- Improved completeness testing with stronger focus on Protocol requirements, priority compounds, key sources and reporting of Not Estimated
- Improved comparability testing by introduction of more pollutant ratios
- Inclusion of inventory comparisons with UNFCCC data
- Inclusion of trend plots
- Streamlining and extension of the time series check for main pollutants to 1980
- Improved IEFs checks by analysis with the UNFCCC outlier tool

We encourage you to take the time to complete the response boxes included in this document and return it to by e-mail to **vigdis.vestreng@met.no** with a copy to elisabeth.rigler@umweltbundesamt.at **by June 15th 2006.**

Efforts have been made to eliminate questions already answered by you in an earlier UNECE/NEC review or in your Informative Inventory Report (IIR). We are still working on improving this part of the review procedure, and apologize beforehand if we have not managed to filter out all explained tasks.

Review tests performed in 2006

The review looks at several aspects of the national inventories. The intention of the review is to understand the common problems faced by countries with estimating and reporting emissions inventories.

- Part 1: An overview of key sources in order to understand the important source sectors for each country and prioritise review questions and improvement suggestions.
- Part 2: Compliance tests where the submissions are evaluated against the reporting guidelines and Protocols and checked according to timeliness, formats, completeness and that internal summations are consistent.
- Part 3: A review of consistency between Parties' inventories on the basis of sector-implied emission factors, key sector pollutant ratios, and sector and national totals in other reported inventories (e.g. NEC and UNFCCC) and within the time series presented. Checks are performed against previously reported inventories for recalculations and changes in reported estimates to determine whether these have been applied consistently across the latest available time series.

We would like to know who is responding to our questions, so please enter your own contact details:

Your name:
Your organisation:
Your e-mail address:

Thank you for your assistance with the 2006 Inventory Review!

1 KEY SOURCE ANALYSIS 2004 emissions

Key source analysis (Good Practice Guidance, page 17 in EMEP/CORINAIR Emission Inventory Guidebook) is increasingly important in order to prioritise emission sources and identify where implementation of improvements is most effective. We have assessed the most important sources (e.g. the sources making up 95% of the national total) for your country based on your latest submission. In the tables below are listed the key sources for 2004 emissions and the corresponding percentages. If there are more than 10 key sources, the number of sources left out from the tables is listed to the far right. Key sources are, if possible, displayed both at aggregated and least aggregated sector level. If inconsistencies larger than 5 percent are found in the internal consistency of sectors, only the aggregated sectors are taken into account.

LEAST AGGREGATED

Component	Key source categories (Sorted from high to low from left to right)										Total (%)	Not listed
SOx	1 A 1 a (37.1%)	1 A 4 a (18.4%)	1 A 4 b i (9.4%)	1 A 2 e (7.4%)	1 A 3 b iii (7.0%)	1 A 3 b i (5.3%)	1 A 2 f (3.2%)	1 A 4 c iii (2.9%)	2 D 1 (2.2%)	2 A 1 (2.1%)	95.0	0
NOx	1 A 3 b i (29.5%)	1 A 3 b iii (17.7%)	1 A 1 a (16.4%)	1 A 4 b i (8.7%)	1 A 3 c (8.3%)	1 A 2 f (5.1%)	1 A 4 a (4.2%)	1 A 3 b ii (2.7%)	1 A 2 e (2.3%)	1 A 2 a (1.5%)	96.3	0
NH3	4 B 1 a (30.8%)	4 D 1 (26.7%)	4 B 1 b (18.5%)	4 B 8 (11.0%)	4 B 9 (8.9%)						95.9	0
NMVOC	1 A 4 b i (28.0%)	1 A 3 b i (12.3%)	3 D (11.2%)	3 A (10.6%)	1 A 4 a (10.5%)	2 D 2 (8.9%)	2 A 6 (6.2%)	3 B (3.1%)	1 A 3 b iii (2.9%)	1 A 4 c ii (1.2%)	94.8	1
CO	1 A 4 b i (41.5%)	1 A 3 b i (20.1%)	1 A 4 a (15.9%)	1 A 2 f (4.6%)	5 B (3.8%)	1 A 3 b iii (3.7%)	1 A 4 b ii (2.9%)	1 A 1 a (2.6%)			95.2	0
TSP	1 A 4 b i (48.2%)	1 A 4 a (18.3%)	4 B 9 (12.2%)	1 A 1 a (5.1%)	1 A 2 f (3.9%)	2 C (3.0%)	4 B 8 (2.3%)	1 A 3 c (2.3%)			95.2	0
PM10	1 A 4 b i (52.3%)	1 A 4 a (19.3%)	4 B 9 (4.4%)	1 A 1 a (4.1%)	1 A 2 f (3.2%)	2 C (2.6%)	1 A 3 c (2.5%)	1 A 3 b i (2.2%)	1 A 3 a ii (ii) (2.1%)	1 A 3 b iii (1.8%)	94.5	1
PM2.5	1 A 4 b i (60.7%)	1 A 4 a (22.2%)	1 A 1 a (3.9%)	1 A 2 f (3.1%)	1 A 3 c (2.9%)	2 C (2.8%)					95.7	0
Pb	2 A 7 (90.0%)	2 C (7.0%)									96.9	0
Hg	1 A 1 a (44.8%)	2 A 1 (13.0%)	2 A 7 (10.0%)	1 A 4 a (8.2%)	1 A 2 e (7.6%)	6 B (3.5%)	6 C (3.2%)	1 A 4 b i (3.1%)	1 A 4 c iii (2.9%)		96.3	0
Cd	2 C (40.3%)	2 A 1 (36.3%)	6 B (12.1%)	1 A 1 a (7.5%)							96.2	0
DIOX	1 A 4 a (29.2%)	1 A 1 a (24.0%)	1 A 2 f (19.3%)	1 A 4 b i (16.5%)	5 B (5.4%)	1 A 2 e (3.9%)					98.3	0
PAH	1 A 3 b (54.3%)	1 A 4 b i (25.7%)	1 A 4 a (9.4%)	5 B (4.2%)	1 A 3 c (3.2%)						96.7	0
HCB	1 A 4 b i (50.4%)	1 A 4 a (18.3%)	1 A 1 a (14.9%)	1 A 2 f (12.0%)							95.6	0

AGGREGATED

Component	Key source categories (Sorted from high to low from left to right)									Total (%)	Not listed
SOx	1 A 1 a (37.1%)	1 A 4 a (18.4%)	1 A 3 b (13.3%)	1 A 2 (10.9%)	1 A 4 b (9.5%)	1 A 4 c (4.2%)	2 D (2.2%)			95.6	0
NOx	1 A 3 b (49.8%)	1 A 1 a (16.4%)	1 A 2 (9.3%)	1 A 4 b (8.8%)	1 A 3 c (8.3%)	1 A 4 a (4.2%)				96.8	0
NH3	4 B (70.7%)	4 D 1 (26.7%)								97.4	0
NMVOC	1 A 4 b (28.5%)	1 A 3 b (15.8%)	3 D (11.2%)	3 A (10.6%)	1 A 4 a (10.5%)	2 D (8.9%)	2 A (6.3%)	3 B (3.1%)	1 A 4 c (2.0%)	96.9	0
CO	1 A 4 b (44.4%)	1 A 3 b (25.3%)	1 A 4 a (15.9%)	1 A 2 (5.5%)	5 B (3.8%)	1 A 1 a (2.6%)				97.6	0
TSP	1 A 4 b (48.2%)	1 A 4 a (18.3%)	4 B (15.6%)	1 A 2 (5.2%)	1 A 1 a (5.1%)	2 C (3.0%)				95.3	0
PM10	1 A 4 b (52.3%)	1 A 4 a (19.3%)	4 B (6.0%)	1 A 3 b (4.4%)	1 A 1 a (4.1%)	1 A 2 (4.1%)	2 C (2.6%)	1 A 3 c (2.5%)		95.4	0
PM2.5	1 A 4 b (60.7%)	1 A 4 a (22.2%)	1 A 2 (4.0%)	1 A 1 a (3.9%)	1 A 3 c (2.9%)	2 C (2.8%)				96.5	0
Pb	2 A (92.6%)	2 C (7.0%)								99.6	0
Hg	1 A 1 a (44.8%)	2 A (23.0%)	1 A 2 (10.9%)	1 A 4 a (8.2%)	6 B (3.5%)	1 A 4 c (3.3%)	6 C (3.2%)			96.9	0
Cd	2 C (40.3%)	2 A (37.0%)	6 B (12.1%)	1 A 1 a (7.5%)						96.9	0
DIOX	1 A 4 a (29.2%)	1 A 1 a (24.0%)	1 A 2 (23.4%)	1 A 4 b (16.5%)	5 B (5.4%)					98.5	0
PAH	1 A 3 b (54.3%)	1 A 4 b (25.7%)	1 A 4 a (9.4%)	5 B (4.2%)	1 A 3 c (3.2%)					96.7	0
HCB	1 A 4 b (50.4%)	1 A 4 a (18.3%)	1 A 1 a (14.9%)	1 A 2 (14.6%)						98.1	0

NEC

Component	Key source categories (Sorted from high to low from left to right)										Total (%)	Not listed
SOx	1 A 1 a (37.5%)	1 A 4 a (18.6%)	1 A 4 b (9.5%)	1 A 2 e (7.4%)	1 A 3 b iii (7.1%)	1 A 3 b i (5.2%)	1 A 2 f (3.2%)	1 A 4 c iii (2.9%)	2 D 1 (2.2%)	2 A 1 (2.2%)	95.9	0
NOx	1 A 3 b i (29.5%)	1 A 3 b iii (17.7%)	1 A 1 a (16.4%)	1 A 4 b (8.8%)	1 A 3 c (8.3%)	1 A 2 f (5.1%)	1 A 4 a (4.2%)	1 A 3 b ii (2.7%)	1 A 2 e (2.3%)	1 A 2 a (1.5%)	96.4	0
NH3	4 B 1 a (30.8%)	4 D 1 (26.6%)	4 B 1 b (18.5%)	4 B 8 (11.0%)	4 B 9 (8.9%)						95.8	0
NMVOC	1 A 4 b (27.4%)	1 A 3 b i (15.6%)	3 D (10.8%)	3 A (10.2%)	1 A 4 a (10.1%)	2 D 2 (8.5%)	2 A 6 (6.0%)	3 B (3.0%)	1 A 3 b iii (2.8%)	1 A 4 c ii (1.1%)	95.5	0

AGGREGATED

Component	Key source categories (Sorted from high to low from left to right)								Total (%)	Not listed
SOx	1 A 1 a (37.5%)	1 A 4 a (18.6%)	1 A 3 b (14.7%)	1 A 2 (11.0%)	1 A 4 b (9.5%)	1 A 4 c (4.2%)			95.6	0
NOx	1 A 3 b (49.9%)	1 A 1 a (16.4%)	1 A 2 (9.3%)	1 A 4 b (8.8%)	1 A 3 c (8.3%)	1 A 4 a (4.2%)			96.8	0
NH3	4 B (70.6%)	4 D 1 (26.6%)							97.2	0
NMVOC	1 A 4 b (27.4%)	1 A 3 b (19.0%)	3 D (10.8%)	3 A (10.2%)	1 A 4 a (10.1%)	2 D (8.5%)	2 A (6.1%)	3 B (3.0%)	95.1	0

Review Team Comment:

Please indicate if the sources (in the table(s) above) are the key sources for your country or whether there are additional sources that are important but not reported. For your information, an overview of key sources for Western and Eastern European countries is found here.

Your comments:

2 COMPLIANCE TESTS

2. A TIMELINESS

Date of submission NEC: 30.12.2005

Review Team Comment: Submission was received within deadline 31.12.2005

Date of submission Convention of LRTAP: 15.2.2006

Review Team Comment: Submission was received within deadline 15.02.2006

Informative Inventory Report: Received by 1st May 2006

You may want to provide additional response to the comments above in the box below.

Your comments:

2 B FORMAT OF SUBMISSION

This section indicates whether the data submitted was in the correct Nomenclature For Reporting (NFR) and the files were formatted as requested in the Guidelines for Estimating and Reporting Emission data to the LRTAP and NEC.

NEC Submitted Format: NFR Version 2002-2

LRTAP Submitted Format: NFR Version 2004-1

Review Team Comment to reporting format:

Please indicate any additional response to the review comments in the box below.

Your comments:

2 C COMPLETENESS PER POLLUTANT

The completeness of your submission of priority pollutants has been evaluated on the basis of the following criteria outlined in the Emission Reporting Guidelines;

- Main Pollutants from 1980 to latest year
- HMs and POPs from 1990 to latest year
- PMs from 2000 to latest year.

All numbers are in percent of the total number of reporting template cells per component and time series. Flagging occurs when the total number of cells containing a value or notation key is less than 80% , if there are more than 10% zeroes reported in cells and if the percent values reported is less than 10%.. An overview of the average completeness for Western and Eastern Europe is found at http://emep.int/REVIEW/2006/examples.

LRTAP:

Component	% Total	% 0	% NO	% NE	% NA	% IE	% C	% NR	% Value
SOx	58	1	12	8	18	1	0	0	15
NOx	58	0	11	6	20	1	0	0	17
NH3	58	2	10	8	23	1	0	0	12
NMVOC	58	0	12	7	14	1	0	0	23
CO	58	0	9	6	23	1	0	0	17
DIOX	98	0	20	20	30	6	0	0	20
PAH	98	0	21	14	39	6	0	0	16
HCB	98	0	14	5	63	0	0	0	13
Pb	98	5	15	10	47	0	0	0	19
Hg	98	1	14	15	47	0	0	0	17
Cd	98	7	13	9	48	0	0	0	18
PM2.5	98	1	18	21	21	6	0	0	29
PM10	98	2	18	21	21	0	0	0	34
TSP	98	1	18	21	20	6	0	0	30

NEC:

Component	% Total	% 0	% NO	% NE	% NA	% IE	% C	% NR	% Value
SOx	97	0	51	11	1	7	0	0	25
NOx	97	0	50	9	1	7	0	0	28
NH3	97	1	62	8	1	0	0	0	23
NMVOC	97	0	30	21	1	7	0	0	36

Review Team Comment:

For the main pollutants submitted to LRTAP the % total values/flags reported is lower than for other pollutants. Please comment. Please also comment on your review results in the context of the reports from Western and Eastern Europe provided here.

Please provide response to the specific request for clarification and any other additional related comments in the box below.

Your comments:

2 D COMPLETENESS PER SECTOR (YEAR 2004 EMISSIONS)

An X in the table below shows for which sectors you have reported Not Estimated (NE) in the 2004 emission data (priority pollutants included). The sectors with no reporting of emission values other than zero are flagged.

LRTAP:

Least aggregated sector	SOx	NOx	NH3	NMVOC	CO	TSP	PM10	PM2.5	Pb	Hg	Cd	DIOX	PAH	HCB
1 A 1 b														
1 A 3 a ii (i)														
1 A 3 a ii (ii)			X									X	X	
1 A 3 b										X				
1 A 3 b iv										X				
1 A 3 b v				X										
1 A 3 b vi						X	X	X					X	
1 A 3 b vii						X	X	X					X	
1 A 3 c												X		
1 A 3 d i (i)												X	X	
1 A 3 d i (ii)	X	X	X	X	X	X	X	X	X	X	X	X	X	
1 A 3 d ii									X			X		
1 A 3 e	X	X	X	X	X	X	X	X				X	X	
1 B 1 b														
1 B 1 c														
1 B 2	X											X		
1 B 2 a	X											X		
1 B 2 a i														
1 B 2 a v	X											X		
1 B 2 a vi														
1 B 2 b	X			X								X		
1 B 2 c														
1 a 3 a i (i)			X			X	X	X	X	X	X	X	X	
1 a 3 a i (ii)			X			X	X	X	X	X	X	X	X	
2 A 3														
2 A 4														
2 A 5						X	X	X	X	X	X	X		
2 B														
2 B 1														
2 B 5														
2 D		X	X		X	X	X	X						
4 B 4						X	X	X						
4 B 5														
4 B 6						X	X	X						
4 B 7														
4 C														
4 F														
6 C			X			X	X	X						X
6 D														
7	X	X	X	X	X	X	X	X	X	X	X	X	X	X
X														

NEC:

Least aggregated sector	SOx	NOx	NH3	NMVOC
1 A 1 b				
1 A 3 a ii (i)			X	
1 A 3 a ii (ii)				
1 A 3 b v				X
1 A 3 b vi				
1 A 3 b vii				
1 A 3 e	X	X		X
1 A 3 e i	X	X		X
1 A 3 e ii	X	X		X
1 B 1	X	X		X
1 B 1 b	X	X		X
1 B 2 a	X			
1 B 2 c				
1 a 3 a i (i)			X	
1 a 3 a i (ii)			X	
2 A 2				
2 A 3				
2 A 4				
2 A 6	X	X		
2 A 7	X	X		
2 B				
2 B 1				
2 B 2				
4 B 1				X
4 B 1 a				X
4 B 1 b				X
4 C				
4 D 1				X
4 F				
4 G	X		X	X
5 B	X		X	X
5 E				
6 A			X	X
X				

Review Team Comment:

Could you please compare your result in the table above with the average result for Eastern and Western Europe found here. Please explain if you have reported notation keys and/or zeroes in sectors where other Parties have estimated emissions.
What can be done in the framework of the TFEIP in order for you to estimate emissions in (some of) the missing sectors? Please provide response to the specific request for clarification and any other additional related comments in the box below.

Your comments:

2 E CONSISTENCY (INTERNAL) for 2004 data

The aim of this test is to confirm the internal data consistency of submissions. It checks that values reported within sub-sectors add up to the reported sector total, and that the values reported for sectors add up to the reported National Total. All notation keys are converted to zero in the calculation.

Review Team Comment:

Your LTRAP submission contained 9 inconsistencies

INCONSISTENCIES:

Internal consistency error: NFR-code 1 A 3 b <-> Sum of NFR-subsectors, Component: PM10: 0.71 <-> 0.72

Internal consistency error: NFR-code 1 A 3 b <-> Sum of NFR-subsectors, Component: benzo(k): 10.86 <-> 0

Internal consistency error: NFR-code 1 A 3 b <-> Sum of NFR-subsectors, Component: SOx: 0.53 <-> 0.54

Internal consistency error: NFR-code 1 A 3 b <-> Sum of NFR-subsectors, Component: PAH: 41.69 <-> 0

Internal consistency error: NFR-code 1 A 3 b <-> Sum of NFR-subsectors, Component: benzo(b): 13.68 <-> 0

Internal consistency error: NFR-code 1 A 3 b <-> Sum of NFR-subsectors, Component: Indeno: 9.81 <-> 0

Internal consistency error: NFR-code 1 A 3 b <-> Sum of NFR-subsectors, Component: benzo(a): 7.34 <-> 0

The REBDAP tool (webdab.emep.int/repdab.html) may be used to test your inventory submission to obtain detailed information regarding any inconsistencies noted

Please provide clarification in the box below.

Your comments:

3 COMPARABILITY TESTS

These tests review the year to year comparability per country for pollutant ratios, recalculation, emission time series, country specific and average implied emission factors and the differences between the LRTAP, NEC and UNFCCC submissions.

3 A CROSS POLLUTANT

A cross pollutant ratio test has been implemented this year. The aim of this test is to check the consistency between reported pollutants and the comparability of pollutant ratios between countries. Pollutant ratios have been calculated for the transport (The sum of: 1 A 3 b i R.T., Passenger cars, 1 A 3 b ii R.T., Light duty vehicles, 1 A 3 b iii R.T., Heavy duty vehicles, 1 A 3 b iv R.T., Mopeds & Motorcycles,1 A 3 b v R.T., Gasoline evaporation), for fuel combustion (sum of all 1A sectors), for landfills (6A), for agriculture (4B+4D) and for national totals. For transport and agriculture, additionally NH3/N2O ratios have been calculated. The results should be compared to the average rations found for the Eastern and Western Europe found here.

LRTAP:

Pollutant ratio	Sector	Ratio calculated from reported data
NOx/NMVOC	Transport	1.96
NOx/CO	Transport	0.22
NOx/PM2.5	Transport	*No PM2.5 reporting in Transport sector, IE*
NH3/N2O	Transport	1.19
NH3/N2O	Agriculture	3.28
PM10/Pb	Fuel combustion	128560.67
PM10/Cd	Fuel combustion	268246.28
PM10/Hg	Fuel combustion	606489.44
TSP/PM2.5	Fuel combustion	1.19
TSP/PM2.5	National totals	1.42
TSP/PM10	Fuel combustion	1.10
TSP/PM10	National totals	1.15
NMVOC/CO	Landfills	*NA/NE is reported for CO and NMVOC, NH3 in 6A*
NMVOC/NH3	Landfills	*NA/NE is reported for CO and NMVOC, NH3 in 6A*
CO/NH3	Landfills	*NA/NE is reported for CO and NMVOC, NH3 in 6A*

NEC:

Pollutant ratio	Sector	Ratio calculated from reported data
NOx/NMVOC	Transport	1.56
NH3/N2O	Transport	1.17
NH3/N2O	Agriculture	3.28
NMVOC/NH3	Landfills	

Review Team Comment:

Please compare your pollutant ratios with the average ratios found here and explain the differences.

Your comments:

3 B RECALCULATIONS

The aim of this test is to identify differences between national totals reported by Parties between the 2006 and 2005 reporting years ($100*[(X_{2006} - X_{2005})/ X_{2005}]$). Differences larger than 10% are flagged.

Key:
Blank cell: Data for one of the reporting years are missing.
Zero: Data (value or notation key) for the two years are equal.
NP (Not Possible): Different notation keys are reported for the two years or reporting 2005 is zero or notation key while reporting year 2006 has a value.
Value: Percentage difference between 2006 and 2005 reporting.

6.1.1.1.1.1.1 LRTAP

year	SOx	NOx	NH3	NMVOC	CO	TSP	PM10	PM2.5	Pb	Hg	Cd	DIOX	PAH	HCB
1990	-1.9736	-2.0510	-9.3656	-17.9999	-12.2508	11180.6497			1279.8402	-56.4376	-16.7615			
1991	0.8677	-1.9238	-9.5746	-32.7467	-47.7619	9357.9187			1828.5972	-57.0547	-4.6274			
1992	-1.4769	-1.9061	-8.7553	-3.7212	-3.2434	4512.1808			2542.2194	-46.9454	-10.9553			
1993	-3.3622	-1.0668	-7.0244	-5.5059	-4.1216	5606.3163			2289.2190	55.9449	-30.2430			
1994	-15.6844	-4.3653	-6.1416	-2.7983	17.8710	15004.4715			2063.8506	6.3294	65.1440			
1995	-1.6919	-1.5637	-7.3702	-12.5429	-6.2044	5283.5640			2498.5485	-15.4263	29.7675			
1996	-1.8902	-1.8675	-7.3197	-13.5411	-6.0509	3244.5917			2505.0894	-31.6249	10.0729			
1997	-4.1923	-3.2019	-6.4770	-18.8830	-8.9374	2822.1118			1840.7822	-35.6029	-6.8389			
1998	-2.6522	-2.5894	-6.0605	-20.4280	-10.6016	2820.7894			1858.0892	61.9424	34.4764			
1999	-1.5139	-1.8091	-6.4642	-19.8637	-11.4657	2861.0575			1840.8735	-42.1997	21.8355			
2000	-31.2921	0.8121	-6.0451	-18.5179	-4.0650	122.3519	193.2966	262.6291	914.9337	-53.8656	33.1813			
2001	-25.7414	1.7160	-6.0682	-22.8490	6.0229	123.5154	214.5873	268.0678	1872.8715	-58.9792	36.2625			
2002	-34.4557	1.1248	-6.7083	-24.6330	10.9120	124.5220	208.9586	262.2519	1766.8739	-67.7928	4.5857	-18.9574		
2003	-37.7633	3.6519	-6.7953	-25.6532	10.1578	112.1365	190.0952	234.4361	1816.4810	-75.8748	-4.0415			

NEC:

year	SOx	NOx	NH3	NMVOC
1990	-2.0970	-0.9723	-9.3526	-14.8884
1991	-0.5741	-2.0790	-9.5585	-13.2402
1992	-1.4367	-1.9194	-8.7556	-2.1116
1993	-3.4235	-1.0824	-7.0302	0.1856
1994	-16.5055	-4.8120	-6.1447	2.5371
1995	-1.7907	-1.4799	-7.3855	-8.2936
1996	-1.4572	-1.7489	-7.3164	-9.2888
1997	-3.4469	-2.5361	-6.3762	-14.9164
1998	-5.0291	-2.5597	-6.0737	-16.8150
1999	1.2455	-1.1628	-6.4429	-16.3925
2000	-26.5464	1.5104	-6.0257	-15.0060
2001	-21.7963	2.3225	-6.0854	-19.3593
2002	-31.5063	1.4364	-6.6840	-21.5454
2003	-35.6689	3.6397	-6.7715	-21.5816

Review Team Comment:

We note very large recalculations. Can you please explain the recalculations flagged? Are there specific additional explanations to the ones given in the IIR?

3 C INVENTORY COMPARISON

The aim of this test is to compare national totals reported to NEC, LRTAP and UNFCCC reported within 10th March 2006 (LRTAP), 28th February 2006 (NEC) and 15th March 2006 (UNFCCC). Flagged values indicate difference of greater than 0.1% between the respective national totals (LRTAP-NEC-UNFCCC).

LRTAP-NEC

year	SOx	NOx	NH3	NMVOC
1990	0.1533	-0.9201	-0.0143	-3.6651
1991	1.4501	0.1589	-0.0178	-22.4833
1992	-0.0378	0.0104	0.0003	-1.6475
1993	0.0634	0.0253	0.0062	-5.6805
1994	0.9835	0.4693	0.0034	-5.2034
1995	0.1150	0.2494	0.0166	-4.6396
1996	-0.0458	-0.0245	-0.0035	-4.6605
1997	-0.6987	-0.0545	-0.1076	-4.5569
1998	2.5031	-0.0305	0.0141	-4.2980
1999	-0.2627	-0.0390	-0.0227	-4.1239
2000	-3.3500	0.0148	-0.0207	-4.0504
2001	-2.1360	0.0190	0.0183	-4.2512
2002	-1.7836	0.1800	-0.0260	-3.8388
2003	-3.2091	0.0024	-0.0255	-5.1193
2004	1.0685	0.0038	-0.1395	-3.8152

LRTAP-UNFCCC

Year	NOx	CO	NMVOC	SOx
1990	0,47	-0,36	-0,08	-1,25
1991	0,88	-0,01	0,13	0
1992	-0,36	-0,09	1,24	-0,89
1993	-1,26	-0,32	-0,25	-1,25
1994	-0,84	-0,31	-0,21	-1,29
1995	-0,92	-0,11	-0,04	-0,77
1996	-0,88	-0,14	-0,12	-0,70
1997	-0,81	-0,15	-0,12	-0,55
1998	-0,85	-0,13	-0,10	-0,57
1999	-0,73	-0,13	-0,07	-0,59

Year	NOx	CO	NMVOC	SOx
2000	-1,15	-0,14	-0,11	-1,38
2001	-1,00	-0,19	-0,15	-2,83
2002	-0,87	-0,17	-0,10	-2,28
2003	-0,71	-0,05	-0,03	-0,23
2004	-0,58	-0,03	6,23	1,92

NEC-UNFCCC

Year	Nox	NMVOC	SOx
1990	1,38	3,59	-1,40
1991	0,72	22,58	-1,45
1992	-0,37	2,87	-0,85
1993	-1,29	5,44	-1,31
1994	-1,31	5,00	-2,29
1995	-1,17	4,60	-0,89
1996	-0,85	4,55	-0,66
1997	-0,75	4,45	0,15
1998	-0,82	4,20	-3,09
1999	-0,69	4,05	-0,33
2000	-1,17	3,94	2,01
2001	-1,02	4,11	-0,64
2002	-1,05	3,75	-0,45
2003	-0,71	5,09	2,98
2004	-0,59	9,81	0,87

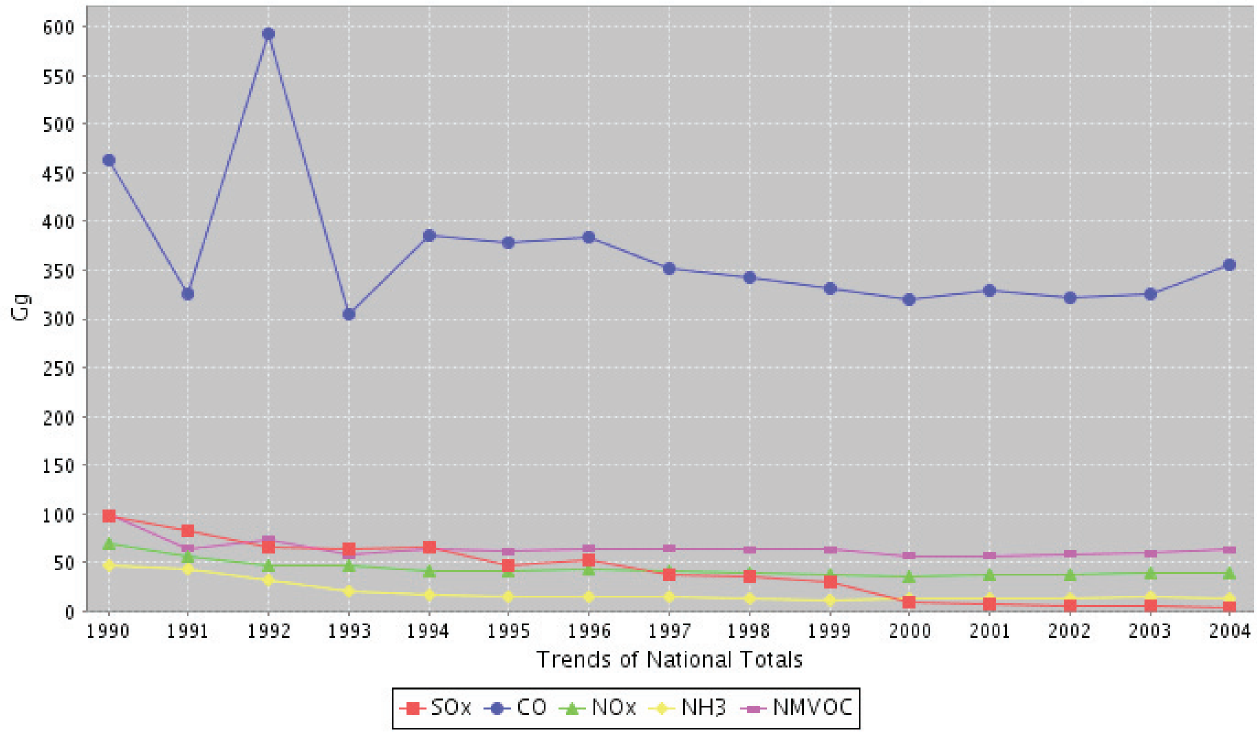
Review Team Comment:

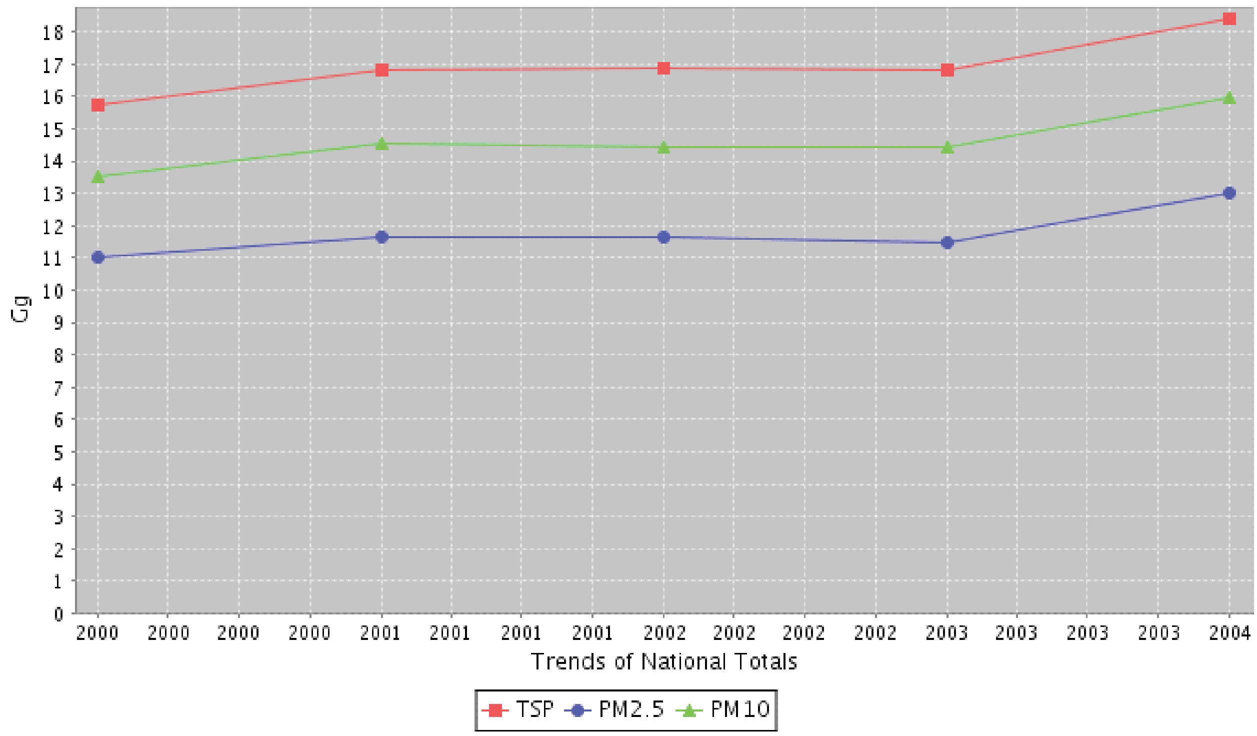
Please explain the flagged values

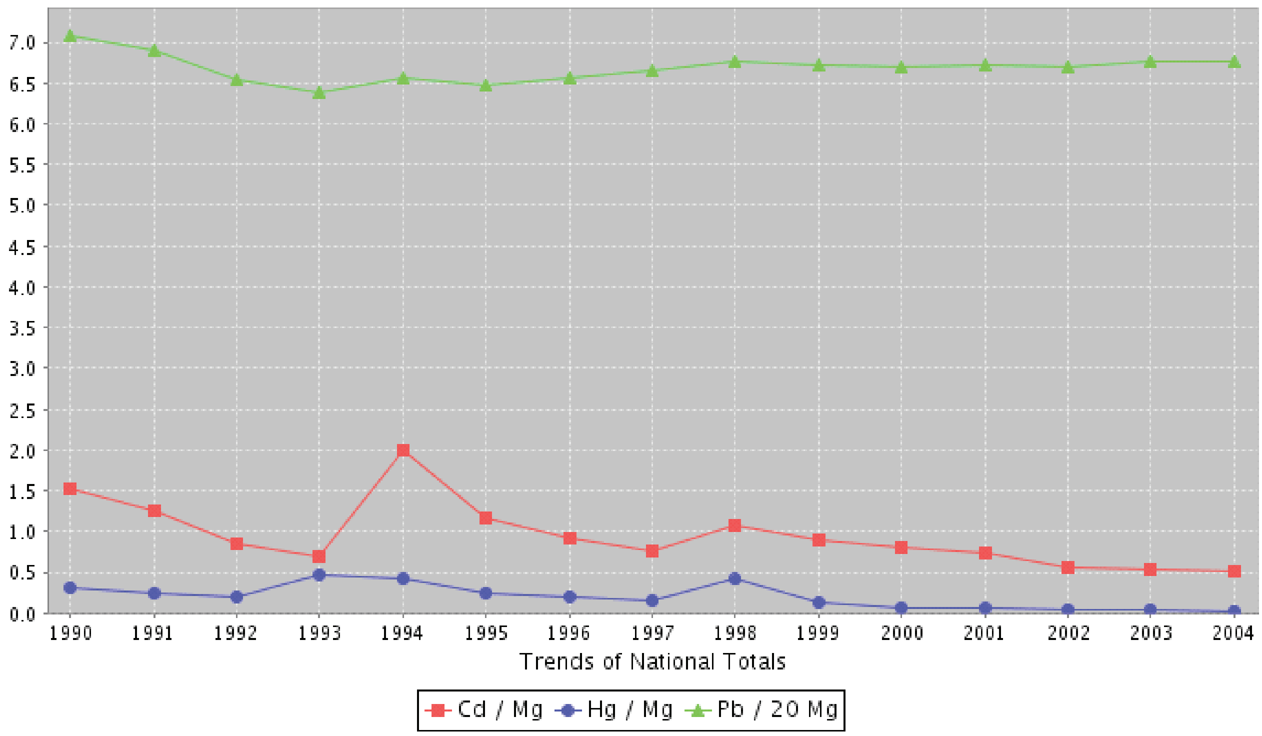
Your comments:

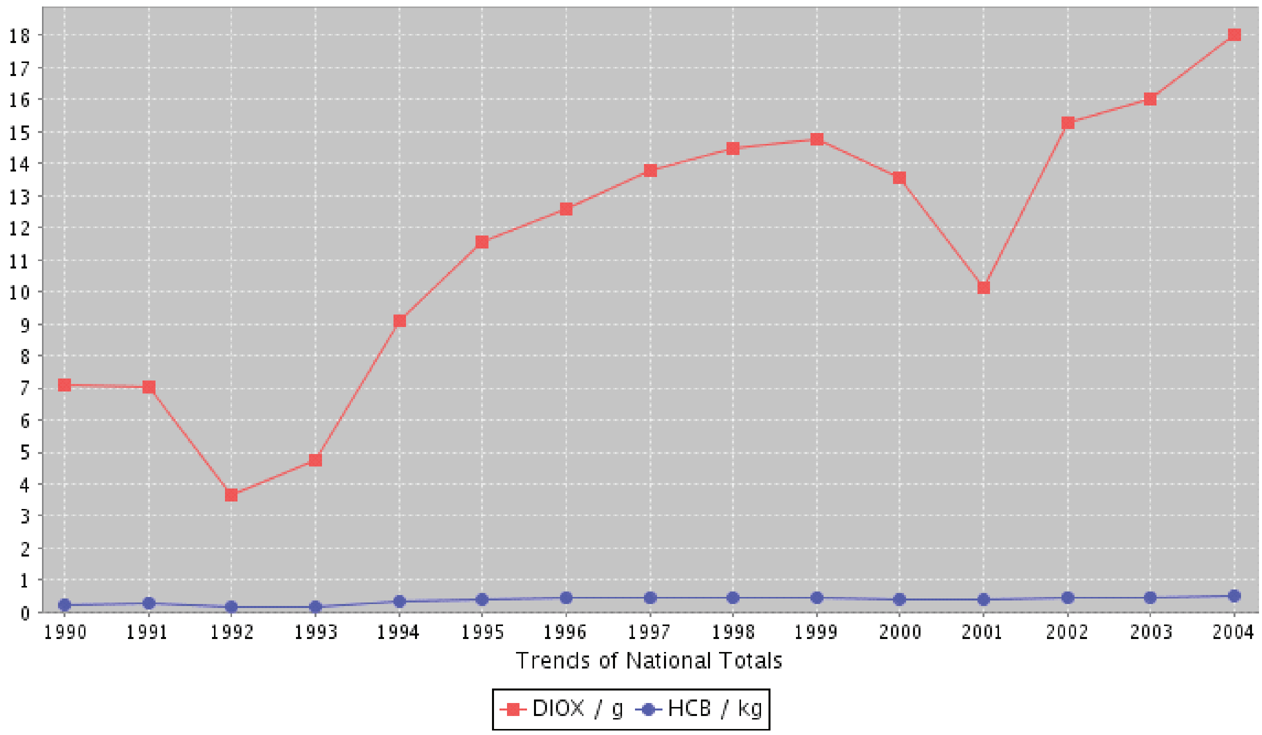
3 D TRENDS

Please find below trends in your national totals of priority pollutants reported under CLRTAP. Please explain the possible dips and jumps seen. These plots add to the dips and jumps picked up in the time series test (3E below) by showing extreme potential outliers not picked up in test 3E because sigma became too large.









Your comments:

3 E TIME SERIES

The aim of this test is to identify instances of dips, jumps, and sudden trends in time series data reported by countries. Only data in new NFR reporting format were analysed, and data for which at least three years was reported. The table below shows data that was flagged where outliers in time series data were identified based on the following methodology: Reported time series data were log 10-transformed prior to analysis to reduce intra-series variability and improve general time series linearity.
A linear regression was subsequently applied to the log-transformed values for each time series. Time series with a large sigma (> 0.2) have been flagged generally. An individual value within the time series was identified as a dip/jump if the respective residual value (regression forecast value - reported value) was greater than 2.5 standard deviations from the mean of all residuals within the time series. Only time series with a significant fraction (>3%) of the national total are included.
Identified dips and jumps have been flagged at both a detailed and aggregated sector level (due to inconsistencies that occur in some cases between the reported subsectors and aggregated sectors).
Please note that time series from 1980-2004 are presented in two rows.

The test was performed for the following time series if data was available:
Main pollutant s 1980-2004
HMs and POPs: 1990-2004
PMs: 2000-2004

Colour Key	
	indicates a dip in the Time Series Data
	indicates a jump in the Time Series Data
	indicates Time Series Data with large sigma

		1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
NMVOC (Gg)	1A4c											28.482	3.070
NMVOC (Gg)	1A4cii											27.657	2.244
NMVOC (Gg)	NATIONALTOTAL											99.092	63.933
CO (Gg)	1A1a											4.175	4.422
CO (Gg)	1A4a											33.512	32.541
CO (Gg)	1A4b											114.271	140.413
CO (Gg)	NATIONALTOTAL											463.437	326.104

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
SOx (Gg)	1A2	15.396	13.623	18.186	16.474	16.458	14.358	10.645	9.138	2.762	1.315	0.902	0.709	0.435
SOx (Gg)	1A2c			1.190	2.354	0.196	1.842	0.078	0.124	0.059	0.059	0.078	0.059	
SOx (Gg)	1A2f			13.664	11.064	13.335	9.493	7.419	6.720	1.803	0.633	0.295	0.303	0.127
SOx (Gg)	1A3di(i)	6.970	11.990	12.020	7.070	4.310	2.930	0.160	0.010	0.010	0.390	0.490	0.470	0.560
NOx (Gg)	1A3di(i)	8.820	15.430	16.880	9.350	5.940	4.230	0.680	0.420	0.340	10.550	11.600	10.700	11.630
NH3 (Gg)	4D1	6.600	3.970	2.900	1.150	1.450	1.940	1.960	1.900	2.300	3.160	2.760	3.740	3.520
NMVOC (Gg)	1A4a	4.743	0.617	3.684	3.172	2.977	2.782	3.193	3.818	3.141	3.194	3.113	2.939	6.634

		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
NMVOC (Gg)	**1A4b**	15.341	9.620	17.012	18.516	19.341	18.282	18.282	17.612	17.386	18.914	18.605	18.205	18.005
CO (Gg)	**1A1a**	27.257	7.455	4.640	5.368	5.648	8.391	8.736	7.713	8.340	8.161	9.134	10.013	9.350
CO (Gg)	**1A4a**	116.093	9.170	35.811	27.092	27.084	25.491	28.102	34.029	28.244	28.679	27.169	25.711	56.526
CO (Gg)	**1A4b**	270.136	81.638	143.110	154.868	161.786	152.876	152.588	146.973	152.712	165.675	162.959	159.622	157.964
CO (Gg)	**NATIONALTOTAL**	592.735	305.113	385.210	378.936	384.284	351.317	342.846	331.337	319.397	328.703	321.297	325.414	355.537

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
DIOX (g)	**1A2**	0.938	0.253	0.172	0.196	1.851	4.087	4.877	4.776	4.296	4.275	3.786		4.568	4.916	4.218
DIOX (g)	**1A2f**	0.823	0.146			1.603	3.876	4.605	4.389	3.976	3.991	3.477	3.913	4.009	4.378	3.481
DIOX (g)	**1A4a**	2.225	2.241	0.020	0.018	2.274	2.268	2.020	1.874	2.268	2.808	2.307	2.357	2.343	2.196	5.265
HCB (kg)	**1A2**		0.008	0.007	0.007	0.033	0.073	0.087	0.085	0.077	0.076	0.068		0.082	0.088	0.076
HCB (kg)	**1A2f**	0.019	0.006			0.029	0.069	0.083	0.078	0.071	0.071	0.062	0.070	0.072	0.078	0.062
HCB (kg)	**1A4a**	0.041	0.041	0.001	0.001	0.042	0.041	0.037	0.034	0.041	0.051	0.042	0.043	0.042	0.040	0.095
HCB (kg)	**1A4c**	0.010	0.010	0.000	0.004	0.011	0.003	0.003	0.005	0.006	0.007	0.007	0.007	0.006	0.005	0.007
HCB (kg)	**1A4ci**	0.010	0.010	0.000	0.004	0.011	0.003	0.002	0.005	0.006	0.007	0.007	0.006	0.006	0.005	0.007

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Pb (Mg)	**2A1**	9.304	9.000	4.250	0.216	3.050	2.550	4.062	3.075	4.575	3.767	2.990	3.107	3.255	3.690	3.546
Hg (Mg)	**1A4ci**	0.001	0.003	0.001	0.000	0.086	0.015	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cd (Mg)	**1A4b**	0.002	0.001	0.005	0.004	0.407	0.168	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cd (Mg)	**1A4bi**	0.002	0.001	0.004	0.004	0.407	0.168	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cd (Mg)	**1A4c**	0.002	0.008	0.001	0.001	0.654	0.278	0.009	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Cd (Mg)	**1A4ci**	0.001	0.008	0.001	0.001	0.318	0.076	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Cd (Mg)	**1A4ciii**					0.335	0.201	0.008	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003
Cd (Mg)	**2A**	0.487	0.472	0.225	0.012	0.162	0.136	0.215	0.164	0.242	0.199	0.159	0.165	0.173	0.196	0.188
Cd (Mg)	**2A1**	0.484	0.468	0.221	0.008	0.159	0.133	0.211	0.160	0.238	0.196	0.156	0.162	0.169	0.192	0.184

Review Team Comment: The table above highlights instances where large variations were found in the reported time series. While the respective jumps/dips may all have logical explanation (e.g. reduced fuel use in a given year) the identified instances may also reflect inconsistencies in underlying activity data/emission factors for that year. Any comments you are able to make concerning the identified jumps and dips are welcomed. (Time series from your NEC data submission that also contained identical flagged years as for CLRTAP NH_3, NMVOC, NO_x and SO_x have been removed from the above table).

Your comments:

3 F Implied emission factors

The aim of this test was to identify outliers in the time series of Implied Emission Factors and across Parties. Activity data was obtained from the Greenhouse Gas Inventories reported under the Monitoring Mechanism (Directive 2004/280/EC) and used in conjunction with reported LRTAP and NEC emissions data to calculate implied emission factors for 1990-2004. Assessment has concentrated on the key categories for Western and Eastern European countries for the main pollutants SO_x, NO_x, NMVOC, NH_3 and CO. For identification of outliers, the UNFCCC outlier tool was used. The table below lists individual country emission factors which are outliers in time series or across Parties (range from lowest to highest IEF provided).

LRTAP:

Key category	Pollutant	Type of outlier	Issue
1A1a	CO	Time series	The IEF of CO from 1A1a increased by 733 % in 1992 from 0.04 to 0.31 t/TJ and decreased by 71 % in 1993 to 0.09 t/TJ.
1A4b	CO	Time series	The IEF of CO from 1A4b increased by 132 % in 1992 from 3.3 to 7.7 t/TJ and decreased by 68 % in 1993 to 2.4 t/TJ.
1A4c	CO	Time series	The IEF of CO from 1A4c decreased by 83 % in 1991 from 5.33 to 0.88 t/TJ and increased by 429 % in 1992 to 4.66 t/TJ.
4D1	NH3	Time series	The IEF of NH3 from 4D1 decreased by 44 % in 1995 from 2.36 to 1.32 kg/kg N.

NEC:

Review Team Comment: Please explain the identified outliers.

Your comments:

4 YOUR COMMENTS ON THE REVIEW

We would greatly appreciate your feedback (positive or negative) on the present review contents and any suggestions on how to improve the presentation of the review questions and responses.

Thank you for completing the 2006 review questionnaire and sending it to vigdis.vestreng@met.no with a copy to elisabeth.rigler@umweltbundesamt.at, before June 15th 2006.

Your comments:

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