



**National Pollutant Inventory**

# **Emission Estimation Technique Manual**

**for**

**Pressure Sensitive  
Tapes and Labels**

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**EMISSION ESTIMATION TECHNIQUES  
FOR  
PRESSURE SENSITIVE TAPES AND LABELS**

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## **PRESSURE SENSITIVE TAPES AND LABELS**

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## 1.0 Introduction

The purpose of all Emission Estimation Technique (EET) Manuals in this series is to assist Australian manufacturing, industrial, and service facilities to report emissions of NPI-listed substances to the National Pollutant Inventory (NPI). This Manual describes the procedures and recommended approaches for estimating emissions from facilities engaged in the pressure sensitive tapes and labels industry.

EET MANUAL:            Pressure Sensitive Tapes and Labels

HANDBOOK:            Adhesive Tapes

ANZSIC CODES :        2563

This Manual was drafted by the NPI Unit of the Queensland Department of Environment and Heritage on behalf of the Commonwealth Government. It has been developed through a process of national consultation involving State and Territory environmental authorities and key industry stakeholders.

### *Context and use of this Manual*

This manual provides a “how to” guide for the application of various methods to estimate emissions as required by the NPI. It is recognised that the data that is generated in this process will have varying degrees of accuracy with respect to the actual emissions from facilities. In some cases there will necessarily be a large potential error due to inherent assumptions in the various emissions estimation techniques (EETs) and/or a lack of available information of chemical processes.

### *EETs should be considered as ‘points of reference’*

The EETs and generic emission factors presented in this Manual should be seen as ‘points of reference’ for guidance purposes only. Each has associated error bands that are potentially quite large (eg. based on generic emission factors only); uncertainties of 100% are considered likely. The potential errors associated with the different EET options should be considered on a case-by-case basis as to their suitability for a particular facility. Facilities may use EETs that are not outlined in this document. They must, however, seek the consent of their relevant environmental authority to determine whether any ‘in house’ EETs are suitable for meeting their NPI reporting requirements.

### *Hierarchical approach recommended in applying EETs*

This manual presents a number of different EETs, each of which could be applied to the estimation of NPI substances. The range of available methods should be viewed as a hierarchy of available techniques in terms of the error associated with the estimate. Each substance needs to be considered in terms of the level of error that is acceptable or appropriate with the use of the various estimation techniques. Also the availability of pre-existing data and the effort required to decrease the error associated with the estimate will need to be considered. For example, if emissions of a substance are clearly very small no

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matter which EET is applied, then there would be little gained by applying an EET which required significant additional sampling.

The steps in meeting the reporting requirements of the NPI can be summarised as follows:

- for Category 1 and 1a substances identify which reportable NPI substances are used (or handled by way of their incidental presence in ore or materials, or exceeds the bulk storage capacity for 1a), and determine whether the amounts used or handled are above the “threshold” values and therefore trigger reporting requirements;
- for Category 2a and 2b substances determine the amount and rate of fuel (or waste) burnt each year, the annual power consumption and the maximum potential power consumption, and assess whether the threshold limits are exceeded;
- for Category 3 substances determine the annual emissions to water and assess whether the threshold limits are exceeded; and
- for those substances above the threshold values, examine the available range of EETs and determine emission estimates using the most appropriate EET.

Generally it will be appropriate to consider various EETs as alternative options whose suitability should be evaluated in terms of:

- the associated reliability or error bands; and
- the cost/benefit of using a more reliable method.

#### *NPI emissions in the environmental context*

It should be noted that the NPI reporting process generates emission estimates only. It does not attempt to relate emissions to potential environmental impacts, bioavailability of emissions, natural background levels etc.

Facilities may undertake ‘Ancillary Activities’, such as the production of substances, either as a process input or through processing of waste streams. When estimating emissions a facility should ensure that emissions are not ‘double accounted’ and process maps should be used to minimise the potential for this.

This manual is structured to allow facilities to work through the manual addressing issues in a structured and coherent manner.

Likely emissions from facilities are discussed in Section 2, while Section 3 discusses the approach to emissions estimation and those elements of the environment where emissions may result.

Section 4 addresses the acceptable reliability of EETs. This approach has been adopted in order to demonstrate how an EET may be applied to estimating emissions of a substance and supported by other EETs. For example facilities may choose to use a mass balance approach to their estimation of emissions. However the mass balance EET is likely to be supported by direct monitoring data and emission factors.

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## 2.0 Processes and Emissions

The following section presents a brief description of the Pressure Sensitive Tapes and Labels Industry and identifies likely sources of emissions.

### 2.1 Process Description

The coating of pressure sensitive tapes and labels (PSTL) is an operation in which some material (paper, cloth, or film) is coated to create a tape or label product that sticks on contact. The term “pressure sensitive” indicates that the adhesive bond is formed on contact, without wetting, heating, or adding a curing agent.

The products manufactured by the PSTL surface coating industry may have several different types of coating applied to them. The two primary types of coating are adhesives and releases. Adhesive coating is a necessary step in the manufacture of almost all PSTL products. It is generally the heaviest coating, and therefore has the highest level of solvent emissions.

Release coatings are applied to the backside of the tape or to the mounting paper of labels. The function of release coating is to allow smooth and easy unrolling of a tape or removal of a label from mounting paper. Release coatings are applied in a very thin coat.

Five basic coating processes can be used to apply adhesive and release coatings:

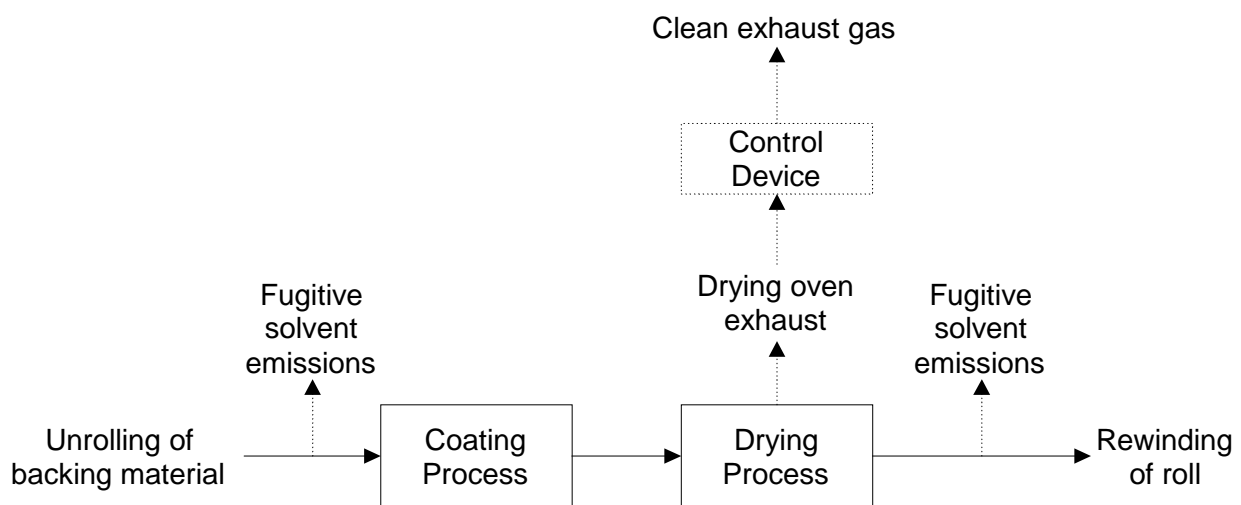
1. solvent-based coating;
2. waterborne (emulsion) coating;
3. 100% solids (hot melt) coating;
4. calender coating; and
5. prepolymer coating.

A solvent-based coating process is used to produce the majority of products in the PSTL industry, and essentially all of the solvent emissions from the industry result from solvent base coating.

Solvent-based surface coating is conceptually a simple process. A continuous roll of backing material (called the web) is unrolled, coated, dried, and rolled again. A typical solvent base coating line is shown in Figure 1. Large lines in this industry generally have web widths of 150 centimetres, while small lines are generally 50 centimetres wide. Line speeds vary substantially, from 3 to 305 metres per minute. To initiate the coating process, the continuous web material is unwound from its roll before it travels to a coating head, where the solvent-based coating formulation is applied. These formulations have specified levels of solvent and coating solids by weight. Solvent-based adhesive formulation contains approximately 67 weight percent solvent and 33 weight percent coating solids. Solvent bases include toluene, xylenes, n-heptane, n-hexane, and methyl ethyl ketone, all of which are inventory substances except n-heptane. The solid portion of the coating formulation consists of elastomers, tackifying resins, plasticisers and fillers.

The process generally consists in the application of a release coat, followed by a primer coat, and an adhesive coat. A web must always have a release coat before the adhesive can be applied. Primer coats are not required on all products, but are generally applied to improve the performance of the adhesives.

Three basic categories of coating heads are used in the PSTL industry. The types of coating head used have a great effect on the quality of the coated product, but only a minor effect on the overall emissions. The first type operates by applying coating to the web and scrapping excess off to a desired thickness. Examples of this type of coater are the knife coater, blade coater and metering rod coater. The second category of coating head applies a specific amount of coating on to the web. Gravure and reverse roll coaters are the most common examples. The third category of coating head does not actually apply a surface coating, but rather saturates the web backing. The most common example in this category is the dip and squeeze coater.



**Figure 1 - General Flow Diagram of a Pressure Sensitive Tape and Label Coating Line**

Source: USEPA, AP-42, Section 4.2.2.9, 1995

After solvent-based coatings have been applied, the web moves into the drying oven where the solvents are evaporated from the web. The important characteristics of the drying oven are:

- source of heat;
- temperature profile;
- residence time;
- allowable hydrocarbon concentration in the dryer; and
- oven air circulation.

Two basic types of heating are used in conventional drying ovens, direct and indirect. Direct heating routes the hot combustion gases (blended with ambient air to the proper temperature) directly into the drying zone. With indirect heating, the incoming oven air stream is heated in a heat exchanger with steam or hot combustion gases but does not physically mix with them. Direct-fired ovens are more common in the PSTL industry because of their higher thermal efficiency.

Temperature control in the drying oven is an important consideration in PSTL production. The oven temperature must be above the boiling point of the applied solvent. However, the temperature profile must be controlled by using multizoned ovens. Coating flaws known as “craters” or “fish-eyes” will develop if the initial drying process proceeds too quickly. These ovens are physically divided into several sections, each with its own hot air supply and exhaust. Keeping the temperature of the first zone low, and then gradually increasing it in the subsequent zones can accomplish uniform drying without flaws. After exiting the drying oven, the continuous web is wound on a roll, and the coating process is complete.

## 2.2 Emission Sources and Control Technologies

### 2.2.1 Emissions to Air

Air emissions may be categorised as:

#### Fugitive Emissions

These are emissions that are not released through a vent or stack. Examples of fugitive emissions include dust from stockpiles, volatilisation of vapour from vats, open vessels, or spills and materials handling. Emissions emanating from louvres, and open doors of a building as well as equipment leaks, and leaks from valves and flanges are also examples of fugitive emissions. Emission factor EETs are the usual method for determining losses through fugitive emissions.

#### Point Source Emissions

These emissions are exhausted into a vent (excluding roof vents) or stack and emitted through a single point source into the atmosphere. Table 1 illustrates possible air emissions from the pressure sensitive tapes and labels industry.

**Table 1 - Common Air Emissions from the Pressure Sensitive Tapes and Labels Industry**

Emission Source	Emission Type
Drying Oven Exhaust	Volatile organic compounds (VOCs - toluene, xylene, n-hexane, methyl ethyl ketone (MEK))
Fugitives	Volatile organic compounds (VOCs - toluene, xylene, n-hexane, methyl ethyl ketone (MEK))
Product Retention	Volatile organic compounds (VOCs - toluene, xylene, n-hexane, methyl ethyl ketone (MEK))
Control Device	Volatile organic compounds (VOCs - toluene, xylene, n-hexane, methyl ethyl ketone (MEK))
Combustion processes	Carbon Monoxide (CO)
Combustion processes	Oxides of Nitrogen (NO <sub>x</sub> )
Combustion processes	Polycyclic aromatic hydrocarbons (PAHs)
Combustion processes	Sulfur Dioxide (SO <sub>2</sub> )
Combustion processes	Particulate Matter (PM <sub>10</sub> )

Source: Queensland Department of Environment and Heritage, 1998



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Air emission control technologies, such as electrostatic precipitators, fabric filters or baghouses, and wet scrubbers, are commonly installed to reduce the concentration of particulates in process off-gases before stack emission. Where such emission abatement equipment has been installed, and where emission factors from uncontrolled sources have been used in emission estimation, the collection efficiency of the abatement equipment needs to be considered. Guidance on applying collection efficiencies to emission factor equations is provided in later sections.

With regards to emission controls for  $PM_{10}$ , in the absence of measured data, or knowledge of the collection efficiency for a particular piece of equipment, an efficiency of 90% should be used in the emission factor equation to calculate actual mass emissions. This default should only be used if there is no other available control efficiency.

### **2.2.2 Emissions to Water**

Emissions of substances to water can be categorised as discharges to:

- Surface waters (eg. lakes, rivers, dams, and estuaries);
- Coastal or marine waters; and
- Stormwater.

Because of the significant environmental hazards posed by emitting toxic substances to water, most facilities emitting NPI-listed substances to waterways are required by their relevant State or Territory environment agency to closely monitor and measure these emissions. This existing sampling data can be used to calculate annual emissions.

If no wastewater monitoring data exists, emissions to process water can be calculated based on a mass balance or using emission factors. The discharge of listed substances to a sewer or tailings dam does not require you to report to the NPI. However leakage and other emissions (including dust) from a tailings storage facility are reportable. (See also Section Three of *the NPI Guide*).

### **2.2.3 Emissions to Land**

Emissions of substances to land on-site include solid wastes, slurries, sediments, spills and leaks, storage and distribution of liquids and may contain listed substances. These emission sources can be broadly categorised as:

- surface impoundments of liquids and slurries; and
- unintentional leaks and spills.

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### 3.0 Emission Estimation Techniques

Estimates of emissions of listed substances to air, water and land should be reported for each substance that triggers a threshold. The reporting list and detailed information on thresholds are contained in *The NPI Guide* at the front of this Handbook.

In general, there are four types of emission estimation techniques (EETs) that may be used to estimate emissions from your facility.

The four types described in *The NPI Guide* are:

- sampling or direct measurement;
- mass balance;
- fuel analysis or other engineering calculations; and
- emission factors.

Select the EET, (or mix of EETs), that is most appropriate for your purposes. For example, you might choose to use a mass balance to best estimate fugitive losses from pumps and vents, direct measurement for stack and pipe emissions, and emission factors when estimating losses from storage tanks and stockpiles.

If you estimate your emission by using any of these EETs, your data will be displayed on the NPI database as being of 'acceptable reliability'. Similarly, if your relevant environmental authority has approved the use of EETs that are not outlined in this handbook, your data will also be displayed as being of 'acceptable reliability'.

This Manual seeks to provide the most effective emission estimation techniques for the NPI substances relevant to this industry. However, the absence of an EET for a substance in this handbook does not necessarily imply that an emission should not be reported to the NPI. The obligation to report on all relevant emissions remains if reporting thresholds have been exceeded.

<p><b>You are able to use emission estimation techniques that are not outlined in this document. You must, however, seek the consent of your relevant environmental authority. For example, if your company has developed site-specific emission factors, you may use these if approved by your relevant environmental authority.</b></p>
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You should note that the EETs presented in this manual relate principally to average process emissions. Emissions resulting from non-routine events are rarely discussed in the literature, and there is a general lack of EETs for such events. However, it is important to recognise that emissions resulting from significant operating excursions and/or accidental situations (eg. spills) will also need to be estimated. Emissions to land, air and water from spills must be estimated and added to process emissions when calculating total emissions for reporting purposes. The emission resulting from a spill is the net emission, ie. the quantity of the NPI reportable substance spilled, less the quantity recovered or consumed during clean up operations.

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The **usage**\* of each of the substances listed as Category 1 and 1a under the NPI must be estimated to determine whether the 10 tonnes (or 25 tonnes for VOCs) reporting threshold is exceeded. If the threshold is exceeded, **emissions** of these Category 1 and 1a substances must be reported for all operations/processes relating to the facility, even if the actual emissions of the substances are very low or zero.

\*Usage is defined as meaning the handling, manufacture, import, processing, coincidental production or other uses of the substances.

Although the NPI does not recommend the use of one emission estimation technique over other techniques, this section does attempt to evaluate the available emission estimation techniques with regards to accuracy.

Several techniques are available for calculating emissions from PSTL manufacturing facilities. The technique chosen is dependent on available data, available resources, and the degree of accuracy sought by the facility in undertaking the estimate. In general, site-specific data that is representative of normal operations is more accurate than industry averaged data.

### 3.1 Direct Measurement

You may wish to undertake direct measurement in order to report to the NPI, particularly if you already do so in order to meet other regulatory requirements. However, the NPI does not require you to undertake additional sampling and measurement. To be adequate, sampling data used for NPI reporting purposes would need to be collected over a period of time representative of the whole year.

#### 3.1.1 Sampling Data

Stack sampling test reports often provide emissions data in terms of kg/hr or g/m<sup>3</sup> (dry). Annual emissions for NPI reporting can be calculated from this data. Stack tests for NPI reporting should be performed under representative (ie. normal) operating conditions. You should be aware that some tests undertaken for a State or Territory license condition may require the test be taken under maximum emissions rating, where emissions are likely to be higher than when operating under normal operating conditions. Data from these tests may need to be *scaled back* for NPI reporting purposes.

This Section shows how to calculate emissions in kg/hr based on stack sampling data, and how to convert this to an annual emissions figure. Calculations involved in determining particulate emissions are used as an example, although the same calculations are applicable for most of the substances listed on the NPI.

Equation 1 indicates how to calculate the concentration of a substance from the weight of the substance and the volume of air sampled:

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**Equation 1**

$$C_{PM} = C_f / V_{m, STP}$$

where:

$$\begin{aligned} C_{PM} &= \text{concentration of particulate matter (PM)} \\ &\quad \text{or gram loading, g/m}^3 \\ C_f &= \text{filter catch, g} \\ V_{m, STP} &= \text{metered volume of sample at standard} \\ &\quad \text{temperature and pressure, m}^3 \end{aligned}$$

Pollutant concentration ( $C_{PM}$ ) from Equation 1 is then multiplied by the volumetric flow rate to determine the emission rate in kilograms per hour, as shown in Equation 2.

**Equation 2**

$$E_{PM} = C_{PM} * Q_d * 3.6 * [273 / (273 + T)]$$

where:

$$\begin{aligned} E_{PM} &= \text{hourly emissions of PM, kg/hr} \\ Q_d &= \text{stack gas volumetric flow rate, m}^3/\text{s} \\ 3.6 &= 3600 \text{ seconds per hour multiplied by} \\ &\quad 0.001 \text{ kilograms per gram} \\ T &= \text{stack gas temperature, } ^\circ\text{C} \end{aligned}$$

The information from some stack tests may be reported in grams of particulate per cubic metre of exhaust gas (wet). Use Equation 3 to calculate the dry particulate emissions in kg/hr.

**Equation 3**

$$E_{PM} = Q_a * C_{PM} * 3.6 * (1 - \text{moist}_R / 100) * [273 / (273 + T)]$$

where:

$$\begin{aligned} E_{PM} &= \text{hourly emissions of PM in kilograms} \\ &\quad \text{per hour, kg/hr} \\ Q_a &= \text{actual (ie. wet) cubic metres of exhaust} \\ &\quad \text{gas per second, m}^3/\text{s} \\ C_{PM} &= \text{concentration of PM or gram loading, g/m}^3 \\ 3.6 &= 3600 \text{ seconds per hour multiplied by } 0.001 \\ &\quad \text{kilograms per gram} \\ \text{moist}_R &= \text{moisture content, \%} \\ 273 &= 273 \text{ K (0}^\circ\text{C)} \\ T &= \text{stack gas temperature, } ^\circ\text{C} \end{aligned}$$

Total suspended particulates (TSP) are also referred to as total particulate matter (total PM). To determine PM<sub>10</sub> from total PM emissions, a size analysis may need to be undertaken. The weight PM<sub>10</sub> fraction can then be multiplied by the total PM emission rate to produce PM<sub>10</sub> emissions. Alternatively, assume that 100% of PM emissions are PM<sub>10</sub>; ie assume that all particulate matter emitted to air has an equivalent aerodynamic diameter of 10 micrometres or less ie. ≤10µm.

To calculate moisture content use Equation 4

#### Equation 4

Moisture percentage = 100 % \* weight of water vapour per specific volume of stack gas/ total weight of the stack gas in that volume.

$$moist_R = \frac{100\% * \left( \frac{g_{moist}}{1000 * V_{m,STP}} \right)}{\left( \frac{g_{moist}}{1000 * V_{m,STP}} \right) + \rho_{STP}}$$

where

moist<sub>R</sub> = moisture content, %  
g<sub>moist</sub> = moisture collected, g  
V<sub>m,STP</sub> = metered volume of sample at STP, m<sup>3</sup>  
ρ<sub>STP</sub> = dry density of stack gas sample, kg/m<sup>3</sup> at STP  
{if the density is not known a default value of 1.62 kg/m<sup>3</sup> may be used. This assumes a dry gas composition of 50% air, 50% CO<sub>2</sub>}

#### Example 1 - Calculating Moisture Percentage

A 1.2m<sup>3</sup> sample (at STP) of gas contains 410g of water. To calculate the moisture percentage use Equation 4.

$$moist_R = \frac{100\% * \left( \frac{g_{moist}}{1000 * V_{m,STP}} \right)}{\left( \frac{g_{moist}}{1000 * V_{m,STP}} \right) + \rho_{STP}}$$

$$\begin{aligned} g_{MOIST}/1000 * V_{m,STP} &= 410/(1000 * 1.2) \\ &= 0.342 \\ moist_R &= 100 * 0.342 / (0.342 + 1.62) \\ &= 17.4\% \end{aligned}$$

### 3.1.2 Continuous Emission Monitoring System (CEMS) Data

A continuous emission monitoring system provides a continuous record of emissions over time, usually by reporting pollutant concentration.

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Once the pollutant concentration is known, emission rates are obtained by multiplying the pollutant concentration by the volumetric gas or liquid flow rate of that pollutant.

It is important to note that prior to using CEMS to estimate emissions, you should develop a protocol for collecting and averaging the data in order that the estimate satisfies your relevant environmental authority's requirement for NPI emission estimations.

### 3.2 Mass Balance

A mass balance identifies the quantity of substance going in and out of an entire facility, process, or piece of equipment. Emissions can be calculated as the difference between input and output of each listed substance. Accumulation or depletion of the substance within the equipment should be accounted for in your calculation.

### 3.3 Engineering Calculations

An engineering calculation is an estimation method based on physical/chemical properties (eg. vapour pressure) of the substance and mathematical relationships (eg. ideal gas law).

#### 3.3.1 Fuel Analysis

Fuel analysis is an example of an engineering calculation and can be used to predict SO<sub>2</sub> and metal emissions based on application of conservation laws, if fuel rate is measured. The presence of certain elements in fuels may be used to predict their presence in emission streams. This includes elements such as sulfur that may be converted into other compounds during the combustion process.

The basic equation used in fuel analysis emission calculations is the following:

#### Equation 5

$$E_{kpy, i} = Q_f * C_i / 100 * (MW_p / EW_f) * OpHrs$$

where:

$E_{kpy, i}$	=	emissions of pollutant i, kg/yr
$Q_f$	=	fuel use, kg/hr
$MW_p$	=	molecular weight of pollutant emitted, kg/kg-mole
$EW_f$	=	elemental weight of substance in fuel, kg/kg-mole
$OpHrs$	=	operating hours, hr/yr
$C_i$	=	concentration of pollutant i in fuel, weight percent, %

For instance, SO<sub>2</sub> emissions from oil combustion can be calculated based on the concentration of sulfur in the oil. This approach assumes complete conversion of sulfur to SO<sub>2</sub>. Therefore, for every kilogram of sulfur (EW = 32) burned, two kilograms of SO<sub>2</sub> (MW = 64) are emitted. The application of this EET is shown in Example 2.

### Example 2 - Using Fuel Analysis

This example illustrates how SO<sub>2</sub> emissions can be calculated from oil combustion based on fuel analysis results and fuel flow information from a facility. The facility is assumed to operate 1500 hours per year.

Annual emissions of SO<sub>2</sub> can be calculated using Equation 5:

Fuel flow = 2000 kg/hr  
Weight percent sulfur in fuel = 1.17 %  
OpHrs = annual operating hours, hr/yr

$$\begin{aligned} E_{\text{kpy, SO}_2} &= Q_f * C_i / 100 * (MW_p / EW_p) * \text{OpHrs} \\ &= (2000 \text{ kg/hr}) * (1.17 / 100) * (64 / 32) * 1500 \text{ hr/yr} \\ &= 46.8 * 1500 \\ &= 70\,200 \text{ kg/yr} \end{aligned}$$

### 3.4 Emission Factors

An emission factor is a tool that is used to estimate emissions to the environment. In this Manual, it relates the quantity of substances emitted from a source to some common activity associated with those emissions. Emission factors are obtained from US, European, and Australian sources and are usually expressed as the weight of a substance emitted divided by the unit weight, volume, distance, or duration of the activity emitting the substance (eg. kilogram of VOC emitted per kilogram of solvent used).

Emission factors are used to estimate a facility's emissions by the generic equation:

#### Equation 6

$$E_{\text{kpy,i}} = [A * \text{OpHrs}] * EF_i * [1 - (CE_i / 100)]$$

where :

$E_{\text{kpy,i}}$  = emission rate of pollutant i, kg/yr  
 $A$  = activity rate, t/hr  
 $\text{OpHrs}$  = operating hours, hr/yr  
 $EF_i$  = uncontrolled emission factor of pollutant i, kg/t  
 $CE_i$  = overall control efficiency for pollutant i, %.

Emission factors developed from measurements for a specific process may sometimes be used to estimate emissions at other sites. Should a company have several processes of similar operation and size, and emissions are measured from one process source, an emission factor can be developed and applied to similar sources. You are required to have the emission factor reviewed and approved by State or Territory environment agencies prior to its use for NPI estimations.

### 3.4.1 Industry-Wide Emission Factors

Table 2 provides emissions factors for volatile organic compound (VOC) emission from the use of solvents in a pressure sensitive tapes and labels facility.

**Table 2 - Emission Factors for Pressure Sensitive Tapes and Labels Surface Coating Operations<sup>a</sup>**

Emission Points	Non-methane VOC <sup>a</sup>		
	Uncontrolled, kg/kg	85% Control, kg/kg	90% Control, kg/kg
Drying oven exhaust <sup>b</sup>	0.8-0.9	-	-
Fugitives <sup>c</sup>	0.01-0.15	0.01-0.095	0.0025-0.0425
Product retention <sup>d</sup>	0.01-0.05	0.01-0.05	0.01-0.05
Control device <sup>e</sup>	-	0.045	0.0475
Total emission <sup>f</sup>	1.0	0.15	0.10

Source: USEPA, AP-42, section 4.2.2.9, 1995.

Emission Factor Rating: C

<sup>a</sup> Expressed as a mass of volatile organic compounds (VOC) emitted per mass of total solvent used. Solvent is assumed to consist entirely of VOC.

<sup>b</sup> Dryer exhaust emissions depending on coating line operating speed, frequency of line down time, coating composition, and oven design.

<sup>c</sup> Determined by difference between total emissions and other point sources. Magnitude is determined by size of the line equipment, line speed, volatility and temperature of the solvents, and air turbulence in the coating area.

<sup>d</sup> Solvent in the product eventually evaporates into the atmosphere.

<sup>e</sup> Emissions are residual content in captured solvent-laden air vented after treatment. Controlled coating line emissions are based on an overall reduction efficiency that is equal to capture efficiency times control device efficiency. For 85% control, capture efficiency is 90% with a 95% efficient control device. For 90% control, capture efficiency is 95% with a 95% efficient control device.

<sup>f</sup> Values assume that uncontrolled coating lines eventually emit 100% of all solvents used.



### Example 3 - Using Emission Factors

Table 2 shows that 1.0 kg of uncontrolled total volatile organic compounds (VOC) is emitted from a facility for every kilogram of solvent used. If it is assumed that the facility operates 8 hours a day, 320 days per year, then

$$\begin{aligned} \text{EF}_{\text{total VOC}} &= 1.0 \text{ kg/kg} \\ \text{Solvent-based adhesive usage (A)} &= 100 \text{ kg/hr} \\ \text{Percentage of solvent in adhesive} &= 67\% \\ \text{OpHrs} &= 8 \text{ hr/d} * 320 \text{ d/yr} \\ &= 2560 \text{ hr/yr} \end{aligned}$$

Using Equation 6:

$$\begin{aligned} E_{\text{kpy,VOC}} &= [A * \text{OpHrs}] * \text{EF}_i * [1 - (\text{CE}_i/100)] \\ &= [100 \text{ kg/hr} * 2560 \text{ hr/yr}] * 1.0 \text{ kg/kg} * 67\% \\ &\quad (\text{percentage of solvent in adhesive}) \\ &= 171\,520 \text{ kg/yr} \end{aligned}$$

#### 3.4.2 Predictive Emission Monitoring (PEM)

Predictive emission monitoring is based on developing a correlation between pollutant emission rates and process parameters. A PEM allows facilities to develop site-specific emission factors, or emission factors more relevant to their particular process.

Based on test data, a mathematical correlation can be developed that predicts emissions using various parameters.

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## **4.0 Emission Estimation Techniques: Acceptable Reliability and Uncertainty**

This section is intended to give a general overview of some of the inaccuracies associated with each of the techniques. Although the National Pollutant Inventory does not favour one emission estimation technique over another, this section does attempt to evaluate the available emission estimation techniques with regards to accuracy.

Several techniques are available for calculating emissions from pressure sensitive tapes and labels facilities. The technique chosen is dependent upon available data, available resources, and the degree of accuracy sought by the facility in undertaking the estimate. In general, site-specific data that is representative of normal operations is more accurate than industry-averaged data, such as the emission factors presented in Section 3.4.1 of this Manual.

### **4.1 Direct Measurement**

Use of stack and/or workplace health and safety sampling data is likely to be a relatively accurate method of estimating air emissions from pressure sensitive tapes and labels facilities. However, collection and analysis of samples from facilities can be very expensive and especially complicated where a variety of NPI-listed substances are emitted and where most of these emissions are fugitive in nature. Sampling data from one specific process may not be representative of the entire manufacturing operation and may provide only one example of the facility's emissions.

To be representative, sampling data used for NPI reporting purposes needs to be collected over a period of time, and to cover all aspects of production of pressure sensitive tapes and labels.

In the case of CEMS, instrument calibration drift can be problematic and uncaptured data can create long-term incomplete data sets. However, it may be misleading to assert that a snapshot (stack sampling) can better predict long-term emission characteristics. It is the responsibility of the facility operator to properly calibrate and maintain monitoring equipment and the corresponding emissions data.

### **4.2 Mass Balance**

Calculating emissions from a pressure sensitive tapes and labels facility using mass balance appears to be a straightforward approach to emissions estimations. However, it is likely that few Australian facilities consistently track material usage and waste generation with the overall accuracy needed for application of this method. Inaccuracies associated with individual material tracking or other activities inherent in each material handling stage can often result in large deviations of total facility emissions. Because emissions from specific materials are typically below 2 percent of gross consumption, an error of only  $\pm 5$  percent in any one step of the operation can significantly skew emission estimations.

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### 4.3 Engineering Calculations

Theoretical and complex equations or *models* can be used for estimating emissions from pressure sensitive tapes and labels processes. EET equations are available for the following types of emissions found at pressure sensitive tapes and labels facilities.

Use of emission equations to estimate emissions from pressure sensitive tapes and labels facilities is a more complex and time-consuming process than the use of emission factors. Emission equations require more detailed inputs than the use of emission factors but they do provide an emission estimate that is based on facility-specific conditions.

### 4.4 Emission Factors

Every emission factor has an associated emission factor rating (EFR) code. This rating system is common to EETs for all industries and sectors and therefore, to all Industry Manuals. They are based on rating systems developed by the United States Environmental Protection Agency (USEPA), and by the European Environment Agency (EEA). Consequently, the ratings may not be directly relevant to Australian industry. Sources for all emission factors cited can be found in Section 5.0 of this Manual. The emission factor ratings will not form part of the public NPI database.

When using emission factors, you should be aware of the associated EFR code and what that rating implies. An A or B rating indicates a greater degree of certainty than a D or E rating. The less certainty, the more likely that a given emission factor for a specific source or category is not representative of the source type. These ratings notwithstanding, the main criterion affecting the uncertainty of an emission factor remains the degree of similarity between the equipment/process selected in applying the factor, and the target equipment/process from which the factor was derived.

The EFR system is as follows:

A	-	Excellent
B	-	Above Average
C	-	Average
D	-	Below Average
E	-	Poor
U	-	Unrated

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## 5.0 References

USEPA, January 1995, *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, fifth edition, AP-42. Section 4.2.2.9 Pressure Sensitive Tapes and Labels*, United States Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, USA.

<http://www.epa.gov/ttn/chief/ap42.html>