

Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory 2002

Canadian Environmental Protection Act, 1999

Canada



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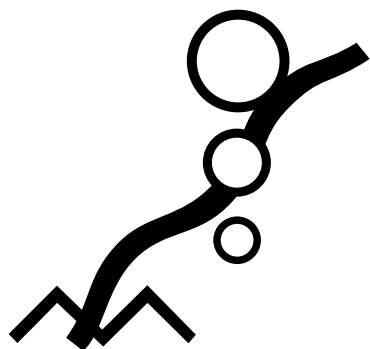
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Should any inconsistencies be found between this Supplementary Guide and the official *Canada Gazette* notice and its amendment, the notice published on December 29, 2001, and the amendment published on December 28, 2002, in the *Canada Gazette*, Part I, will prevail.



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Preface

The National Pollutant Release Inventory (NPRI) is at the centre of Environment Canada's efforts to track substances of concern. It is the only nation-wide, publicly-accessible program of its type in Canada that provides information on pollutants released to the environment and transferred for disposal. Since its inception in 1992, the role of the NPRI has expanded to include the collection of information on NPRI substances being recycled and pollution-prevention activities.

The addition of Criteria Air Contaminants (CACs) for the 2002 reporting year is a significant expansion of the NPRI. Environment Canada held extensive consultations with stakeholders during 2001 to explore the addition of CACs to the 2002 NPRI.

CACs are comprised of oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), and particulate matter, including total particulate matter (TPM), particulate matter with a diameter less than or equal to 10 microns (PM_{10}), and particulate matter with a diameter less than or equal to 2.5 microns ($\text{PM}_{2.5}$).

The federal government, recognizing that clean air is a priority for Canadians, is working to improve air quality. CAC data collected through the NPRI will support numerous government initiatives to improve air quality.

The requirements for reporting CAC emissions to the NPRI for the 2002 reporting year were published in the *Canada Gazette*, Part I, on December 29, 2001, and in an amendment published on December 28, 2002.

This Supplementary Guide is intended to assist owners and operators of facilities in determining whether they should report for any CAC substances, to understand the specific reporting criteria for these substances, and to determine and report their on-site releases to air for these substances.

This Supplementary Guide is a companion document to the *Guide for Reporting to the National Pollutant Release Inventory – 2002*, which outlines the NPRI reporting criteria for all substances listed in the NPRI and assists facility owners and operators in determining if they are required to report to the NPRI for the 2002 reporting year. The *Guide for Reporting to the National Pollutant Release Inventory – 2002*, also provides instructions on how to complete the electronic reporting form and submit the report to Environment Canada. If you determine that you are required to report to the NPRI for any of the CACs, it is essential you review the *Guide for Reporting to the National Pollutant Release Inventory – 2002*, as well as this document.

Cette publication est aussi disponible en français sous le titre « Guide supplémentaire de déclaration des principaux contaminants atmosphériques (PCA) à l'Inventaire national des rejets de polluants – 2002 ». L'autre guide général mentionné est aussi disponible en français sous le titre de « Guide de déclaration à l'Inventaire national des rejets de polluants – 2002 ».

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1. Introduction

The National Pollutant Release Inventory (NPRI) was created through a multi-stakeholder process in 1992. The data collected by the NPRI supports a wide range of environmental initiatives, including pollution-prevention and abatement activities. The NPRI has enabled governments and interested stakeholders to track the progress on the reduction of releases, and to assist in identifying areas where reductions are required. The NPRI data also provide Canadians with information on the pollutants released into their environment.

The reporting criteria and requirements for the 2002 NPRI were published in the *Canada Gazette*, Part I, under the authority of the *Canadian Environmental Protection Act, 1999* (CEPA 1999). The notice specifies that any person owning or operating a facility that meets the reporting criteria prescribed in the notice, provide certain information to the Minister of the Environment by **June 1, 2003**.

Since CACs were added for the first time to the NPRI for the 2002 reporting year, this Supplementary Guide was created to assist facility owners and operators understand the NPRI reporting criteria for CACs, determine if they should report for any of these substance, and estimate air releases for these substances. Throughout this Supplementary Guide, all references of “emission” or “emissions” refer to air releases.

For the purposes of reporting to the NPRI, CACs consist of the following seven pollutants:

- oxides of nitrogen (NO_x , expressed as NO_2)
- sulphur dioxide (SO_2)
- carbon monoxide (CO)
- volatile organic compounds (VOCs)
- total particulate matter (TPM)
- particulate matter with a diameter less than or equal to 10 microns (PM_{10}), and
- particulate matter with a diameter less than or equal to 2.5 microns ($\text{PM}_{2.5}$).

This Supplementary Guide contains information on the reporting criteria for CACs, examples of CAC sources at facilities, methods of estimating emissions of CACs, the NPRI reporting form for CACs and a list of reference materials.

The *Guide for Reporting to the National Pollutant Release Inventory – 2002* details the information to be reported and explains how to complete an NPRI report for all substances listed in the NPRI, including CACs.

More information about the NPRI is available on Environment Canada’s Web site at <www.ec.gc.ca/pdb/npri>.

Facilities that have reported to the NPRI in previous years and are already familiar with the program may proceed directly to Chapter 2 of this Supplementary Guide for reference to reporting criteria specific to CACs. New and potential reporters are encouraged to proceed to Section 1.1.

1.1 Overview of the Addition of CACs to the NPRI

To date, Environment Canada has been working with the provinces, territories and industry to estimate and publish national comprehensive CAC emissions’ inventories on a five-year cycle.

In 2001, the federal government launched the *Interim Plan 2001 on Particulate Matter and Ozone*, which included the commitment to expand the NPRI to collect annual information on emissions of CACs, beginning with the 2002 reporting year.

During 2001, Environment Canada consulted with stakeholders, including a discussion on the proposed requirements for reporting CACs to the NPRI for the 2002 reporting year. These consultations involved industry, environmental non-government organizations, other federal government departments and provinces/territories. Details of the NPRI consultations are available on the NPRI Web site.

Information on CAC emissions are required to enable governments to monitor and assess whether risk-management activities for various industrial sources of CACs are resulting in reduced emissions. The emissions' inventories are also required to perform joint Canada–U.S. reporting, analyses, and source receptor modelling, as required under the Ozone Annex of the *Canada–U.S. Air Quality Agreement*, and to meet requirements under a number of domestic and international programs.

1.2 Importance of CAC Inventory Data

The CAC information that is collected through the NPRI will be used to compile Environment Canada's Comprehensive CAC Emissions' Inventory on an annual basis. A number of programs and agreements that specifically require this emission information include the following:

1.2.1 Ozone Annex

In December 2000, Canada and the U.S. signed the Ozone Annex to the 1991 *Canada–U.S. Air Quality Agreement*. The Annex includes commitments by both Canada and the U.S. to reduce NO_x and VOC emissions from power plants and transportation sources, as well as taking initial action for other industrial sources. The collection of emission information on CACs via the NPRI will be used to track Canada's progress on meeting these commitments.

1.2.2 Other Federal Government Actions

Other examples where the Government of Canada has taken proactive measures include:

- Canada-wide Acid Rain Strategy
- Canada-wide Standards (CWS) for Particulate Matter (PM) and Ozone
- Convention on the Long-Range Transport of Air Pollutants, and
- Development of Ambient Air Quality Objectives.

Information on actions being taken by the federal government are posted on Environment Canada's Clean Air Web site at <www.ec.gc.ca/air/introduction_e.cfm>.

2. Reporting Criteria for CACs

Criteria air contaminant thresholds are release based and can apply to facilities with less than 20 000 employee hours as well as to previously-exempt facilities. This chapter explains in detail the reporting criteria for CACs.

2.1 Legal Basis for the NPRI

The legal basis for the 2002 NPRI is the “Notice with Respect to Substances in the National Pollutant Release Inventory for 2002” published in the *Canada Gazette*, Part I, on December 29, 2001. The notice was published under the authority of subsection 46(1) of the *Canadian Environmental Protection Act, 1999* (CEPA 1999). This notice specifies that any person who owned or operated a facility during the calendar year 2002, under the conditions prescribed in the notice, must provide certain information to the Minister of the Environment by no later than **June 1, 2003**.

An amendment to the *Canada Gazette* notice for the 2002 NPRI was published on December 28, 2002, to revise or clarify certain provisions for 2002. Notices are published annually in the *Canada Gazette*, Part I. The contents of both the Notice and its are reflected in this Supplementary Guide.

Refer to Step 1 of the *Guide for Reporting to the National Pollutant Release Inventory – 2002* for details on understanding the *Canada Gazette* notice for the NPRI.

2.2 Facility Definitions

In previous years, there was only one definition of a facility. With the addition of CACs to the NPRI, a second definition was required to capture reporting from another type of facility. As such, the original definition of facility was renamed to “contiguous facility”, and “pipeline installations” are a new type of facility now subject to reporting to the NPRI, specifically for CACs. In the *Canada Gazette* notice, the term “facility” is used in a broader context to refer to both “contiguous facilities” and “pipeline installations”. Definitions for contiguous facility and pipeline installation are provided below.

2.2.1 Contiguous Facility (formerly “facility”)

A *contiguous facility* (formerly “facility”) means all buildings, equipment, structures and stationary items that are located on a single site or on contiguous or adjacent sites and that are owned or operated by the same person and that function as a single integrated site and includes wastewater collection systems that discharge treated or untreated wastewater into surface waters.

2.2.2 Pipeline Installation

A *pipeline installation* is defined as a collection of equipment situated at a single site, used in the operation of a natural gas transmission or distribution pipeline. Pipeline installations are subject only to the reporting criteria for CACs and not other NPRI substances.

Pipeline installations are spaced approximately 80 to 160 kilometres (50 to 100 miles) apart along a pipeline that stretches from a gas supply area to a market area. This definition includes pipeline compressor and storage stations along pipelines used to transport natural gas.

2.3 Who is Exempt from Reporting CACs to the NPRI?

2.3.1 Oil and Gas Sector

The activities of drilling or operating of wells to obtain oil and gas products are not required to be reported to the NPRI for CACs. **However**, contiguous facilities that further process or otherwise use these oil and gas products, and met the employee threshold, **are required** to report CACs which exceeded the substance threshold. For example, if your facility submitted an NPRI report for the 2001 reporting year, you would be required to report for each CAC exceeding the substance threshold.

In summary, a contiguous facility is not required to report to the NPRI for CACs if it met the following requirements:

- (i) the contiguous facility was used for drilling or operating of oil or gas wells or associated activities, including gas production, gas processing, conventional crude oil production, heavy oil production, crude bitumen production, and
- (ii) employees worked a total of less than 20 000 hours.

If your facility did not meet the above criteria, proceed to Section 2.4. If your facility met the above criteria, you are not required to submit an NPRI report for CAC emissions for the 2002 reporting year.

2.4 Overview of Reporting Criteria

The reporting criteria for CAC substances are provided in Part 4, Schedule 2, of the *Canada Gazette* notice for the 2002 NPRI reporting year. The term “emissions” refers to releases to air only. The reporting criteria for CAC substances are summarized in Figure 1.

By answering the questions presented in Figure 1, you will determine if a report for CACs is required from your facility. The remaining sections in this chapter explain the flowchart in detail.

In the past, certain activities were exempt from reporting to the NPRI. The addition of CACs may affect that status. If your facility was engaged in a previously-exempt activity, you may be required to report for CAC emissions from stationary combustion equipment. For the purposes of the NPRI, stationary combustion equipment includes any combustion equipment which needs to be stationary to function or operate properly or is not capable of self-propulsion. For example, a portable generator which had to be hard wired into the process and bolted down to eliminate vibrations during operation, would be considered stationary. Both internal and external combustion equipment can fall into the stationary category.

Read Section 2.5 to determine if you are affected by the addition of CACs to the NPRI.

2.5 Employee Criteria

2.5.1 20 000-hour Employee Threshold

The 20 000-hour employee threshold is based on the number of hours worked by all employees at the facility during the calendar year and not on the number of employees. To determine if your facility met the 20 000-hour employee threshold, include all hours worked by:

- persons employed at the facility, including students, part-time and term employees
- owner(s) who performed work on site at the facility, and
- persons who performed work on site at the facility on a routine basis related to the normal operation of the facility, for the period of time the person performed that work, such as contractors.

The total number of hours worked includes paid vacation and sick leave. The hours worked by contractors performing non-routine jobs at the facility should not be included in the 20 000-hour employee threshold.

2.5.2 Activities to Which the 20 000-hour Employee Threshold Does Not Apply

Facilities that engaged in the activities in Table 1 must consider if they met the CAC reporting criteria, regardless of the number of employee hours worked.

TABLE 1: ACTIVITIES TO WHICH THE 20 000-HOUR EMPLOYEE THRESHOLD DOES NOT APPLY

-
- | |
|--|
| <ul style="list-style-type: none"> (a) non-hazardous solid waste incineration of 26 tonnes or more of waste per year, including small combustion units, conical burners and beehive burners (b) biomedical or hospital waste incineration of 26 tonnes or more of waste per year (c) hazardous waste incineration (d) sewage sludge incineration (e) wood preservation (f) terminal operations, and (g) discharge of treated or untreated wastewater from a wastewater collection system with an annual average discharge of 10 000 m³/day or more, into surface waters (e.g., municipal wastewater treatment plants). |
|--|
-

For a description of these activities, refer to Step 1, Employee Criteria, in the *Guide for Reporting to the National Pollutant Release Inventory – 2002*.

Facilities that did not meet the employee threshold and were not engaged in an activity listed in Table 1 are still subject to reporting CAC emissions from stationary combustion equipment if they met the thresholds set out in Table 3.

If your facility met the criteria in either Sections 2.5.1 or 2.5.2, proceed to Section 2.6.1. If your facility did not meet the criteria listed in Section 2.5.1 or 2.5.2, proceed to Section 2.6.2.

2.6 Sources of CAC Emissions to Consider When Determining if your Facility Met the Threshold

The first step in determining if your facility met the CAC reporting threshold is to decide what emission sources should be included in your calculation. There are two possible scenarios that must be considered. In Case 1, all CAC emission sources at the facility must be included in the calculation; in Case 2, only the releases from the stationary combustion equipment at the facility must be included. The details of each case can be found below.

2.6.1 CASE 1 - Consider All Sources of CAC Emissions at the Facility

You are required to consider stationary combustion equipment and **all other** sources of CAC emissions at your facility if your facility fell under the following criteria:

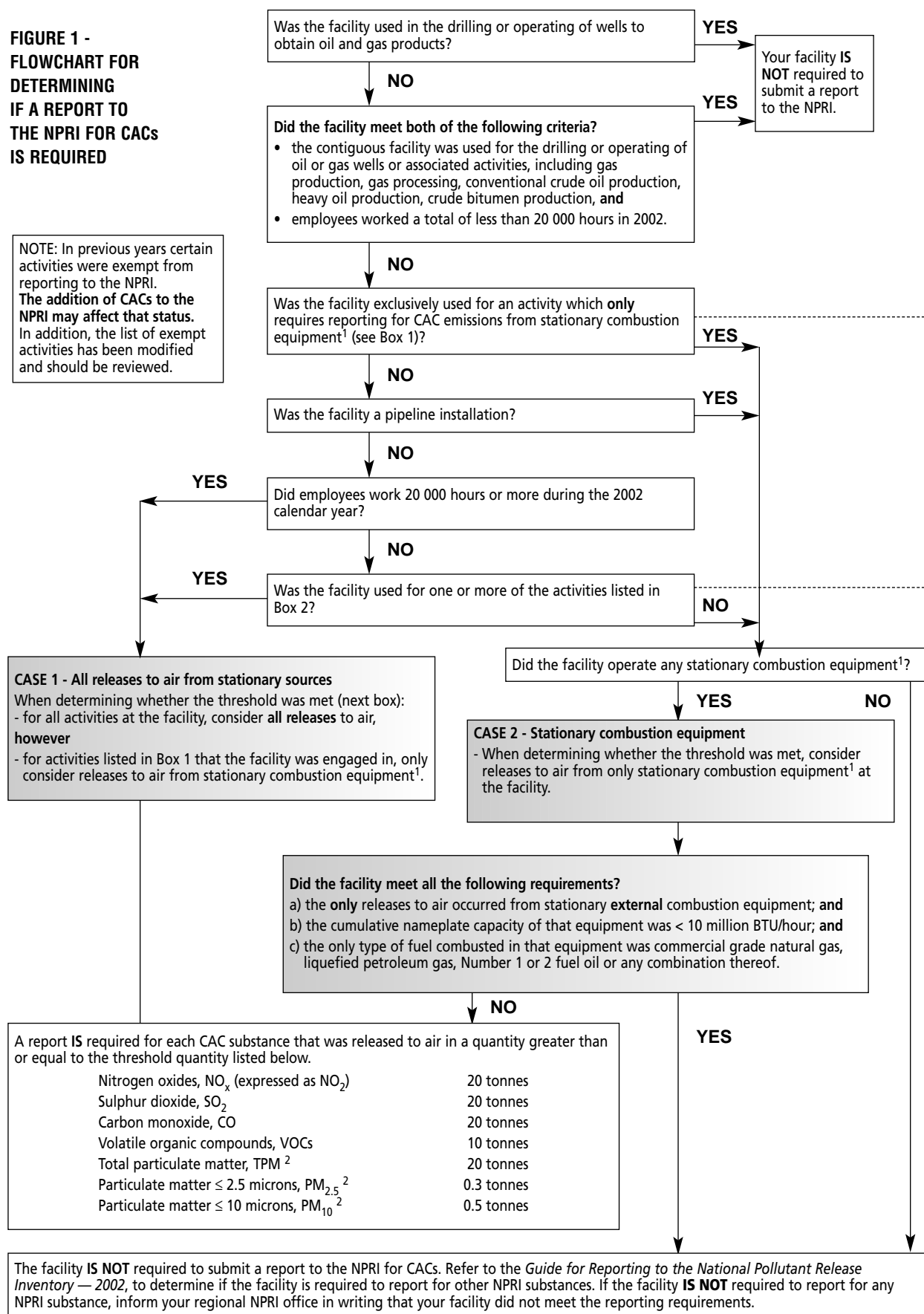
- a contiguous facility with 20 000 employee-hours or more, or
- a facility used for an activity listed in Table 1, regardless of the hours worked by employees.

Additionally, CAC emissions from stationary combustion equipment used in the activities listed in Table 1 or Box 2 of Figure 1 must be included when determining whether your facility met a CAC threshold and when reporting to the NPRI. However, emissions from the sources listed in Table 2 should not be included in your estimate.

You now can proceed to Section 2.6.3 to identify what sources of CACs are not to be considered when reporting to the NPRI.

**FIGURE 1 -
FLOWCHART FOR
DETERMINING
IF A REPORT TO
THE NPRI FOR CACs
IS REQUIRED**

NOTE: In previous years certain activities were exempt from reporting to the NPRI. The addition of CACs to the NPRI may affect that status. In addition, the list of exempt activities has been modified and should be reviewed.



¹ Stationary combustion equipment includes both external and internal combustion equipment.

² Do not consider releases from road dust.

Box 1

Activities Where Only CAC Emissions from Stationary Combustion Equipment are Considered:

- education or training of students, such as at universities, colleges and schools
- research or testing
- maintaining and repairing of transportation vehicles, such as automobiles, trucks, locomotives, ships or aircraft, **except** painting and stripping of vehicles or their components, or the rebuilding or remanufacturing of vehicle components
- distribution, storage or retail sale of fuels, **except** as part of the terminal operations
- wholesale or retail sale of articles or products, if the substance is not released to the environment during normal use at the facility
- retail sale of the substance
- growing, harvesting or managing renewable natural resources, such as fisheries, forestry or agriculture, **but not** the processing or other use of renewable natural resources
- mining, **but not** the further processing or other use of mined materials
- the practice of dentistry.

Box 2

- non-hazardous solid waste incineration of 26 tonnes or more of waste per year, including small combustion units, conical burners and beehive burners
- biomedical or hospital waste incineration of 26 tonnes or more of waste per year
- hazardous waste incineration
- sewage sludge incineration
- wood preservation;
- terminal operations
- discharge of treated or untreated wastewater from a wastewater collection system with an annual average discharge of 10 000 m³/day or more, into surface waters.

2.6.2 CASE 2 - Only Consider CAC Emissions from Stationary Combustion Equipment

Only consider emissions from stationary combustion equipment for the following cases:

- facility with less than 20 000 employee-hours, or
- facility used exclusively for an activity listed in Box 1 of Figure 1, or
- pipeline installation.

2.6.2.1 Exclusion of Stationary External Combustion Equipment Burning Certain Types of Fuels

If you are a Case 2 reporter, you are **not** required to submit a report to the NPRI for any CAC, if **all** of the following criteria are met:

- a) the substances were only emitted to air at the facility from stationary, external combustion equipment; **and**
- b) the cumulative nameplate capacity of **all** stationary, **external** combustion equipment was less than 10 million BTU/hour (10.55 million kJ/hour); **and**
- c) the only type of fuel combusted in that equipment was commercial grade natural gas, liquefied petroleum gas, Number 1 or 2 fuel oil or any combination thereof.

This exclusion does not apply if any fuel other than commercial grade natural gas, liquefied petroleum gas, Number 1 or 2 fuel oil or any combination thereof was also burned in the stationary, external combustion equipment.

You now have identified what CAC sources at your facility should and should not be considered when determining if your facility met the substance threshold. If you require clarification on the terms used in Section 2.6.2.1, proceed to Section 2.6.2.2. If not, proceed directly to Section 2.7 for the substance thresholds for each CAC.

2.6.2.2 Explanation of Terms used in Section 2.6.2.1

Stationary, external combustion equipment refers to any stationary equipment with a combustion process that occurs at atmospheric pressure and with excess air. This may include thermal electric generating plants, industrial boilers, and commercial and domestic combustion units. Commercial grade natural gas, liquefied petroleum gas, and Number 1 and 2 fuel oils are among fuels used.

Cumulative nameplate capacity refers to the total nameplate capacities of all stationary **external** combustion equipment at the facility.

Nameplate capacity refers to the total designed energy input capacity of the **stationary, external** combustion equipment.

Fuel Types:

- **Commercial grade natural gas** consists of a high percentage of methane (generally above 85%) and varying amounts of ethane, propane, butane and inerts. The average gross heating value is approximately 37.4 MJ/m³ (36.01 BTU/m³).
- **Liquefied petroleum gas (LPG or LP-gas)** consists of propane, propylene, butane and butylenes. There are two grades of LPG available as heating fuels. Grade 1 fuel is intended for use in internal combustion engines operating under moderate to high engine severity. Grade 2 fuel is adequate for most industrial uses, especially where low ambient temperatures exist and uniformity of fuel volatility are important. Propane is also used as an alternative to gasoline and as a standby fuel for facilities with interruptible natural gas service contracts.
- **Number 1 or 2 fuel oil** are distillate oils suitable for use in liquid fuel burning equipment without preheating. Type 1 fuel oil is primarily intended for use in sleeve type, wick fed and most vapourizing pot-type burners. Type 2 fuel oil is a heavier distillate than Type 1. Type 2 intended use is medium-capacity, commercial-industrial burners where ease of handling and availability justifies its use. Neither Type 1 or 2 fuel oils include heavy fuel oils or residual oils.

You now can proceed to Section 2.6.3 to identify what sources of CACs are not considered when reporting to the NPRI.

2.6.3 Sources Not Included When Determining if the Facility Met a CAC Release Threshold

CAC emissions from sources shown in Table 2 should not be considered when determining whether your facility met a CAC threshold or when reporting to the NPRI.

TABLE 2: SOURCES NOT CONSIDERED WHEN REPORTING TO THE NPRI

<ul style="list-style-type: none"> articles that are processed or otherwise used
<ul style="list-style-type: none"> materials used as structural components of the facility – The exclusion of structural components of the facility from the reporting threshold is limited to buildings and other fixed structures but does not include process equipment.
<ul style="list-style-type: none"> materials used in routine janitorial or facility grounds maintenance – This includes NPRI substances contained in fertilizers and pesticides used for grounds maintenance and cleaning agents, floor waxes, etc., used for maintaining facility cleanliness. The maintenance of processing equipment is not considered “routine janitorial” or “facility grounds” maintenance. For example, if manufacturing or processing equipment is cleaned with a solvent, the amount of the NPRI substance(s) contained in the solvent should be included in the threshold calculation.
<ul style="list-style-type: none"> materials used for personal use by employees or other persons
<ul style="list-style-type: none"> materials used for the purpose of maintaining motor vehicles operated by the facility
<ul style="list-style-type: none"> in intake water or intake air – This refers to water used for process cooling or air used either as compressed air or for combustion

In addition to Table 2, neither road dust nor vehicle emissions should be considered when calculating the substance threshold or reporting the amount released to the NPRI.

Proceed to Section 2.7 for the thresholds for each CAC.

The CACs resulting from other sources at the facility, including those listed in Table 2, should not be included in the facility’s release estimate.

2.7 Substance Thresholds

A report is required for each CAC substance emitted (released to air) in a quantity greater than or equal to the threshold listed in Table 3. Details on reporting each of these substances is provided in the following sections.

TABLE 3: CAC REPORTING THRESHOLDS

CAS No.	CAC Substance	Substance Threshold
11104-93-1	Oxides of nitrogen (expressed as NO ₂)	20 tonnes
7446-09-5	Sulphur dioxide	20 tonnes
630-08-0	Carbon monoxide	20 tonnes
N/A	Volatile organic compounds (VOCs)	10 tonnes
N/A	Total particulate matter ¹	20 tonnes
N/A	PM _{2.5} ¹	0.3 tonnes
N/A	PM ₁₀ ¹	0.5 tonnes

¹ Do not include emissions from road dust.

It is important to note that the thresholds for CAC emissions are based on the quantity released to air, rather than on the quantity manufactured, processed or otherwise used as is the basis for the majority of other substances listed in the NPRI. When reporting to the NPRI for the 2002 reporting year, facilities meeting the reporting thresholds for CACs (e.g., VOCs) are required to report their air emissions based on the total mass emitted annually.

More information is provided in Chapter 3 for each CAC substance.

You now are ready to calculate your facility's releases to determine if you are legally required to report to the NPRI for CAC emissions. Chapter 3 provides more information on the CAC substances and possible sources at your facility. Chapter 4 provides information on the common estimation techniques for CAC emissions and factors affecting release quantity. If you are required to report to the NPRI for CACs, proceed to Section 2.8 to determine what you are required to report.

2.8 If You Are Required to Report

Once you have determined that you are required to report for any CAC, refer to the *Guide for Reporting to the National Pollutant Release Inventory – 2002*, for details on how to proceed with reporting to the NPRI (i.e., installing and using the reporting software, and submitting your NPRI report to Environment Canada).

The remainder of this Supplementary Guide provides information on CAC substances, sources of CACs, estimating emissions of CACs, details on the CAC-specific fields in the reporting form, and a list of reference materials.

The case studies in Appendix 1 were designed to provide step-by-step estimation assistance on a facility scale following the information presented in Chapter 2.

3. CAC Substances and Possible Sources of CAC Emissions

3.1 CAC Substances

3.1.1 Oxides of Nitrogen (expressed as NO_x) [CAS No. 11104-93-1]

Nitrogen and oxygen in air at high temperatures can combine to form oxides of nitrogen (NO_x). Furthermore, fuel combustion and high temperature, and industrial processes produce NO_x. In addition, nitrogen in fuel also increases the amount of NO_x produced. The atmospheric reactions involving NO_x are complex. Oxides of nitrogen play an important role in the formation of ground-level ozone. NO_x can react with other air contaminants (e.g., ammonia) to form PM_{2.5}. NO_x is also a major component in the formation of acid rain.

Oxides of nitrogen (NO_x) include both nitric oxide (NO) [CAS No. 10102-43-9] and nitrogen dioxide (NO₂) [CAS No. 10102-44-0]. Since NO_x is a mixture, both NO and NO₂, must be expressed on an NO₂-equivalent basis before their individual quantities are combined for the total NO_x release. Do not include nitrous oxide (N₂O) [CAS No. 10024-97-2] when calculating your NO_x release.

As with other CACs, the value for NO_x (expressed as NO₂) may be in units of parts per million volume (ppmv or ppm (volume)). Before you use this value to estimate your emissions, you will need to convert this value to tonnes. This is a two-step process. The first step is to convert the ppmv concentration to a mass per unit volume in g/m³. Once the mass per unit volume is determined the second step is to use the stack flow rate to determine an annual release value from that stack. This process is shown in detail in Appendix 2, Example 2.1.

Emission factors for NO_x are available from various emission factor databases, such as the U.S. Environmental Protection Agency Factor Information REtrieval (FIRE) database (version 6.23). More information on FIRE is provided in Section 6.8 of this Supplementary Guide. If you are using an emission factor to determine your NO_x release, it is important to determine how the emission is expressed. FIRE, for example, will give you the total NO_x released already expressed as NO₂. Determining in what units the emission factor is expressed is also important. You may need to convert from Imperial or U.S. units to metric units. A conversion table is included in Sections 6.7.7 to 6.7.9 of this Supplementary Guide.

3.1.2 Sulphur Dioxide [CAS No. 7446-09-5]

Sulphur dioxide (SO₂) is a pollutant formed when sulphur is oxidized and emitted to the atmosphere. Fuel containing sulphur emits SO₂ when it is burned. Common sulphur-containing fuels include coal and oil. SO₂ is also released during metal smelting and other industrial processes. Like NO_x, SO₂ is a precursor to the formation of particulate matter and, subsequently, smog. It is also a major component of acid rain.

Sulphur dioxide belongs to the sulphur oxide (SO_x) family of gases. However, reporting to the NPRI is only required for SO₂, not SO_x. Therefore the quantity of sulphite or sulphur trioxide (SO₃) and sulphate (SO₄) released at your facility should not be considered when calculating your SO₂ release. Sulphuric acid (H₂SO₄) is listed in the NPRI; refer to the *Guide for Reporting to the National Pollutant Release Inventory – 2002*, to determine if you met the reporting threshold for sulphuric acid.

If you are using emission factors to determine your SO₂ release, some important points must be kept in mind. The emissions estimation documents and the FIRE database provide emission factors for both SO₂ and SO_x. Ensure that you are using the most applicable emission factor. However, if you only have access to an SO_x emission factor for your process, you can use it because the concentration of other sulphur oxides is generally low. When calculating SO₂ emissions based on the sulphur content in fuel, you can report all sulphur as SO₂ if you do not have information to estimate the portion of sulphur emitted as SO₂ or SO₄ since the percentage of these species is low.

3.1.3 Carbon Monoxide [CAS No. 630-08-0]

Carbon monoxide is a colourless, odourless, poisonous gas formed during the incomplete combustion of carbon. The rate of carbon monoxide (CO) emissions from combustion sources depends on the overall oxidation efficiency of the carbon to carbon dioxide. The presence of CO in the exhaust gases of combustion systems results principally from incomplete fuel combustion.

3.1.4 Volatile Organic Compounds (VOCs)

Volatile organic compounds (VOCs) are substances that can photochemically react in the atmosphere. In addition, VOCs are precursors to the formation of secondary particulate matter and ground-level ozone.

There are many industrial and commercial sources of VOCs, such as loading and unloading of petroleum products, petroleum spills, process venting, spill remediation, flaring of untreated natural gas, evaporative losses from storage tanks, painting and stripping activities, degreasing activities, burning fuel (e.g., oil, wood, coal, and natural gas), solvents, wood preservatives, and stored fuels.

The NPRI uses the definition of VOC as proposed under CEPA 1999 (refer to Appendix 3). This VOC definition includes a list of individual and classes of substances that do not fall under the VOC definition and should not be considered in your threshold calculations or when reporting emissions of total VOC to the NPRI.

For the purposes of reporting to the NPRI, it is important to note that:

- VOCs are a class of substances that are not limited to the approximately 100 VOC substances listed in the NPRI with either a 10-tonne manufacture, process and otherwise use reporting threshold or an alternative reporting threshold. You must consider these VOC substances in your threshold calculations for total VOC and ALL other VOC substances emitted at your facility during 2002.
- substances that are considered VOCs include but are not limited to the acetic acid, acetylene, acrolein, aniline, ethylene glycol, hexane (all isomers), methyl ethyl ketone, mineral spirits, heavy and light aromatic solvent naphtha, octane (all isomers), other petroleum distillates, phenol, propylene, Stoddard solvent, styrene, trichloroethylene, vinyl acetate and vinyl chloride. Refer to Table 4 for examples of VOC categories and other VOC substances.
- when reporting to the NPRI, your estimate for total VOCs emitted to air should be based on the **total mass of all VOC substances** that are emitted annually at your facility.

TABLE 4: CATEGORIES OF VOLATILE ORGANIC COMPOUNDS

CATEGORY	EXAMPLE COMPOUNDS
Alcohols	Ethanol Isopropyl alcohol Methanol
Alkanes	<i>n</i> -Butane Propane Octane
Alkenes	Ethylene Propylene Isobutene trans-2-Pentene
Alkynes	Acetylene
Aromatics	Benzene Benzo(a)pyrene Fluoranthene Toluene 1,2,4-Trimethylbenzene Xylene (all isomers)
Aldehydes	Formaldehyde Acetaldehyde
Ketones	Methyl isobutyl ketone
Ethers	Methyl <i>tert</i> -butyl ether Tripropylene glycol monomethyl ether

3.1.5 Particulate Matter

Particulate matter is any solid particle found in the air. Particulate matter in the atmosphere reduces visibility and forms haze. Smaller-sized particulate matter can be inhaled and may cause respiratory problems. Particulate matter may be released directly into the atmosphere or formed secondarily in the atmosphere from precursors as a result of physical or chemical transformations. Primary particulate matter (Primary PM), as measured using U.S. EPA Method 5 or 5a, includes both filterable and condensable PM. Only **filterable PM** is to be reported to the NPRI. Emission factors exist for primary PM, condensable PM and filterable PM; ensure you are using the correct factor. Road dust emissions are not to be included in your particulate matter estimates or when reporting to the NPRI.

The NPRI requires reporting for three size fractions of particulate matter:

- total particulate matter with a diameter less than 100 microns (TPM), and
- particulate matter with a diameter less than or equal to 10 microns (PM₁₀), and
- particulate matter with a diameter less than or equal to 2.5 microns (PM_{2.5}).

PM₁₀ may be released directly into the atmosphere or formed secondarily in the atmosphere from precursors as a result of physical or chemical transformations. PM_{2.5}, also referred to as fine particulate, is the fraction of particulate matter recognized as having the greatest effect on human health.

Particulate matter is formed in various industrial and non-industrial processes. Some common sources of particulate matter include burning of fuels in combustion units, separation processes, land treatment, mine tailings and storage piles. Wet stacks release considerable amounts of water/steam into the atmosphere from which particulate matter can form. However, for the purposes of NPRI, TPM, PM₁₀ and PM_{2.5} emissions should be reported on a dry basis.

The emission factors for TPM include the size fractions for PM₁₀ and PM_{2.5}. In addition, the PM₁₀ emission factor includes the PM_{2.5} fraction. Because of this, emissions of PM should not be added. The potential double-counting issue will be addressed in the reporting out of CAC emissions.

In some cases, there may be TPM emissions available (from testing or emission factors) but no size distribution. The U.S. EPA has software available, PM Calculator, which contains particle size distribution information and size-specific control information for control devices. This software may be used to estimate the PM₁₀ and PM_{2.5} emissions from a process. The software can be found on the U.S. EPA's Web site at www.epa.gov/ttn/chief/software/pmcalc/index.html. Read the documentation accompanying the software for information on preparing the input files.

In some cases, there is no emission factor available for TPM but PM₁₀ and PM_{2.5} emission factors are available. In the absence of other information, the PM₁₀ emission factor may be assumed to be the same for the TPM emission factor.

3.2 Stationary Combustion Equipment and Other CAC Sources

The NPRI requires reporting for stationary combustion equipment that forms part of the facility. For the purposes of reporting to the NPRI, stationary combustion equipment refers to any combustion equipment which needs to be stationary to function or operate properly or is not capable of self-propulsion. Both internal and external combustion equipment can fall into the stationary category. The definitions of internal and external combustion equipment can be found in subsections 3.2.1 and 3.2.2 respectively.

The sum of the contribution from a number of smaller sources should not be overlooked. If your facility has a number of smaller sources, you are still required to calculate your combined release from each source to determine if you are required to submit a report to the NPRI for CACs.

3.2.1 External Combustion Equipment

An external combustion unit is defined as any equipment with a combustion process that occurs at atmospheric pressure and with excess air. Some examples of equipment that may fall within this definition include heaters, furnaces, incinerators, boilers, flares, combustion chambers, external combustion engines such as steam engines and Stirling engines, steam/electric generating plants, and other commercial units.

3.2.2 Internal Combustion Equipment

Internal combustion units are identified as ones in which combustion of the fuel takes place in a confined space and above atmospheric pressure. The expanding gases produced by the combustion are used to provide mechanical power. Some examples of stationary internal combustion equipment include but are not limited to gas turbines, natural gas-fired reciprocating engines, gasoline and diesel industrial engines, large stationary diesel and stationary dual-fuel engines.

3.2.3 Storage Tank Emissions

CAC emissions may result from any storage tank containing fuels, solvents, hydrocarbons, paints and other solutions that contain VOC substances. The emissions are the result of the evaporation of stored substances. The rate of evaporation depends on the type of storage tank, ambient conditions, as well as the vapour pressure of the substance(s). Generally, there are six basic tank designs that are used for organic liquid storage vessels – fixed roof (vertical and horizontal), external floating roof, domed external (or covered) floating roof, internal floating roof, variable vapour space, and pressure (low and high). A brief description of each tank and the vapour loss mechanisms associated with it is provided in Appendix 4 of this Supplementary Guide.

The U.S. EPA's TANKS software may be used to estimate emissions from storage tanks. For common fuels there is default information available, otherwise the procedure outlined in the U.S. EPA's documentation should be followed.

3.2.4 Other Sources of Emissions

Combustion is not the only source of CAC emissions. It is, however, the major source of industrial and commercial CAC emissions. To assist in identifying other sources at your facility, the following section has been prepared. Note that the sources discussed in this section do not make up a comprehensive list. CAC emissions from sources other than those discussed here should be considered when determining if the facility met the substance threshold.

- **Storage Piles**

Storage piles are a source of fugitive CAC emissions. The bulk solids that make up the pile are subject to wind erosion, which results in particulate matter being released to air. Pile moisture content and surface area, size of solids, force of wind and amount of wind received all impact the total emissions released from the storage pile.

To calculate the release of a certain storage pile, use the following equation:

$$E = k \times (0.0016) \times \left[\frac{(U_{12.2})^{1.3}}{(M_{12})^{1.4}} \right] \text{ kg/tonne}$$

Where:

E	=	emission factor, kg/tonne
k	=	particle size multiplier (dimensionless)
U	=	mean wind speed, metres per second (m/s)
M	=	material moisture content (%)

Once the emission factor is calculated using the above equation, multiply it by the number of tonnes of the substance in the storage pile.

Refer to the Chapter 13, subsection 13.2.4, in the U.S. EPA's AP-42 document for further information on emissions from these sources. [Reference: <http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s02-4.pdf>]

- **Loading/Unloading**

Fugitive CAC emissions can result from the loading and unloading of vehicles or containers. If the material being transferred is a liquid, the resulting emissions would likely be in the form of VOCs. If the material is a solid, the resulting emissions would likely be in the form of particulate matter.

Emission factors are available for calculating the release from loading or unloading either a solid or liquid material. [Reference: http://www.epa.gov/ttnchie1/eiip/techreport/volume03/iii12_apr2001.pdf]

- **Fermenting**

The process of fermentation involves the use of yeast, bacteria, enzymes, etc., to breakdown complex organic compounds into intermediate or final products. Many industries use the fermentation process. They include those involved in the production of bread, spirits, pharmaceuticals and fuel, beer and wine making, and environmental bioremediation processes. Emission factors and mass balances can be used to estimate the CAC emissions using the formula presented in the U.S. EPA's methodology. [Reference: <http://www.epa.gov/ttn/chief/ap42/ch09/final/c9s09-6.pdf>]

- **Painting**

Volatile organic compounds are released from paint during its application and drying. This category includes, but is not limited to, the painting of vehicles, storage tanks and any other painted product.

It is possible to estimate the release by assuming that the entire VOC content of the paint and solvents is released. The percentage of VOC in the paint and solvents used should be listed on the MSDS for the products. The total release then would be equal to the VOC percentage multiplied by the total weight of the paint used. Generic emission factors are also available for painting and coating processes. However, consult the coatings' manufacturer to determine if an emission factor specific to the product used is available. [Reference: http://www.epa.gov/ttn/chief/eiip/techreport/volume02/ii07_july2001.pdf]

- **Abrasive Blasting**

Abrasives blasting is the process of cleaning or texturing materials such as metal and ceramics with an abrasive material. Sand is the common abrasive used in blasting. However, coal, smelter slag, mineral, metallic and synthetic abrasives are also used. The blasting process itself is a source of particulate matter emissions, especially PM₁₀ and PM_{2.5}.

Emission factors and mass balances can be used to estimate the CAC emissions using the formula presented in the U.S. EPA's methodology. [Reference: <http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s02-6.pdf>]

- **Equipment Leaks**

Equipment connections, joints and interfaces can be the source of both gaseous and liquid releases. If the equipment is handling a gaseous stream containing a CAC substance, the gaseous leak would result in a fugitive CAC release. Depending on the properties of a liquid (such as vapour pressure, temperature and pressure), the liquid release may also result in a fugitive CAC emission.

Emission factors are available for estimating the release of CAC substances from equipment leaks. [References: http://www.epa.gov/ttn/chief/eiip/techreport/volume02/ii04_a.pdf and http://www.epa.gov/ttn/chief/eiip/techreport/volume02/ii04_b.pdf]

- **Open Burning**

Open burning consists of the burning of any material in a pit or pile. The material being burned is not contained in any structure and is completely open to the atmosphere.

Open burning can release any or all seven of the criteria air contaminants. The emissions from this activity are often estimated using emission factors. [Reference: http://www.epa.gov/ttnchie1/eiip/techreport/volume03/iii16_apr2001.pdf]

- **Solvent Use**

Solvent use includes, but is not limited, to solvent degreasing, waste solvent reclamation, fugitive emissions during product formulation and commercial solvent use. Many solvents contain VOCs which are released during use and storage through evaporation.

Emission factors, mass balances, and engineering estimates are often used to estimate VOC emissions from solvent use. [Reference: <http://www.epa.gov/ttn/chief/ap42/ch04/final/c4s06.pdf>]

Methods of estimation commonly used to calculate CAC emissions and the pollution-control equipment that will affect your releases are provided in Chapter 4.

4. Methods of Estimating CAC Emissions

Chapter 6 contains a list of technical guidance documents that can be consulted for technical information on CAC substances or processes. This includes technical guides prepared by Environment Canada, the U.S. EPA and industry associations. Other guidance documents and methods may also be appropriate for your facility's determination of CAC emissions. Furthermore, other sources of information that can be used to estimate CAC emissions include municipal, provincial, territorial or regional operating permits and certificates of approvals.

There are four commonly-used methods of estimating CAC emissions. They are described in detail below. For more information and examples on how to use these methods, refer to Appendix 2.

Facilities are only required to provide information to the NPRI which they possess or may reasonably be expected to have access. Consequently, the NPRI does not require additional monitoring or measurement of the quantities or concentration of substances released to the environment, beyond those already required under the provisions of other laws or regulations. You are, however, required to demonstrate "due diligence" in obtaining the information required.

For any of the methods listed, the use of air pollution control equipment should be considered in the estimation of emissions.

4.1 Direct Measurement

4.1.1 Continuous Emission Monitoring Systems (CEMS) for Emissions Stacks

CEMS records emissions over an extended and uninterrupted period. Various principles (usually based on photometric measurements) are employed to measure the concentration of contaminants in the gas stream. Once the contaminant concentration and the flow rate have been determined, emission rates can be calculated by multiplying the contaminant concentration by the volumetric stack gas flow rate. Annual emissions of the contaminant can then be estimated using the contaminant concentration and the annual flow rate of the discharged gases in the stack or duct.

4.1.2 Predictive Emission Monitoring (PEM)

PEM is based on developing a correlation between contaminant emission rates and process parameters (e.g., fuel usage, steam production or furnace temperature). PEM may be considered a hybrid of continuous monitoring, emission factors and stack tests. A correlation test must first be performed to develop the relationship between contaminant emission rates and process parameters. Emissions can then be calculated or predicted using process parameters to predict emission rates based on the results of the initial source test. For example, emissions of particulate matter from a boiler may be predicted based on the correlation of the particulate emissions with the fuel flow rate.

4.1.3 Source Testing

Source sampling provides a "snapshot" of source emissions during the test period. Generally, a sampling probe is inserted into the stack or duct and a volume of exhaust effluent is collected isokinetically, such that contaminants are collected in or on various media and subsequently analyzed. Emission rates are then determined by multiplying the contaminant concentration by the volumetric flow rate or production rate at reference conditions. The emission loading is subsequently calculated from these emission rates and the total period of operation.

Source testing is often conducted as part of a regulatory requirement for provincial, territorial or regional regulatory requirements.

4.2 Mass Balance

Mass balances apply the law of conservation of mass to a facility, process or equipment. Essentially, if there is no accumulation, then all the materials that go into the system must come out. Emissions are determined from the difference in the input and output of a unit operation where the accumulation and depletion of a substance are included in the calculations.

The general equation for the mass balance is:

$$M_{\text{in}} = M_{\text{out}} + M_{\text{accumulated/depleted}}$$

Where:

M_{in} = Mass of compound in the raw material feed

M_{out} = Mass of compound in the finished product and emitted to air

$$(M_{\text{out}} = M_{\text{product}} + M_{\text{emitted}})$$

$M_{\text{accumulated/depleted}}$ = Mass of compound accumulated or depleted in the system

Fuel analysis data is a good example of how the mass balance approach can be used in estimating emissions. For example, if the concentration of a contaminant or contaminant precursor in a fuel is known, emissions of that contaminant or contaminant precursor can be calculated by assuming that all of the contaminant is emitted prior to the application of emission control. This approach is appropriate for contaminants such as SO_2 and VOCs. It should be noted that some contaminants require further analysis to determine the portion emitted to the atmosphere because some of these contaminants may end up in various physical or chemical states (e.g., ash) not emitted to the atmosphere.

The reliability of emission estimates based on mass balances are dependent on the source type considered. Mass balance methods may be a preferred method for some emission sources, such as solvent loss from coating applications and solvent use. This method may not be suitable for many other sources, such as in cases where chemical transformation of the input streams occurs in the process.

Mass balance methods may or may not account for emission controls, depending on the system, process or operation to which the mass balance is applied. Care should be taken to ensure that the effect of pollution-control equipment is taken into account when performing mass balance calculations.

4.3 Emission Factors

Emission factors are available for many emission source categories and are generally based on the results of source sampling tests performed at one or more facilities within a specific industry. Generally, emission factors relate the quantity of substances emitted from a source to some common activity associated with those emissions. Emission factors have been published by government agencies and industry associations for application to emission sources in their particular jurisdiction or industry sector. Industrial facilities may also develop their own site-specific emission factors using emission-testing data and source-activity information. For a particular piece of equipment, specified emission factors may be available from the manufacturer or sales centre.

The basic equations to determine emissions from emission factors are as follows:

$$E_x = BQ \times CEF_x \quad \text{or} \quad E_x = BQ \times EF_x \times \frac{100 - CE_x}{100}$$

Where:

E_x = Emission of contaminant x, kg

BQ = Activity rate or base quantity (BQ), base quantity unit

CEF_x = Controlled emission factors of contaminant x, kg/BQ unit
(value is dependent on the external control device installed)

EF_x = Uncontrolled emission factors of contaminant x, kg/BQ unit

CE_x = Overall emission control efficiency of contaminant x, %

The U.S. EPA's FIRE database and AP-42 are the most comprehensive and commonly used sources of process specific CAC emission factors. If you wish to make use of this information it can be downloaded from the Web site at <www.epa.gov/ttn/chief/>.

It should be noted that this information is currently available in English only. The database comes with comprehensive instructions and users are advised to consult those instructions before using the database. Environment Canada cannot provide software support for this product.

In general, baseline emissions of air contaminants from facilities are from uncontrolled combustion sources. An uncontrolled source is one without add-on air pollution control equipment or other modifications designed to control emissions. There are emission factors that will take into account pollution-control equipment. Before using an emission factor, ensure that it accounts for the pollution-control equipment you are or are not using. If you are using the FIRE database this is information you will find in the Details tab of the software. If you are using an uncontrolled emission factor for estimating emissions from a unit with pollution-control equipment, you may over-report your releases for some substances released from that unit. You can apply the designed control efficiency of your pollution-control equipment to the uncontrolled emission factor if no adequate FIRE emission factor exists.

For fuel combustion, facilities should check with their combustion equipment suppliers and/or their fuel suppliers for any specific or recommended emission factor for their specific combustion combination. If your supplier does not have an emission factor, you may then refer to the tables found in Appendix 6 of this Supplementary Guide.

For all emission factors, note the units being used and convert if necessary to the metric units used for NPRI reporting.

Emission factors often specify whether the estimated emission is on a “controlled” or “uncontrolled” basis. For controlled emission factors, the user should select the emission factor which is representative of the source. In some cases, an emission source may be controlled but only an uncontrolled emission factor is available. The best solution in this situation is to ask your supplier to provide you with the control efficiency rating relevant to your process and equipment. If the supplier does not have the control efficiency rating, you may then use the tables in Appendix 6.

Appendix 6 lists air emission control equipment and typical control efficiencies. Environment Canada recommends using the middle value if a range is given for a specific piece of pollution-control equipment. With the control efficiencies you can use the emission factor for an uncontrolled emission and apply the control efficiency to the resulting emissions. The control efficiencies are dependent on the age of the device, maintenance, process rates and other parameters. Judgment should be used in selecting the appropriate efficiency.

4.4 Engineering Estimates

4.4.1 Engineering Estimates

In many cases, sound engineering assessment is the most appropriate approach to determine process factors and base quantity values. Emissions can be estimated from engineering principles and judgment, using knowledge of the chemical and physical processes involved, the design features of the source, and an understanding of the applicable physical and chemical laws. The reliability of these estimates depends on the complexity of the process and the level of understanding of its emission behaviour. To apply an engineering assessment method, there are four basic principles to be followed:

- review all data pertaining to the specific emission source and to the industrial sector in general
- use this data to provide gross approximations and refine these using sound engineering principles as data become available to provide more accurate estimations
- whenever possible, alternate methods of calculation should be conducted to cross-check each level of approximation, and
- employ good record keeping which involves documenting all related information for further emission refinement when more accurate data become available.

There are additional examples presented in Appendix 2, which provide reference for calculating emissions.

4.4.2 Emission Models

Emission estimation models, also known as emission estimation tools, are equipment specific and may be available from process developers and designers, government agencies or others. Common examples include the U.S. EPA's TANKS model for calculating VOCs for storage tanks and the Landfill Gas Emissions Model software which is used for calculating air contaminant emissions from municipal solid waste landfills. Appendix 5 provides a description and areas of strength for the common tools used for estimating CAC emissions.

Emission models generally require detailed input such as equipment specifications, process and environmental conditions and other factors that affect emissions. Generally, these models also have default input parameters, such as meteorological data, which can be used when site-specific information is not available. Care should be taken to review the default data to determine their applicability to local conditions. The resulting estimates should be reviewed to ensure they are accurate.

5. Reporting Form for CACs

This Chapter describes each field in the reporting form for CACs as well as the information required for those fields. The reporting form for CACs differs somewhat from that for other substances listed on the NPRI. Only the quantity of CACs released by a facility to air is to be reported to the NPRI and, as such, the CAC threshold criteria for reporting and the reporting form are based on on-site releases to air. Unlike the reporting form for other NPRI substances, information will not be collected for CAC on-site releases to media other than air (i.e., water, land and underground injection) or for off-site transfers for disposal or recycling. The specifications for information to be reported for CACs are provided in Parts 1 and 3 of Schedule 3 of the *Canada Gazette* notice for the 2002 NPRI.

For more information on fields in the electronic reporting or that are not specific to CACs, refer to Steps 3 to 6 in the *Guide for Reporting to the National Pollutant Release Inventory – 2002*:

- Step 3 - Install the 2002 reporting software and upload data from your 2001 NPRI report (if applicable)
- Step 4 - Enter or update the facility information
- Step 5 - Enter or update the NPRI substance information
- Step 6 - Check errors, make corrections, export data and print the Statement of Certification

5.1 Opening and Main Menu Screens

The first time you use the software, you will be asked to select the inventory programs to which you wish to report. After you have selected these, the software will confirm your choices and include an explanation of the programs you selected.

The first opportunity you have to enter information specific to CACs is from the “Main Menu” and by selecting the “View / Enter / Edit Data” button. Selecting this option will open a screen with the option “Stacks (≥ 50 metres)”. This option will allow you to enter stacks into your facility’s stack pick-list which will be used later in the software when entering release information.

When you select the “Stacks (≥ 50 metres)” button, you will be shown the stack pick-list. If the pick-list is empty, you may add a stack by selecting the “Add” button at the bottom of the screen. This will take you to the “Identification of Stacks (≥ 50 metres)” screen. Here you will be asked to supply information for any stack greater than or equal to 50 metres above grade meeting the stack release thresholds. This information will appear in fields S2.1 to S2.8. The stack information can also be entered within the individual CAC substance reporting screens. Refer to Section 5.3, Field B12.1.a, entitled “Stack or point releases”.

S2.1 and S2.2 Stack ID Number and Stack Name

The software will assign each stack an identification number and provide a field for you to assign a name/description to the stack. This is intended to ease stack identification by the facility for current and future reporting. Environment Canada strongly recommends that facilities provide an appropriate stack name.

S2.3 Stack Height (m)

This refers to the height of the stack above grade. The height of the stack is determined by taking the measurement from ground level to the exit level of the stack. This is the same procedure used if the stack is on top of a building. For example, if you have a 30-m stack sitting on top of a building that is 20 tall, your total stack height is 50 m.

S2.4 Stack Diameter (m)

Report the inner diameter at the exit level of the stack. If the opening at the top of the stack is not circular, calculate and report the equivalent diameter using the equation in Section 6.7.3 of this document.

S2.5 Exit Velocity (m/s)

Enter the average exit velocity of the gas where it exits the stack or flare. This number is often required for an operating permit. Use the number on the permit where applicable. In the case where only the exit flow rate is known, use the equation in Section 6.7.4 to convert the flow rate (i.e., m^3/s) to velocity (m/s).

S2.6 Exit Temperature (°C)

Enter the average temperature of the gas when it exits the stack, or the average temperature at the top of the flame for a flare. This number is often required for an operating permit. Use the number on the permit number where applicable. Section 6.7.1 provides the equations to convert Kelvin and degrees Fahrenheit to degrees Celsius.

S2.7 and S2.8 Stack Latitude and Longitude (optional)

If the latitude and longitude value of the stack is known (e.g., documented in regulatory permits or site plans), report this information in the field provided. The required format is *degrees, minutes, seconds*. Reporting this information is not mandatory, but it is of use to regional air-quality modellers who will use the information collected through the NPRI for CACs.

5.2 Facility Reporting Form

This section describes only the fields specific to CAC reporting. For information on the other fields, refer to the *Guide for Reporting to the National Pollutant Release Inventory – 2002*, Step 4.

- A1.0 NPRI ID, Web Site Address, Dun and Bradstreet Number
- A2.0 Facility Identification and Site Address
- A3.0 Identification of Parent Companies
- A4.0 Facility Public Contact
- A5.0 Facility Public Contact Address
- A6.0 Facility Technical Contact
- A7.0 Facility Technical Contact Address
- A21.0 Contractor Contact
- A22.0 Contractor Contact Address
- A8.0 Company Coordinator
- A9.0 Company Coordinator Address
- A.10.0 Primary Industrial Classification Codes
- A11.0 Number of Full-Time Employees or Equivalent
- A12.0 Activities Relevant to Reporting Dioxins/Furans and Hexachlorobenzene
- A13.0 Activity Relevant to Reporting Polycyclic Aromatic Hydrocarbons (PAHs)
- A25.0 Criteria Air Contaminants (CACs)
- A25.1 Are you required to report for one or more criteria air contaminants?

Select either “Yes” or “No”. If you select “Yes”, you are required to enter the facility operating schedule (fields T1.1 through T1.5). Otherwise, leave the answer as “No”. To enter the operating schedule, select the “View Operating Schedule” button on the right of the field.

T1.0 Facility Operating Schedule (Temporal Variation)

For a detailed explanation of temporal variation, refer to Appendix 7 of this Supplementary Guide.

T1.1 Days of Operation

You must select the appropriate days of the week on which your facility operates.

T1.2 Hours of Operation

You are required to select the appropriate hours of operation for your facility. Three common hours-per-day schedules are given; “other” is used to capture non-standard schedules. If you choose “other”, you must complete sections T1.2.a(ii) and T1.2.b.

T1.2.a Hours of operation

T1.2.a(i) Select the appropriate hours of operation. Your options are 24, 16, or 8 hours per day. If none of these options are applicable, select “other” and complete field T1.2.a(ii).

T1.2.a(ii) If “Other”, then provide the average total daily hours of operation

On this portion of the screen you will need to complete the following statement: “Average total daily hours of operation: __hours.” (input is in hours, to 2 decimal places, e.g., 21.15).

T1.2.b Average daily start time of operation

This portion of the screen follows up your total daily hours of operation (response to T1.2.a) by asking you to provide Environment Canada with your average daily start time. The software will ask you to complete the following statement: “Average daily start time of operation: ____.” (use the 24-hour format of *hhmm*, e.g., 1130).

T1.3 Were there any periods of time longer than one week when operations at your facility were shut down?

The shutdown could be for scheduled or unscheduled maintenance or any other operations requiring a facility shutdown. Selecting either “Yes” or “No” is all that is required for reporting. Selecting “Yes” will present the screen for entering your shutdown periods and pressing the “View Shutdown Periods” button will present the shutdown screen for your viewing (field T1.4).

The purpose of this question is to identify shutdown times when emissions are zero or low. If this is not the case, then do not report shutdowns.

T1.4 Dates and times of shutdown periods (one week or longer)

To add the duration information about a shutdown select “Add” on the right of the screen. You are required to enter the start date (as *yyyy.mm.dd*), the start time (as *hhmm*), end date (as *yyyy.mm.dd*), and end time (as *hhmm*) of the operation’s shutdown. Ensure that the start and finish time are in the 24-hour time format, where 0000 and 2400 indicate midnight.

T1.5 Comments (Shutdown periods) (optional)

If you wish to provide comments on releases during the shutdown, or reasons for shutdown or other relevant information, select “Yes.” You will then be presented with a screen to enter your comments.

A26.0 Pollution-Prevention (P2) Planning**A14.0 Other Environmental Regulations or Permits (optional)****A15.0 Comments****A16.0 Company Official Certifying this Submission****A17.0 Company Official Address****5.3 Substance Reporting Form for CACs**

If your facility is located in Ontario and you are required to report to the NPRI and the Ontario Ministry of the Environment (ON MOE), the software will display both the NPRI and ON MOE fields. Refer to the *Guide for Reporting under O.Reg.127/01 Using the NPRI Software – 2002* or “Help” file for a description of the ON MOE fields.

Occasionally, fields will be disabled if they are not relevant to your inventory program selection. This is normal and should not cause alarm.

This section describes only the fields specific to CAC reporting. For information on the other fields, refer to the *Guide for Reporting to the National Pollutant Release Inventory – 2002*, Step 5.

B1.0 Substance Identity**B2.0 Nature of Activities****B9.0 ARET 2 - Collection of Use Information****B10.1 Do You Release This Substance On Site?****B11.1 Releases of Less Than One Tonne****B12.0 On-site Releases of the Substance to the Environment****B12.1 Air Releases**

Report all air emissions of the CAC substance, the basis of the estimate and the detail code, if applicable. Both routine releases, such as fugitive releases to air, and accidental or non-routine releases, such as a relief valve opening as the result of process upset, should be included in your estimate of the quantity released. You are only required to submit a report for those substances that met their respective release threshold.

For the purposes of reporting VOC information to the NPRI for the 2002 reporting year, facilities meeting the

reporting thresholds for total VOC are required to report their air emissions based on the total mass of all VOC substances emitted annually.

B12.1.a Stack or point releases – Total releases from stack or point sources including stacks, vents, ducts, pipes or other confined process streams. Releases to air from pollution-control equipment generally fall into this category.

For each stack greater than or equal to 50 metres above grade, you must identify CAC releases from the stack that met or exceeded the stack thresholds in Table 5. The button in the “# of Stacks” column shows the number of stacks that met the stack criteria and had attributable CAC releases. It will display a “?” if no stacks have been identified. Select the button to open a screen that allows you to attribute all or a portion of the identified release of a CAC substance to a stack greater than or equal to 50 metres above grade. Selecting “Add a Stack from pick-list” will present a screen with a “Pick-list of Stacks” that relate to this facility. If stacks have not been entered for this facility, then select the “Add a NEW Stack to the pick-list” button to add stacks to the pick-list.

You may add the names of new stacks to the pick-list if it is incomplete as described above or from the “View / Enter / Edit Data” menu by selecting the “Stacks (≥ 50 metres)” option.

TABLE 5: CAC THRESHOLDS FOR IDENTIFYING AND REPORTING FOR STACKS ≥ 50 METRES

CAC Substance	Stack Threshold
Carbon monoxide	5 tonnes
NO _x (expressed as NO ₂)	5 tonnes
Sulphur dioxide	5 tonnes
Total particulate matter	5 tonnes
Volatile organic compounds	5 tonnes
PM _{2.5}	0.15 tonnes
PM ₁₀	0.25 tonnes

For each stack greater than or equal to 50 metres above grade that met one or more of the stack thresholds, report the quantity released of each substance, and the physical parameters of that stack. If the physical parameters for the stack were already entered when reporting for another CAC substance, you are not required to enter them again as this information is retained within the stack pick-list.

Important: A stack may meet the criteria for one CAC substance but not for another.

Physical parameters of stacks greater than or equal to 50 metres:

For each stack which met one or more of the stack thresholds, the stack height and diameter must be reported, as well as the average exit temperature and average exit velocity, if known. This information will already be entered if a stack was selected from the stack pick-list.

B12.1.b Storage or handling releases – The quantity of releases to air from storage or handling of a listed substance should be entered in this field.

B12.1.c Fugitive releases – Fugitive releases are the total of all releases to air that are not released through confined process streams. These releases include:

- fugitive equipment leaks from valves, pump seals, flanges, compressors, sampling connections, open-ended lines, etc.
- evaporative losses from surface impoundments and spills
- releases from building ventilation systems, and
- any other fugitive or non-point air emissions from land treatment, mine tailings, storage piles, etc.

Do not include emissions from road dust when reporting total particulate matter, PM₁₀, and PM_{2.5}.

B12.1.d Spills – Any accidental releases to air that do not qualify as point or non-point air releases should be entered in this field.

B12.1.e Other non-point releases – Any other non-point air releases not estimated in one of the above air-related release types should be entered in this field.

B12.5 Total Quantity Released

For CAC emissions reporting, this field will display the total quantity released to air (i.e., sum of fields B12.1.a to B12.1.e).

B13.0 Monthly Breakdown of Releases by Percentage

This field is intended for facilities that have monthly fluctuations in their releases. Releases for the 12 months must total 100%.

B14.0 Reasons for Changes in Quantities Released from Previous Year

Since this is the first year that the NPRI is collecting information on CAC emissions, select field B14.1.i (Not applicable).

In future years, your facility will be expected to provide a reason for changes in release amounts for the reported CACs.

B14.2 Comments (Releases)

Comments specific to the releases to air of this substance may be provided in this field. The comments will appear in the NPRI database available to the public and are an opportunity to provide context for the information reported to the NPRI.

B15.0 Anticipated Releases

Enter your estimates of total releases to air, for the years 2003, 2004 and 2005 in field B15.1. Estimates for the years 2006 and 2007 are optional (select “Not applicable” if you do not want to make an entry). Factors that should be considered when making these estimates include future production levels, product or process changes, pollution-prevention measures, addition of pollution-control equipment, etc.

B30.0 Pollution-Prevention (P2) Activities

In this section, facilities that have taken measures to prevent the generation of NPRI pollutants and wastes are required to indicate what P2 activities they have implemented, for each substance. This section allows facilities to identify P2 activities that were newly implemented, in whole or in part, during the 2002 calendar year specifically for the substance being reported. If you are reporting for P2 activities not specific to a particular substance, or if you are providing information on P2 activities that were not newly implemented in 2002, identify these activities and the year in which they were implemented, in field A15.2, Comments (Pollution Prevention).

Information on how to complete this section of the reporting form is in Step 5 of the *Guide for Reporting to the National Pollutant Release Inventory – 2002*.

B40.0 Production Ratio and Activity Index (optional)

This section allows facilities, on a voluntary basis, to show the relationship between year-to-year fluctuations of their production levels and the relative decrease or increase in the sum of their on-site releases plus off-site transfers of the reported substance.

Information on how to complete this section of the reporting form is in Step 5 of the *Guide for Reporting to the National Pollutant Release Inventory – 2002*.

6. Additional Information

6.1 Background and Legal Information

The following references provide background information on stakeholder (federal and provincial governments, industry and environmental non-governmental organizations) consultations for adding CAC substances to the NPRI for the 2002 reporting year.

The *Canada Gazette*, Part I notice provides the legal basis for reporting to the NPRI.

- 1st NPRI Work Group Report (Fall 2001).
<www.ec.gc.ca/pdb/npri/documents/FINAL_WG_Report_E.PDF>
- Environment Canada Response to 1st Work Group Report.
<[www.ec.gc.ca/pdb/npri/documents/FINAL_EC_Response_English_\(January_2002\).pdf](http://www.ec.gc.ca/pdb/npri/documents/FINAL_EC_Response_English_(January_2002).pdf)>

6.2 References and Bibliography

Canada Gazette (2001) “Notice with Respect to Substances in the National Pollutant Release Inventory for 2002”, Department of the Environment, Extract *Canada Gazette*, Part I (December 29, 2001).

Canada Gazette (2002) “Notice with Respect to Substances in the National Pollutant Release Inventory for 2002 – Amendment”, Department of the Environment, Extract *Canada Gazette*, Part I (December 28, 2002).

Canada Gazette (1992) “Export and Import of Hazardous Wastes Regulations”, Department of the Environment, Extract *Canada Gazette*, Part II (December 2, 1992).

Canada Gazette (1991) “Domestic Substances List”, Department of the Environment, Extract, Supplement *Canada Gazette*, Part I (January 26, 1991).

Environment Canada (2003) “Guide for Reporting to the National Pollutant Release Inventory – 2002”.

Statistics Canada (1998) “North American Industry Classification System (NAICS) Canada Manual – 1997”, Catalogue 12-501-XPE, Ottawa, ON.

Statistics Canada (1989) “Standard Industrial Classification – 1980”, Standards Division, Catalogue 12-501E, Ottawa, ON.

Canadian Environmental Protection Act, 1999. <<http://laws.justice.gc.ca/en/C-15.31/text.html>>

Canada-wide Standards for Particulate Matter and Ozone.
<http://www2.ccme.ca/assets/pdf/pmozone_standard_e.pdf>

Government of Canada’s Interim Plan 2001 on Particulate Matter and Ozone. <www.ec.gc.ca>

Government of Ontario (2001). *Environmental Protection Act* - O. Reg.127/01.
<<http://192.75.156.68:81/ISYSQuery/IRLF9E.tmp/2/doc>>

Ozone Annex to Canada–U.S. Air Quality Agreement.
<www.ec.gc.ca>

6.3 Software and Publications of the U.S. Environmental Protection Agency

U.S. EPA Software Tools

Technology Transfer Network Clearinghouse for Inventories & Emission Factors.

<www.epa.gov/ttn/chief/index.html>

Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: *Stationary Point and Area Sources*.

<www.epa.gov/ttn/chief/ap42/index.html>

Factor Information REtrieval (FIRE). <www.epa.gov/ttn/chief/software/fire/index.html>

PM Calculator. <www.epa.gov/ttn/chief/software/pmcalc/index.html>

TANKS Emission Estimation Software. <www.epa.gov/ttn/chief/software/tanks/index.html>

Guidance Documents for Reporting to the Toxics Release Inventory

In 1988 and 1990, the Office of Pollution Prevention and Toxics of the U.S. EPA developed many industry-specific guidance manuals to help industries estimate the releases for reporting to the U.S. Toxics Release Inventory (TRI). Since 1998, some of these manuals have been revised and additional industry-specific guidance manuals have been prepared. These manuals, listed below, can also be used for reporting to the NPRI.

1. *Estimating Chemical Releases from Monofilament Fiber Manufacturing*, EPA 560/4-88-004a (January, 1988).
2. *Estimating Chemical Releases from Printing Operations*, EPA 560/4-88-004b (January, 1988).
3. *Estimating Chemical Releases from Electrodeposition of Organic Coatings*, EPA 560/4-88-004c (January, 1988).
4. *Estimating Chemical Releases from Spray Application of Organic Coatings*, EPA 560/4-88-004d (January, 1988).
5. *Estimating Chemical Releases from Semi-Conductor Manufacturing*, EPA 560/4-88-004e (January, 1988).
6. *Estimating Chemical Releases from Formulation of Aqueous Solutions*, EPA 560/4-88-004f (March, 1988).
7. *Estimating Chemical Releases from Electroplating Operations*, EPA 560/4-88-004g (January, 1988).
8. *Estimating Chemical Releases from Textile Dyeing*, EPA 560/4-88-004h (February, 1988).
9. *Estimating Chemical Releases from Presswood and Laminated Wood Products Manufacturing*, EPA 560/4-88-004i (March, 1988).
10. *Estimating Chemical Releases from Roller, Knife, and Gravure Coating Operations*, EPA 560/4-88-004j (February, 1988).
11. *Estimating Chemical Releases from Paper and Paperboard Production*, EPA 560/4-88-004k (February, 1988).
12. *Estimating Chemical Releases from Leather Tanning and Finishing*, EPA 560/4-88-004l (February, 1988).
13. *Estimating Chemical Releases from Wood Preserving Operations*, EPA 560/4-88-004p (February, 1988).
14. *Estimating Chemical Releases from Rubber Production and Compounding Operations*, EPA 560/4-88-004q (March, 1988).
15. *Issue Paper – Clarification and Guidance for the Metal Fabrication Industry*, (January, 1990).
16. *Guidance for Food Processors*, EPA 560/4-90-014 (June, 1990).

17. *EPCRA Section 313 Reporting Guidance For Food Processors (Update)*, EPA 745-R-98-011 (September, 1998).
18. *EPCRA Section 313 Reporting Guidance for Spray Application and Electrodeposition of Organic Coatings*, EPA 745-R-98-014 (December, 1998).
19. *Industry Guidance for Coal Mining Facilities*, EPA 745-B-99-002 (January, 1999).
20. *Industry Guidance for Electricity Generating Facilities*, EPA 745-B-99-003 (January, 1999).
21. *Industry Guidance for Metal Mining Facilities*, EPA 745-B-99-001 (January, 1999).
22. *Industry Guidance for Chemical Distribution Facilities*, EPA 745-B-99-005 (January, 1999).
23. *Industry Guidance for RCRA Subtitle C TSD Facilities and Solvent Recovery Facilities*, EPA 745-B-99-004 (January, 1999).
24. *Industry Guidance for Petroleum Terminals and Bulk Storage Facilities*, EPA 745-B-99-006 (January, 1999).
25. *EPCRA Section 313 Reporting Guidance for Semiconductor Manufacturing*, EPA 745-R-99-007 (July, 1999).
26. *EPCRA Section 313 Reporting Guidance for Leather Tanning and Finishing Industry*, EPA 745-B-00-012 (April, 2000).
27. *EPCRA Section 313 Reporting Guidance for the Printing, Publishing, and Packaging Industry*, EPA 745-B-00-005 (May, 2000).
28. *EPCRA Section 313 Reporting Guidance for Rubber and Plastics Manufacturing*, EPA 745-B-00-017 (May, 2000).
29. *EPCRA Section 313 Reporting Guidance for the Textile Processing Industry*, EPA 745-B-00-008 (May, 2000).
30. *EPCRA Section 313 Reporting Guidance for the Presswood and Laminated Products Industry*, EPA 260-B-01-013 (August, 2001).

In addition, the U.S. EPA has developed guidance documents specific to individual chemicals and chemical categories. Some of these documents are relevant to reporting to the NPRI:

31. *Guidance for Reporting Sulfuric Acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size)*, EPA 745-R-97-007 (November, 1997 and updated March, 1998).
32. *Guidance for Reporting Toxic Chemicals within the Polycyclic Aromatic Compounds Category (Final)*, EPA 260-B-01-03 (August, 2001).
33. *List of Toxic Chemicals within the Polychlorinated Alkanes Category and Guidance for Reporting*, EPA 745-B-99-023 (June, 1999).
34. *Guidance for Reporting Hydrochloric Acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size)*, EPA 745-B-99-014 (December, 1999).
35. *Guidance for Reporting Toxic Chemicals within the Dioxin and Dioxin-like Compounds Category (Final)*, EPA 260-B-01-004 (August, 2001).

Other Documents from the U.S. EPA

36. *Compilation of Air Pollutant Emission Factors, Vol. 1: Stationary Point and Area Sources*, AP-42, 5th Edition (1996), and AP-42 Supplements A, B, C, D, E, and F (1996, 1997, 1998, 1999, and 2000).
37. EPA Emission Inventory Improvement Program (EIIP).
<<http://www.epa.gov/ttn/chief/eiip/techreport/volume02/index.html>>.
38. *Toxic Air Pollutant Emission Factors – A Compilation for Selected Air Toxic Compounds and Sources, Second Edition*, EPA 450/2-90-011 (1990).

39. *Protocols for Equipment Leak Emission Estimates*, EPA 453/R-95-017 (November, 1995).
40. *Hot Mix Asphalt Plants - Emission Assessment Report (Draft)*, EPA 454/R-00-0XX (June, 2000).
<www.epa.gov/ttn/emc/asphalt.html>.

Copies of U.S. EPA documents are available from:

U.S. Environmental Protection Agency
National Center For Environmental Publications and Information (NCEPI)
P.O. Box 42419
Cincinnati, OH 45242
U.S.A.

Tel: (513) 489-8190
Fax: (513) 489-8695

U.S. EPA documents can be downloaded from the U.S. Toxics Release Inventory (TRI) Web site at
<www.epa.gov/tri> or the U.S. EPA's Technology Transfer Network Web site at <www.epa.gov/ttn/chief/>.

Or, they can be ordered from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
U.S.A.

Tel: (703) 605-6000
Fax: (703) 605-6900
E-mail: orders@ntis.fedworld.gov
<www.ntis.gov/>

6.4 Documents Produced by Industry Associations

41. *Code of Practice for Developing a Refinery Emission Inventory, Rev.5*, Canadian Petroleum Products Institute (CPPI) (2001). <[www.cppei.ca/tech/cppi_refinery_emissions_cop_\(Dec2001\).pdf](http://www.cppei.ca/tech/cppi_refinery_emissions_cop_(Dec2001).pdf)>
42. *Evaporation Loss from External Floating-roof Tanks*, American Petroleum Institute, Publication 2517 (1994).
43. *Evaporation Loss from Fixed-roof Tanks*, American Petroleum Institute, Chapter 19.1 (1991).
44. *Evaporation Loss from Internal Floating-roof Tanks*, American Petroleum Institute, Publication 2519 (1996).
45. *Review of Air Toxic Emission Calculations from Storage Tanks, Air Toxic Emissions Calculation Validation Program: Analysis of Crude Oil and Refined Product Samples and Comparison of Vapor Composition to Model Predictions*, American Petroleum Institute, Publication 2525 (1992).

Copies of the above reports for references 42-45 can be ordered from:

American Petroleum Institute
Order Desk
1200 L Street Northwest
Washington, DC 20005
U.S.A.

Tel: (202) 682-8375
Fax: (202) 962-4776

6.5 General Information

46. Howard, P. H. and M. Neal, *Dictionary of Chemical Names and Synonyms*, Lewis Publishers, Chelsea, MI (1992).
47. Lide, David R., *CRC Handbook of Chemistry and Physics, 75th Edition*, CRC Press, Inc., Boca Raton, FL (1995) pp. 15-38, *Characteristics of Particles and Particle Dispersoids*.

6.6 Internet Sources of General Guidance Information

The following documents and associated Web sites provide useful information on preparing CAC emission estimates.

- Criteria Air Contaminants (CACs) Technical Source Guide for Reporting to the National Pollutant Release Inventory – 2002. <www.ec.gc.ca/pdb/npri/>
- National Pollutant Release Inventory Web site. <www.ec.gc.ca/pdb/npri/>
- Ontario Ministry of Environment (ON MOE). <www.ene.gov.on.ca/envision/monitoring/monitoring.htm>
- Ontario Ministry of Environment (ON MOE). “Step by Step Guideline for Emission Calculation, Record Keeping and Reporting for Airborne Contaminant Discharge”. <www.ene.gov.on.ca/envision/env_reg/er/documents/2001/ra00e0016b.pdf>.
- *Canadian Environmental Protection Act (CEPA)* Criteria Air Pollutants. <www.ec.gc.ca/CEPARRegistry/the_act/http://www.ec.gc.ca/pdb/ape/cape_home_e.cfm>
- National Pollutant Inventory (NPI) Web site (Government of Australia). <www.npi.gov.au>
- NPI Industry Handbooks. <www.npi.gov.au/handbooks/approved_handbooks/index.html>

6.7 Useful Equations and Conversion Factors

6.7.1 Temperature conversions

- Fahrenheit ($^{\circ}F$) to Celsius ($^{\circ}C$):

$$^{\circ}C = \frac{5}{9} \left[^{\circ}F - 32 \right]$$

- Kelvin (K) to Celsius ($^{\circ}C$):
 $K = ^{\circ}C + 273.16$

6.7.2 Stack Diameter

$$d = 2 \sqrt{\frac{A}{\pi}}$$

Where:

$\pi = 3.1416$ (approximately)

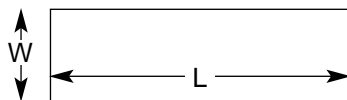
A = cross-sectional area in m^2

d = diameter in m

6.7.3 Equivalent Stack Diameter for Non-circular Stacks

$$E_d = 2 \left(\frac{L \times W}{L + W} \right)$$

Where:
L = length
W = width



6.7.4 Exit Velocity of Stack using a Known Volumetric Flow Rate

$$v = \frac{\dot{V}}{A}$$

Where:
v = exit velocity in m/s
 \dot{V} = volumetric flow rate in m³/s
A = stack area in m²

6.7.5 Calculation of Stack Gas Flow Rate for a Cylindrical Stack

Volumetric stack flow rate (m³/s) = (gas velocity, m/s) \times $\left[\frac{\pi \times (\text{internal stack diameter, m})^2}{4} \right]$

6.7.6 Determination of the Stack Gas Flow Rate, Dry Basis

Stack flow rate [Dry Basis] (m³/s) = (volumetric stack flow rate, m³/s) \times (1-fraction water vapour)

6.7.7 General Conversion Factors from Imperial to Metric Units

<i>Convert from:</i>	<i>To:</i>	<i>Multiply by:</i>
pounds (lb)	kilograms (kg)	0.454
ton (short ton)	tonnes	0.907185
foot (ft)	metres (m)	0.3048
gallon (U.S. gal)	litres (L)	3.78541
cubic foot (ft ³)	cubic metres (m ³)	0.0283168

6.7.8 Other Useful Conversions

<i>Convert from:</i>	<i>To:</i>	<i>Multiply by:</i>
10 million BTUs	kilowatts (kW)	2 930
10 million BTUs	Horsepower (Hp)	3 928
10 million BTUs	kilojoules (kJ)	10.55 million
10 million BTUs	Gigajoules (GJ)	10.55

6.7.9 Emission Factor Conversions: Imperial to Metric Units

<i>Convert from:</i>	<i>To:</i>	<i>Multiply by:</i>
lb/1 000 gal	kg/1 000 L	0.1199
lb/ton	kg/tonne	0.500
lb/million BTUs	kg/ million BTUs	0.454
lb/1 000 ton	kg/1 000 tonnes	0.500
lb/million ft ³	kg/million m ³	16.033

6.8 Basic FIRE Database Operating Instructions

The Factor Information REtrieval (FIRE) Data System from the U.S. EPA is a database containing U.S. EPA's recommended emission estimation factors for criteria and hazardous air pollutants. The database contains a mixture of both Imperial and metric units.

Facilities should refer to the U.S. EPA FIRE database manual that is downloaded with the program to ensure that you understand the use and limitations of the program, and of the emission factors provided. Emission factors are stored with information on the emitting process (e.g., Source Classification Code (SCC)), control devices and reference information.

6.8.1 Emission Factor Quality

Emission factors are usually based on a relatively limited number of tests on sources installed elsewhere that may differ slightly or substantially from the particular source being analyzed. If you are using the FIRE database, you will notice on the "Details" page a field titled "quality". This is a rating that the U.S. EPA uses to attach reliability to its published emission factors. The system is alphabetical with "A" being the most reliable and "E" being the least.

6.8.2 FIRE System – General Operating Procedure

When you open the program, you will have three tab options – Browse, Detail and Query. The rows in the "Browse" tab can be sorted by SCC, pollutant (POL) or control device (CTL). To determine which mode you are in, look above the "Browse" tab to see which of the three buttons appears to be selected.

Scrolling and Other Methods of Navigation

You can scroll through the list using either the up / down arrows, page up / page down, by selecting the "Move" menu, using the buttons on the tool bar, or using the scroll bar on the right of the screen. By using the "Go to..." button on the toolbar, you can search by SCC number, SCC description, CAS number, pollutant name, control code or control description. The default "Go to..." search is for the SCC number. To change this, you must select the desired criteria from the "Sort" menu.

Sorting

The "Query" tab can be used to filter the data by selecting the SCC, pollutant and controls. To set filter criteria, use the "Include..." button on the toolbar. After you have set the filter criteria, you must select the "Run" button on the toolbar. The results will automatically be displayed in the "Browse" tab.

Emission Factor Determination

The most efficient way to ensure you are using the correct emission factor is to make the "Browse" sheet active and select the "POL" and "Code" buttons on the top, right-hand side of the screen. Ensure that the SCC for the emission factors that you are reviewing describe the appropriate process. You can then scroll down to the substance of interest and determine which emission factor is relevant to the process you are analyzing. More information on using this program can be found in the "Help" files in the FIRE system.

Detailed Emission Factor Information

To view details of a specific emission factor, select the row for the emission factor of interest and then select the "Detail" tab. Information will be displayed on the emission factor quality, special notes, equations for the emission factor (if applicable), as well as other necessary information on the emission factor.

7. Glossary

- “abrasive blasting” is the process of cleaning or texturing materials such as metal and ceramics with an abrasive material.
- “ambient” means surround, or on all sides. For example, the air outside surrounding the facility or city.
- “article” means a manufactured item that does not release a substance, listed in Schedule 1 of the *Canada Gazette* notice, under normal conditions of processing or other use.
- “boiler” is an external combustion unit which turns water into steam for heating or power; or a tank for heating or storing water.
- “carbon monoxide” is a colourless, odourless, poisonous gas that is formed during the incomplete combustion of fossil fuels or the incomplete oxidation of carbon to carbon dioxide.
- “CAS number” mean the Chemical Abstracts Service Registry Number.
- “commercial grade natural gas” consists of a high percentage of methane (generally above 85%) and varying amounts of ethane, propane, butane and inerts.
- “contiguous facility” means all buildings, equipment, structures, and stationary items that are located on a single site or contiguous or on adjacent sites and that are owned or operated by the same person and that function as a single integrated site and includes wastewater collection systems that discharge treated or untreated wastewater to surface waters.
- “cumulative nameplate capacity” refers to the total nameplate capacities of all stationary **external** combustion equipment at the facility.
- “emission” means, for the purposes of reporting CACs to the NPRI, any discharge of a CAC substance to air.
- “employee” includes a person employed at the facility, an owner who performs work on site at the facility, and a person who performs work on site at the facility on a routine basis that is related to the normal operations of the facility, for the period of time the person is performing that work, such as contractors.
- “external combustion equipment” means any equipment with a combustion process that occurs at atmospheric pressure and with excess air.
- “facility” means a contiguous facility and a pipeline installation.
- “fermentation” the use of yeast to breakdown complex organic compounds, used in alcohol production and baking processes.
- “fermentor” is a container in which fermentation takes place.
- “fugitive release” means the total of all releases to air that are not released through confined process streams. These releases include:
- fugitive equipment leaks from valves, pump seals, flanges, compressors, sampling connections, open-ended lines, etc.
 - evaporative losses from surface impoundments and spills
 - releases from building ventilation systems, and
 - any other fugitive or non-point air emissions from land treatment, mine tailings, storage piles, etc.
- “generator” is an internal combustion unit that produces gas or steam, or that changes mechanical energy into electrical energy.
- “industrial space heater” is an external combustion unit used to heat a single confined area.
- “internal combustion equipment” means any equipment with a combustion process that occurs in a confined space and above atmospheric pressure.
- “isokinetically” refers specifically to the term “isokinetic source sampling” which means sampling in a manner where the linear velocity of the gas entering the sampling nozzle is equal to that of the undisturbed gas stream at the sampling point.
- “liquefied petroleum gas” consists of propane, propylene, butane and butylenes.
- “manufacture” means to produce, prepare or compound a substance in Schedule 1 of the *Canada Gazette* notice and includes the coincidental production of a substance listed in Schedule 1, as a by-product as a result of the manufacturing, processing or other use of other substances.
- “nameplate capacity” refers to the total designed energy input capacity of the external stationary combustion equipment.
- “other use” includes any use or disposal of a substance, listed in Schedule 1 of the *Canada Gazette* notice, relevant to the purpose of the facility which is not included under the definitions of “manufacture” or “process”.
- “oxides of nitrogen (expressed as NO₂)” includes nitric oxide (NO) [CAS No. 10102-43-9] and nitrogen dioxide (NO₂) [CAS No. 10102-44-0]. Nitrogen and oxygen in air at high temperatures can combine to form oxides of nitrogen (NO_x). Furthermore, fuel combustion and high temperature, and industrial processes produce NO_x. In addition, nitrogen in fuel also increases the amount of NO_x produced.

- “pipeline installation” means a collection of equipment situated at a single site, used in the operation of a natural gas transmission or distribution pipeline.
- “PM_{2.5}” means any particulate matter with a diameter less than or equal to 2.5 microns.
- “PM₁₀” means any particulate matter with a diameter less than or equal to 10 microns.
- “ppm” means the concentration in units of parts per million.
- “process” means the preparation of a substance, listed in Schedule 1 of the *Canada Gazette* notice, after its manufacture, for commercial distribution and includes preparation of a substance in the same physical state or chemical form as that received by the facility, or preparation which produces a change in physical state or chemical form.
- “release” means for the purposes of reporting CACs to the NPRI, the same as emission.
- “stationary combustion equipment” means any combustion equipment which needs to be stationary to function or operate properly or is not capable of self-propulsion.
- “sulphur dioxide (SO₂)” is formed during oxidation reactions involving sulphur and oxygen. SO₂ emissions are generated primarily from the smelting of ore and fuel combustion.
- “terminal operations” means:
- a) the use of storage tanks and associated equipment at a site used to store or transfer crude oil, artificial crude or intermediates of fuel products into or out of a pipeline, or
 - b) operating activities of a primary distribution installation normally equipped with floating-roof tanks that receives gasoline by pipeline, rail car, marine vessel or directly from a refinery.
- “total particulate matter” means any particulate matter with a diameter less than 100 microns.
- “turbine” is an internal combustion unit that is driven by the pressure of steam, water, air, etc., against the curved vanes of a wheel or set of wheels attached to a drive shaft.
- “volatile organic compounds” are discussed in Section 3.1.4 and defined in Appendix 3 of this Supplementary Guide.

Appendix 1 – Case Studies (Revised)

The case studies presented here were designed to provide step by step estimation assistance on a facility scale following the information presented in Chapter 2. Only CAC reporting aspects of NPRI reporting are discussed in these case studies. In many cases, the types of industries identified might also be required to report for other NPRI substances.

Case Study 1

The facility, Example Industries, operates a metal cover-finishing facility that employs 15-full time staff. Metal covers are prefabricated and transported to the facility for finishing. The facility has been informed that it may be subject to NPRI reporting criteria for the 2002 reporting year. Therefore the facility is required to estimate emissions from its operation to determine if it met the thresholds and reporting criteria. There are no monitoring systems at this facility and no stack test has been performed. There is a filter for the painting operation.

Step 1 – Identify requirements

The first step is to identify the CAC criteria for NPRI reporting. The total number of hours worked by employees at the facility exceeded the 20 000-hour employee threshold. Refer to Chapter 2 of this Supplementary Guide.

Step 2 – Identify the emission sources at the facility

After reviewing the *Guide for Reporting to the National Pollutant Release Inventory – 2002* and this Supplementary Guide (and taking into account exemptions), a survey of the facility emission sources was performed. Based on the survey, the following sources were identified:

- Source 1: A boiler of 85 million BTU/hour (24.911 million joules/sec) capacity firing natural gas and Number 6 fuel oil, vented by a stack of 12 metres in height
- Source 2: An open-top vapour degreaser for cleaning metal parts (no stack)
- Source 3: Painting operation for the final product, vented by a stack of 52 metres in height

Step 3 – Calculate emissions for each identified source at the facility

Emission source 1 - Boiler of 85 million BTU/hour (24.911 million joules/sec) capacity firing natural gas and Number 6 fuel oil.

Step 3a - Identify the method(s) of calculating emissions

Since the facility did not have any monitoring system installed or stack testing performed, an appropriate method to use is emission factors. Determine if there are any manufacturer-supplied boiler specific emission factors for both fuels. If none are available, an appropriate emission factor is the one published by the U.S. EPA, in the AP-42 document (see note below) or the latest version of FIRE 6.23 database (see note below). Calculate emissions for each type of fuel (natural gas and fuel oil) used for the boiler.

(AP-42: compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources; FIRE is a database and accessing software containing U.S. EPA's recommended emission estimation factors for criteria and hazardous air contaminants.)

Step 3b - Calculate emissions for each type of fuel (natural gas and fuel oil) used in the boiler

Natural gas:

Annual consumption: 4×10^6 cubic metres (4 million cubic metres)

The following table provides emission factors (from section 1.4 of AP-42 or FIRE database) for natural gas:

NPRI SUBSTANCE	EMISSION FACTOR (KG/10⁶ CUBIC METRES OF NATURAL GAS)
Total particulate matter (TPM)	30.4
Particulate matter 10 microns (PM ₁₀)	30.4
Particulate matter 2.5 microns (PM)	30.4
Volatile organic compound (VOC)	88
Oxides of nitrogen (NO _x)	1 600
Sulphur dioxide (SO ₂)	9.6
Carbon monoxide (CO)	1 344

Particulate matter emission from natural gas combustion is <1.0 micron in size. Therefore, the same emission factor (EF) is used for all three particulate fractions EFs for boilers <100 million BTU/hr: The EF is converted from lb/million cubic feet to kg/million cubic metres using a conversion factor of 16. Check the following Web site for more details <www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf>. EFs also conform to the latest available FIRE (version 6.23) database.

The general equation that is used for estimating uncontrolled emissions from natural gas combustion in boilers is:

Emission = Fuel consumption (million cubic metres) x EF (kg/million cubic metres)

Example calculation:

VOC emissions = (4 x 10⁶ cubic metres) x (88 kg/10⁶ cubic metres)
 = 352 kg
 = 0.35 tonnes

Use the same method to calculate other CAC emissions using emission factors.

[Note – other NPRI substances that may be present as a result of natural gas combustion should be reviewed.]

The following table shows uncontrolled emissions from the boiler as a result of natural gas combustion:

NPRI SUBSTANCE	ANNUAL UNCONTROLLED EMISSIONS (TONNES)
TPM	0.122
PM ₁₀	0.122
PM _{2.5}	0.122
VOC	0.35
NO _x	6.40
SO ₂	0.04
CO	5.38

Number 6 fuel oil:

Annual consumption: 300 000 litres

Sulphur content: 1%

Since there are no boiler-specific emission factors provided by the manufacturer, the appropriate emission factors to use are those published by the U.S. EPA, in the AP-42 document Section 1.3, Table 1.3-1 for boilers using Number 6 fuel oil (less than 100 million BTU/hour) and the FIRE 6.23 database.

The following table shows uncontrolled emissions from the boiler as a result of the combustion of Number 6 fuel oil:

NPRI SUBSTANCE	EMISSION FACTOR (KG/1 000 LITRES OF FUEL OIL)
TPM	1.5
PM ₁₀	1.29
PM _{2.5}	0.84
VOC	0.0336
NO _x	6.6
SO ₂	18.84S
CO	0.6

Note: EFs from Section 1.3 of AP-42 is converted from lb/1 000 gallons to kg/1 000 litres using a conversion factor of 0.12. Check the Web site for more details.
TPM emission factor = $9.19 \times S + 3.22$ (lb/1 000 gallons) where S= Sulphur content in the fuel oil, expressed as percentage. See errata for Chapter 1.3 in AP-42.
(0.12 is the conversion factor from lb/1 000 gallons to kg/1 000 litres)

EFs obtained from AP-42, except for VOC EF. See sample calculations below.

EF for VOC obtained from FIRE Database.

PM₁₀ and PM_{2.5} EFs were calculated using the formula given in Tables 1.3-5 of AP-42.

The general equation for estimating uncontrolled emissions from fuel oil combustion in boilers is:

Emissions = Fuel consumption in litres x Emission factor (kg/1 000 litres)

Example:

Sulphur dioxide emission factor = 18.84 (S) kg/1 000 litres of fuel oil, where S is the weight percent of sulphur in the oil

SO₂ emission factor = 18.84 (1) kg/1 000 litres of fuel oil = 18.84 kg/1 000 litres of fuel oil

SO₂ emissions = Fuel oil consumption in litres x EF (kg/1 000 litres)

= 300 000 litres of fuel oil consumed x 18.84 kg/1 000 litres of fuel oil

= 5 652 kg/year x 0.001 tonnes/kg

= 5.65 tonnes per year

Use the same method to calculate other CAC emissions using the emission factors.

[Note – other NPRI substances that may be present as a result of natural gas combustion should be reviewed.]

The following table provides details of the uncontrolled emissions from the boiler as a result of fuel oil combustion:

NPRI SUBSTANCE	ANNUAL UNCONTROLLED EMISSIONS (TONNES)
TPM	0.45
PM ₁₀	0.38
PM _{2.5}	0.25
VOC	0.010
NO _x	1.98
SO ₂	5.65
CO	0.18

PM₁₀ = 1.5 kg/tonnes x 0.86 = 1.29 kg/tonne (from Section 1.3, Table 1.3-5 in AP-42, uncontrolled PM₁₀ emission factor is 86% of the total particulate emission factor using cumulative mass %)

PM_{2.5} = 1.5 kg/tonnes x 0.56 = 0.84 kg/tonne (from Section 1.3, Table 1.3-5 in AP-42, uncontrolled PM_{2.5} emission factor is 56% of the total particulate emission factor using cumulative mass %)

Note – PM₁₀ and PM_{2.5} emissions can be either expressed as cumulative mass %, OR calculated using the cumulative emission factor. See Table 1.3-5 in AP-42 for details.

Step 4 – Add emissions from natural gas and fuel oil (since the boiler burns both fuels)

Total emission from the boiler

NPRI SUBSTANCE	ANNUAL UNCONTROLLED EMISSIONS (TONNES/YEAR)
TPM	0.57
PM ₁₀	0.50
PM _{2.5}	0.37
VOC	0.36
NO _x	8.38
SO ₂	5.69
CO	5.56

Step 5 – Calculate emission from source 2

Operating parameters:

At the beginning of each month, 200 litres of solvent (density of 0.95 kg/litre) is added to the open-top degreaser. During the month, an additional 50 litres is added to replenish losses. At the end of the month, 200 litres of waste solvent is sent for off-site recycling. About 1 kg of solid waste is collected for disposal. The solvent is 100% VOC (from the MSDS), the waste solvent is 98% VOC and the solid waste is 5% VOC.

Step 5a - Identify the appropriate method

Knowing the VOC content of all solvents, the appropriate estimation method is mass balance

Step 5b - Calculate solvent used per month

Solvent in = (New solvent + Replenishment solvent) x density x VOC content
 = (200 litres/month + 50 litres/month) x 0.95 kg/litre x 100%
 = 237.5 kg solvent /month
 = 0.237 tonnes solvent per month

Step 5c - Calculate waste solvent generated per month

Solvent out = (litres of solvent sent for recycling x solvent density x waste solvent VOC content) + (solid waste x solid waste VOC content)
 = (200 litres solvent/month x 0.95 kg/litre of solvent x 0.98) + (1 kg of waste/month x 0.05)
 = 186.25 kg solvent/month
 = 0.186 tonnes solvent per month

Step 5d - Calculate VOC emitted

VOC emission = Solvent in - Solvent out
 = 237.5 kg/month – 186.25 kg/month
 = 51.25 kg/month
 Annual VOC emission = 51.25 kg/month x 12 months/year
 = 615 kg/year
 = 0.615 tonnes

[Note – other NPRI substances that may be in the solvent should be reviewed; refer to the solvent MSDS for information.]

Step 6 – Calculate emissions from source 3

Operating parameters:

Example Industries uses “COAT-ABC” as a surface-coating compound. Last year it used approximately 10 000 litres of the compound.

- Spray booth type: dry filter spray booth
- Spray gun transfer efficiency: 70%
- Dry filter control efficiency: 99%

Step 6a - Identify the appropriate method

Since there are no emission factors available for this type of operation, the appropriate estimation method is using the mass balance.

The mass balance equation is:

$$M_E = M_I - M_O - M_A - M_R$$

Where:

M_E = Mass of coating compound emitted, kg

M_I = Mass of coating compound in the input stream, kg

M_O = Mass of coating compound in the output stream in the finished product, kg

M_A = Mass of coating compound accumulated in the system, kg

M_R = Mass of coating compound captured for recovery or disposal, kg

Step 6b - Identify the VOC in the coating material

To apply the mass balance approach, the VOC content in the coating compound must be determined. In many instances, the MSDS for that compound will indicate percent weight content of the predominant VOC. The annual consumption of the compound could be obtained from the facility's operation log or sales slips.

[Note – other NPRI substances that may be in the coating material should be reviewed; refer to the solvent MSDS for information.]

Sample MSDS for "COAT-ABC"**MATERIAL SAFETY DATA SHEET****SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION**

PRODUCT NAME: COAT-ABC

SUPPLIER: ABC CORP

SECTION 2 - COMPOSITION /INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	PERCENT BY WEIGHT
Methyl Ethyl Ketone	78-93-3	20%
Xylene	1330-20-7	25%
Ethyl Benzene	100-41-4	20%
N-Butyl Alcohol	123-86-4	15%
Carbon Black	133-86-4	<2%
Other balance		

SECTION 3 - PHYSICAL AND CHEMICAL PROPERTIES

Specific Gravity: 1.35

Percent volatile: 80% by weight

Note: In some cases, the % of volatiles value reported in the MSDS contains water and other non-VOC components. The quantities of these components, if they can be identified, should be excluded from the % volatiles during VOC emission calculations.

For this coating operation, there is no loss of coating compound to the coating equipment and no loss to the system's liquid/solid waste streams. All the volatiles, including VOCs that are in a particular coating, are assumed to have been released into the atmosphere.

Step 6c - Calculate VOC emissions

It is assumed that all VOCs in “COAT-ABC” were released into the atmosphere [$M_A = M_R = M_O = 0$ and $M_E = M_I$]. The threshold criteria for VOC must still be assessed based on the specific gravity and percent volatiles.

$$M_E = Q \times D \times c$$

Where:

M_E = Total uncontrolled VOC emission, kg

Q = Total annual consumption of coating material, litres = 10 000 litres

D = Density of coating material, kg/litre = 1.35×1 kg/litre = 1.35 kg/litre (from MSDS)

c = VOC content by weight in coating material, % = 80 % (from MSDS)

$$\begin{aligned} M_E &= 10\,000 \text{ litres of coating} \times 1.35 \text{ kg/litre} \times (80/100 \text{ VOC content}) \\ &= 10\,800 \text{ kg} \\ &= 10.8 \text{ tonnes} \end{aligned}$$

Step 6d - Calculate uncontrolled particulate matter emissions

$$\begin{aligned} \text{Coating density of solid content} &= \text{Density of coating} - \text{Density of volatile content} \\ &= 1.35 \text{ kg/litre} - (1.35 \times 80/100) \text{ kg/litre} \\ &= 0.27 \text{ kg solids/litre (since VOC content by weight is 80\%)} \end{aligned}$$

$$\begin{aligned} \text{Uncontrolled PM emissions} &= \text{Density of solid content} \times \text{annual usage} \times (1 - \text{transfer efficiency}) \\ &= 0.27 \text{ kg/litre} \times 10\,000 \text{ litres/year} \times (1 - 0.7) \\ &= 810 \text{ kg/year} \times 0.001 \text{ tonnes/kg} \\ &= 0.81 \text{ tonnes} \end{aligned}$$

Step 6e - Estimate controlled particulate matter emissions

$$\begin{aligned} \text{Controlled PM emissions} &= \text{Uncontrolled PM} \times (1 - \text{control efficiency}) \\ &= 0.81 \text{ tonnes} \times (1 - 99/100) \\ &= 0.0081 \text{ tonnes} \end{aligned}$$

Assume that only very fine particles are released from the operation. Assume also that only $PM_{2.5}$ is released to air. TPM and PM_{10} therefore have the same values as $PM_{2.5}$ thus $TPM = PM_{10} = PM_{2.5}$.

As the PM emissions are from a spray operation and pass through a filter, the PM that is emitted is assumed to be $PM_{2.5}$ and the TPM and PM_{10} would also be 0.0081 tonnes.

Step 7 – Add emissions from all sources

After calculating emissions from each source at the facility, the next step is to add emissions from each source and calculate the total emissions from the facility to determine if the NPRI thresholds were met:

TOTAL FACILITY EMISSIONS

NPRI SUBSTANCE	ANNUAL BOILER EMISSIONS (TONNES)	ANNUAL DEGREASER EMISSIONS (TONNES)	ANNUAL COATING EMISSIONS (TONNES)	TOTAL FACILITY EMISSION (TONNES)	TOTAL FROM POINT SOURCES (TONNES)	TOTAL FROM FUGITIVE SOURCES (TONNES)
VOC	0.36	0.615	10.8	11.78	11.16	0.615
TPM	0.57	0	0.0081	0.58	0.58	0
PM_{10}	0.50	0	0.0081	0.51	0.51	0
$PM_{2.5}$	0.37	0	0.0081	0.38	0.38	0
NO_x	8.38	0	0	8.38	8.38	0
SO_2	5.69	0	0	5.69	5.69	0
CO	5.56	0	0	5.56	5.56	0

NPRI REPORTING DETERMINATION

NPRI SUBSTANCE	TOTAL EMISSION (TONNES/YEAR)	NPRI FACILITY THRESHOLD (TONNES/YEAR)	NPRI THRESHOLD EXCEEDED (?)	RATIONALE
VOC	11.78	10	Yes	Facility emission is > than NPRI threshold
TPM	0.58	20	No	Facility emission is < than NPRI threshold
PM ₁₀	0.51	0.5	Yes	Facility emission is > than NPRI threshold
PM _{2.5}	0.38	0.3	Yes	Facility emission is > than NPRI threshold
NO _x	8.38	20	No	Facility emission is < than NPRI threshold
SO ₂	5.69	20	No	Facility emission is < than NPRI threshold
CO	5.56	20	No	Facility emission is < than NPRI threshold

Note: > Indicates greater than
< Indicates less than

Conclusion:

Since the estimated VOC, PM₁₀ and PM_{2.5} emissions for the year from the facility are greater than their thresholds, Example Industries must submit an NPRI report for the three pollutants (VOC, PM₁₀ and PM_{2.5}). Reporting is not required for other CACs (TPM, NO_x, SO₂, and CO).

Step 8 – How to report facility emissions

Emissions from boiler and paint booth operations are considered stack/point source emissions (since the emissions are vented through stacks). From the open-top degreaser, it is considered as fugitive emissions (since there is no stack for the degreaser). Add all the point and fugitive source emissions for each substance as shown in the table above.

Substance information is entered in the reporting form starting at the “Substance Identification” screen (section B1.0). Report all air releases of the NPRI substance to be reported, the basis of estimate and the detail code, if applicable. Air releases for each substance is entered in section B12.0 for stacks and fugitives.

B12.1.a Stack or point releases - Total releases from stack or point sources

B12.1.c Fugitive releases - Air releases that are not released through stacks or points.

NPRI SUBSTANCE	TOTAL POINT SOURCE EMISSION (TONNES)	ENTER AS STACK/POINT RELEASE (IN FIELD NUMBER)	BASIS OF ESTIMATE*	TOTAL FUGITIVE EMISSIONS (TONNES)	ENTER AS FUGITIVE RELEASES (IN FIELD NUMBER)	BASIS OF ESTIMATE
VOC	11.16	B12.1.a	C	0.615	B12.1.c	C
PM ₁₀	0.51	B12.1.a	E	B12.1.c		
PM _{2.5}	0.38	B12.1.a	E	B12.1.c		

* The reporting software has a pick-list for choosing the “Basis of Estimate” codes. Select the letter code identifying the method that applies to the largest portion of the estimated releases or transfers (you can choose only one code). In this case study, the bases of estimates are E (emission factor) and C (mass balance). Select C as the basis of estimate since the mass balance method provides the majority of the total VOC emission from the facility.

Step 9 – Reporting information for stacks with a height ≥ 50 metres above grade

If the facility has a stack with a height greater than or equal to 50 metres above grade that emits CACs, additional information may be required. The stack emission and physical parameter details must be provided by the facility if the emission quantity from the stack exceeds the stack threshold as shown in the table below (see Section 5.1 for details).

The painting operation has a stack that is 52 metres in height above grade. VOC emissions from the painting operation is 10.8 tonnes which is greater than the tall stack threshold of 5 tonnes (for VOC). Therefore, the facility must report VOC emissions for that stack.

Note: The “stack \geq 50 metres” criteria are triggered only when the facility exceeds the NPRI threshold for any CAC substance. The following table provides the CAC thresholds for a stack \geq 50 metres for which the facility must consider when reporting:

NPRI SUBSTANCE	FOR A STACK \geq 50 METRES STACK THRESHOLD (TONNES/YEAR)	PAINT BOOTH EMISSION (TONNES/YEAR)
PM ₁₀	0.25	
PM _{2.5}	0.15	
VOC	5	10.8

Step 10 – How to report stack emissions

Since the painting operation has a stack greater than 50 metres and emissions greater than the threshold for VOC, the facility must report stack emissions and physical parameters for that stack. Enter emission information in the screen titled “NPRI (Stack Entry)” for VOCs only (since PM₁₀ or PM_{2.5} emissions do not trigger the “stack \geq 50 metres” criteria). Physical parameters that must be reported for this stack are: height above grade, diameter, exit temperature and exit velocity (reporting of latitude and longitude parameters is optional).

Step 11 – Calculate the monthly breakdown of annual releases to air by percentage

Detailed emission estimates show that the facility is required to report to the NPRI. Additional reporting such as monthly breakdown of emissions by percentage for each pollutant, must be reported. The general equation and methodologies for estimating monthly emissions is the same as the annual emissions for each source.

Example

Usage of natural gas, fuel oil, coating and degreaser solvent for each month is obtained from records kept at the facility. You can calculate emissions for each month and add the total at the end of the year. Using the annual total, calculate the monthly emission percentage using the following equation:

$$\text{January emission percentage} = (\text{January emission} / \text{Total annual emissions}) \times 100$$

For example, add the VOC emission from each source for the month of January. If the January emission of VOC from the three emission sources is 1.1 tonnes, the January percentage VOC emission is:

$$1.1 \text{ tonnes} / 11.78 \text{ tonnes} \times 100 = 9.34\%$$

Enter the information (calculated percentage emission) for each substance in field B13.1 of the reporting form. The percentage for all months must total 100%.

Step 12 – Anticipated releases to air

Enter emission numbers for each substance that is anticipated to be released to air from the facility for the years 2003 through 2005. This reporting is optional for the years 2006 and 2007. Enter the information for each substance in field B15.1 of the reporting form.

Step 13 – Pollution-prevention (P2) activities

If the facility has employed P2 activities, it should be noted in section B30.0 of the reporting form (check the applicable boxes from B30.1.a through B30.1.g).

Case Study 2

AB Printers operates a newspaper printing facility in Hamilton, ON. The facility has 45 full-time employees. The facility has been informed that it may be subject to the NPRI reporting requirements for the 2002 reporting year. Therefore, the facility is required to estimate emissions from its operation to determine whether thresholds and reporting criteria were met. There are no monitoring systems at this facility and no stack test has been performed.

The primary operation of the facility is the printing of newspapers. The general process followed is printing plates are prepared and then, using ink, the information is transferred to the paper using a press. The paper is cut and folded. Each newspaper then receives any inserts and is bundled for distribution. Besides the printing process, there are two small natural gas boilers used for facility heating and a diesel-powered generator is used during emergencies.

Step 1 – Identify requirements

The first step is to identify the requirements for NPRI reporting. Details are given in Chapter 2 of this Supplementary Guide. The total number of hours worked by employees at the facility exceeded the 20 000-hour employee threshold. The facility contains CAC-emitting sources such as boilers, a diesel generator and printing operation. Therefore, the facility must estimate air releases from its sources to determine if it met or exceeded the NPRI thresholds.

Step 2 – Identify the emission sources at the facility

After referring to the *Guide for Reporting to the National Pollutant Release Inventory – 2002* and this Supplementary Guide (and taking into account exemptions), a survey of the facility emission sources was performed. Based on the survey, the following sources were identified:

Source 1:	Camera plate department	Source 2:	Press room
Source 3:	Printing room	Source 4:	Boilers for heating
Source 5:	Emergency generator		

Step 3 – Calculate emissions for each source identified at the facility

Emission source 1: Camera plate department

This area prepares the plates that are to be printed onto the newspapers. Air emissions from this source are vented entirely through a stack. The camera plate department operates 89 hours per week and 50 weeks per year. The materials used and their properties are given below:

MATERIALS USED*	DENSITY* (KG/LITRE)	VOC CONTENT* (BY WEIGHT)	WEEKLY USAGE (LITRES)
Developer	0.97	100%	120
Powder fixer	0.9	0%	280
Aqueous Developer	1.05	100%	55

* obtained from the MSDS supplied by the manufacturer

Step 3a - Identify the method(s) of calculating emissions

Since there are no monitoring systems at this facility, no stack test has been performed and no emission factors are available for this type of operation, the appropriate estimation method is the mass balance.

Step 3b - Identify the VOC in the coating material

To apply the mass balance approach, the VOC content in the materials used in the process need to be determined. In many instances, the MSDS for the particular material will indicate the percent by weight content of the predominant VOCs. You will also need the annual consumption of the solutions used which may be obtained from the facility's operation log or purchase order slips.

Step 3c - Calculate VOC emissions

The general equation for calculating VOC emission is:

$$M_E = Q \times D \times c$$

Where:

M_E = Total uncontrolled VOC emission, kg

Q = Total annual consumption of material, litres

D = Density of material, kg/litre

c = VOC content by weight in the material, %

VOC emission from developer:

$$\begin{aligned} M_E &= \text{Weekly developer consumption} \times \text{weeks used per year} \times \text{density} \times \text{VOC \%} \\ &= 120 \text{ litres/week} \times 50 \text{ weeks/year} \times 0.97 \text{ kg/litre} \times 100/100 \text{ VOC} \\ &= 5\,820 \text{ kg} \\ &= 5.82 \text{ tonnes} \end{aligned}$$

VOC emission from powder fixer:

$$\begin{aligned} M_E &= 280 \text{ litres/week} \times 50 \text{ weeks/year} \times 0 \text{ kg/litre} \times 0 / 100 \text{ VOC} \\ &= 0 \text{ kg} \\ &= 0 \text{ tonnes} \end{aligned}$$

VOC emission from aqueous developer:

$$\begin{aligned} M_E &= 55 \text{ litres/week} \times 50 \text{ weeks/year} \times 1.05 \text{ kg/litre} \times 100 / 100 \text{ VOC} \\ &= 2\,878 \text{ kg} \\ &= 2.88 \text{ tonnes} \end{aligned}$$

Total VOC emissions from camera plate department

$$\begin{aligned} &= \text{VOC emission from developer} + \text{VOC emission from powder fixer} + \text{VOC emission from aqueous developer} \\ &= 5.82 \text{ tonnes} + 0 \text{ tonnes} + 2.88 \text{ tonnes} \\ &= 8.70 \text{ tonnes} \end{aligned}$$

Emission source 2: Press room

Rolls of paper are inserted into the presses, which print the newspapers from the plates. The paper is then cut and folded as individual newspapers. Air emissions from the press room are vented through a stack. The presses operate for 140 hours/week and 50 weeks/year. The materials used and their properties are given below:

MATERIALS USED*	DENSITY* (KG/LITRE)	VOC CONTENT* (BY WEIGHT)	WEEKLY USAGE (LITRES)
News rub	1.0	22%	20
WD-40	0.87	20%	110
Varsol	0.7	80%	230
Varn swell	0.128	50%	25
Plate cleaner	0.28	100%	200
Silicone lube	0.074	100%	150
Solvent	0.78	100%	85

* obtained from the MSDS supplied by the manufacturer .

Example

Use the general equation to calculate VOC emissions:

$$M_E = Q \times D \times c$$

VOC emissions from the use of varsol:

$$\begin{aligned} M_E &= 230 \text{ litres/week} \times 50 \text{ weeks/year} \times 0.7 \text{ kg/litre} \times 80 / 100 \text{ VOC} \\ &= 6\,440 \text{ kg} \\ &= 6.44 \text{ tonnes/year} \end{aligned}$$

Calculate the VOC emission for each of the seven materials used in the press room using the example calculations shown above. The following table provides VOC emissions for each of the materials used:

MATERIALS USED	VOC EMISSIONS (TONNES/YEAR)
News rub	0.22
WD-40	0.96
Varsol	6.44
Varn swell	0.08
Plate cleaner	2.8
Silicone lube	0.56
Washer solvent	3.32
Total	14.38

Emission source 3: Printing room

All printing for internal use, such as business cards, is performed in this room. Emissions from this source are vented through a general exhaust to a dedicated stack. The printing room operates 40 hours/week and 50 weeks/year. The materials used and their properties are given below:

MATERIALS USED*	DENSITY* (KG/LITRE)	VOC CONTENT* (BY WEIGHT)	WEEKLY USAGE (LITRES)
Plus AZ	0.091	0%	45
Rejuvenator	0.45	0%	0.5
Cleaner	0.77	0%	0.5
Adhesive	0.55	0%	0.25

* obtained from the MSDS supplied by the manufacturer

The activities in the printing room do not result in VOC emissions since there are no VOCs identified in the materials used.

Emission source 4: Heating

There are two natural gas-fired boilers that are used for heating the facility and are served by a stack. The heat output of each boiler is 4 million BTU/hr. Though the boilers are less than 10 million BTU/hr cumulative nameplate capacity, they are not exempt since there are other sources in the facility that release CACs. Therefore, the facility must estimate emissions from the boilers.

Step 3d - Calculate CAC emissions from the boilers

Because the facility does not have a monitoring system installed and there is no stack testing performed, the appropriate method of calculating CAC emissions is to use emission factors. If none are available, the emission factors published by the U.S. EPA, in the AP-42 document (see note below) or the latest version of FIRE 6.23 database (see note below) may be used. Calculate emissions for the type of fuel (natural gas) used in the boiler. (AP-42: compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources; FIRE is a database and accessing software containing the U.S. EPA's recommended emission estimation factors for criteria and hazardous air contaminants.)

Natural Gas:

Annual consumption: 1.2×10^6 cubic metres (1.2 million cubic metres)

The following table provides the emission factors (from Section 1.4 of AP-42 or FIRE database) for natural gas:

NPRI SUBSTANCE	EMISSION FACTOR (KG/10⁶ CUBIC METRES OF NATURAL GAS)
Total particulate matter (TPM)	30.4
Particulate matter 10 microns (PM ₁₀)	30.4
Particulate matter 2.5 microns (PM _{2.5})	30.4
Volatile organic compound (VOC)	88
Oxides of nitrogen (NO _x)	1 600
Sulphur dioxide (SO ₂)	9.6
Carbon monoxide (CO)	1 344

Particulate matter emissions from natural gas combustion is <1.0 micron in size. Therefore, the same emission factor is used for all three particulate fractions (TPM contains both PM₁₀ and PM_{2.5}).

Emission factors (EF) for boilers <100 million BTU/hr: The EF is converted from lb/million cubic feet to kg/million cubic metres using a conversion factor of 16. Check the following Web site for details <www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf>.

EFs also conform to the latest available FIRE (version 6.23) database.

The general equation for estimating uncontrolled emissions from the combustion of natural gas in boilers is:

Emission = Fuel consumption (million cubic metres) x EF (kg/million cubic metres)

Example calculation

VOC emissions = 1.2×10^6 cubic metres x 88 kg/million cubic metres
 = 105.6 kg
 = 0.11 tonnes

Use the same method to calculate other CAC emissions using the emission factors.

[Note – other NPRI substances that may result from the combustion of natural gas should be reviewed.]

The following table shows uncontrolled emissions from the boilers as a result of natural gas combustion:

NPRI SUBSTANCE	ANNUAL UNCONTROLLED EMISSIONS (TONNES)
TPM	0.036
PM ₁₀	0.036
PM _{2.5}	0.036
VOC	0.11
NO _x	1.92
SO ₂	0.012
CO	1.61

Emission source 5: Emergency generator

There is a diesel-fired generator in the facility for emergency situations. It is operated as required. The emissions are exhausted through a stack. The maximum unit rating is 200 kW. The generator was operated approximately 24 hours during the year 2002.

Step 3e - Calculate CAC emissions from the diesel generator

Determine if there are any manufacturer-supplied, source-specific emission factors. If none are available, the appropriate emission factors are published by the U.S. EPA, in the AP-42 document (see note below).

(AP-42: *compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources*; FIRE is a database and accessing software containing the U.S. EPA's recommended emission estimation factors for criteria and hazardous air contaminants.)

The following table provides the emission factors (from Section 3.3 of AP-42, Table 3.3-1) for diesel fuel:

NPRI SUBSTANCE	EMISSION FACTOR (POWER OUTPUT KG/KW-HR)
TPM	0.0013
PM ₁₀	0.0013
PM _{2.5}	0.0013
VOC	0.0015
NO _x	0.0188
SO ₂	0.00125
CO	0.0041

Particulate matter emissions from diesel fuel internal combustion is <1.0 micron in size. Therefore, the same emission factor is used for all the three particulate fractions (TPM contains both PM₁₀ and PM_{2.5}).

The EFs from this AP-42 section are converted from lb/hp-hr to kg/kW-hr using a conversion factor of 0.608. Check the AP-42 (Section 3.3) Web site for details <www.epa.gov/ttn/chief/ap42/ch03/final/c03s03.pdf>.

The general equation for estimating uncontrolled emissions from diesel fuel combustion is:

$$\text{Emission} = \text{Power output (kW)} \times \text{EF (kg/kW-hr)} \times \text{hours/year}$$

Example calculation

$$\begin{aligned} \text{NO}_x \text{ emission} &= 200 \text{ kW} \times 0.0188 \text{ kg/kW-hr} \times 24 \text{ hours/year} \\ &= 90.2 \text{ kg} \\ &= 0.09 \text{ tonnes} \end{aligned}$$

Use the same method to calculate other CAC emissions using the emission factors. The following table shows uncontrolled emissions from the diesel-fired generator:

NPRI SUBSTANCE	ANNUAL UNCONTROLLED EMISSIONS (TONNES)
TPM	0.0062
PM ₁₀	0.0062
PM _{2.5}	0.0062
VOC	0.0072
NO _x	0.09
SO ₂	0.006
CO	0.02

Step 4 – Add emissions from all sources

After calculating emissions from each source at the facility, add emissions from each source and calculate the total emission from the facility to determine if NPRI thresholds were met.

TOTAL FACILITY EMISSIONS

NPRI SUBSTANCE	ANNUAL CAMERA PLATE EMISSIONS (TONNES)	ANNUAL PRESS ROOM EMISSIONS (TONNES)	ANNUAL PRINTING ROOM EMISSIONS (TONNES)	ANNUAL GENERATOR EMISSION (TONNES)	ANNUAL BOILER EMISSION (TONNES)	TOTAL FACILITY EMISSION (TONNES)
TPM	0	0	0	0.0062	0.036	0.042
PM ₁₀	0	0	0	0.0062	0.036	0.042
PM _{2.5}	0	0	0	0.0062	0.036	0.042
VOC	8.70	14.38	0	0.0072	0.11	23.19
NO _x	0	0	0	0.09	1.92	2.01
SO ₂	0	0	0	0.006	0.012	0.018
CO	0	0	0	0.02	1.61	1.63

NPRI REPORTING DETERMINATION

NPRI SUBSTANCE	TOTAL FACILITY EMISSION (TONNES/YEAR)	NPRI THRESHOLD (TONNES/YEAR)	NPRI THRESHOLD EXCEEDED (?)	RATIONALE
TPM	0.042	20	No	Facility emission is < than NPRI threshold
PM ₁₀	0.042	0.5	No	Facility emission is < than NPRI threshold
PM _{2.5}	0.042	0.3	No	Facility emission is < than NPRI threshold
VOC	23.19	10	Yes	Facility emission is > than NPRI threshold
NO _x	2.01	20	No	Facility emission is < than NPRI threshold
SO ₂	0.018	20	No	Facility emission is < than NPRI threshold
CO	1.63	20	No	Facility emission is < than NPRI threshold

Note: > Indicates greater than
< Indicates less than

Note: There may be other NPRI-listed substances in the solutions used in this process. Refer to the *Guide for Reporting to the National Pollutant Release Inventory – 2002* to determine if this is the case. If other NPRI-listed substances are present and exceeded their reporting thresholds, you must also calculate the releases and transfers for disposal and recycling of those NPRI substances.

Conclusion:

Since the estimated VOC emissions (tonnes/year) from the facility was greater than the VOC reporting threshold, AB Printers must submit an NPRI report for VOC. Reporting is not required for the other CACs since they did not meet the reporting thresholds.

Step 5 – How to report facility emissions

Emissions from the sources are considered “stack or point” source emissions (since the emissions are vented through stacks). Add all point source emissions for VOC as shown in the table above.

In the reporting software, substance information is entered starting with the “Substance Identification” screen (section B1.0). Report all air releases of the NPRI substance, basis of estimate, and the detail code, if applicable. Air releases for each substance are entered in section B12.0 for stacks and fugitive releases.

B12.1.a Stack or point releases - Total releases from stacks or point sources

NPRI SUBSTANCE	TOTAL POINT SOURCE EMISSION (TONNES)	ENTER AS STACKS/POINTS (IN FIELD NUMBER)	BASIS OF ESTIMATE*
VOC	23.19	B12.1.a	C

* The reporting software has a pick-list for choosing the “Basis of Estimate” codes. Select the letter code identifying the method that applies to the largest portion of the estimated releases or transfers (you can choose only one code). In this case study, the bases of estimates are E (emission factor) and C (mass balance). Select C as the basis of estimate since the mass balance method included the majority of total VOC emissions from the facility.

Step 6 – Reporting information for stacks with a height ≥ 50 Metres above grade

If the facility has a stack with a height greater than or equal to 50 metres above grade, and that stack emits CACs above the stack thresholds, additional information may be required. The stack emissions and physical parameter details are required to be provided by the facility if the emissions quantity from the stack exceeded the stack reporting threshold as shown in the table below.

Note: The “stack ≥ 50 metres” reporting criteria are met only when the facility exceeded the substance threshold for any CAC substance. The following table provides the NPRI thresholds for a stack ≥ 50 metres for this facility:

NPRI SUBSTANCE	FOR A STACK ≥ 50 METRES STACK THRESHOLD (TONNES/YEAR)
VOC	5.0

This facility does not have any stacks that are equal to or greater than 50 metres above grade, and as such stack reporting is not required.

Step 7 – Calculate the monthly breakdown of annual releases to air by percentage

Detailed emissions estimates show that the facility is required to report to the NPRI. Additional reporting, such as the monthly breakdown of emission by percentage for each pollutant, is needed. The general equation and methodologies for estimating monthly emissions are the same as for annual emissions for each source.

Example

Material usage for each source per month is obtained from records kept at the facility. You can calculate emissions for each month and then total them to obtain the annual total. Using this annual total, calculate the monthly emission percentage using the following equation:

$$\text{January emission percentage} = (\text{January emission} / \text{Total annual emissions}) \times 100$$

For example, add the VOC emission from each source for the month of January. If the January emissions for VOC from the three emission sources was 2.33 tonnes, the January percentage of VOC emission was:

$$2.33 \text{ tonnes} / 23.19 \text{ tonnes} \times 100 = 10.05\%$$

Enter the information (calculated percentage emission) for each substance in field B13.1 of the reporting form. The percentage for all months must total 100%.

Step 8 – Anticipated releases to air

Enter emission values for each substance that is anticipated to be released to the air from the facility for the years 2003 through 2005. This reporting is optional for 2006 and 2007. Enter the information for each substance in field B15.1 of the reporting form.

Step 9 – Pollution-prevention (P2) activities

If the facility employed P2 activities, it should be noted in section B30.0 of the reporting form (check the applicable boxes from B30.1.a through B30.1.g).

Appendix 2 – How To Estimate CAC Releases

Example 2.1 Estimating NO_x Emissions

The methodology used to estimate emissions from source sampling or stack sampling is explained here. In many cases, stack testing results received from the laboratory report the units of parts per million (ppm). Before you can calculate whether you met the substance threshold or report these values to the NPRI, you must convert the ppm to a mass release in tonnes.

1. The first step is to calculate the stack's volumetric gas flow rate (\dot{V}), using the formula below:

$$\dot{V} \text{ (m}^3\text{/min)} = (\text{gas velocity, m/s}) \times [\pi \times (\text{internal stack diameter, m})^2 / 4] \times 60 \text{ s/min}$$

2. You then must correct for the moisture content in the stack gas flow rate using the formula below:

$$\text{Dry } \dot{V} \text{ (m}^3\text{/min)} = (\text{volumetric stack flow rate, m}^3\text{/min}) \times (1 - \text{fraction water vapour})$$

Example:

If the stack gas volumetric flow is 0.6 m³/s with a moisture content of 10%, the dry volumetric stack flow rate is:
(0.6 m³/min) × (1 – 0.10) = 0.54 m³/min

3. The next step is to convert from ppm (volume) to mass emission rate.

Example:

NO_x is emitted from a stack that is 1.0 ppm by volume. The dry volumetric stack flow rate is 1 000 m³/min under standard conditions.

- a) Use the ideal gas law: PV = nRT

$$\text{Molar volume} = V/n = (RT) / P$$

(the molar volume of an ideal gas at 237 Kelvin and 1 atmosphere is 22.4 litre/mole)

Where:

R = the ideal gas constant of 0.082057 litre-atm / mole-Kelvin

T = Temperature in Kelvin = 273 + 25°C = 298 Kelvin

P = 1 atmosphere

V = Volume

n = number of moles

$$\begin{aligned} \text{Molar volume} &= [(0.082057 \text{ litre atmosphere / mole-Kelvin}) \times (298 \text{ Kelvin})] / 1 \text{ atmosphere} \\ &= 24.45 \text{ litres/mole} \end{aligned}$$

Convert to kg/m³:

$$\text{kg/m}^3 = \frac{(\text{NO}_x \text{ concentration, ppmv})}{(\text{Molar Volume, litre/mole})} \times \frac{1}{10^6} \times (\text{MW, g/mole}) \times \left[\frac{1\,000 \text{ litres}}{1 \text{ m}^3} \right] \times \left[\frac{1 \text{ kg}}{1\,000 \text{ g}} \right]$$

Where: MW is the molecular weight of NO_x (expressed as NO₂) = 46 g/mole

Concentration of NO_x in stack gas flow:

$$\begin{aligned} \text{kg/m}^3 &= \frac{(1 \text{ ppmv})}{24.45 \text{ litre/mole}} \times \frac{1}{10^6} \times (46 \text{ g/mole}) \times \left[\frac{1\,000 \text{ litres}}{1 \text{ m}^3} \right] \times \left[\frac{1 \text{ kg}}{1\,000 \text{ g}} \right] \\ &= 0.0000018 \text{ kg/m}^3 \end{aligned}$$

- b) Using stack dry gas flow rate, calculate the mass emission rate:

$$\begin{aligned}\text{Mass emission rate} &= 1\,000 \text{ m}^3/\text{minute} \times 0.0000018 \text{ kg/m}^3 \\ &= 0.0018 \text{ kg/minute} \times 60 \text{ minutes/hour} \\ &= 0.108 \text{ kg/hour}\end{aligned}$$

4. Use the mass emission rate to calculate the yearly NO_x release (assuming 8 760 hours/year of operation).

$$\text{Yearly release} = \text{Mass Emission Rate} \times \frac{\text{hours}}{\text{year}}$$

$$= \frac{0.108 \text{ kg}}{\text{hour}} \times \frac{8\,760 \text{ hours}}{\text{year}}$$

$$= 946.08 \text{ kg}$$

$$= 0.946 \text{ tonnes NO}_x \text{ released yearly}$$

Example 2.2 Estimating Emissions from an Industrial Boiler

This describes the calculation of emissions (annual emissions and monthly percentage breakdown) from an industrial boiler with a capacity of 35 Megawatts (119 million BTU/hr) that uses anthracite coal as fuel, and fugitive emissions (from the coal pile). The coal is stored in an uncovered pile outside the facility.

Operating parameters:

Annual coal consumption: 100 000 tonnes

Ash content of coal: 5%

Sulphur content of coal: 1.5%

Particulate emissions are controlled with multiple cyclones (total efficiency 75%).

Sulphur oxides emissions are controlled with a 93% efficient limestone injection system.

Boiler Type: Traveling grate stoker

Step 1 – Identify the resources

Determine if there are any manufacturer-supplied, boiler-specific emission factors. If none are available, the appropriate emission factors are those published by the U.S. EPA, in the AP-42 document and the latest version of the FIRE database. Reporters are required to demonstrate due diligence when selecting the emission factors. (AP-42: *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources; FIRE is a database and accessing software containing the U.S. EPA's recommended emission estimation factors for criteria and hazardous air contaminants.*)

Step 2 – Identify the appropriate emission factor and calculate uncontrolled emissions

Since no data were found from the manufacturer, emission factors from other sources can be used. Emission factors obtained from AP-42 (section 1.2) for anthracite coal combustion (Web site below) except for VOC. Following are the emission factors for CACs:

NPRI SUBSTANCE*	EMISSION FACTOR (KG/TONNE)
Total particulate matter (TPM)	1
Particulate matter (PM ₁₀)	**
Particulate matter (PM _{2.5})	**
Volatile organic compound (VOC)	0.035
Oxides of nitrogen (NO _x)	4.5
Sulphur dioxide (SO ₂)	19.5S
Carbon monoxide (CO)	0.3

AP-42 reference - section 1.2 for stoker fired boilers. The emission factor (EF) from this section is converted to kg/tonne from lb/ton using a conversion factor of 0.5. Check the Web site for details <www.epa.gov/ttn/chieff/ap-42/ch01/final/c01s02.pdf>.

1 Megawatt = 3.41 million BTU/hr

* There are other non-CAC NPRI substances that are emitted from coal combustion and are not estimated in this example. Refer to AP-42 and FIRE database.

EF from AP-42 is for SO₂ (due to sulphur formula)

EFs from FIRE database are for VOC, TPM, NO_x, and CO

** Expressed in cumulative mass %, see below for percentages.

Where:

S is the sulphur content in coal, expressed as percentage. The sulphur content in this example is 1.5%. Therefore S=1.5 (available from the coal supplier).

Estimating VOC, NO_x and CO emissions:

The general equation for estimating uncontrolled emissions of VOC, NO_x and CO from coal combustion in boilers is:

Boiler emissions (uncontrolled) = Annual coal consumption in tonnes x Emission factor (kg/tonne of coal burned)

Example

$$\begin{aligned}\text{VOC emission} &= 100\,000 \text{ tonnes/year} \times 0.035 \text{ kg/tonne} \\ &= 3\,500 \text{ kg/year} \\ &= 3.5 \text{ tonnes per year}\end{aligned}$$

NO_x and CO emissions are estimated in the same manner.

Estimating TPM emissions:

The general equation for estimating uncontrolled emissions of TPM from coal combustion in boilers is:

$$\text{Uncontrolled TPM emissions} = \text{Annual coal consumption in tonnes} \times \text{Emission factor (kg/tonne)}$$

[Note: Some of the coal emission factors include the ash component when creating the emission factor.]

$$\begin{aligned}\text{TPM} &= 100\,000 \text{ tonnes/year} \times (1 \text{ kg/tonne}) \\ &= 100\,000 \text{ kg} \\ &= 100 \text{ tonnes}\end{aligned}$$

Estimation of PM₁₀ and PM_{2.5} emissions are provided in Step 3 below.

Estimating SO₂ emissions:

The general equation for estimating uncontrolled emissions of SO₂ from anthracite coal combustion in boilers is:

$$\begin{aligned}\text{SO}_2 \text{ emissions} &= \text{Annual coal consumption in tonnes} \times \text{Emission factor (kg/tonne} \times \text{Coal sulphur content)} \\ &= 100\,000 \text{ tonnes/year} \times (19.5 \text{ kg/tonne} \times 1.5) \\ &= 2\,925\,000 \text{ kg} \\ &= 2\,925 \text{ tonnes}\end{aligned}$$

[Note: The example is for CAC emissions only; other NPRI substances that may be emitted during coal combustion should be considered.]

Step 3 – Estimating Controlled Emissions

This step explains the method of estimating controlled emissions. Particulate emissions are controlled with a 75% efficient cyclone and SO₂ emissions are controlled with a 93% efficient limestone injection system. The general equation for estimating controlled emissions of PM and SO₂ is:

$$\text{Controlled emissions} = \text{Uncontrolled emissions} \times (1 - \text{Efficiency}/100)$$

TPM, PM₁₀ and PM_{2.5} emissions:

$$\begin{aligned}\text{TPM emissions} &= 100 \text{ tonnes per year} \times (1 - 75/100) \\ &= 25 \text{ tonnes}\end{aligned}$$

$$\begin{aligned}\text{PM}_{10} \text{ emissions} &= \text{TPM emissions} \times \text{mass percentage of PM}_{10}^{**} \\ &= 25 \text{ tonnes} \times 0.55 \\ &= 13.75 \text{ tonnes per year}\end{aligned}$$

(** from Table 1.2-4 in AP-42, controlled PM₁₀ emission is 55% of the controlled total particulate emission)

$$\begin{aligned}\text{PM}_{2.5} \text{ emissions} &= \text{TPM emissions} \times \text{mass percentage of PM}_{2.5}^{***} \\ &= 25 \text{ tonnes} \times 0.24 \\ &= 6.00 \text{ tonnes per year}\end{aligned}$$

(*** from Table 1.2-4 in AP-42, controlled PM_{2.5} emission is 24% of the controlled total particulate emission)

Controlled SO₂ emissions:

$$\begin{aligned}
 \text{SO}_2 \text{ emission} &= 2\,925 \text{ tonnes per year} \times (1 - 93/100) \\
 &= 2\,925 \text{ tonnes per year} \times (0.07) \\
 &= 204.75 \text{ tonnes}
 \end{aligned}$$

Step 4 – Calculate fugitive emissions from coal dust

Coal is stored outside the facility and is not covered to prevent wind erosion. As a result, fugitive emissions from the pile must be calculated. Only emissions from particulate matter are found for this source.

The appropriate emission factors are published by U.S. EPA, in the AP-42 document, Chapter 13.2.4. Using equation 1 of this chapter, calculate the emission factor (in kg/tonne of material transferred) for total particulate matter emissions.

The equation is:

$$E = k \times (0.0016) \times [(U/2.2)^{1.3} / (M/2)^{1.4}]$$

Where:

E = emission factor, kg/tonne of coal

k = particle size multiplier (dimensionless)

U = mean wind speed, metres per second (m/s)

M = material moisture content (%)

Assumptions:

For TPM emissions, assume the aerodynamic particle diameter less than 30 microns, the particle size multiplier value is 0.74 (from the table in chapter 13.2.4 of AP-42). Assuming the average wind speed (obtained from the local meteorological station for the area) as 7.0 metres/second. The moisture content of coal is 4.4 (from Table 13.2.4-1 of AP-42).

$$\begin{aligned}
 E &= 0.74 \times 0.0016 [(7.0/2.2)^{1.3} / (4.4/2)^{1.4}] \\
 &= 0.00177 \text{ kg of TPM per tonne of material transferred}
 \end{aligned}$$

The total coal transferred is 100 000 tonnes. Therefore the particulate matter emission is:

$$\begin{aligned}
 \text{TPM emission} &= 0.00177 \text{ kg/tonne} \times 100\,000 \text{ tonnes} \\
 &= 177 \text{ kg} \\
 &= 0.177 \text{ tonnes}
 \end{aligned}$$

Emissions for PM₁₀ and PM_{2.5} are also estimated with the same formula. Only the variable k, the particle size multiplier, changes.

PM₁₀ emissions:

$$\begin{aligned}
 E &= 0.35 \times 0.0016 [(7.0/2.2)^{1.3} / (4.4/2)^{1.4}] \\
 &= 0.00083 \text{ kg of PM}_{10} \text{ per tonne of material transferred}
 \end{aligned}$$

(particle size multiplier k is 0.35 for particle size less than 10 microns from the table in chapter 13.2.4 of AP-42)

The total coal transferred is 100 000 tonnes. Therefore the particulate matter emission is:

$$\begin{aligned}
 \text{PM}_{10} \text{ emission} &= 0.00083 \text{ kg/tonne} \times 100\,000 \text{ tonnes} \\
 &= 83 \text{ kg} \\
 &= 0.083 \text{ tonnes}
 \end{aligned}$$

PM_{2.5} emissions:

$$E = 0.11 \times 0.0016 [(7.0/2.2)^{1.3} / (4.4/2)^{1.4}]$$

$$= 0.00026 \text{ kg of PM}_{10} \text{ per tonne of material transferred}$$

(particle size multiplier k is 0.11 for particle size less than 2.5 microns from the table in Chapter 13.2.4 of AP-42)

The total coal transferred is 100 000 tonnes. Therefore the particulate matter emission is:

$$\text{PM}_{2.5} \text{ emission} = 0.00026 \text{ kg/tonne} \times 100\,000 \text{ tonnes}$$

$$= 26 \text{ kg}$$

$$= 0.026 \text{ tonnes}$$

Step 5 – Calculate total emissions

The total emissions for our example are the combination of the emissions from the boilers and the fugitive emissions from the coal pile. The following formula must be used for the calculation.

Total emission = Boiler emission + Coal pile emission (fugitive emission)

NPRI SUBSTANCE	TOTAL EMISSION (TONNES)
TPM	25.177
PM ₁₀	13.83
PM _{2.5}	6.03
VOC	3.5
NO _x	450
SO ₂	204.75
CO	30

[Note: the coal-fired boiler in the above example exceeded the threshold for all the CACs.]

Step 6 – Calculate the monthly breakdown of emission by percentage**Boiler emissions:**

Calculate the monthly breakdown of emissions by percentage for each pollutant. The general equation for estimating monthly emissions is the same as for annual emissions. The coal used each month is obtained from records at the facility. You can calculate emissions for each month and add the total at the end of the year. Using the annual total, calculate the monthly emission percentage using the following equation:

$$\text{January \% emission} = (\text{January emission} / \text{Total annual emissions}) \times 100$$

Example:

$$\text{If the January emission of CO was 2.8 tonnes, the January \% emission} = (2.8 \text{ tonnes} / 30 \text{ tonnes}) \times 100$$

$$= 9.33\%$$

Fugitive emissions:

The general equation for estimating monthly emissions is the same as for annual emissions. The quantity of coal transferred each month is obtained from records at the facility. The mean wind speed for the month can be obtained from a local meteorological source. You can calculate the emissions for each month and add the total at the end of the year. Using the annual total, calculate the monthly emission percentage using the following equation:

$$\text{January \% emission} = (\text{January emission} / \text{Total annual emissions}) \times 100$$

Example:

$$\text{If the January emission of TPM was 0.01 tonnes, the January \% emission} = (0.01 \text{ tonnes} / 0.177 \text{ tonnes}) \times 100$$

$$= 5.65\%$$

Example 2.3 Emission Estimation for a Sulphuric Acid Plant Using Emission Factors

To calculate sulphur dioxide emissions from a sulphuric acid (H_2SO_4) plant that produces 200 tonnes of 100% H_2SO_4 per day by converting sulphur dioxide (SO_2) into sulphur trioxide (SO_3) at 97.5% efficiency. There are no controls at the facility for SO_2 emissions.

Step 1 – Calculate the EF for SO_2

In Section 8.10 of AP-42, “Sulphuric Acid”, the SO_2 emission factors are listed according to SO_2 -to- SO_3 conversion efficiencies in whole numbers (Table 8.10-1). See footnote “b” of the U.S. EPA table to obtain the interpolation formula that may be used to obtain the emission factor for 97.5% SO_2 -to- SO_3 conversion. [source: <www.epa.gov/ttn/chief/ap42/c00s00.pdf>]

The emission factor for kg SO_2 / tonne 100% H_2SO_4
 $= 682 - [(6.82)(\% \text{SO}_2\text{-to-}\text{SO}_3 \text{ conversion})]$
 $= 682 - [6.82](97.5)]$
 $= 682 - 665$
 $= 17 \text{ kg of } \text{SO}_2 \text{ emitted/tonne of } \text{H}_2\text{SO}_4$

Step 2 – Calculate SO_2 emissions

Using the H_2SO_4 production data:

SO_2 emissions $= 17 \text{ kg } \text{SO}_2 \text{ emissions/tonne } 100\% \text{H}_2\text{SO}_4 \times 200 \text{ tonne of } 100\% \text{H}_2\text{SO}_4/\text{day}$
 $= 3\,400 \text{ kg } \text{SO}_2 \text{ emissions/day}$
 $= 3.4 \text{ tonnes/day}$

If the facility operated 240 days/year, annual SO_2 emissions from the facility were:

$3.4 \text{ tonnes/day} \times 240 \text{ days/year} = 816 \text{ tonnes/year}$

Step 3 – Calculate the monthly breakdown of emission by percentage

The general equation for estimating monthly emissions is the same as for annual emissions. The daily/monthly production of H_2SO_4 is obtained from records at the facility. You can calculate the emissions for each month and add the total at the end of the year. Using the annual total, calculate the monthly emission percentage using the following equation:

January emission percentage $= (\text{January emission} / \text{Total annual emissions}) \times 100$

Example:

If the January emission of SO_2 was 68 tonnes and the annual emission of SO_2 was 816 tonnes, the percentage emission $= (68 \text{ tonnes} / 816 \text{ tonnes}) \times 100$
 $= 8.3\%$

[Note: monthly percentages must total 100 at the end of the year]

Example 2.4 Emission Estimation for the Baking Industry Using Emission Factors

To calculate VOC emissions from a large commercial bakery that produces 9 000 tonnes of yeast-leavened bread annually.

Step 1 – Data Collection

Collect the following data:

- for each type of bread, tonnes of bread baked annually
- initial baker's percent of yeast
- the total yeast action time in hours
- the final baker's percent of yeast
- spiking time in hours

Step 2 – Calculate the emission factor (EF)

There are no emission factors published for VOC emissions yeast-leavened products in AP-42. The EF for each type of yeast-leavened product must be calculated before calculating the VOC emissions. EF varies from product to product (yeast leavened) based on the factors given in Step 1.

VOC EF in terms of kg VOC/tonne of bread produced:

$$EF = 0.475Y_i + 0.0975t_i - 0.255S - 0.43t_s + 0.95$$

Where:

VOC EF = kg VOC per tonne of baked bread

Y_i = initial baker's percent of yeast

t_i = total yeast action time in hours

S = final (spike) baker's percent of yeast

t_s = spiking time in hours

Example:

The facility has the following data for one of its yeast-leavened products:

Y_i = initial baker's percent of yeast = 2%

t_i = total yeast action time in hours = 2

S = final (spike) baker's percent of yeast = 2%

t_s = spiking time in hours = 1

Calculate the VOC emission factor using the equation:

$$\begin{aligned} EF &= [0.475 (2) + 0.0975 (2) - 0.255 (2) - 0.43 (1) + 0.95] \\ &= 1.155 \text{ kg of VOC per tonne of bread produced} \end{aligned}$$

Step 3 – Calculate VOC emissions

$$\begin{aligned} \text{VOC emission} &= \text{emission factor (kg/tonne)} \times \text{production (tonnes)} \\ &= 1.155 \text{ kg/tonne} \times 9\,000 \text{ tonnes of bread} \\ &= 10\,395 \text{ kg} \\ &= 10.395 \text{ tonnes} \end{aligned}$$

Repeat steps 2 and 3 for each type of yeast-leavened product (and also collect the data in step 1 for each product) and add the emissions for each yeast-leavened product since the parameters vary for each.

Note: Only total VOC from the ovens is calculated. In addition, quantify emissions from fuel combustion for each oven (if any fuel is used for heating the oven). Finally, you must add emissions from all the sources in the facility to determine the facility total.

Step 4 – Calculate the monthly breakdown of emission by percentage

This is calculated by using the annual total. First, the monthly VOC emission must be calculated using the same equation and method shown in steps 2 and 3. The monthly production of yeast-leavened product is obtained from the records at the facility. Then calculate the monthly emission percentage using the following equation:

$$\text{January \% emission} = (\text{January emission} / \text{Total annual emissions}) \times 100$$

Total annual emission from the facility is 10.395 tonnes of VOC and if the total January emission of VOC was 1.1 tonnes, the % emission = $(1.1 \text{ tonnes} / 10.395 \text{ tonnes}) \times 100$
=10.58%

[Note: the monthly breakdown of emission by percentage is calculated for each pollutant emitted from the entire facility.]

Example 2.5 Emission Estimation Using Emission Factors

Operating Parameters:

Cooling tower type: Wet with induced draft

Average cooling tower throughput rate: 27 000 litres per minute

Average total dissolved solids (TDS) concentration during the year: 2 000 ppm

Actual hours of operation: 8 400 hours

Number of cells: 8

Step 1 – Identify emission factor(s)

Appropriate emission factors are published by the U.S. EPA, in the AP-42 document, section 13.4 <www.epa.gov/ttn/chief/ap42/ch13/>.

Step 2 – Estimate emissions

Total liquid drift (TLD) is 0.204 kg/1 000 litres = 0.000204 kg/litre

Uncontrolled PM₁₀ emissions are calculated as follows:

$$\begin{aligned}\text{PM}_{10} \text{ emission in kg/hour} &= \text{TLD (kg/litre)} \times [\text{TDS (ppm)} \times \text{throughput (litres/minute)} \times 60 \text{ min/hour}] \\ &= 0.000204 \text{ kg/litre} \times 2\,000 \times 1/10^6 \times 27\,000 \text{ litres/minute} \times 60 \text{ min/hour} \\ &\quad (\text{parts per million conversion is } 1/10^6) \\ &= 0.661 \text{ kg PM}_{10} \text{ per hour}\end{aligned}$$

Actual hours of operation = 8 400 h/year

Therefore:

$$\begin{aligned}\text{Uncontrolled PM}_{10} \text{ emissions} &= 0.661 \text{ kg/hour} \times 8\,400 \text{ hours/year} \\ &= 5\,552.4 \text{ kg} \\ &= 5.55 \text{ tonnes from each cell}\end{aligned}$$

$$\begin{aligned}\text{Total uncontrolled PM}_{10} \text{ emissions from all eight cells:} \\ &= 8 \times 5.55 \text{ tonnes} \\ &= 44.4 \text{ tonnes}\end{aligned}$$

In this example, the TPM emissions would be assumed the same as the PM₁₀. Other methods would be used to estimate the PM_{2.5}.

Step 3 – Calculate the monthly breakdown of emission by percentage

The general equation for estimating monthly emissions is the same as that for annual emissions. The monthly average TDS concentration (in ppm), the monthly average cooling tower throughput rate (litres/minute) and monthly cooling tower operation (in hours) are obtained from records at the facility. Calculate emissions per month and add the total at the end of the year. Using the annual total, the monthly emission percentage is calculated using the following equation:

$$\text{January emission percentage} = (\text{January emission} / \text{Total annual emissions}) \times 100$$

Example 2.6 Emission Estimation Using the Mass Balance Approach

This example shows the use of mass balances as a method for estimating emissions from a metal-rolling unit that processes copper coil. Prior to a rolling step, copper coil is sprayed with oil for lubrication and heat dispersion. After rolling, the copper coil is sent to an annealer that has been shown to destroy 85% of the oil during the heat treatment of the copper coil. Negligible amounts of oil remain on the copper coil after annealing. The oil is assumed to be 100% VOC. The VOC emissions associated with this process occur from volatilization of lubricating oil during its application prior to rolling as well as the non-destroyed oil exhausted from the annealer.

Operating Parameters:

Mass of copper coil processed: 5 000 kg

Mass of copper coil and oil sent to annealer: 5 075 kg

Mass of lubricating oil sprayed onto the copper: 3 000 kg

Mass of lubricating oil recovered: 2 800 kg

[source: <www.epa.gov/ttn/chief/eidocs/beginner.pdf>]

Step 1 – Estimating emissions

The general formula to complete a material balance is:

$$\text{Input} + \text{Generation} - \text{Output} - \text{Consumption} = \text{Accumulation}$$

Where:

Input:	mass entering the process
Generation:	mass produced in the process
Output:	mass exiting the process
Consumption:	mass consumed in the process
Accumulation:	mass that builds up within the process

For this example, the parameters listed above are described as:

Input:	mass of lubricating oil applied (3 000 kg)
Generation:	not applicable/no material generation (0 kg)
Output:	mass of oil lost as an emission
Consumption:	mass of oil destroyed in the annealer
Accumulation:	mass of lubricating oil recovered (2 800 kg)

The estimate for the consumption parameter is calculated from the mass of copper coil processed, the mass of copper coil and oil sent to the annealer, and the oil destruction efficiency as it is exposed to high temperatures in the annealer.

$$\begin{aligned}\text{Consumption} &= (\text{mass of coil and oil to annealer} - \text{mass of coil processed}) \times 85\% \\ &= (5\,075\text{ kg} - 5\,000\text{ kg}) \times 0.85 \\ &= 64\text{ kg oil destroyed in the annealer}\end{aligned}$$

After simplifying the material balance formula, the estimate of the Output (emissions) from this process is:

$$\text{Input} - \text{Output} - \text{Consumption} = \text{Accumulation}$$

Or:

$$\begin{aligned}\text{Output} &= \text{Input} - \text{Consumption} - \text{Accumulation} \\ &= 3\,000\text{ kg} - 64\text{ kg} - 2\,800\text{ kg} \\ &= 136\text{ kg}\end{aligned}$$

The VOC emissions associated with this process are 136 kg oil per 5 000 kg of copper coil processed, or 0.027 kg oil per kg of copper coil processed.

Example 2.7 Estimating Emissions using Predictive Emission Monitoring (PEM)

Total particulate matter (TPM) emissions from a boiler unit firing heavy fuel oil (HFO) are estimated in this example. To utilize the PEM approach, a model or relationship between TPM emission rates and fuel consumption must first be developed. An example of a model relationship is shown below.

Step 1 – Obtain the PEM data

Correlate the TPM emission rates to the HFO consumption rate of the boiler in the PEM as listed in the table below.

PARAMETERS	PEM DATA									
HFO consumption rate (GJ/h)	71	72	73	74	75	76	77	78	79	80
TPM emission rate (kg/h)	16	17	17	17	17	18	18	18	18	19

Once the predictive model has been tested and verified, it can then be used along with operation fuel use consumption rate to estimate annual TPM emissions from the unit. The following table illustrates how the predictive model is used to estimate TPM emissions for a specific time period.

PEM MONITORING RESULTS		PREDICTED TPM
TIME (HOUR)	FUEL RATE (GJ/h)	EMISSION RATE (kg/H)
1	74	17
2	74	17
3	76	18
4	75	17
5	76	18
6	77	18
7	78	18
8	79	18
9	80	19
10	80	19
Total for period	769 GJ	179 kg
Average for period	76.9 GJ/h	17.9 kg/h

Step 2 – Calculate emissions

The general formula for estimating emissions for contaminant x is:

$$E_X = E_{x, \text{ave}} \times T$$

Where:

$$\begin{aligned} E_X &= \text{Emission of contaminant } x, \text{ kg/year} \\ E_{x, \text{ave}} &= \text{Average emission rate of contaminant } x, \text{ kg/hr} \\ T &= \text{Total operating hours in a given year} \end{aligned}$$

Given that the above boiler unit operated under the same condition for 7 500 hours in the year, the estimated TPM emissions (E_{TPM}) will be as follows:

$$\begin{aligned} E_{\text{TPM}} &= 17.9 \times 7\,500 \\ &= 134\,250 \text{ kg PM/year} \\ &= 134.25 \text{ tonnes per year} \end{aligned}$$

Step 3 – Calculate monthly breakdown of emission by percentage

Determine the number of hours the boiler operated for each month and calculate monthly emission using the same method as shown above (using hourly emissions). Add monthly emission and obtain the annual emission rate. The percentage monthly breakdown is calculated using the following equation:

January emission percentage = (January emission / Total annual emissions) x 100

Example:

If the total annual emission from the facility is 134.25 tonnes of TPM and the total January emission of TPM was 10.74 tonnes, the percentage emission = (10.74 tonnes / 134.25 tonnes) x 100
= 8.0 %

Example 2.8 Estimating Emissions using Continuous Emission Monitoring Systems (CEMS)

Estimate emissions from an oil-fired boiler that has a Continuous Emission Monitoring System (CEMS).

Step 1 – Obtain the CEMS output

PERIOD	O ₂ (%V)	FUEL RATE, Q _{FUEL} (10 ³ kg/hr)	STACK GAS FLOW RATE, Q _{STACK} (dRm ³ /min)	MEASURED CONCENTRATION, C (ppmvd)			CALCULATED EMISSION RATE, CER (kg/hr)		
				SO ₂	NO _x	CO	SO ₂	NO _x	CO
1:00	1.5	15.4	3 576	799	175	20.2	461	73	5
1:10	1.7	16.9	3 855	830	186	23.9	500	81	6
1:20	1.4	15.3	3 433	755	155	19.9	445	66	5
1:30	1.6	16.0	3 720	821	175	20.5	480	74	5
1:40	1.5	16.5	3 760	814	164	19.5	529	77	6
1:50	1.5	16.3	3 754	825	158	29.5	529	73	8
2:00	1.6	16.2	3 825	812	179	26.3	494	79	7

Step 2 – Calculate emissions

The following equation is used to calculate emissions from the measured concentrations:

$$CER_x \times \frac{C_x \times MW_x \times Q_{stack} \times 60}{V \times 10^6}$$

Where:

CER_x = Calculated emission rate of contaminant x, kg/hr

C_x = Concentration of contaminant x, ppmvd

MW_x = Molecular weight of the contaminant x, g/g-mole

MW_{SO2} = 64

MW_{NOx} = 46 (as MW_{NO2})

MW_{CO} = 28

Q_{stack} = Dry stack gas volumetric flow rate at reference conditions, dRm³/min (reference conditions: 101.325 kPa and 25°C)

V = Volume occupied by 1 mole of ideal gas at reference conditions (24.45 litres/g-mole)

The average SO₂ emissions for the 1 hour = (461 + 500 + 445 + 480 + 529 + 529)/6 kg
= 490 kg of SO₂.

Note: Each of the readings is assumed to be valid for 0:09:59 minutes and seconds so the 1:00 through 1:50 readings were used for the hour's estimates and the 2:00 was assumed to be for the next hour.

Step 3 – Calculate monthly breakdown of emission by percentage

Calculate SO₂ emissions using the same method (use rolling average) for each month and sum all these emission values to obtain the annual emissions total. The percentage monthly breakdown is calculated using the following equation:

January emission percentage = (January emission / Total annual emissions) x 100

Example 2.9 Volatile Organic Compound Emission Estimation using Source Testing

This example illustrates the use of source test data to estimate process emissions from a paint spray booth. The materials emitted from the spray booth stack are 100% VOC.

Operating Parameters:

Stack flow rate: 30 000 standard cubic metres (scm)/hour

Average measured VOC concentration from stack: 0.002 kg VOC/scm

Spray booth annual operation: 2 000 hours

Step 1 – Estimating emissions

Since source testing provides a VOC concentration and the average stack exhaust flow rate, the concentration can be converted to a mass flow rate:

$$\begin{aligned}\text{Mass flow rate} &= \text{volumetric flow rate} \times \text{concentration} \\ &= 30\,000 \text{ scm/hour} \times 0.002 \text{ kg VOC/scm} \\ &= 60 \text{ kg VOC/hour}\end{aligned}$$

The annual VOC emissions can be estimated using the mass flow rate and the annual hours of operation for the spray booth:

$$\begin{aligned}\text{VOC emissions} &= \text{mass flow rate} \times \text{annual hours operation} \\ &= 60 \text{ kg VOC/hour} \times 2\,000 \text{ hours} \\ &= 120\,000 \text{ kg VOC or 120 tonnes}\end{aligned}$$

Step 2 – Calculate the monthly breakdown of emission by percentage

The general equation for estimating monthly emissions is the same as that for annual emissions. The spray booth's monthly operation (in hours) and the average measured VOC concentration from the stack is obtained from records at the facility. You can calculate the emissions for each month and add the total at the end of the year. Using the annual total, calculate the monthly emission percentage using the following equation:

$$\text{January emission percentage} = (\text{January emission} / \text{Total annual emissions}) \times 100$$

Example:

$$\begin{aligned}\text{If the January emission of VOC was 12.0 tonnes, the percentage emission} &= (12.0 \text{ tonnes} / 120 \text{ tonnes}) \times 100 \\ &= 10.00\%\end{aligned}$$

Example 2.10 Total Particulate Matter (TPM) Emission Estimation using Source Testing

Assume the source operates for 5 760 hours per year for this example.

Step 1 – Obtain the source test data (summary)

SUMMARY OF TPM SOURCE TESTING RESULTS*

Test date	May 3/02	May 3/02	May 3/02	
Test run	#1	#2	#3	
Time (hhmm)	0940-1043	1059-1202	1216-1319	Average
Emission test parameters				
No. of traverse points	18	18	18	
Sampling duration (minutes)	60	60	60	
Gas sample volume (dscm)	1.20	1.11	1.17	
Particulate collected (g)	44.7	48.7	46.8	
Isokinetic sampling variation (%)	102	101	102	
Stack gas parameters				
Temperature (°C)	82	84	84	
Oxygen (vol %, dry)	19	19	19	
Carbon dioxide (vol %, dry)	2	2	2	
Moisture (vol %, total)	11	11	12	
Flow rate (dscm/min)	1 250	1 170	1 235	1 218
TPM emissions				
Concentration (g/dscm)	37.3	43.9	40.0	40.4
Emission rate (kg/hour)	0.045	0.049	0.047	0.047

* Standard/Reference conditions: 25°C, 1 atm and normal operating conditions

Step 2 – Calculate emissions

The estimated emission from source testing results:

$$E_X = E_{x,ave} \times T$$

Where:

$$\begin{aligned} E_X &= \text{Emission of contaminant } x, \text{ kg/year} \\ E_{x,ave} &= \text{Average emission rate of contaminant } x, \text{ kg/hour} \\ T &= \text{Total operating hours in a given year} \end{aligned}$$

Since the process operated 5 760 hours under normal (i.e., testing) conditions in the reporting year, the calculated annual emission for particulate matter (PM) is:

$$\begin{aligned} E_{PM} &= 0.047 \text{ kg/hour} \times 5\,760 \text{ hr} \\ &= 271 \text{ kg} \\ &= 0.27 \text{ tonnes} \end{aligned}$$

Step 3 – Calculate monthly breakdown of emission by percentage

The general equation for estimating monthly emissions is the same as that for annual emissions. The source **monthly operation** (in hours) and the average measured PM concentration from the stack is obtained from records at the facility. Calculate emissions for each month and add the total at the end of the year. Using the annual total, calculate the monthly emission percentage using the following equation:

$$\text{January emission percentage} = (\text{January emission} / \text{Total annual emissions}) \times 100$$

Appendix 3 – Definition of VOCs

This definition for VOCs was first published in the *Notice of Intent to recommend that ozone and its precursors (nitrogen oxides (nitric oxide and nitrogen dioxide) and volatile organic compounds) be added to Schedule 1 of CEPA 1999*, in the *Canada Gazette*.

NOTE: This definition excludes substances from consideration, but does not directly name substances that are VOCs. Section 3.1.4 of this Supplementary Guide explains VOCs in greater detail. The substances listed below **are not** to be considered in calculating total VOCs for the purposes of NPRI reporting.

Definition of VOCs

Volatile organic compounds that participate in atmospheric photochemical reactions, **exclude** the following:

SUBSTANCES NOT CONSIDERED VOCs

NAME OF SUBSTANCE OR GROUP OF SUBSTANCES	CAS NO.
(a) methane	74-82-8
(b) ethane	74-84-0
(c) methylene chloride (dichloromethane)	75-09-2
(d) 1,1,1-trichloroethane (methyl chloroform)	71-55-6
(e) 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-113)	76-13-1
(f) trichlorofluoromethane (CFC-11)	75-69-4
(g) dichlorodifluoromethane (CFC-12)	75-71-8
(h) chlorodifluoromethane (HCFC-22)	75-45-6
(i) trifluoromethane (HFC-23)	75-46-7
(j) 1,2-dichloro-1,1,2,2-tetrafluoroethane (CFC-114)	76-14-2
(k) chloropentafluoroethane (CFC-115)	76-15-3
(l) 1,1,1-trifluoro-2,2-dichloroethane (HCFC-123)	306-83-2
(m) 1,1,1,2-tetrafluoroethane (HFC-134a)	811-97-2
(n) 1,1-dichloro-1-fluoroethane (HCFC-141b)	1717-00-6
(o) 1-chloro-1,1-difluoroethane (HCFC-142b)	75-68-3
(p) 2-chloro-1,1,1,2-tetrafluoroethane (HCFC-124)	2837-89-0
(q) pentafluoroethane (HFC-125)	354-33-6
(r) 1,1,2,2-tetrafluoroethane (HFC-134)	359-35-3
(s) 1,1,1-trifluoroethane (HFC-143a)	420-46-2
(t) 1,1-difluoroethane (HFC-152a)	75-37-6
(u) parachlorobenzotrifluoride (PCBTF)	98-56-6
(v) cyclic, branched, or linear completely methylated siloxanes	various
(w) acetone	67-64-1
(x) perchloroethylene (tetrachloroethylene)	127-18-4
(y) 3,3-dichloro-1,1,1,2,2-pentafluoropropane (HCFC-225ca)	422-56-0
(z) 1,3-dichloro-1,1,2,2,3-pentafluoropropane (HCFC-225cb)	507-55-1
(z,1) 1,1,1,2,3,4,4,5,5,5-decafluoropentane (HFC-43-10mee)	138495-42-8
(z,2) difluoromethane (HFC-32)	75-10-5
(z,3) ethylfluoride (HFC-161)	353-36-6
(z,4) 1,1,1,3,3,3-hexafluoropropane (HFC-236fa)	690-39-1
(z,5) 1,1,2,2,3-pentafluoropropane (HFC-245ca)	679-86-7
(z,6) 1,1,2,3,3-pentafluoropropane (HFC-245ea)	24270-66-4
(z,7) 1,1,1,2,3-pentafluoropropane (HFC-245eb)	431-31-2
(z,8) 1,1,1,3,3-pentafluoropropane (HFC-245fa)	460-73-1
(z,9) 1,1,1,2,3,3-hexafluoropropane (HFC-236ea)	431-63-0
(z,10) 1,1,1,3,3-pentafluorobutane (HFC-365mfc)	406-58-6
(z,11) chlorofluoromethane (HCFC-31)	593-70-4
(z,12) 1-chloro-1-fluoroethane (HCFC-151a)	1615-75-4

SUBSTANCES NOT CONSIDERED VOCs (CONTINUED)

NAME OF SUBSTANCE OR GROUP OF SUBSTANCES	CAS NO.
(z,13) 1,2-dichloro-1,1,2-trifluoroethane (HCFC-123a)	354-23-4
(z,14) 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-butane (C ₄ F ₉ OCH ₃)	163702-07-6
(z,15) (difluoromethoxymethyl)-1,1,1,2,3,3,3-heptafluoropropane ((CF ₃) ₂ CFCF ₂ OCH ₃)	163702-08-7
(z,16) 1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluorobutane (C ₄ F ₉ OC ₂ H ₅)	163702-05-4
(z,17) (ethoxydifluoromethyl)-1,1,1,2,3,3,3-heptafluoropropane (-(CF ₃) ₂ CFCF ₂ OC ₂ H ₅)	163702-06-5
(z,18) methyl acetate	79-20-9
perfluorocarbon compounds which fall into these classes:	
(i) cyclic, branched, or linear, completely fluorinated alkanes	various
(ii) cyclic, branched, or linear, completely fluorinated ethers with no unsaturations	various
(iii) cyclic, branched, or linear, completely fluorinated tertiary amines with no unsaturations, and	various
(iv) sulphur containing perfluorocarbons with no unsaturations and with sulphur bonds only to carbon and fluorine.	various

Appendix 4 – Storage Tanks and their Evaporation Implications

Fixed-Roof Tanks

This type of tank consists of a cylindrical steel shell with a permanently-affixed roof, varying in design from cone- or dome-shaped to flat. Losses from fixed-roof tanks are caused by changes in temperature, pressure and liquid level.

Of current tank designs, the fixed-roof tank is the least expensive to construct and is generally considered the minimum acceptable equipment for storing organic liquids.

Horizontal fixed-roof tanks are constructed for both above-ground and underground service and are usually built of steel, steel with a fiberglass overlay, or fiberglass-reinforced polyester. They are usually equipped with pressure-vacuum vents, gauge hatches, sample wells, and access points. In addition, underground tanks may be cathodically protected to prevent corrosion of the tank shell. Their capacity is generally less than 150 000 litres.

The potential emission sources for above-ground horizontal tanks are the same as those for vertical fixed-roof tanks. Emissions from underground storage tanks are associated mainly with changes in the liquid level in the tank. Losses caused by changes in temperature or barometric pressure are minimal for underground tanks, because the surrounding earth limits the diurnal temperature change; changes in barometric pressure result in only small losses.

Emissions:

The two significant types of emissions from fixed-roof tanks are storage and working losses. Storage loss is the expulsion of vapour from a tank through vapour expansion and contraction, which are the results of changes in temperature and barometric pressure. This loss occurs without any change in the liquid level in the tank.

The combined loss from filling and emptying is called working loss. Evaporation during filling operations is a result of an increase in the liquid level in the tank. As the liquid level increases, the pressure inside the tank exceeds the relief pressure and vapours are expelled from the tank. Evaporative loss during emptying occurs when air drawn into the tank during liquid removal becomes saturated with organic vapour and expands, thus exceeding the capacity of the vapour space.

Several methods are used to control emissions from fixed-roof tanks. They can be controlled by installing an internal floating roof and seals to minimize evaporation of the product being stored.

Vapour balancing is another means of emission control, and is probably most common in the filling of tanks at gasoline stations. As the storage tank is filled, the vapours expelled are directed to the emptying gasoline tanker truck. The truck then transports the vapours to a central station where a vapour recovery or control system is used to control emissions.

Vapour-recovery systems collect emissions from storage vessels and convert them to liquid product. Several vapour-recovery procedures may be used, including vapour/liquid absorption, vapour compression, vapour cooling, vapour/solid adsorption, or a combination of these.

Floating-Roof Tanks

External Floating-roof Tanks:

A typical external floating-roof tank consists of an open-topped cylindrical steel shell equipped with a roof that floats on the surface of the stored liquid. The floating roof consists of a deck, fittings, and rim seal system. Floating decks currently in use are constructed of welded steel plate and are of two general types – pontoon or double-deck. With all types of external floating-roof tanks, the roof rises and falls with the liquid level in the tank. External floating decks are equipped with a rim seal system, attached to the deck perimeter and contacts the tank wall. The purpose of the floating roof and rim seal system is to reduce evaporative loss of the stored liquid. Some annular space remains between the seal system and the tank wall. The seal system slides against the tank wall as the roof

raises and lowers. The floating deck is also equipped with fittings that penetrate the deck and serve operational functions. The external floating-roof design is such that evaporative losses from the stored liquid are limited to losses from the rim seal system and deck fittings (standing storage loss) and any exposed liquid on the tank walls (withdrawal loss).

Internal Floating-roof Tanks:

An internal floating-roof tank has both a permanent fixed roof and a floating roof inside. There are two basic types of internal floating-roof tanks – tanks in which the fixed roof is supported by vertical columns within the tank, and tanks with a self-supporting fixed roof and no internal support columns. Fixed-roof tanks that have been retrofitted to use a floating roof are typically of the first type. External floating-roof tanks that have been converted to internal floating-roof tanks typically have a self-supporting roof. Newly-constructed internal floating-roof tanks may be of either type. The deck in internal floating-roof tanks rises and falls with the liquid level and either floats directly on the liquid surface (contact deck) or rests on pontoons several inches above the liquid surface (non-contact deck).

Non-contact decks are the most common type currently in use. Typical non-contact decks are constructed of an aluminum deck and an aluminum grid framework supported above the liquid surface by tubular aluminum pontoons or some other buoyant structure. Evaporative losses from floating roofs may come from deck fittings, non-welded deck seams, and the annular space between the deck and tank wall. In addition, these tanks are freely vented by circulation vents at the top of the fixed roof. The vents minimize the possibility of organic vapour accumulation in the tank vapour space in concentrations approaching the flammable range.

Domed External Floating-roof Tanks:

Domed external (or covered) floating-roof tanks have the heavier type of deck used in external floating-roof tanks as well as a fixed roof at the top of the shell like internal floating-roof tanks. Domed external floating-roof tanks usually result from retrofitting an external floating-roof tank with a fixed roof. This type of tank is similar to an internal floating-roof tank with a welded deck and self-supporting fixed roof.

As with the internal floating-roof tanks, the function of the fixed roof is not to act as a vapour barrier, but to block the wind. The type of fixed roof most commonly used is a self-supporting aluminum dome roof, which is of bolted construction. Like the internal floating-roof tanks, these tanks are freely vented by circulation vents at the top of the fixed roof.

Emissions:

Total emissions from floating-roof tanks are the sum of withdrawal losses and standing storage losses. Withdrawal losses occur as the liquid level, and thus the floating roof, is lowered. Some liquid remains on the inner tank wall surface and evaporates. For an internal floating-roof tank that has a column supported fixed roof, some liquid also clings to the columns and evaporates. Evaporative loss occurs until the tank is filled and the exposed surfaces are again covered. Standing storage losses from floating-roof tanks include rim seal and deck fitting losses, and for internal floating-roof tanks also include deck seam losses for constructions other than welded decks. Other potential standing storage loss mechanisms include breathing losses as a result of temperature and pressure changes.

Variable Vapour Space Tanks

Variable vapour space tanks are equipped with expandable vapour reservoirs to accommodate vapour volume fluctuations attributable to temperature and barometric pressure changes. Although variable vapour space tanks are sometimes used independently, they are normally connected to the vapour spaces of one or more fixed-roof tanks. The two most common types of variable vapour space tanks are lifter roof tanks and flexible diaphragm tanks. Lifter roof tanks have a telescoping roof that fits loosely around the outside of the main tank wall. The space between the roof and the wall is closed by either a wet seal, which is a trough filled with liquid, or a dry seal, which uses a flexible coated fabric. Flexible diaphragm tanks use flexible membranes to provide expandable volume. They may be either separate gas holder units or integral units mounted atop fixed-roof tanks. Variable vapour space tank losses occur during tank filling when vapour is displaced by liquid. Loss of vapour occurs only when the tank's vapour storage capacity is exceeded.

Pressure Tanks

Two classes of pressure tanks are in general use – low pressure (2.5 to 15 psig) and high pressure (higher than 15 psig). Pressure tanks generally are used for storing organic liquids and gases with high vapour pressures and are found in many sizes and shapes, depending on the operating pressure of the tank. Pressure tanks are equipped with a pressure/vacuum vent that is set to prevent venting loss from boiling and breathing loss from temperature or barometric pressure changes. High-pressure storage tanks can be operated so that virtually no evaporative or working losses occur. In low-pressure tanks, working losses can occur with atmospheric venting of the tank during filling operations. No appropriate correlations are available to estimate vapour losses from pressure tanks.

Appendix 5 – Emission Estimation Tools

It should be noted that there are many sources of emission factors and models, a few of which are as follows:

U.S. EPA: <www.epa.gov/ttn/chief/>
UN ECE EMEP: <http://reports.eea.eu.int/technical_report_2001_3/en>
Australian NPI: <www.npi.gov.au/>
Great Britain: <www.airquality.co.uk/>

Other sources include industrial associations (e.g., Canadian Petroleum Products Institute and Canadian Association of Petroleum Producers), technical reports and other organizations (e.g., Air and Waste Management Association (AWMA)).

SPECIATE

SPECIATE is EPA's repository of Total Organic Compound (TOC) and Particulate Matter (PM) speciated profiles for a variety of sources for use in source apportionment studies. Users can search for profiles by keyword and browse through the profiles to locate the most appropriate. Profiles from this software may be used to estimate releases of NPRI substances from PM (e.g., metals such as Hg, Pb) or TOC. The TOC profiles are not for VOC. For VOC, the profile that is produced from SPECIATE will require non-VOC substances to be removed (see Appendix 3).

Web site: <www.epa.gov/ttn/chief/software/speciate/index.html>

TANKS

TANKS is a Windows-based computer software program that estimates volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions from fixed- and floating-roof storage tanks. TANKS is based on the emission estimation procedures from Chapter 7 of EPA's Compilation Of Air Pollutant Emission Factors (AP-42). TANKS uses chemical, meteorological, roof fitting and rim seal data to generate emissions estimates for several types of storage tanks, including:

- vertical and horizontal fixed-roof tanks
- internal and external floating-roof tanks
- domed external floating-roof tanks, and
- underground tanks.

To use the program, one enters specific information about storage tank construction and the stored liquid. The program produces a report estimating VOC emissions. A batch mode of operation is available to generate a single report for multiple tanks.

The TANKS program employs a chemical database of more than 100 organic liquids, and a meteorological database of more than 240 U.S. cities. The program allows the addition of more chemicals and cities, if desired. TANKS is capable of calculating individual component emissions from known mixtures and estimating emissions from crude oils and selected refined petroleum products using liquid concentration HAP profiles supplied with the program.

Web site: <www.epa.gov/ttn/chief/software/tanks/index.html>

Climate Normal Data for Canada is available from:

English: <www.msc-smc.ec.gc.ca/climate/index_e.cfm>
French: <www.msc-smc.ec.gc.ca/climate/index_f.cfm>

Landfill Gas Emissions Model (LandGEM)

Landfill Gas Emissions Model (LandGEM) may be used to estimate air emissions from municipal solid waste (MSW) landfills. The model was developed by the U.S. EPA's Control Technology Center. The Landfill Gas Emissions Model can be used to estimate emission rates for methane, carbon dioxide, non-methane organic compounds and individual air pollutants from landfills. The program can also be used by landfill owners and operators to determine if a landfill is subject to the reporting requirements of the NPRI through the estimation of releases.

The model is based on a first order decay equation. The model can be run using site-specific data for the parameters needed to estimate emissions or, if no site-specific data are available, using default values. There are two sets of default values. One set is based on the requirements of the U.S. EPA's New Source Performance Standards (NSPS) and emission guidelines. This set of default values produces conservative emission estimates. The other set of default values is based on emission factors in the U.S. EPA's *Compilation of Air Pollutant Emission Factors, AP-42*. This set of default values produces more representative emission values and can be used to produce typical emission estimates in the absence of site-specific test data. The default values presently in the model are the parameter values recommended by the U.S. EPA's NSPS and AP-42 as of September 1997. However, these parameter values may be revised in future updates of the model based on new information collected by the EPA.

Web site: <www.epa.gov/ttn/catc/products.html>

Particulate Matter Calculator

The Particulate Matter Calculator (hereafter referred to as the Calculator) was developed to help the U.S. develop PM₁₀ (particulate matter less than 10 microns in diameter) and PM_{2.5} (particulate matter less than 2.5 microns in diameter) inventories. The Calculator requests the SCC (source classification code), the primary particulate control device code, the secondary control device code, and the uncontrolled emissions. The uncontrolled emissions may be either PM_{fil} (filterable particulate measured) or PM_{10-fil} (filterable).

The Calculator uses information from AP-42 to calculate controlled filterable particulate emissions. It calculates controlled PM_{10-fil} and PM_{2.5-fil} from uncontrolled point sources and PM_{10-fil} or PM_{fil} for point sources with up to two pollution-control devices. The program is run in batch mode. The Calculator accepts input files in fixed-width text, Access 97, Excel 5.0, Lotus wk3, or dBASE IV formats. The output file formats are the same. The program permits the user to specify a name, drive and directory for each input and output file.

First, the Calculator searches for an uncontrolled distribution for the input SCC. It then searches for control efficiencies for the primary particulate device code, and concludes with searches for the control efficiencies of the secondary particulate control device. These data are used to calculate controlled PM_{10-fil} and PM_{2.5-fil} emissions and overall PM_{10-fil} and PM_{2.5-fil} control efficiencies.

Web site: <www.epa.gov/ttn/chief/software/pmcalc/index.html>

Appendix 6 – Common Pollution-Control Devices with Respective Removal Efficiencies

This table provides an overview of Control Device Efficiencies, [Reference: EPA Emission Inventory Improvement Program (EIIP) Volume II Chapter 12]. Environment Canada recommends using the middle value if a range is given for specific pollution-control equipment.

AVERAGE PERCENT CONTROL EFFICIENCIES (% CE) OR % CE RANGE FOR EACH CAC BY PROCESS AND CONTROL DEVICE TYPE

DEVICE	TPM	PM ₁₀	PM _{2.5}	SO _x	NO _x	VOC	CO
Selective non-catalytic reduction					50-90		
Selective catalytic reduction					63-94		
Flue gas recirculation					5-55		
Low excess air					2-30		
Low NO _x burners					35-85		
Natural gas burners / reburn					50-70		
Overfire air					5-60		
Low-NO _x burner with selective non-catalytic reduction					50-80		
Low-NO _x burner with overfire air and selective catalytic reduction					85-95		
Low -NO _x burner with overfire air					40-60		
Wet acid gas scrubber				80-99			
Scrubber, general				90-99			
Spray dryer absorber				50-90		90 - 99	
Thermal incinerator						90 - 99.9	90
Catalytic incinerator						90 - 99.9	90
Flare						90 - 99	98
Carbon adsorber						90 - 99	
Mechanical collector	20 - 60						
Gravity collector - high-efficiency	6	5	3.6				
Gravity collector - medium-efficiency	4.8	4	2.9				
Gravity collector - low-efficiency	3.7	3.2	1.5				
Wet PM scrubber	50 - 99						
Wet scrubber - high-efficiency	99	95	90				
Wet scrubber - medium-efficiency	95	85	25				
Wet scrubber - low-efficiency	90	80	20				
Electrostatic precipitator	90 - 99.9						
Electrostatic precipitator - high-efficiency	99.5	99	95				
Electrostatic precipitator - medium-efficiency	97	90	80				
Electrostatic precipitator - low-efficiency	90	80	70				
Fabric filter	95 - 99.4						
Fabric filter - high temperature	99.5	99.5	99				
Fabric filter - medium temperature	99.5	99.5	99				
Fabric filter - low temperature	99.5	99.5	99				
Centrifugal collector - high-efficiency	95	95	80				
Centrifugal collector - medium-efficiency	85	75	50				
Centrifugal collector - low-efficiency	50	35	10				
Mist eliminator - high velocity >250 FPM	90	75	10				
Mist eliminator - low velocity <250 FPM	75	40	5				
Liquid filtration system	85	75	50				
Packed-gas absorption column	99	95	90				
Tray-type gas absorption column	95	85	25				
Spray tower	90	80	20				
Venturi scrubber	99	95	90				
Process enclosed	3.7	3.2	1.5				
Impingement plate scrubber	99	95	25				
Dynamic separator (dry)	99	95	90				

**AVERAGE PERCENT CONTROL EFFICIENCIES (% CE) OR % CE RANGE FOR EACH CAC
BY PROCESS AND CONTROL DEVICE TYPE (CONTINUED)**

DEVICE	TPM	PM ₁₀	PM _{2.5}	SO _x	NO _x	VOC	CO
Dynamic separator (wet)	85	75	50				
Mat or panel filter - mist collector	97	94	92				
Multiple cyclone with fly ash reinjection	20	15	10				
Metal fabric filter screen	90	65	40				
Dust suppression by water sprays	90	65	40				
Dust suppression by chemical stabilizer or wetting	80	5	0				
Wet cyclonic separator	97	90	80				
Gravel bed filter	90	20	10				
Annular ring filter	50	35	10				
Fluid bed dry scrubber	85	75	50				
Single cyclone	95	95	80				
Multiple cyclone without fly ash reinjection	85	75	50				
Water curtain	90	45	10				
Catalytic oxidation-flue gas desulphurization				97.0			
Alkalized alumina				85.0			
Dry limestone injection				85.0			
Wet limestone injection				70.0			
H ₂ SO ₄ plant-contact process				95.0			
H ₂ SO ₄ plant-double contact process				99.0			
Sulphur plant				99.0			
Packed gas absorption column	98.0			98.0		98.0	
Tray gas absorption column	98.0			98.0		98.0	

Appendix 7 – Data Requirements for Regional Air Quality Modelling

This Appendix explains the data requirements for CAC regional air-quality models, and how that information will be collected through the NPRI. Refer to Chapter 5 of this Supplementary Guide, for a description of the fields in the facility and substance sections of the reporting form for CACs.

What Is a Regional Air-Quality Model?

A regional air-quality model (RAQM) is a time-dependent mathematical model of air-quality processes in the atmosphere. RAQMs use equations and relationships to simulate/describe the set of atmospheric dynamic, physical and chemical processes that govern air quality. Air-quality models are “prognostic” in that they attempt to simulate the changing air-quality conditions that would occur naturally for a given set of time dependent pollutant emissions and meteorological conditions.

Operating Schedule (Temporal Variation)

Information on temporal variation of emissions of CACs from individual facilities is required for RAQMs to represent the physical and chemical processes that occur over a given time and their impacts on concentrations and transport of these substances.

The quantity and concentration of emissions fluctuates over time at a facility as a result of its operation schedules, which include considerations such as changes in level of operations, shutdowns for routine maintenance and periods of operation. The quantity and concentration of the emissions may also fluctuate because of changes in process throughputs.

While information on temporal variation of actual CAC emissions is ideal for modelling purposes, a general description of the operating schedule of the facility is simpler to report to the NPRI, and will still meet the input needs for most air-quality models. This information is reported in fields T1.0 to T1.5 in the Facility Report, and these fields are described in Section 5.2 of this Supplementary Guide.

The thresholds for CACs are based on the quantity released to air. Once a threshold is met, only quantities of CACs released to air will be reported. CAC substances are of concern because they contribute to air pollution; therefore Environment Canada will not require information on releases to other media, nor transfers off site for disposal or recycling.

Emissions from Stacks Greater Than 50 Metres Above Grade

The majority of pollutant emissions are essentially at ground level or within the boundary layer (see diagram below). Pollutants within the boundary layer are usually dispersed/mixed quickly as a result of boundary-layer turbulence, whereas pollutants reaching the free troposphere are dispersed more slowly because of greater vertical stability and lower turbulence intensity. Of particular interest to modellers are emissions of CACs from stacks that reach the upper layers of the atmosphere, where the pollutants experience a different transport, diffusion, temperature, and chemical environment than in the atmospheric boundary layer. Complicating the situation is the change of boundary-layer depth that occurs with time of day, time of year and meteorological conditions. Some stacks may therefore emit into the boundary layer part of the time and into the free troposphere at other times.

Rather than require the facility to determine the plume rise from each stack and then report for those that enter the upper troposphere, Environment Canada performed analyses to select a stack height and quantity of CAC emissions that will likely be of significance for modelling purposes.

Specific to CAC substances only, the NPRI will require reporting of CAC releases from stacks ≥ 50 metres above grade if the stack release threshold is met. The emission quantity of the CAC from the stack, together with the stack's physical parameters must be reported to the NPRI. A detailed description of the reporting requirements for stacks greater than or equal to 50 metres is provided in Section 5.3.

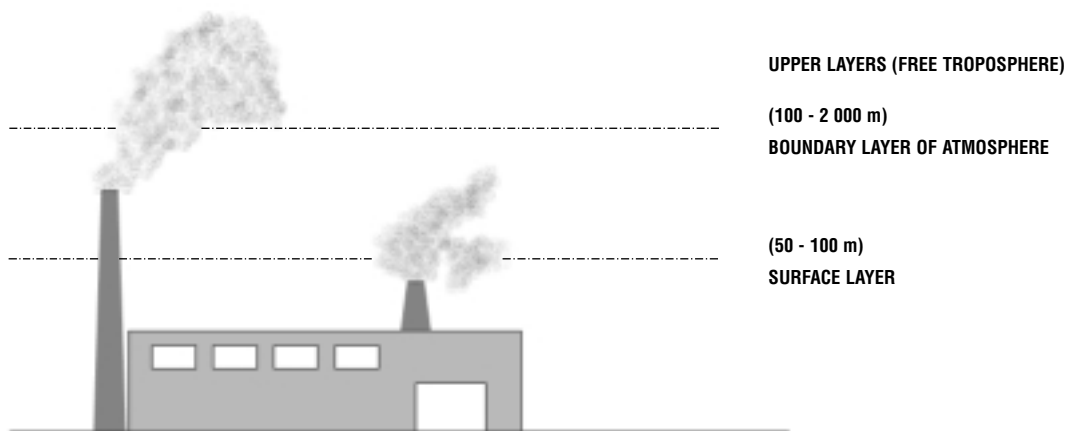


DIAGRAM OF LAYERS OF ATMOSPHERE

Monthly Breakdown of Releases to Air

A monthly breakdown of annual emissions for each CAC that met the reporting threshold is required for regional air-quality modelling. Of particular importance are CAC emissions during the summer months, also known as smog season (May 1 - August 31) during which smog creates the greatest health risks.