

Guidance on the Solvents Emissions Directive for chlorinated solvent users

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The **Solvents Emissions Directive**, also known as the **VOC (Volatile Organic Compounds) Directive (1999/13/EC)**, entered into force on 1 April 2001 for new installations and applies to all installations since 31 October 2007. In order to help the users of chlorinated solvents to use them in accordance with the requirements of the VOC Directive, ECSA has prepared these guidelines providing detailed information on how to implement the Directive in the various applications of chlorinated solvents and explaining the following concepts:

Abatement of chlorinated solvent emissions

Industrial sectors whose solvent consumption is above the thresholds set by the Solvents Emission Directive will have to reduce their emissions in order to match the emission limits. In particular, for halogenated solvents with the risk phrase R40, if the flow rate is above 100 g/h, the maximum allowable concentration is set at 20 mg/m³. This drops to 2 mg/m³ if the flow rate is above 10 g/h for a solvent labelled R45.

ECSA suggests that initially every step is taken to reduce emissions and consumption by enclosure of the equipment, making use of the inherent internal recyclability of chlorinated solvents, and increasing the efficiency of their use. For use of chlorinate solvents in the industrial surface cleaning sector, hermetically closed equipment and closed loop solvent handling systems are available and recommended which in general guarantee equipment stack emission levels under 20 mg/m³ (20 mg/m³ for TRI) and additional abatement technology not necessary.

If abatement is needed, the two currently available technologies are adsorption on activated carbon or condensation of vapours at temperatures of -30°C to -180°C, followed by either recovery or destruction.

Adsorption is specifically adapted to single solvent processes or solvents non miscible with water. If abatement needed, ECSA therefore recommends installations using chlorinated solvents to be equipped with activated carbon recovery units so that the trapped solvent is re-used eventually after re-stabilisation. This provides not only environmental but also economical benefit as the solvent consumption is drastically reduced. It should be noted that activated carbon is the only abatement technology allowing to treat low fluxes, usually between 100 and 100, 000 m³/h, with solvent concentrations of up to 50 g/m³.

Solvent adsorbed on activated carbon can be recovered on site by desorption using either hot air or steam. In the case of hot air desorption the solvent is condensed out of the air and the cooled air is fed back on to the activated carbon bed(s) for abatement of residual solvent. If the desorption is done with steam, the steam is condensed and the solvent phase separated in a water separator. The solvent remaining in the contact water is stripped with air which is fed back on to the activated carbon. The air stripped water is further purified by passing it over an activated carbon cartridge filter which removes chlorinated solvents down to below 0.1 mg/litre.

On-site recovery is likely to be of limited benefit to small companies as the requirements of steam for desorption, cooling, solvent/water separation, and purification of solvent and water streams, is likely to be outside the experience and capability of most small businesses.

Absorption in cartridge systems for ultimate disposal, or even off-site recovery may be an alternative to use for small businesses..

Destruction techniques are thermal oxidation (incineration) or biodegradation. The first one turns hydrocarbons into carbon dioxide and water. Heat can be valued for steam production for example. However this technique is not economically viable for halogenated hydrocarbons since it will require expensive special incineration technology to prevent the formation/ emission of dioxins. The second, biodegradation, is the preferred technique for odour treatment.

ECSA does not recommend thermal destruction of chlorinated solvent streams without rigorous control to prevent dioxin formation/emission.

A non-exhaustive list of manufacturers of modern closed surface cleaning equipment is accessible through www.chemaware.org under the section "Cleaning Equipment Technology"

Here is a non-exhaustive list of manufacturers of abatement equipment (with links if appropriate):

- Rotamill (<http://www.rotamill.de>)
- RELOX (<http://www.reinluft-relox.de/>)
- SILICA (<http://www.silica.de/index.php?lang=en>)
- MEGTEC (<http://www.megtec.com/index.php?language=en>)

- Stein

A non-exhaustive list of companies offering active carbon are:

- CECA
- Chemviron
- Norit

Solvent consumption

The level of solvent use for which the **Solvent Emissions Directive 1999/13/EC** applies is dependent on a strict definition of solvent consumption, and those installations operating below this threshold are exempt from the Regulation.

Consumption is defined as "the total input of organic solvents into an installation per calendar year, less any VOCs that are recovered for re-use"

Re-use is defined as "the use of organic solvents recovered from an installation for any technical or commercial purpose, and including use as a fuel, but excluding the final disposal of such recovered organic solvents as waste"

To determine whether or not your installation will be subject to the limits of the Solvent Emissions Directive you need to carry out a simple mass balance of solvent input and output.

You must evaluate all inputs of solvent to the process, whether pure solvents, or in formulated products such as paints, adhesives etc. These are Input 1 (I1) in the Solvent Management Plan, detailed in Annex III of the Directive.

You need to measure, or estimate solvent-containing residues so that these can be counted against Consumption, where appropriate.

Residues recovered on site for re-use do not need to be included in the calculation, only those sent off-site for treatment.

Those residues sent for destruction, or chemical incineration cannot be discounted against input when calculating Consumption. These are included in Output 6 (O6) of the Solvent Management Plan.

Residues which are sent for recovery are allowed to be used to offset purchases when calculating Consumption. These are included in Output 8 (O8) of the Solvent Management Plan

Consumption = I1 - O8

If your consumption exceeds the threshold for your activity in Annex IIA, you need to take action.

For Halogenated Solvents with the R40 and R45 Risk phrases, the enclosure of operations will in many cases increase the efficiency of solvent use, and in many cases reduce the Consumption below the threshold¹. ECSA is recommending the use of closed systems where ever possible since it will not only reduce emissions but also improve the exposure situation of workers.

¹ Pls. Note that implementation of the VOC Directive into national legislation may set lower threshold values. EG Germany was opting for no exemption threshold in case of surface cleaning.

Calculation of solvent consumption (metal cleaning)

For metal cleaning, consumption can be defined as: Quantity of solvent put into the cleaning equipment, minus quantity of used solvent taken out for recycling (but not for disposal or destruction/incineration.)

To keep record about the use of chlorinated solvent in the cleaning operations is both an obligation by the VOC Directive as well as a very useful tool to keep track on the incoming and outgoing solvent streams.

As specified in Annex IIA par. 4 of the Directive, there is a threshold value set for the consumption of solvent in an installation of 1 t/yr., above which the operation is subject to the regulations of the VOC Directive (referred to as exemption threshold in the remaining document). In case the annual consumption is less than 1 t/yr., the operation is exempted from the VOC Directive¹.

In case the annual consumption of solvent, according to above definition, does exceed the exemption threshold, all threshold values for losses and emissions, as given in Annex IIA par.4, have to be obeyed.

In order to help the solvent user to determine whether his operation is subject to the VOC Directive, (solvent consumption more or less than the exemption threshold) and if it is, whether it fulfils the requirements, ECSA has developed a calculation tool (see attached EXCEL spreadsheet [LINK]) which facilitates the required calculations upon inputting a few relevant data only.

NOTE: NOT all data in the spreadsheet are needed as input; some will come out as a result of the calculation. As a rule, data easiest to obtain are:

- Quantity of input solvent (I1) (Purchased solvent)
- Quantity of output of used solvent (O8) (Both total kg as well as solvent content in waste to be provided by solvent recycler);
- Quantity of solvent recycled internally in the machine (I2), important to calculate fugitive losses percentage (Distillation capacity, to be provided by the machine manufacturer, times hours of actual operation).

If you encounter problems using this tool or if anything is not clear, please contact your solvent supplier for assistance.

Dry cleaning

The [Solvent Emissions Directive 1999/13/EC](#) applies to all dry-cleaning installations irrespective of size, and total emissions should not exceed 20 g solvent for every kg of garments cleaned.

Solvent consumption can be evaluated as described in the paragraph paper on [Consumption and Thresholds](#).

Fugitive emissions

The [Solvent Emissions Directive 1999/13/EC](#) defines Fugitive Emissions as any emissions not in waste gases, of VOCs into air, soil and water, as well as, unless otherwise stated in Annex IIA, solvents contained in any products. They include uncaptured emissions to the outside environment via windows, doors, vents and similar openings.

The Solvent Management Plan in Annex III of the Directive gives a mathematical definition in terms of various measured Inputs and Outputs.

The percentage fugitive emission limits in Annex IIA for each activity are based on **Input**, also closely defined as "the quantity of organic solvents and their quantity in preparations used when carrying out an activity, including the solvents recycled inside and outside the installation, and which are counted every time they are used to carry out the activity."

For Surface Cleaning with halogenated Solvents assigned the Risk R40 and R45 phrases in section 4 of Annex IIA, where fugitive emission limits are set at 10 or 15% of Input depending on solvent Consumption.

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Total enclosure will reduce stack emissions and result in a higher percentage of Fugitive Emissions. In order to meet the limits of 10 or 15% of Input, solvent **MUST** count as Input each time it returns to the process. For cleaning plant with separate distillation equipment, the redistilled solvent needs to be measured or estimated.

For vapour degreasers, where solvent condenses both on cooling coils, and on the work being cleaned, it may be more difficult to persuade authorities that this condensate should count as Input. However it can be shown that as enclosure is improved, and solvent is used more efficiently, the percentage of fugitive emissions increase, unless internal recycle is counted as Input.

The quantity of solvent condensing can be estimated from the heating rate, and the solvent properties.

In certain cases it may be possible to modify equipment to transfer condensed solvent via a meter, or an external tank and pump, in order to effectively measure and demonstrate this recovery.

Interpretation of installation in the VOC Directive

Using the interpretation published by the UK as part of its National Transposition of IPPC, ECSA has tried to understand how surface cleaning and dry-cleaning installations might be considered using similar logic.

Our view is that two separate surface cleaning units, or dry-cleaning units can only be treated as independent installations if they have no technical connection between them.

Reading the UK paper, it is obvious that a shared stack, shared bulk solvent supply, or shared waste handling would connect two or more cleaning units. What is less clear is whether a shared warehouse for solvent or waste drum storage connects the units technically.

Again, if the cleaning units are used for separate successive steps of a production process, they are considered connected. Similarly, we would suggest that two separate processes, prior to final assembly of parts from each, could be interpreted as connected technically.

Dry cleaning installations would be easier to define as separate units, depending on the interpretation of solvent storage facilities. However, as dry-cleaning has limits based on throughput, this is irrelevant.

For surface cleaning, it would be necessary to have no technical connection between units for them to be treated as separate installations. A production line cleaning parts for valves, and a separate line producing pipe-fittings, could be treated as two installations, provided that solvent supply, and waste solvent handling were separate, and no assembly of the two types of part was carried out at that site.

SUMMARY

Cleaning machines on a site would be technically connected and treated as one installation if:

- Solvent supply was shared (bulk, or decanted from the same drum);
- Waste solvent handling was shared (bulked from both units for disposal);
- Ventilation stacks were common;
- Cooling water was part of the same recirculated supply;
- Separator water was sent to a shared on-site effluent plant;
- The same parts are cleaned for successive operations in production;
- The different parts cleaned are brought together for assembly in a process on the same site.

One or more cleaning machines, which fitted the above description, would be subject to the exemption threshold under the VOC Directive of 1 t/yr of Halogenated Solvents classed as R40 and R45.

Cleaning machines, which are not technically connected as described above, could each be treated as an installation with an exemption threshold of 1 t/yr for each unit.

Monitoring

The **Solvent Emissions Directive 1999/13/EC** requires Stack Emissions of R45 halogenated solvents to be below 2mg/m³ of substance if the mass flow is equal or exceeds 10g/hour and R40 halogenated solvents to be below 20 mg/m³ of substance .

In the unlikely event of mass flow exceeding 10 kg/hr of total organic carbon (up to 60 kg/hr) of chlorinated solvents) continuous monitoring will be needed.

In most cases periodic measurements should be acceptable, as dictated by National Law.

Substitution

Since the **Solvent Emission Directive 1999/13/EC** was finalised, there has been a change in classification of trichloroethylene from a Category 3 Carcinogen (requiring the R40 risk phrase) to a Category 2 Carcinogen (requiring the R45 risk phrase). As a result of this classification, trichloroethylene is now subject to additional controls under the Directive.

ECSA believes that the need for substitution is primarily determined by the risk of the chemical in the particular application, rather than by the intrinsic properties of the chemical ECSA recommends users of trichloroethylene to investigate substitution possibilities and ECSA member companies producing trichloroethylene are committed to help users to find the best solution. Local conditions will need to be taken into account as substitution, whether by alternative chemicals or alternative processes, is highly application- specific. There are known cases where the use of trichloroethylene is critical and substitution currently not possible. For these cases it ECSA and its trichloroethylene producing companies urge users to apply closed systems as required to meet the VOC limits. This will not only assure compliance with the VOC directive but will also assure adequate risk control under REACH a precondition to further defend and support critical uses under REACH .

Considering an alternative:

- Care needs to be taken not to choose a substitute with a greater overall health, safety and environmental risk. Otherwise you may expose workers to higher risks of a different hazard;even choosing a substitute with an equal overall health, safety and environmental risk is not acceptable because it only generates substitution costs without any EH&S benefit.
- Plant need to be in good condition. Using a substitute without improving the equipment is unlikely to provide any health and safety benefit and again may even increase the risks for workers;
- Plant controls, such as thermostats, need to be adjusted to the specific requirements of your substitute;
- Care needs to be taken when replacing the solvent. In cases of deplorably bad practice, workers have died after entering plants without breathing apparatus. If you cannot clean the equipment without entering it, follow current good practice;
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- Consider all possibilities of product substitution: single product or mixtures of products, used in one step or more, not forgetting process help (heat, ultra sounds, rotating baskets, filters, regeneration, collecting, handling systems...);
- Reconsider all the manufacturing process organisation itself. When possible it can be an opportunity to follow both the product and the VOC regulations with an easier and more efficient way.

The consideration of Substitution is a normal business process with a continuous drive to look for the best products and processes and to apply them. Any evaluation must take account of all performance, health, environmental and socio-economic aspects.

The outcome of your assessment may be that Substitution is unacceptable, and working practices have to be established to adequately control the risks in product use and handling. ECSA recommend the use of trichloroethylene in modern close equipment wherever possible, , by fully trained personnel operating in accordance with standard guidelines with the use of closed systems, emission free delivery systems, and properly ventilated areas. The practices are well known and have been recommended for many years, and are becoming standard in Europe.

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Whatever you do, consider all the options, keep abreast of developments and, if needed, seek expert advice, from your solvent or equipment supplier.

Interpretation of the Directive

The Solvent Emission Directive requires Substitution of Category 1 and 2 Carcinogens, Mutagens and Reproductive Toxins, as specified in Articles 5.6 and 5.7 of the Directive as follows:

Article 5.6: Substances or preparations which, because of their content of VOCs classified as carcinogens, mutagens, or toxic to reproduction under Directive 67/548/EEC, are assigned or need to carry the risk phrases R45, R46, R49, R60, R61, shall be replaced, as far as possible and by taking into account the guidance as mentioned in Article 7(1), by less harmful substances or preparations within the shortest possible time.

Article 5.7: For discharges of the VOCs referred to in paragraph 6, where the mass flow of the sum of the compounds causing the labelling referred to in that paragraph is greater than, or equal to, 10 g/h, an emission limit value of 2 mg/Nm³ shall be complied with. The emission limit value refers to the mass sum of the individual compounds.

However, the entire Directive, according to Article 1 applies to:

... the activities defined in Annex I, in so far as they are operated above the solvent consumption thresholds listed in Annex IIA.

Consequently for surface cleaning using chlorinated solvents the Directive only applies to those Installations where the Consumption of solvents exceeds the 1 t/yr threshold. Below this Consumption level, the requirements of the Directive, both the Emission Limit Values and Substitution of CMRs is not required.

ECSA however urges the enclosure of installations to minimise emissions and worker exposure and to gain adequate risk control independent if the VOC directive applies or not. In the Risk Assessment of trichloroethylene the exemption of installations with yearly consumptions of below 1 mt/ year from the VOC directive has been identified as a gap to ensure adequate risk control in all cases. ECSA has worked together with the Commission to close this gap and has developed the "Trichloroethylene Charter" [LINK] as a voluntary commitment of producers of trichloroethylene to limit sales into surface cleaning as of end 2010 to customers having confirmed the use of closed systems..

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