

**GUIDANCE DOCUMENT  
ON  
FUGITIVE EMISSION CONTROL**

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## ABBREVIATIONS

<b>NMVOG</b>	Non Methane Volatile Organic Compound
<b>MEK</b>	methyl ethyl ketone
<b>IPA</b>	isopropyl alcohol
<b>LEV</b>	Local exhaust ventilation

## PART 1 - FUGITIVE EMISSION

Fugitive emissions are random escaping pollutant, not from chimneys, stacks or vents, but from equipment, pipe lines, seals, and valves. As well as the economic cost of lost commodities, fugitive emissions contribute to air pollution and climate change.

Fugitive emissions can also cause serious financial loss as manufacturers, plants, and refineries lose products due to leaks. For example, when refineries lose fuel through fugitive emission leaks, the fuel is never used or sold. This can lead to a huge financial loss over time. While small fugitive emission leaks may not seem like a huge issue, leaks that continue undetected for a long period of time add up to a substantial product and financial loss.

Fugitive emission leaks present a dangerous threat to human health and safety as well. Inhaling fugitive emissions can make a person sick, and they're also often a fire hazard. When occurring over time, fugitive emission leaks can put entire communities at risk.

### 1.0 SOURCES AND MITIGATION MEASURES OF FUGITIVE EMISSIONS

#### 1.1 NMVOC

- a. Pumps** for liquid organic substances shall technologically be designed to be tight such as canned motor pumps, magnetic drive pumps, pumps with double-action mechanical seals and a sealing or locking medium, pumps fitted with double - action mechanical seals and seals dry to atmosphere, diaphragm pumps or bellow pumps.
- b. Compressors:** If organics gases or vapours are compressed, multiple sealing systems shall be used.
- c. Flanged joints:** As a rule, flanged joints shall only be used where they are necessary for reasons regarding process technology, safety or maintenance. In this event, technically tight flanged joints shall be used.
- d. Blockage and control devices:** In order to seal spindle guides of blockage and control devices such as valves or gates, metal bellows with a high-grade seal and a downstream safety packing gland or sealing systems of similar effect shall be used.
- e. Sampling points** shall be encapsulated or fitted with blockage and control devices in a way to ensure that emissions may only occur when sampling; in sampling, the sampling medium shall either be re-fed or collected completely.

- f. Decanting:** In decanting, it is a priority to take measures to avoid emissions, e.g. vapour recovery in connection with bottom loading or below-surfaces filling. Extracting and feeding the waste gas to a waste gas purification facility may be approved if vapour recovery is not a viable technical option or where the necessary efforts are disproportionate.
- g. Vapour recovery systems** shall be operated in away to ensure that the flow of organic substances is only released when the vapour recovery system is connected and so that the vapour recovery system and the facilities connected to it may not let us out gas to the atmosphere during the recovery process due to their design, except for emissions released for safety reasons.
- h. Storage:** In order to store liquid organic substances, fixed roof tanks connected to collector gas lines or connected to a waste gas purification facility shall be used. Gases and vapours let out from pressure relief fittings and discharging facilities shall be disposed of to the gas gathering systems or fed to a waste gas purification facility insofar as this does not conflict with safety-related aspects. Waste gases occurring during inspection or while the storage are cleaned shall be fed to a post-combustion system or similar measures shall be applied to reduce emissions. Insofar as storage tanks are set up and operated above ground, the outer wall and the roof shall be covered with suitable paint whose total heat reflection permanently amounts to a minimum of 70 percent.

## 1.2 Dust

Suitable requirements shall be made to emissions reduction with regard to facilities at which solid substances are loaded or unloaded, hoisted, transported, worked, prepared or stored if these substances may cause dust emissions due to their density, grain size distribution, grain shape, surface condition, abrasion resistance, shearing resistance, resistance to fracture, composition or due to their low humidity content.

While taking into account the principle of proportionally,

- i. the type and properties of solid substances and of their components (e.g. hazardousness and toxicity, possible effects on soil and water, possible development of explosible mixtures of dust/air, dusting propensity, humidity),
- ii. the loading equipment or the loading method,
- iii. the mass flow and the period during which emissions occur,
- iv. the meteorological conditions,
- v. the location of the loading site (e.g. distance to residential areas)

shall be taken into account in particular while establishing such requirements. The measures shall be established while also taking into account their possible effects on water and soil.

Fugitive dust emissions control shall be achieved via good housekeeping and appropriate equipment. Relevant measures include:

**a. Loading and unloading:**

- i.* minimizing the falling distance when discharging (e.g. with chutes involving guiding panels or reeds ),
- ii.* automated discharging height adjustment with changing bulk heights,
- iii.* equipment adjustable to the respective bulk material (e.g. avoiding excess loads and missed discharging points with grippers),
- iv.* empty start of loaded grippers,
- v.* empty grippers are closed while re-set,
- vi.* minimized trimming and cleaning operations,
- vii.* automated loading operations;
- viii.* increased materials humidity, if necessary, by applying surface tension relaxation agents, insofar as humidity does not conflict with subsequent further processing, storage properties or the product quality of the materials loaded,
- ix.* applying dust bonding agents,
- x.* pelletisation,
- xi.* standardized grain size (finest-grain separation),
- xii.* avoiding blockages,
- xiii.* reducing the amount of loading processes.

**b. Shipment or transport:**

If vehicles are used for transport, closed receptacles (silo vehicles, containers, tarpaulin) shall be applied. Moreover, when materials are shipped or transported on the premises of the enterprise, closed facilities (e.g. cased conveyor belts, bucket conveyors, worm conveyors, feed screws or pneumatic conveyors) shall be applied.

If closed transportation receptacles are loaded with solid substances, the displaced air shall be collected and fed to a dedusting system.

If dust emissions may develop due to the use of roadways, such roadways shall be enhanced with a cover of asphalt concrete, concrete or similar materials and they shall be kept in good condition.

**c. Working or preparation:**

Machines, equipment or other systems used to work solid substances (e.g. by breaking, grinding, sifting, screening, mixing, briquetting, heating, drying cooling) shall be encapsulated or fitted with emission-reducing technologies of similar effect.

**d. Storage**

When establishing the requirements for storage, enclosed construction systems (e.g. silos, bunkers, magazines, warehouses, containers) shall be preferred as an option. Insofar as storage facilities are not completely enclosed, the development of dust shall be minimized. Waste gases from charging or discharging units and displaced air from receptacles shall be collected and fed to a deducting system.

When establishing requirements to be made for setting up or extracting piles or to operate open-air homogenization facilities, the following measures may be considered:

- covering the surface (e.g. with mats ),
- surface grassing
- spraying the pile with dust-bonding agents while the pile is set up,
- surface solidification,
- piles, charging points and discharging points shall be humidified sufficiently, insofar as such humidifying does not conflict with subsequent further processing.
- charging or extraction protected by earth banks,
- conveyor belts with adjustable height,
- plants as windbreakers,
- aligning the longitudinal axis of the pile with the main wind direction,
- limiting piles in height.

## **PART 2 – REDUCING SOLVENT CONSUMPTION AND LOSSES**

Reducing solvent consumption and waste has many potential benefits including:

- i. reduced raw material and waste disposal costs;
- ii. a better working environment;
- iii. improved relationships with ‘green’ customers and local residents;
- iv. lower insurance premiums due to reduced risks from holding solvent stocks on site.

## 1.0 Compiling Solvent Inventory

Compiling a solvent inventory, i.e. a record of solvent supply, stock, consumption and waste, will help to identify opportunities to reduce solvent consumption. The mass balance or inventory approach described based on measuring and understanding solvent inputs and outputs by weight.

### 1) The Solvent Content Of Materials

To understand the use of solvents:

- i. list all the materials used on site that are, or contain, organic solvents such as trichloroethylene, white spirit, methyl ethyl ketone (MEK), isopropyl alcohol (IPA) and toluene;
- ii. establish how much solvent these materials contain by weight.

Some materials will be virgin or recovered solvents used for dilution, cleaning, etc. Other solvents will be coatings such as inks, paints and adhesives. Cleaning solvents are usually 100% solvent.

#### (i) Converting solvent volumes to weights

Density of the volumes is important to convert solvent volumes to weights. Table 1 gives the densities of some common industrial solvents. Information on densities of the solvents is provided by the supplier. The equation below calculates weight of solvent from its density and volume.

$$\text{Solvent weight in kg} = \frac{\text{Volume in litres} \times \text{Density in g/litre}}{1000}$$

Solvent	Density (g/litre)
Acetone	791
Alcohols, eg ethanol, methanol and isopropyl alcohol	790
Gunwash	800
Methylethylketone	805
Toluene	867
Trichloroethylene	1 460
White spirit	775
Xylene	881

*Table 1 Density of some common industrial solvents*

**(ii) Solvent content of coatings**

The content of a coating is included in the information provided by the supplier, i.e. on technical and safety data sheets and/or delivery notes/invoices. The calculation of the solvents content of made-up coatings, i.e. those that have been diluted or thinned ready for use is explained below.

**(iii) Calculating the solvent content of made-up coatings**

Important thing before calculating:

- the percentage solvent content of the coating by weight (A%);
- either the density of the coating including solvent (B) in g/liter (or kg/litre), or its specific gravity (C);
- the amount, in litres, of diluting solvent per litre of coating (E);
- the density of the diluting solvent (F) in g/litre (or kg/litre).

The worked example for a litre of coating is in g/litre; the overall consumption example is in kg/litre.

The first step is to calculate the solvent content of the coating in terms of g/litre.

$$\begin{aligned} \text{Coating solvent content (D) in g/litre} &= A\% \times B \\ \text{or} \\ \text{Coating solvent content (D) in g/litre} &= A\% \times C \times 1000 \end{aligned}$$

The solvent content of the diluted coating in g/litre can be calculated:

$$\text{Solvent content of the diluted coating (G)} = \frac{D + (E \times F)}{1 + E} \text{ g/litre}$$

Worked example – coating solvent content

A coating that contains 60% solvent (A%) by weight has a specific gravity (C) of 0.9, i.e. a density of 900 g/litre.

$$\begin{aligned} \text{Coating solvent content (D):} \\ &= A\% \times C \times 1000 \\ &= 60\% \times 0.9 \times 1000 \\ &= 60\% \times 900 \\ &= 540 \text{ g / litre} \end{aligned}$$

The coating has been diluted 30% by volume (ie 0.3 litres of diluting solvent are added to every litre of coating (E)) using a solvent of density 800 g/litre (F).

Solvent content of the diluted coating (G)

$$= \frac{D + (E \times F)}{1 + E}$$

$$= \frac{540 + (0.3 \times 800)}{1 + 0.3}$$

If the initial volume of coating is one litre, 240 g of diluting solvent (30% of 800 g) will have been added to the 540 g of solvent already in the coating

$$= \frac{540 + 240}{1.3}$$

This gives a total of 780 g of solvent

$$= \frac{780}{1.3}$$

However, the total volume has increased to 1.3 litres

$$= 600 \text{ g/litre}$$

Therefore, the solvent content for the made-up coating is actually 600 g/litre or 0.6 kg/litre

## 2) Identifying Solvent Inputs And Outputs

Recording material movements – both for the site as a whole and from process to process – allows unintentional losses and wasteful processes to be identified.

Sources of information listed in Table 2 will help to understand the solvent inputs and outputs. Waste is used to mean all residues materials, including those sold for recovery or to be burnt as a fuel.

Type of material	Source of information
Inputs:	
Bought-in solvents	Purchase/dispense records, stocktaking
Coatings, eg inks, paints and adhesives	Purchase/dispense records, data sheets, stocktaking
Outputs:	
Waste solvents, eg from cleaning	Disposal and sales records, audits
Waste coatings, eg process residues	Disposal and sales records, audits, analyses
Wastes containing solvent	Disposal and sales records, audits, analyses
Solvent-based products	Sales records, stocktaking

**Table 2 Typical solvent inputs and outputs**

### 3) Calculating Solvent Inputs And Outputs

In practice, these calculations are best carried out for one material at a time. The results can be added together to give the overall figure for the site.

The same units – usually kilograms of solvent – should be used throughout the input and output calculations. The quantities in the equations below can be calculated by multiplying the volume of material in litres by the proportion of solvent it contains.

Inputs and outputs must be measured over the same period.

#### (i) Inputs

For any given period (say six weeks), the overall solvent input to the site can be calculated from the following equation:

$$\text{Overall Input} = \text{Initial Stock} + \text{Material Purchases} - \text{Final Stock}$$

Note that 'stock' should include redundant materials

#### (ii) Outputs

This calculation is similar to that for inputs, but solvent-containing wastes and any solvent-containing products are substituted for purchases and stocks of raw materials.

The equation used for calculating overall solvent output is:

$$\text{Overall Output} = \text{Final Waste and/or Final Product Stock Levels} + \text{Waste Disposals and/or Product} - \text{Initial Waste and/or Initial Product Stock Levels}$$

For companies that use coatings/inks, the solvent content of the product can generally be considered to be negligible. However, companies that manufacture coatings and fine chemicals will need to take account of the solvent content of product that has been reacted, sold or is in stock.

Solvent discharges to water/drain are also usually negligible. However if this is not the case, e.g. When hosing down printing screens, these discharges should be measured or estimated and recorded as a disposal.

### ***Minimising Uncertainty***

Unlike the overall input calculation, the calculation of overall solvent output from the site can contain more uncertainties.

Major errors can be minimized by :

- a. keeping waste streams separate so that the proportion of solvent is always known;
- b. only, missing similar materials, e.g. low solvent inks.

To obtain an accurate solvent content figures, the waste streams have to be analysed. Such analyses can be carried out cheaply.

Cleaning solvents that contain only a small amount of waste coating can generally be treated as though they are 100% solvent.

## **4) Calculating Overall Consumption**

Overall consumption, i.e. emissions to air including unintentional leaks and spillages, can be calculated from the following equation:

$$\begin{array}{|c|} \hline \text{Overall} \\ \text{Consumption} \\ \hline \end{array} = \begin{array}{|c|} \hline \text{Overall Input} \\ \hline \end{array} - \begin{array}{|c|} \hline \text{Overall Output} \\ \hline \end{array}$$

Any solvent that is recovered by distillation and subsequently re-used on site should not be included; it is both an input and an output and therefore it is assumed to cancel out in the calculations. The solvent inventory calculations will allow you to identify. For a given period:

- iii. the overall quantity of solvent and each solvent-based material coming onto the site;
- iv. the overall quantity of solvent-based waste of each type;
- v. the overall consumption of solvent-based material.

Worked example – consumption calculation

In one year, a company buys 6 000 litres of solvent for thinning/cleaning and 10 000 litres of coating containing 0,35 kg/litre of solvent (D). The density of the solvent for thinning/cleaning is 0.8 kg/litre (F). At the beginning of the year the company had 500 litres of solvent and 1 000 litres of coating in stock. At the end of the year it had 700 litres of solvent and 800 litres of coating in stock.

The first step is to calculate the overall input :

$$\begin{aligned} \text{Initial stock (I)} &= (500 \times 0.8) + (1000 \times 0.35) \\ &= 750 \text{ kg} \end{aligned}$$

$$\begin{aligned} \text{Material purchases (M)} &= (6000 \times 0.8) + (10000 \times 0.35) \\ &= 8300 \text{ kg} \end{aligned}$$

$$\begin{aligned} \text{Final stock (FS)} &= (700 \times 0.8) + (800 \times 0.35) \\ &= 840 \text{ kg} \end{aligned}$$

*Overall input*

$$\begin{aligned} &= I + M - FS \\ &= 750 + 8300 - 840 \\ &= 8210 \text{ kg} \end{aligned}$$

During the year, the company disposes of 1 000 litres of spent solvent and 2 000 litres of made-up coating prepared by diluting 20% by volume (E) with solvent. At the beginning of the year there were 40 litres of spent solvent and 200 litres of waste coating stored at the site. At the end of the year there were 80 litres of spent solvent and 160 litres of waste coating.

The solvent content of the diluted coating can be calculate by:

*Solvent content of the diluted coating (G)*

$$\begin{aligned}
 &= \frac{D + (E \times F)}{1 + E} \\
 &= \frac{0.35 + (0.2 \times 0.8)}{1 + 0.2} \\
 &= \frac{0.35 + 0.16}{1.2} \\
 &= \frac{0.51}{1.2} \\
 &= 0.425 \text{ kg / litre}
 \end{aligned}$$

$$\begin{aligned}
 \text{Initial waste (IW)} &= (40 \times 0.8) + (200 \times 0.425) \\
 &= 117 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 \text{Waste disposals (WD)} &= (1000 \times 0.8) + (2000 \times 0.425) \\
 &= 1650 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 \text{Final waste (FW)} &= (80 \times 0.8) + (160 \times 0.425) \\
 &= 132 \text{ kg}
 \end{aligned}$$

*Overall output*

$$\begin{aligned}
 &= FW + WD - IW \\
 &= 132 + 1650 - 117 \\
 &= 1665 \text{ kg}
 \end{aligned}$$

*Overall consumption*

$$\begin{aligned}
 &= \text{Overall input} - \text{Overall output} \\
 &= 8210 - 1665 \\
 &= 6545 \text{ kg} \\
 &= 80\%
 \end{aligned}$$

This calculation shows that 80% of the solvent input is emitted to air via the local exhaust ventilation (LEV) system or unintentional fugitive emissions.

## 5) Other Methods

In some cases, e.g. when numerous small quantities of coating are mixed each day or where materials are pumped from bulk containers, it may not be practicable to record dispenses on a log. In such cases take an alternative approach, e.g. :

- a. measure the remaining stock levels, e.g. the number of five-litre cans, to establish how much material has been dispensed;
- b. check the mixing record on the mixing machine;
- c. install simple meters to keep track of piped solvents.

This information can then be entered in the dispense log – preferably on a daily basis.

### ***Helpful Tips***

When decanting from large drums, use measures of known size (e.g. litre jugs) or mark set measures (e.g. 1 litre, 2 litres) on the side of large containers such as buckets and intermediate bulk containers.

Use dipsticks for large (e.g. bulk) containers without level meters.

Weight part-filled containers (eg. five-litre containers) and subtract the weight of the empty container. This quick method avoids solvent evaporation and spillage. Otherwise use dipsticks.

## REFERENCES

1. Environmental Technology Best Practice (September 1998). Reduce Costs by Tracking Solvents. United Kingdom.