World Health Organization
Sustainable Development and Healthy Environments

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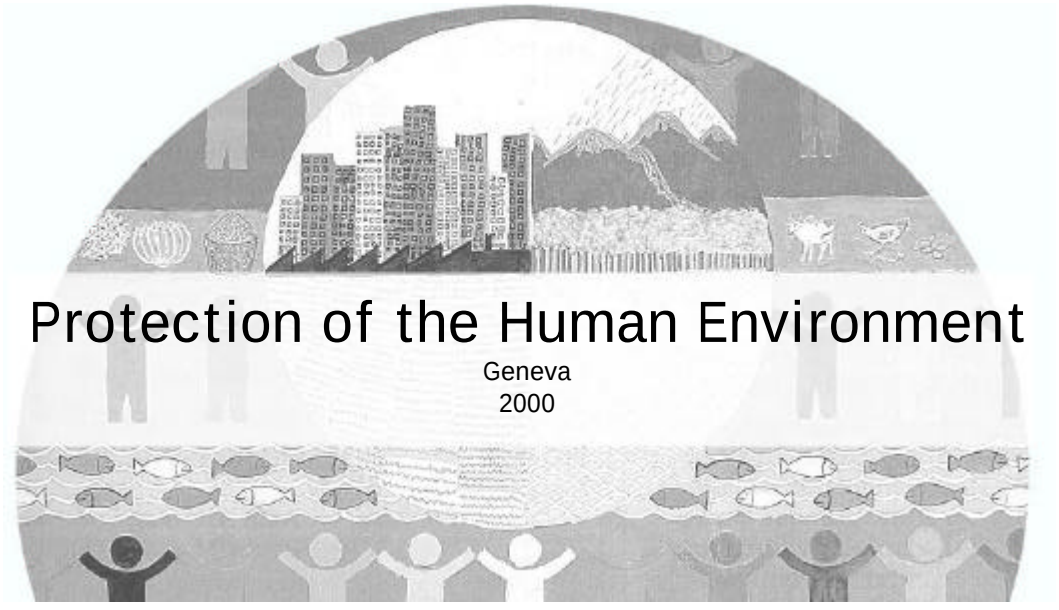
Reference Guide to Emission Estimation Models for Pollutant Release and Transfer Registers



Protection of the Human Environment

Geneva
2000

This document has been prepared by Edward Mullin

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1. INTRODUCTION

This document presents an overview of some of the emission estimation methods that are available for use by both developing and developed countries. The choice of estimation methods will be greatly dependant on the needs and capabilities of the implementing organization (either a government agency or an industrial facility).

Organizations that already have emission or process data will be able to use estimation methods that are different from those used by organizations that have limited information available. The availability of resources, both work force and capital, will also affect the selection of estimation methods.

The methods reviewed in this document do not represent all the emission estimation methods that are available, but rather represent those that have developed a large amount of data or methods for the preparation of emission inventories. Subsequent revisions to this document will attempt to include other documents and methodologies for consideration by environmental managers and policy makers.

2. OVERVIEW OF METHODOLOGIES AND CONSIDERATIONS ON SELECTION

2.1 Overall survey of emission estimation methods

Based on the review of documents available from various countries and organizations (the World Health Organization , The European Commission) there appears to be several basic estimation methods which are “repackaged” by various organizations for their own use. Often times the basic methods are supplemented with additional new data and methods, however, the basic concept remains the same.

The most common method of estimating emissions (especially from point sources) is the use of emission factors. The emissions are estimated based on the production or activity level of the source, from which an emission level is calculated using existing emission factors. This method is widespread because it is both cost effective, and provides a relatively accurate estimate. The accuracy of the estimate can be increased as more agencies and organizations conduct measurements to validate the published emission factors.

At this time the most extensive database of emission factors is maintained by the United States Environmental Protection Agency (USEPA). This database is widely distributed, and undergoes regular updates and refinements. Because of this USEPA emission factors can often be found at the root of other emission factor listings. The European Commission, with the CORINAIR project, has undertaken a considerable effort to develop emission factors which are based on emission measurements from European industries.

This reference guide will present and review various compilations of Emission Estimation Techniques, and also attempt to organize the review in a manner that will permit the user to identify methods and resources that will be most useful for implementing a PRTR program.

2.2 The use of emission estimation methods

The use of emission factors is perhaps the easiest method for obtaining emission estimates. This approach provides a quick method for calculating emissions, and can also provide a more detailed and accurate estimate of emissions if some additional background information is obtained to refine both the process being estimated, and the emission factor that is used to calculate the emission.

The USEPA defines an emission factor as:

> *"a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e. g., kilograms of particulate emitted per megagram of coal burned)."*

Figure 1 depicts various approaches that can be used to estimate emissions. The graph depicts a hierarchy of requirements and levels of sophistication, that should be considered when analyzing the tradeoffs between cost of the estimates and the quality of the resulting estimates. The choice of estimation method should be based on an evaluation of the risks of environmental effects and regulatory outcomes. Where the risks of using a poor estimate are low, and the costs of more extensive methods are unattractive, then less expensive estimation methods such as emission factors and emission models may be both satisfactory and appropriate.

Selecting the method to be used to estimate source-specific emissions may warrant a case-by-case analysis considering the costs and risks in the specific situation. All sources and regulatory agencies should be aware of these risks and costs and should assess them accordingly.

This relationship between cost and reliability exists, because increasing the reliability requires an increase in the accuracy and reliability of the data, which will call for either more testing or more sophisticated testing, both of which will increase the costs associated with obtaining the data.

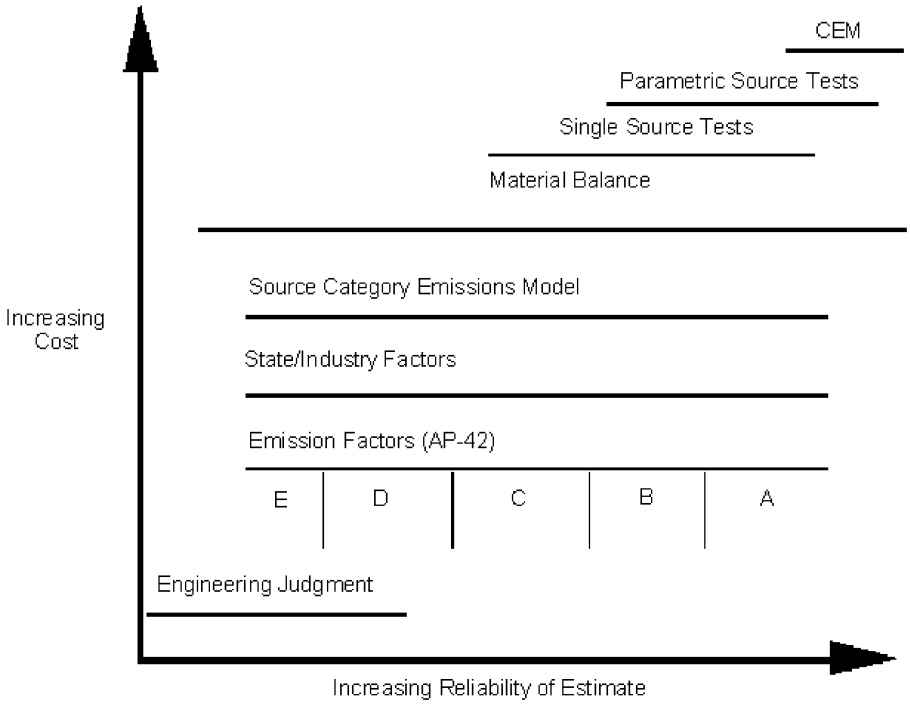

FIGURE 1 Risk Sensitivity Emission Estimation Approaches

(Source: USEPA) AP-42)

The Emission Factors (AP-42) listed in Figure 1 are presented by the USEPA in its compilation of emission factors. They indicate the reliability of its estimate by use of an emission factor quality rating, which indicates the reliability of any given emission factor. Their rankings are as follows:

A Excellent. Factor is developed from A- and B-rated source test data taken from many randomly chosen facilities in the industry population. The source category population is sufficiently specific to minimize variability.

B Above average. Factor is developed from A- or B-rated test data from a "reasonable number" of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with an A rating, the source category population is sufficiently specific to minimize variability.

C Average. Factor is developed from A-, B-, and/or C-rated test data from a reasonable number of facilities. Although no specific bias is evident, it is not clear if the facilities tested represent a random sample of the industry. As with the A rating, the source category population is sufficiently specific to minimize variability.

D Below average. Factor is developed from A-, B- and/or C-rated test data from a small number of facilities, and there may be reason to suspect that these facilities do not represent a random

sample of the industry. There also may be evidence of variability within the source population.

E Poor. Factor is developed from C- and D-rated test data, and there may be reason to suspect that the facilities tested do not represent a random sample of the industry. There also may be evidence of variability within the source category population.

(Source: USEPA AP-42 Fifth Edition, November 1996)

These rankings are included here primarily to provide the reader with some background on the variability of emission factors, and also provide perspective on some of the items that should be considered in the selection of emission factors for use in the preparation of an emission inventory.

The USEPA document "Compilation Of Air Pollutant Emission Factors**"**, (AP-42 Fifth Edition, November 1996) provides a comprehensive overview of emission factors and estimation methods as recommended by that agency. Any reader who desires to obtain more detailed information on emission estimation is recommended to review this document. Information on obtaining this document is contained in Section 3.3.

2.3 Considerations on selection of estimation methods

The selection of an emission estimation method will be determined by numerous factors, some related to the actual pollutants and sources being estimated, and others that are related to the resources available for the estimation effort. These factors will be briefly discussed in this section to provide a background to the reference guide.

Each of these factors are of equal importance to producing accurate emission estimates, however for the purposes of this guide, only those factors which apply to the estimation effort will be evaluated. Factors such as the staffing required for utilizing the method, will be indicated, but not discussed.

2.3.1 Type of emission source (Point versus diffuse source)

The type of emission source is one of the key factors in determining which estimation method is to be used. Point source emissions can be estimated using several different methods, ranging from estimates based on production levels, mass balances, engineering estimates, or actual emission measurements. Methods are also available for the estimation of specific chemicals. The estimation of particulate emissions from a power plant based on the amount of coal burned is an example of this type of method.

Diffuse or area sources require different techniques due to the nature of the emissions. These techniques are usually based on mass balances (facility-wide or area-wide), or overall production (or activity) levels. The use of traffic data to estimate vehicle emissions is an example of this approach.

2.3.2 Desired level of detail

The level of detail that is required by the organization requesting the estimates will also govern the method selected. For example, a national government interested in establishing a PRTR programme, may initiate a programme requiring that industrial facilities only identify and estimate pollutant release of "major" pollutants. In this case, a simple model that estimates emissions at the plant level using mass balances would be adequate for this initial phase.

However, if a local or regional government is interested in determining the emission levels of a specific pollutant in order to alleviate a local or regional problem, a different level of detail will be necessary. In this case, an estimation method that is based on either pollutant specific monitoring or process specific estimates will be required.

2.3.3 Available resources

An important consideration in the selection of emission estimation methods is the availability of resources necessary to prepare and evaluate the estimates. These resources will be unique to each situation, but can be generalized for planning purposes. These should include, but are not limited to, the resources necessary to identify the sources, gather data for estimating the emissions, and then processing the data to develop the emission estimates.

2.4 Matrix of Models

A matrix of the estimation methods is included in Appendixes A and B of this document. The purpose of the matrix is to allow an easy comparison of features of each model. The matrix can be used at the beginning of the selection process to help the users quickly identify which methods are applicable to their situation. These particular methods can then be reviewed and evaluated in more detail. The matrix will also enable the users to compare the requirements, etc. of specific methods after reading the more detailed evaluations of several methods.

3. MODEL SUMMARIES

3.1 European Commission - Corinair Project

Corinair,

Technical Annexes Volume 1 and 2,
European Commission,
Directorate-General
Environment, Nuclear Safety and Civil Protection
B-1049 Brussels

Document number: EUR 12586/1 EN

3.1.1 Description

The Corinair Emission estimation model has been prepared by the European Commission for use within the European Union (EU). The project has been developed by using emission data generated within the European community whenever possible. The project has produced several documents, including the two volume set that was reviewed for this report.

Volume 1 of the Technical Annexes contains information on the terminology used for estimating emissions, the installation and operation of the software that is available to support the Corinair methodology.

Volume 2 of the Technical Annexes contains tables listing the various Default Emission Factors that are used in the Corinair project, as well as additional information on some selected industrial processes. This is intended to provide a perspective on how the emission estimates were derived, and in some cases where modifications or refinements have been addressed.

The section containing the Emission Factors is organized by type of source and pollutant. For example the first major section addresses stationary sources of NOx, SOx, and VOC (including CH_4), while subsequent sections address emission factors from nature, and road traffic. Within these sections different industrial categories are discussed individually. For example the iron & steel industry, and the non-ferrous metal industries are typical categories.

The Default Emission Factors that are contained in Volume 2 are usually presented in both table and narrative format. The narrative section provides additional information on the how the emission factor was calculated, any process specific information, the information sources used for the estimate, as well as data on chemicals that might be useful as background information but is not necessary for the preparation of a valid emission estimate.

a. Data requirements

The data required for this model vary according to the sources being estimated. Estimates are based on the process usage or activity level. For example the emissions from a cement manufacturing plant would be based on the number of tons of cement that are produced. Therefore basic production data (either raw material inputs or the quantity of product manufactured) will be needed to complete the emission estimates.

The authors recommend that whenever possible the input data to be used should be collected from the sources that are to be estimated. If this is not possible the default values provided with the model can be used. As always the more precise the input data, the more accurate the calculated estimates will be.

b. Model outputs

The outputs from the Corinair model are thorough and extensive, including comment fields, estimation methods, fuel consumption of point sources and area sources, as well as several others. Some additional outputs are aggregated emissions by activity group. Emissions can also be output by SNAP (selected nomenclature for air pollution) activities groups.
These groupings are predefined in the Corinair program and include such production processes as ferrous metal foundries (SNAP code 4040). This category includes process activities as: blast furnace charging, pig iron tapping, solid smokeless fuel, open hearth furnace steel plant, basic oxygen furnace, electric furnace steel plant, and rolling mills.
The European Commission maintains an Internet site that presents some of the emissions data from Europe
(http://themes.eea.eu.int/toc.php/state/air?doc=39186&l=en).
It is possible to search the data by pollutant and by country
(http://www.aeat.co.uk/netcen/corinair/94/).
See also http://themes.eea.eu.int/showpage.php/state/air?pg=40467.

c. Computer capabilities and requirements

The Corinair method includes a detailed computer program for the calculation and summation of emissions. The basic operation of the program (CORINAIR94) is discussed in Volume 1 of the document, although the software is not included with this document. It is expected that more detailed instructions would be included with the actual software. The Corinair software is actually developed using the Dbase database software and CA-VO (Computer Associate Visual Object).
The documentation lists the following as the minimum hardware requirements to use the Corinair software:

- Computer type: PC (486-PC recommended)
- DOS/Windows 3.11
- RAM: 640 kb or higher
- Hard disk requirement: 10 Mb.

This configuration is relatively minimal by current standards. Presently the software is (re-)designed and will probably use MsAccess (Windows95) (source: Corinair website).

Operation of Computer software

The document provides instructions on the various steps for the initialization and operation of the software. The input data are not complex and appear to allow for some flexibility in the level of data that are needed. It is possible to enter actual source data or utilize default data that is included in the Corinair model. Within the model there are options for the modification, addition and deletion of data and other parameters. These operations appear to be relatively easy to implement, and can be done on an individual basis or by a group of parameters.

The model includes standardized information and definitions that can be used throughout the model, or substituted with user supplied data. These definitions include parameters such as emission sources (SNAP: Selected nomenclature for air pollution) fuel characteristics (Napfue: Nomenclature for air pollution of fuels), and emission estimates.

d. Technical Contacts

For additional information on upgrades and the currently available version the following contact information is provided:

Mailing Address

J. P. Fontelle, or J. P. Chang
Citepa
3 rue Henri Heine
F-75016 Paris, France
tel: +33 1 45 27 12 88
fax: +33 1 40 50 07 54

Internet Address

The European Commission maintains an Internet site to provide information on the use of Corinair. It is anticipated that information on revisions to the program can be obtained on this site.

http://themes.eea.eu.int/toc.php/state/air?doc=39186&l=en

3.2 WHO Rapid Source Inventory Techniques
Assessment of Sources of Air, Water, and Land Pollution

A Guide to Rapid Source Inventory Techniques and Their Use in Formulating Environmental Control Strategies,
World Health Organization, 1993

Part One: Rapid Inventory Techniques in Environmental Pollution
Part Two: Approaches for Consideration in Formulating Environmental Control Strategies.

3.2.1 Description

The Rapid Assessment Technique was developed for the World Health Organization for use in making an initial appraisal of the sources and levels of emissions from an area that has little or no previous pollution load data. It can also be used for selecting priority areas to conduct more extensive studies including monitoring programs or detailed emission inventories.

The document is divided into two volumes, Part I contains the rapid assessment factors for air, water and land emissions. In addition this part contains information on how to collect the necessary data, how to define study areas, and other information that is pertinent to preparing a rapid assessment.

Throughout the document the estimates are based on the use of waste load factors. These factors are determined using relevant experience (measurements etc.) from the same or similar sources. The waste load factor (ej) is defined as the "normalized released load of pollutant j expressed in kg/(unit of activity) of the particular source under consideration." For example the waste load factor for power plants would be listed as "kg of SO_2 per ton of coal burned". The selected activity unit must bear a close and proportional relationship to the pollutant loads generated. In addition it should also "offer convenience during field-work."

The document contains numerous tables that contain Emission factors for air, water and land emissions from various industrial processes, and other processes that emit pollutants (i.e. service industries such as cleaners, and retail stores). Each table is clearly labeled as to the emission factor and the associated activity level.

a. Data requirements

The data required for this model vary according to the sources being estimated. Estimates are based on the process usage or activity level. For example the fugitive particulate emissions from the log debarking and sawing operation in the manufacture of plywood veneer would be based on the number of tons of logs that are processed. Therefore basic production data (either raw material inputs or the quantity of product manufactured) will be needed to complete the emission estimates.

The authors recommend that whenever possible the input data to be used should be collected from the sources that are to be estimated. If this is not possible the default values provided with the model or the original sources of the estimate can be used. As always the more precise the input data, the more accurate the calculated estimates will be.

b. Model outputs

The outputs from the Rapid Assessment Inventory are basically tabular in format, and therefore somewhat flexible according to the needs of the user. In the version reviewed, there was not a computer component associated with the model. However WHO, in collaboration with the World Bank, has developed a computerized implementation of the Rapid Assessment Inventory, the *Decision Support System for Industrial Pollution Control* (DSS IPC). This programme is available on WHO's AMIS CD-ROM (Healthy City Air Management Information System).

Once the sources to be inventoried are identified, the emissions can be tabulated using the "Data and Calculations Sheet" provided in the document. These worksheets provide for listing of sources, emission factors, activity level (production levels, raw material inputs etc.) and then the subsequent calculation of the emissions from that process. For more complicated processes it is also relatively easy to segment the process and calculate the emissions from each phase of the process. This approach would also be useful in the evaluation of a process for either control measures of pollution prevention activities.

An updated version of this model is in preparation and will be made available by 1999.

c. Computer capabilities and requirements

The hardware requirements to run the AMIS CD-ROM are the following:

Computer type: PC (486/66 or higher, or pentium)
Windows 3.1, 3.11, or Windows 95
RAM: 32 MB

In addition, WordPerfect 6.0/MS Word 6.0 and MS Excel 4.0 are needed to access the files.

It is also possible to computerize the calculations by using any spreadsheet programme. Since most of the estimation techniques are simple calculations based on an emission factor and an activity level, the worksheets presented in the document could be easily transferred to most personal computers. The advantages of a "developed" computer implementation would be the assistance in the selection of the correct emission factor and the related activity level.

d. Technical contacts

For additional information on upgrades and the currently available hard copy version the following contact information is provided:

Occupational and Environmental Health (OEH)
Department of Protection of the Human Environment (PHE)
World Health Organization
1211 Geneva 27, Switzerland
Fax: +41 22 791 41 27

The AMIS CD-ROM is available free of charge for non-profit organizations. Companies can order it for US$ 300 from:

Dr Peter Williams
Director
Monitoring & Research Assessment Centre (MARC)
King's College
The Old Coach House
Campden Hill
GB - London W8 7AD
Tel: +44 171 376 1577

3.3 U.S. EPA Emission Factors

3.3.1 Description

The U.S. EPA has been active in the development of emission factors for air pollutants for many years. Much of the background data cited in other PRTR methodologies has been prepared by the USEPA. Because there are so many different sources of information on emission factors that are published by the USEPA, this section will try to address as many of these sources as possible, rather than focus on any one publication.

Since the early 1980's the primary source of emission factors within the US has been a USEPA document "the Compilation Of Air Pollutant Emission Factors" which is usually referred to as "AP-42". This document contains the emission factors that have been developed for a wide variety of industrial sources. The document has grown to two volumes, Vol. 1 for stationary sources, and Vol. 2 for mobile sources. The original versions were available only as a printed document, however, now the information is available on the Internet and also as CD-ROM, enabling much easier access to the data and the background information that was used to prepare the emission factors.

In addition to AP-42 the USEPA has developed other publications and software to assist in the preparation of emission inventories. Briefly these resources are as follows:

Compilation of Air Pollutant Emission Factors,
Volume I: Stationary Point And Area Sources
Volume II: Mobile Sources
AP-42 Fifth Edition, November 1996

Emission Factor And Inventory Group (MD-14)
Office Of Air Quality Planning And Standards
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711

tel +1 919 541-5285, fax +1 919 541-5680

The Emission Factor And Inventory Group (EFIG), in the U. S. Environmental Protection Agency's (EPA) Office Of Air Quality Planning And Standards (OAQPS), develops and maintains emission estimating tools to support the many EPA activities related to air quality. The AP-42 series is the principal means by which EFIG can document its emission factors. These factors are cited in numerous other EPA publications and electronic data bases, but without the process details and supporting reference material provided in AP-42.

The Clearinghouse for Inventories and Emission Factors (CHIEF)

(http://www.epa.gov/ttnchie1/index.html)

- provides access to tools for estimating emissions of air pollutants and performing air pollutant inventories.
- Current information on EPA emission factors for air pollutants can be retrieved from the AP-42 and Other Estimation References section. (http://www.epa.gov/ttn/chief/ap42etc.html)
- Many emission inventory guidance documents are available on the General EFIG (Emission Factor and Inventory Group) Information section contains recent changes to inventory guidance and emission estimation factors and procedures, bulletins, news items, reports and database descriptions and contacts. (http://www.epa.gov/ttn/chief/general.html)
- Many items on the CHIEF BBS website can either be read on-line or downloaded for future reference.

Emission Factor And Inventory Group (MD-14)
Office of Air Quality Planning and Standards
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711
tel: +1 919 541-5285, fax +1 919 541-5680

Air CHIEF CD-ROM

The *Air CHIEF* CD-ROM gives the public and private sector users access to air emission data specific to estimating the types and quantities of pollutants that may be emitted from a wide variety of sources.

Included on Air CHIEF version 5.0 are:

- Compilation of Air Pollutant Emission Factors (AP-42), Fifth Edition, Volume 1: Stationary Point and Area Sources
  (including Sup. A, B, & C)
- Locating and Estimating Document Series
- Emission Inventory Improvement Program Documents
- Factor Information REtrieval (FIRE) Version 5.1b Data
- Source Classification Codes (SCC) / Area & Mobile Source (AMS) Codes
- Standard Industrial Classification (SIC) Codes
- NIOSH Registry of Toxic Effects of Chemicals Synonym List

Also included on Air CHIEF are the installable copies of these MS-DOS software programs:

- TANKS version 3.0
- PC BEIS
- Water 8
- Chemdat 8
- FIRE

Compressed versions of the AP-42 Background Files are also included on Air CHIEF.

Information on Air CHIEF can be obtained at:

Emission Factor And Inventory Group (MD-14)
Office of Air Quality Planning and Standards
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711
tel: +1 919 541-5285, fax +1 919 541-5680

Information on purchasing Air CHIEF:

The *Air CHIEF* CD-ROM Version 5.0 is available from
The Government Printing Office (GPO) for $15.00 (USD)
(Stock Number: 055-000-00580-0).

To order, visit the Government Printing Office Web Site: (https://orders.access.gpo.gov/su_docs/sale/prf/prf.html).
You can also call +1 202 512-1800, fax +1 202 512-2250, or mail a check payable to:

Superintendent of Documents
P. O. Box 371954
Pittsburgh, PA 15250-7954
USA

While there are other sources of emission inventory methods and background information available from the USEPA these sources will provide the most important information within the fewest references. It is recommended that the USEPA website be visited to obtain the most recent information and also to find additional information. The website can also be used as a method to obtain answers to questions or clarifications on the materials that USEPA provides.

a. Data requirements

As with other emission inventory methodologies, the data requirements for using USEPA methods are flexible, and the reliability and accuracy of the calculated estimates is dependant on the data used. Typically the data needed includes the type of process that is being estimated, the pollutant to be estimated, the activity level for that process, and the emission factor. The activity level is typically defined as the quantity of product or raw material that is produced or used over a given period of time.

On some processes it may be necessary to include the efficiency of any emission reductions (control equipment, etc.) that are currently in use on that process. AP-42 provides the following equation to describe the estimation calculation for a simple process:

$$E = A \times EF \times (1-ER/100)$$

where: E = emissions,
A = activity rate,
EF = emission factor, and
ER= overall emission reduction efficiency, %.

Some processes listed in AP-42 and other USEPA sources contain one emission factor for that particular process, while other processes have emission factors listed for individual process steps. Therefore the documentation should be reviewed carefully to determine which emission factor should be used for the process that is being estimated. Due to subtle process changes or modifications it may be possible to identify an emission factor for a process step that more accurately estimates the emissions than the emission factor listed for the “entire” process. However, a thorough understanding of the process and the assumptions used to derive the emission factor is necessary to accomplish this.

b. Model outputs

The outputs from these documents are typically limited to the emissions based on the process and pollutant chosen to be determined. As with the WHO Rapid Inventory Method, it is relatively simple to prepare a summary report of emissions in a tabular form, either manually or using a spreadsheet program, and the formula listed in the previous section.

c. Computer capabilities and requirements

The USEPA does provide several computer programs that assist the user in calculating emissions. Several of these programs are included on the *Air CHIEF* CD-ROM, these are:

- TANKS v. 3.0 Calculates the emissions from storage tanks (fixed and floating roof tanks)

PC BEIS Biogenic Emissions Inventory System (PCBEIS2.2) allows users to estimate hourly emissions of biogenic VOC and soil nitrogen oxide emissions for any county in the US.

- Water 8 An analytical model for estimating compound-specific air emissions from wastewater collection & treatment systems.
- Chemdat 8 a Lotus spreadsheet includes analytical models for estimating VOC emissions from treatment, storage and disposal facility (TSDF) processes.
- FIRE Factor Information Retrieval System - software to locate emission factors contained in AP-42.

These programs are not reviewed in this document, however information on them is readily available on the internet (http://www.epa.gov/ttn/chief/software.html) on the “CHIEF Emission Estimation Software” page.

d. Technical contacts

For additional information on upgrades and the currently available version You may contact the USEPA directly at the address listed below, or locate the information you need on their internet site, which is also listed below.

USEPA Mailing Address

Emission Factor And Inventory Group (MD-14)
Office of Air Quality Planning and Standards
U. S. Environmental Protection Agency
Research Triangle Park, NC 27711

+1 919 541-5285, fax +1 919 541-5680

Email: info.chief@epamail.epa.gov

USEPA Internet Address

Clearinghouse for Inventories and Emission Factors Website:

http://www.epa.gov/ttnchie1/index.html

This website contains links to the various sources of information on emission estimating that are maintained by the USEPA.

U.S. Government Printing Office

Documents listed on USEPA web sites can also be obtained in printed form by ordering them from the U.S. Government Printing Office (GPO):

Superintendent of Documents
P. O. Box 371954
Pittsburgh, PA 15250-7954
USA

tel +1 202 512-1800, fax (202) 512-2250

GPO Internet Address

Document can also be ordered via the internet from the Government Printing Office Web Site:
(http://www.access.gpo.gov/su_docs/sale/prf/prf.html)

3.4 Australian Environment Protection Agency

The document reviewed is a Final Report to the Australian Environment Protection Agency prepared by their consultant Dames & Moore.

National Pollutant Inventory, Emission Estimation Techniques

Final Report
Dames & Moore, July 1995
Job No. 30067-002-362 Revision 2
A.C.N. 003 293 696

3.4.1 Description

This document differs from the others included in this report in that it does not list emission factors for use in preparing emission inventories. Rather it has taken the approach of reviewing the existing methodologies and available data for their use in Australia. For this reason this document is not included in the emission factor matrix included in Appendix A of this document.

However, this report does provide important information on the evaluation of existing emission factors for use in a location or nationality different from that which the factor was developed. It identifies technical areas and process considerations which should be evaluated prior to use of a given emission factor for estimating emissions.

For example the report cautions the user, “Therefore emission factors must be examined in terms of the parameters by which they were statistically constructed and not blindly used as an ‘off the shelf product’.” The authors provide this warning because emission factors for toxic air pollutants developed in the US and Europe are based on required baseline control technologies that are different from what is required in Australia. The authors also recommend that emission factors be evaluated on a source by source basis to account for these and other differences.

a. Data requirements

As no specific emission factors or methodologies are presented in this document, the data requirements are also not included. However, in various sections basic data requirements are discussed, often as a comparison between different methods for obtaining emission data, i.e source testing versus material balance.

Included in Volumes 2 and 3 of this report are several appendices that contain various information on both industrial processes, and related information. Appendix E contains summaries of reported emissions to water organized by both pollutants and chemical group. References and a brief summary of the results are included in table format.

b. Model outputs

As with the data requirements there are no model outputs provided, other than a few selected examples and case studies provided in the appendices.

c. Computer capabilities

No computer capabilities are discussed in the report, other than those that might be included in sources from other countries and organizations that are discussed in the report.

d. Technical contacts

For additional information on the report and the Australian program the following contact is provided:

National Pollutant Inventory Taskforce
Environment Protection Agency
40 Blackwall Street
Barton ACT 2600
Australia

Tel: + 61 6 274 1513
Fax: +61 6 274 1230

Internet Address

The Australian Environment Protection Agency maintains an Internet site to provide information on the results of their National Pollutant Inventory. Information on their NPI can be obtained, as well as background information on the program, including the Executive Summary of this report.

National Pollutant Inventory (NPI) - Home Page:

http://www.environment.gov.au/epg/npi/

Appendix A Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Air							Air							Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Agriculture, Hunting Forestry, and Fishing																					
Open Burning	x			x	x										x	x	x	x	x		
Forestry																					
Charcoal mfg.	x		x	x	x																
Mining & Quarrying																					
Coal Mining & Cleaning	x	x	x		x										x	x	x	x	x		
Crude Petroleum & Nat. Gas Prod.																					
N.G. Production		x										x				x			x		
Crude Pet. prod.												x							x		
Desulfurization of N.G.		x																			
Non-Ferrous Ore mining																					
Metallic mineral Processing	x														x	x	x		x		
Leadbearing Ore crush & grind	x					x									x	x	x		x	x	
Stone Quarrying, clay & sand pits																					
Sand & gravel	x														x	x	x		x		
Stone quarrying & processing	x														x	x	x		x		
Chemical & Fertilizer Mineral mining																					
Phosphate rock proc.	x																				

Appendix A Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Air							Air							Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Manufacture of Food, Beverage, etc.																					
Meat Smokehouses	x			x	x										x	x	x	x	x		
Fish Processing	x						x								x				x		
Grain mills	x														x						
Starch Manufacturing	x														x		x		x		
Alfalfa Dehydrating	x														x	x	x	x	x		
Bread Baking												x							x		
Beer Brewing	x			x	x							x			x				x		
Wine Production					x							x							x		
Textile wearing Apparel & Leather																					
Textile Fabric Printing					x														x		
Cotton Ginning	x														x						
Wood & Wood Products (exp furniture)																					
Plywood veneer	x				x																
Paper & Paper Products																					
Sulfate (Kraft) Pulping	x	x		x			x		x	x		x			x	x	x	x	x		
Sulfite Pulping		x							x	x		x			x	x	x		x		
Printing & Publishing																					
Graphic Arts							x														
Publication Gravure Printing							x														

Appendix A Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Air							Air							Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Manufacture of Chemicals & chemical, petroleum, coal, rubber, and plastic products																					
Basic Industrial Chemicals except fertilizers																					
Phthalic anhydride	x	x		x	x										x	x	x	x	x		
Chlor-Alkali							x								x	x	x	x	x		
Hydrochloric acid							x									x	x				
Hydrofluoric Acid	x	x					x								x	x	x	x	x		
Sulfuric Acid		x					x		x						x	x	x	x	x		
Nitric Acid			x							x						x	x		x		
Phosphoric Acid							x								x	x	x		x		
Lead Oxide & Inorganic pigments	x						x								x	x		x	x	x	
Ammonia Production	x	x	x	x	x		x			x					x	x	x	x	x		
Sodium Carbonate Production	x						x								x	x	x	x	x		
Calcium Carbide Production	x	x																			
Adipic Acid	x		x	x	x										x	x	x	x	x		
Lead Alkyl Manufacture						x										x			x		
Maleic Anhydride				x	x											x	x	x	x		
Terephthalic				x	x										x	x	x	x	x		

Appendix A Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Air							Air							Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Pesticides & fertilizers																					
Urea Production	x						x								x				x		
Ammonium Nitrate	x						x								x				x		
Ammonium Sulfate	x				x																
Ammonium Phosphates	x						x								x	x	x		x		
Normal Superphosphates	x						x								x	x	x	x	x		
Triple Superphosphates	x						x								x	x	x	x	x		
Manufacture of Synthetic Resins, Plastic Materials and Man-Made fibers except Glass																					
Styrene-Butadiene Copolymers					x							x									
Polypropylene Copolymers	x				x							x			x		x		x		
Polyvinyl Chlorides	x				x							x			x	x	x		x		
Rayon							x												x		
Cellulose Acetate					x														x		
Polyesters	x				x							x							x		
Acrylics	x				x														x		
Nylons	x				x														x		
Manufacture of Paints, varnishes, lacquers																					
Paint Manufacture	x				x										x	x	x	x	x		
Varnish Manufacture					x											x	x		x		

Appendix A Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Air							Air							Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Manufacture of soap & cleaning preparations																					
Spray-dried detergents	x																		x		
Manufacture of Chemical Products not elsewhere classified																					
Carbon Black	x	x	x	x	x		x								x	x	x	x	x		
Printing Ink	x				x										x				x		
Trinitrotoulene	x	x	x				x								x	x	x		x		
Nitrocellulose		x	x				x								x	x	x	x	x		
Petroleum Refineries																					
Petroleum Refining	x	x	x	x	x				x	x		x			x	x	x	x	x		
Rail & Tank Loading					x							x									
Barge Loading					x							x									
Ship/Ocean Barge loading					x							x									
Manufacture of Miscellaenous Products of Petroleum and Coal																					
Asphaltic Concrete plants	x	x	x	x	x										x	x	x	x	x		
Asphalt Roofing	x			x	x										x	x	x	x	x		
Coke Production	x	x	x	x	x		x								x	x	x	x	x		
Manufacture of Nonmetallic Mineral Products except Products of Petroleum and Coke																					
Manufacture of Glass and Glass Products																					
Glass & Glass Products	x	x	x	x	x				x	x					x	x	x	x	x		
Glass Fiber Manufacture	x	x	x	x	x				x	x					x	x	x	x	x		

Appendix A — Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory – Air							Corinair – Air							USEPA - AIRS / AP-42 – Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Manufacture of Structural Clay Products																					
Bricks & clay products	x							x	x			x		x	x	x	x	x	x		
Curing and Firing	x	x	x	x	x		x	x	x			x		x	x	x	x	x	x		
Manufacture of Cement Lime & Plaster																					
Lime Manufacture	x	x	x	x											x	x	x	x	x		
Cement Manufacture	x	x	x						x	x					x	x	x	x	x	x	
Raw Material Grinding & Calcining	x	x	x																		
Manufacture of Non-Metallic Mineral Products not elsewhere Classified																					
Gypsum Manufacture	x														x	x	x	x	x		
Concrete Batching	x														x	x	x	x	x		
Perlite Manufacture	x														x	x	x		x		
Basic Metal Industries																					
Iron and Steel Industries																					
Gray Iron Foundries	x	x	x	x	x	x									x	x	x	x	x	x	
Iron and Steel Mills	x			x					x	x		x			x	x	x	x	x	x	
Blast Furnace	x			x					x	x		x			x	x	x	x	x	x	
Ferroalloy Production	x								x	x		x			x	x	x		x	x	
Steel Foundries	x		x						x	x		x			x	x	x	x		x	

Appendix A Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Air							Air							Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Non-Ferrous Metal Basic Industries																					
Primary Copper Smelting	x	x							x	x		x			x	x	x		x	x	
Secondary Copper Smelting	x								x	x		x			x	x	x		x		
Alumina Production (Bayer proc.)	x								x												
Primary Aluminum Production	x	x					x					x			x	x	x	x	x		
Secondary Aluminum Production	x								x	x		x			x	x	x	x	x		
Primary Lead Smelting	x	x				x			x	x		x			x	x	x	x	x	x	
Secondary Lead Processing	x	x				x			x	x		x			x	x	x	x	x	x	
Storage Battery Production	x					x									x	x	x	x	x	x	
Primary Zinc Smelting	x	x							x	x		x			x	x	x	x	x	x	
Secondary Zinc Smelting	x								x	x		x			x	x	x		x		
Electricity Gas and Water																					
Electricity Gas & Steam																					
Gaseous Fuels (NG and LPG)	x	x	x	x	x				x	x		x			x	x	x	x	x	x	
Liquid Fuels (fuel oil, waste oil)	x	x	x	x	x		x		x	x		x			x	x	x	x	x	x	
Solid Fuels (coal, lignite, bagasse	x	x	x	x	x				x	x		x			x	x	x	x	x	x	

Appendix A Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Air							Air							Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Wholesale Retail Trade																					
Wholesale Trade																					
Bulk Fuel Terminals					x														x		
Retail Trade																					
Service Stations					x														x		
Transport, Storage, and Communication																					
Land Transport																					
Light Duty gasoline powered cars	x	x	x	x	x	x		x		x	x	x			x	x	x	x	x		
Heavy Duty gasoline powered cars	x	x	x	x	x	x		x		x	x	x			x	x	x	x	x		
Light Duty diesel powered cars	x	x	x	x	x			x		x	x	x			x	x	x	x	x		
Heavy Duty diesel powered cars	x	x	x	x	x			x		x	x	x			x	x	x	x	x		
Heavy Duty diesel powered trucks	x	x	x	x	x			x		x	x	x			x	x	x	x	x		
Light Duty LPG powered vehicles	x	x	x	x	x			x		x	x	x									
Motorcycles	x	x	x	x	x			x		x	x	x									
Fugitive dust from vehicle traffic	x					x															
Water Transport																					
Ships in berths	x	x	x	x	x										x	x	x	x	x		
Air Transport																					
Landing & takeoff of aircraft					x																
Services allied to Transport																					
Storage & warehousing	x																				

Appendix A Air Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Air							Air							Air						
	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other	TSP	SO2	NOx	CO	VOC	Metals	Other
Community. Social and Personal Services																					
Sanitary and similar services																					
Mun./Domestic waste Incineration	x	x	x	x	x	x	x		x	x		x			x	x	x	x	x		
Sewage Sludge Incinerators	x	x	x	x	x	x	x		x	x		x			x	x	x	x	x		
Hazardous Waste Incineration										x			x	x	x	x	x	x	x		
Waste water Treatment												x		x					x		
Laundries, cleaning & dyeing plants																					
Dry Cleaning					x																

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Water							Water							Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Agriculture, Hunting Forestry, and Fishing																					
Agricultural and Livestock Production																					
Beef Cattle	x	x	x	x																	
Dairy Cattle	x	x	x	x																	
Swine feedlot	x	x	x	x																	
Sheep	x	x	x	x																	
Lambs	x	x	x	x																	
Chicken	x	x	x																		
Turkeys	x	x	x	x																	
Ducks	x	x	x	x																	
Horses	x	x	x	x																	
Manufacture of Food, Beverage, etc.																					
Food Manufacturing																					
Slaughtering. preparing etc.	x	x	x	x	x																
Complex slaugherhouses	x	x	x	x	x																
Packing houses	x	x	x	x	x																
Rendering plants	x	x	x	x	x																
Poultyr processing	x	x	x	x	x																

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory – Water							Corinair – Water							USEPA - AIRS / AP-42 – Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Manufacturing of Dairy Products																					
Dairies	x	x	x	x	x																
Canning & preserving fruits & vegetables																					
Fruit processing	x	x																			
Vegetable processing	x	x																			
Canning & preserving fish & similar foods																					
Fish & seafood processing	x	x	x		x																
Manufacture of veg. oil & fats																					
Olive Oil	x	x			x																
Edible oil refining	x	x			x																
Grain Mill Products																					
Corn	x	x																			
Wheat	x	x																			
Rice	x	x																			
Manufacture of bakery products																					
Bread	x		x																		
pastry	x		x																		
Sugar factories & refineries																					
Beet sugar	x	x																			
Cane sugar	x	x																			

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory – Water							Corinair – Water							USEPA - AIRS / AP-42 – Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Manufacture of food prod. not otherwise listed																					
Specialty foods	x	x	x	x	x																
Egg breaking	x																				
Wheat, starch, & glucose	x	x	x	x																	
Yeast Manufacturing	x	x	x			x															
Beverage Industries																					
Distilleries	x	x																			
Wine Production	x	x																			
Malt Liquors & Beer	x	x																			
Soft drinks	x	x																			
Textile, Wearing Apparel & Leather Industries																					
Manufacture of Textiles																					
Wool Processing	x	x				x															
Cotton Processing	x	x																			
Rayon Processing	x	x																			
Acetate Processing	x	x																			
Nylon Processing	x	x																			
Acrylic Processing	x	x																			
Polyester Processing	x	x																			
Manufacture of Leather & Leather Products																					
Tanneries & leather finishing	x	x	x		x	x															

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory – Water							Corinair – Water							USEPA - AIRS / AP-42 – Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Manufacture of wood & wood products																					
Plywood manufacturing	x	x	x			x															
Fiberboard manufacturing	x	x																			
Paper & Paper Products																					
Pulp Mills	x	x																			
Paper Mills	x	x																			
Manufacture of Chemicals & chemical, petroleum, coal, rubber, and plastic products																					
Basic Industrial Chemicals except fertilizers																					
Primary Petrochemicals	x																				
Primary Intermediates	x		x		x																
Secondary Intermediates	x				x																
Primary Polymers	x																				
Dyes & Pigments	x																				
Miscellaneous Organics	x																				
Chlor-Alkali		x				x															
Manufacture of fertilizers & pesticides																					
Nitrogenous fertilizers	x		x																		
Phosphatic fertilizers	x	x		x		x															
Insecticides, Fungicides	x	x			x	x															
Syn. resins, plastic & fibers	x	x			x	x															

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory – Water							Corinair – Water							USEPA - AIRS / AP-42 – Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Manufacture of Other Chemical Products																					
Drugs & medicines	x	x	x	x	x																
Soap production	x	x			x																
Detergent production	x	x			x	x															
Manufacture of chemical products not otherwise classified																					
Animal glue	x	x																			
Petroleum Refineries																					
Topping refinery	x	x	x		x	x															
Cracking refinery	x	x	x		x	x															
Petrochemical refinery	x	x	x		x	x															
Lube oil refinery	x	x	x		x	x															
Integrated refinery	x	x	x		x	x															
Manufacture of Miscellaneous Products of Petroleum and Coal																					
Building felt tar & tar paper	x	x																			
Coke Plant	x	x				x															
Manufacture of Rubber Products																					
Tire & tube industries	x	x			x																

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory – Water							Corinair – Water							USEPA - AIRS / AP-42 – Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Manufacture of Nonmetallic Mineral Products except products of petroleum & coke																					
Manufacture of Glass & Glass Products																					
Plate glass	x	x			x																
Float glass	x	x			x																
Windsheild glass	x	x			x																
Basic Metal Industries																					
Iron & Steel Industries																					
Iron & steel mills		x	x			x															
Basic Oxygen furnace		x																			
Electric arc furnace		x																			
Open hearth furnace		x																			
Hot-rolling mills		x			x																
Cold rolling	x	x			x																
Sulfuric acid pickling						x															
HCl pickling						x															
Galvanizing		x		x	x	x															
Non-Ferrous Metal Basic Industries																					
Primary Aluminum Production		x			x	x															
Secondary Aluminum		x			x																
Primary Lead		x																			
Primary Zinc		x				x															

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Water							Water							Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Manufacture of Fabricated Metal Products, except machinery & equipment																					
Electroplating					x	x															
Copper					x	x															
Cadmium						x															
Silver						x															
Tin						x															
Gold						x															
Electroless metal bath					x	x															
Electricity Gas and Water																					
Electricity Gas & Steam																					
Steam Turbines	x	x			x	x															
Wholesale Retail Trade																					
Retail Trade																					
Shopping Centers	x																				
Restaurants, Cafes, & Other Eating & Drinking																					
Restaurants	x																				
Hotels, Rooming Houses, Camps, & other lodging																					
Motels with restaurant	x																				
Camps	x																				
Parks	x																				

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Water							Water							Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Transport, Storage, and Communication																					
Air Transport																					
Airports	x																				
Community. Social and Personal Services																					
Sanitary and similar services																					
Community & personal services	x	x	x	x	x																

Appendix B Water Emission Estimates Comparison Matrix

Category	WHO Rapid Inventory							Corinair							USEPA - AIRS / AP-42						
	Water							Water							Water						
	BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other		BOD5	TSS	Tot N	Tot P	Oil	Other	
Education Services																					
Schools	x																				
Recreational & Cultural Services																					
Theaters	x																				
Swimming Pools	x																				