eVOC SERBIA

REDUCTION OF EMISSIONS OF VOLATILE ORGANIC COMPOUNDS DUE TO THE USE OF ORGANIC SOLVENTS IN CERTAIN ACTIVITIES AND INSTALLATIONS

REQUIREMENTS FOR CHEMICAL DRY CLEANERS

Norway

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eVOC SERBIA

This brochure has been prepared within the project "Implementation of European Regulation on Volatile Organic Compounds Emissions (eVOC Serbia)" implemented by the Cleaner Production Centre of the Faculty of Technology and Metallurgy, University of Belgrade and financially supported by The Royal Norwegian Embassy in Belgrade.

The eVOC Serbia Project is being implemented with the aim of achieving environmental and VOC emission standards. The Project provides assistance to the Ministry of Environmental Protection of the Republic of Serbia and Serbian Environmental Protection Agency in transposing the chapter of the Industrial Emission Directive pertaining to operators and activities that use organic solvents, and provides full support to operators in Serbia, primarily small and medium-sized enterprises, by strengthening their capacities.

The Project Info Centre is available for all questions regarding organic solvents management and VOC emissions for each stakeholder, which will ensure more effective implementation of the Serbian VOC Regulation, thus making a greater contribution to environmental protection. In addition, one of the goals of the Info Centre is to improve knowledge and awareness about VOCs and their use, as well as the impact of these compounds on human health and the environment.

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1 INTRODUCTION

Volatile organic compounds (VOCs) encompass a very wide range of organic compounds characterized by high vapour pressure at lower temperatures, which gives them significant volatility already at room temperatures. This group comprises over 10,000 currently known compounds, such as methane, benzene, xylene, propane, and butane.

Although they can be naturally occurring as well, from the legislative viewpoint, the important VOCs are those arising from different anthropogenic activities. They have a wide industrial application, primarily as organic solvents, which means they can be found in many paints, coatings, and adhesives – and consequently, in many objects and products we use every day. Typical activities where they are used include printing, paints and coatings manufacture, coating activities, production of construction materials, production of furniture and wood products, as well as dry cleaning.

The intensity of health and environmental effects of volatile organic compounds primarily depends on the type of compound, its concentration and exposure time. Long-term indoor exposure can cause fatigue, headache, nausea, eye, nose, and throat irritation in sensitive persons, but also damage the central nervous system and other organs. Not all VOCs show harmful health effects, but some can have carcinogenic and mutagenic effects or affect reproduction (CMR).

Environmental impacts of volatile organic compounds are primarily seen in the decreased air quality, but they can also be found as water and soil pollutants. In the atmosphere, they lead to the formation of harmful ozone and photochemical smog in the lower layers of the atmosphere and contribute to the formation of acid rain and greenhouse gases. In the presence of sunlight, VOCs produce ozone by reacting with nitrogen oxides and carbon monoxide. In the troposphere, ozone increases the formation of fine particles in the air, and the mixture of ozone, particles and other gaseous pollutants is known as smog. In addition to lowering visibility, substances in smog can affect plant health, lowering yields of seeds and pollination efficiency, and they can have harmful effects on respiratory systems of humans and animals.

In the European union (EU), the key legislative instrument for the reduction of industrial emissions of VOCs is the Industrial Emissions Directive (IED) (2010/75/EU), or, more precisely, its Chapter V. This chapter lists the special requirements for industrial installations using volatile organic compounds in their production processes. Provisions of Chapter V of the Directive pertain to 20 types of activities which use organic solvents, and operators who manage installations where such activities take place are obliged to undertake all necessary measures to comply with them. Technical provisions pertaining to installations and activities using organic solvents are listed in Annex VII of the Directive.

In the Republic of Serbia, the key document in this field is the Regulation on the list of industrial installations and activities for which volatile organic compounds emissions are controlled, on the values of volatile organic compounds emissions at a certain solvent consumption and total emission limit values, as well as an emissions reduction scheme ("Official Gazette of the RS", no. 100/11). Implementation of the Regulation began on 1 January 2013, and it prescribes the obligations of operators engaged in one or more of 20 activities relevant for volatile organic compounds emissions, which exceed the prescribed annual thresholds for solvent consumption. All key provisions regarding the list of activities, substitution of certain substances with less hazardous alternatives, selection of a reduction scheme, manner of elaborating an annual solvent mass balance, monitoring, and reporting obligations, annual consumption threshold and annual emission limit values for flue gas and emission limit values for fugitives for each activity are all prescribed in the Regulation.

2 WHO IS CONCERNED?

The VOC regulation applies to twenty categories of industry activities using volatile organic solvents. Each chemical dry-cleaning when using volatile organic solvents is always under the scope of the Industrial Emissions Directive and Serbian VOC Regulation.

According to the current legislation, **a volatile organic compound (VOC)** is any organic compound, including a fraction of the creosote, which has, at the temperature of 293.15K a vapour pressure of 0.01 kPa or greater, or the equivalent volatility under the conditions of temperature and pressure under which it is used.

Chemical Dry Cleaning is defined as:

Any industrial or commercial activity using VOCs in an installation to clean garments, furnishing and similar consumer goods with the exception of the manual removal of stains and spots in the textile and clothing industry

This means that the Serbian VOC Regulation is addressed only to those chemical dry-cleaning installations that are operated on the commercial or industrial bases. The use of solvents to manually remove stains and spots in the textile and clothing industry is **not** covered by the Regulation.

Typical organic VOC solvents are Perchloroethylene Perc, but others like hydrocarbons, liquid silicone (“green earth”), glycol ether and K4.

3 WHAT ARE THE REQUIREMENTS FOR THE OPERATOR?

In line with the Regulation, all installations in the Republic of Serbia performing dry cleaning, regardless of their total annual solvent consumption, are subject to the requirements prescribed in the VOC Regulation and classified as VOC operators and are obliged to:

- Monitor and submit data to the Environmental Protection Agency, by filling in and submitting a form provided in Annex 3 of the Regulation. The form includes administrative and technical information on the company, activities performed, and quantities and types of used solvents;

- Ensure that volatile organic compound emissions from installations remain within the range of the allowed emission limit values for waste gas and for fugitive emissions, or within total emission limit values prescribed in the Regulation (Annexes 5 and 6 of the VOC Regulation).

3.1 Protection Against Harmful Volatile Organic Substances

The VOC Regulation provides special protection against harmful solvents. Hazardous substances or mixtures that are classified as carcinogenic, mutagenic, or toxic (CMR) for reproduction based on the volatile organic compounds they contain, i.e., those with hazard statements H340, H350, H350i, H360d or H360f, or those with risk phrases R45, R46, R49, R60 or R61 must be substituted, whenever possible, with less harmful substances or mixtures without delay.

In addition, operators using compounds with the aforementioned hazard statements or risk phrases must comply, as soon as possible, with emission limit values for such compounds prescribed in Article 8 of the Regulation.

Note:
Because **Trichloroethylene** (Tri) is a CMR VOC substance it must be substituted in the shortest possible time!

3.2 Compliance with Total Emission Limit Value

For chemical dry cleaning a product related total Emission Limit Value (ELV) has to be complied with:

Total Emission Limit Value ELV:
20 g/kg expressed in mass of solvent emitted per kilogram of product cleaned and dried

Please note:

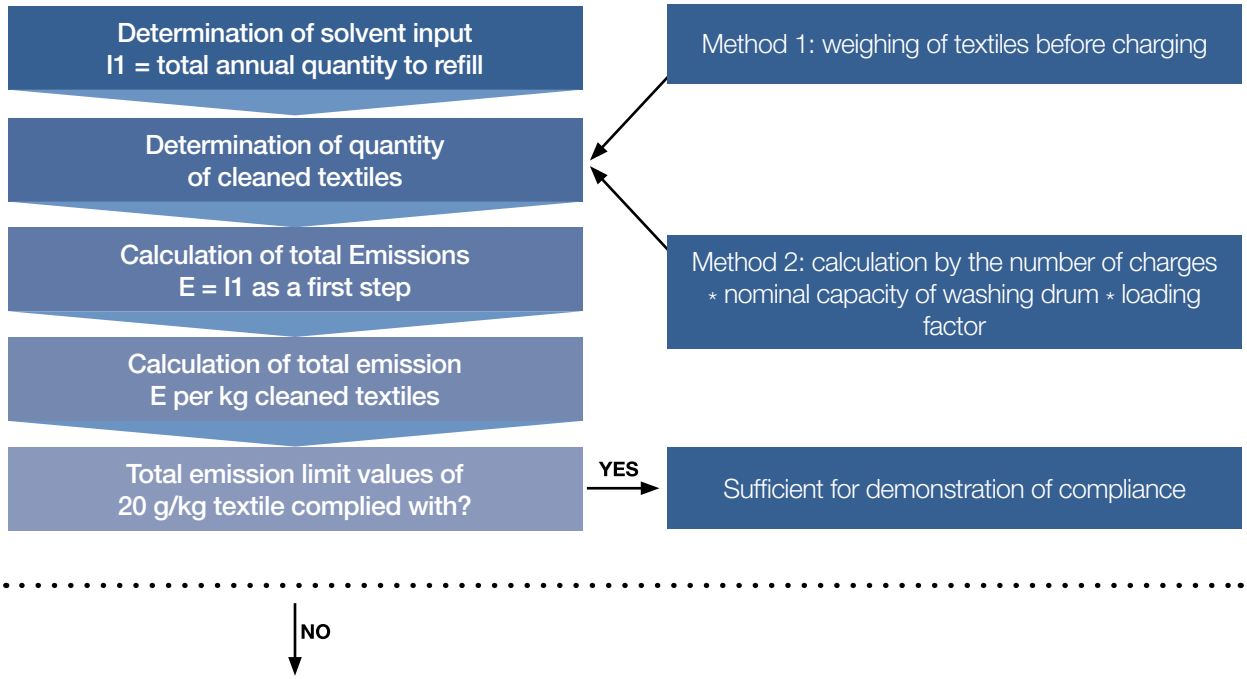
- Transfer machines are not Best Available Techniques anymore and compliance with the given ELV cannot be reached.
- For compliance with given ELV at least closed machines with refrigerators are required.

3.3 Monitoring of the Emissions – Annual Solvent Mass Balance

A solvent mass balance according to the procedure described in the VOC Regulation has to be carried out at least one time a year (time period: 12 months; from the practical point of view the period should be chosen from 01.01. - 31.12.). The solvent mass balance is aimed to verify compliance with the total emission limit value by the operator.

The solvent mass balance will have a positive significance for the chemical dry cleaning as a future controlling and management system to reduce operating costs. You will get an overview of operation processes using solvents by the solvent mass balance and you can recognize weak points more easily.

Solvent mass balance stage 1



Solvent mass balance stage 2: Calculation of total Emission = I1 – O6 (VOC content in solvent waste like distillation sludge)

To determine the weight of the cleaned product it is important to sample and store the information and records on the weight of all charges of textile goods that are cleaned. It is suggested that an appropriate digital and calibrated scales, capable of weighing the required volumes of clothing, be used for this purpose. Staff must be trained in the proper use of the scales. In case only the numbers of clothes have been documented, approximately the weight can be calculated by using the average weight of clothing parts (a factor of 0,6 kg can be applied):

weight of textiles = 0,6 kg * number of textile parts

or as an alternative:

weight of textiles = number of textile parts * nominal load of machines * loading factor (around 0,8[1]).

Example: With a number of charges (charge counter) of 720 in 2020, a nominal load of the machine drum of 20 kg and a loading factor of 0,8 the quantity of cleaned textile was 11520 kg.

[1] Solvent Balance / BÜFA (buefa.de)

4 EXAMPLES

4.1 Machine with Perc as Cleaning Solvent

Ms. Elena is operating a chemical dry-cleaning shop in Belgrade. She has two wet-cleaning machines (operated with water) and two chemical dry-cleaning machines with Perc. After checking the VOC Regulation, she can identify easily that only the Perc machines will fall under the scope of this regulation. She uses the form sheet provided in Annex 3 of the VOC Regulation and sends data for both chemical dry-cleaning machines to the responsible authority. Because she wants to comply with the legal requirements, she checks the situation for both of her Perc machines. One machine is rather old and has a water-cooled condenser (vented) with a carbon adsorber on the exhaust vent, so she has some doubts if this machine complies with the new standards. The other machine is newer and is equipped with a refrigerator and an internal active carbon filter. To ensure legal compliance, she is now carrying out a daily documentation on solvent consumption and weighting all textiles before cleaning for each machine (see example in Annex 1). As expected, the old machines have a large solvent consumption, and the emissions are higher than the allowed total emission limit value. She decides to take this machine out of order and buy a Perc machine of the newest generation with an internal active carbon filter and an additional analytical device that measures the solvent concentration in the drum chamber during each cycle and is tied to a door-lock mechanism, which will not allow the door to be opened until the desired vapour concentration (2 g/m^3) in the drum chamber is achieved. For the other machine she gets following results over a 12-month period: Weight of cleaned textiles: 20017 kg; total consumed solvent: 314 kg Perc.

Total Emission = 314 * 1000 g Perc/20017 kg textile = 15,69 g Perc/kg textile.

Ms. Elena is happy that this machine complies with the limit value of 20 g Perc/kg textile, but she is not really satisfied because the emissions are rather high compared to the applied machine technique. She decides to carry out from now on regular controls and maintenance according to the instruction of the manufacturer. She also buys a sniffing device to identify leaks more easily. Because she found some leaks, she orders a specialist company to carry out the tightening of the leaks and the maintenance of the machine. Additionally, she is using from now on gas balancing for filling the machine with Perc from a special solvent container designed for Perc and for taking off the wet sludge from the machine into a special solvent waste container.

Result: By regular control of the machines including daily checks and leakage control with a sniffling device, the Perc solvent consumption could be reduced significantly and compliance with the VOC emission limit values would be ensured. She will demonstrate compliance from now on an annual basis by submitting data in time electronically to SEPA.

4.2 Machine with Hydrocarbons as Cleaning Solvent

In her second shop, Ms. Elena is operating a chemical dry-cleaning machine with hydrocarbons as solvent. The quantity of the cleaned textile goods is recorded via the number of machines run by means of a built-in batch counter, multiplied by the factor of 0.8 of the maximum nominal filling weight specified by the manufacturer of the machine (loading factor, which takes into account the degree of filling). With a batch count of 3000, a maximum nominal load of 22 kg and a loading factor of 0.8, she calculates that 52800 kg of goods were cleaned in this shop annually.

$$3000 * 22 * 0.8 = 52800\text{kg}$$

The amount of solvent used in the year was 1700 l. To convert litres into kg, multiply by density. With a density of 0.744 kg/l, this results in a quantity of 1265 kg of hydrocarbons.

$$m=\rho * V= 0.744\ \text{kg/l} * 1700\ \text{l}=1264.8\ \text{kg} \approx 1265\ \text{kg}$$

In addition, there was 770 kg of cleaning intensifiers with a solvent content of 22.5 % and 240 kg of impregnating agents with a solvent content of 77.5 %, i.e., a total VOC quantity of 359.25 kg.

$$770\text{kg} * 22.5\% + 240\text{kg} * 77.5\% = 173.25\ \text{kg} + 186\ \text{kg} = 359.25\ \text{kg}$$

A total of 1.4 m^3 of waste containing solvents was disposed of as distillate sludge. At 40% solvent content, the annual amount of solvent-containing waste disposed of is O6 = 417 kg.

$$1.4\ m^3=1400\ \text{l}$$
$$1400\ \text{l} * 40\% =560\ \text{l}$$
$$m=\rho * V = 560\ \text{l} * 0.744\ \text{kg/l} = 416.64\ \text{kg} \approx 417\ \text{kg}$$

Now she calculates the total emission E = solvent input I1 – VOC quantity of disposed waste O6.

$$E = I1 – O6$$
$$E = (1265\ \text{kg} + 359.25\ \text{kg}) - 417\ \text{kg}$$
$$=1207.25\ \text{kg} = 1\ 207\ 250\ \text{g}$$

Now she divides this total emissions E by the total annual cleaned quantity of textile goods (52800 kg) and she gets the total emission factor of 22,87 g/kg. Because she exceeds the given total emission limit value of Serbian VOC Regulation of 20 g/kg expressed in mass of solvent emitted per kilogram of product cleaned and dried - she is not happy. She orders an inspection of a specialized company and improves her good housekeeping. Furthermore, she is using scales to weigh the cleaned textile goods for each batch, so she achieves a much more precise solvent mass balance that shows her compliance.

5 CHECKLIST FOR OPERATORS

Checklist to achieve a more accurate solvent mass balance:

1. Control of used cleaning solvents -> contact the supplier to get a supplier confirmation

☐ Request a confirmation for cleaning solvents (mainly relevant if other solvents than Perc are applied)

☐ Request a confirmation for auxiliary and other added substances for cleaning the cleaning process.

2. Control of dry-cleaning machines -> contact the manufacturer of machines to get a confirmation declaration on compliance with EU Chapter V IED regulation (or 1999/13/EC)

☐ Request a confirmation for closed system

☐ Request a confirmation for maximum mass concentration of VOC after drying before opening the drum door

3. Register the solvent consumption of cleaning solvents (confirmation of suppliers of solvents for the delivered input quantities)

☐ Determination of annual VOC solvent input of cleaning solvents I1 including auxiliary and addition substances taking into account solvent stock at start and end of the year as well as solvent quantity purchased under the year

4. Register quantity of distillation sludge (from waste disposal documents)

☐ Determination of annual VOC solvent content from waste quantities listed in disposal documents given from specialized waste disposal company.

5. Register quantity of cleaned textiles (carry out documentation on the weight of cleaned textiles)

☐ Bookkeeping of number of charges or weight of cleaned textiles per batch

6. Calculation of total emission value (according to calculation scheme)

☐ Check if calculated total emissions are ≤ 20 g VOC/kg textile

E = (total solvent input I1 – solvent quantity in disposed waste O6) / total weight of textile cleaned goods ≤ 20 g VOC/kg textile

6 APPLICATION OF BEST AVAILABLE TECHNIQUES

- Don't use CMR solvents like Trichloroethylene (Tri) for chemical dry cleaning.
- Use – if possible – the latest generation of chemical dry-cleaning machines. To reduce the VOC emissions, the machines should be designed as closed systems with refrigerated cooled condensers with internal integrated carbon adsorber for Perc recovery.
- The machine should be equipped with analytical device that measures the solvent concentration in the drum chamber during each cycle and is tied to an interelectronic door-lock mechanism, which will not allow the door to be opened until the desired vapor concentration (i.e., < 300 ppmv, in Germany 2 g/m^3) in the drum chamber is achieved.
- Regularly inspection especially for leaks and maintenance according to the instructions of the manufacturer.
- Application of good housekeeping techniques like application of gas balancing during loading/unloading processes of solvents, using closed systems for transfilling solvent containing sludges to containers for disposal etc.

7 MORE INFORMATION

The Project eVOC Serbia Info Centre is available for all questions regarding organic solvents management and VOC emissions for all operators. The Centre supports one of the project goals to increase the competitiveness of Serbian operators, primarily small and medium enterprises, by strengthening their capacities related to proper use of organic solvents. For more information, please visit **www.evocs.org.** You can also refer to the Project Expert Team directly, or via the following email address: evoc@tmf.bg.ac.rs.

Annex 1: Example for Records of Solvent Consumption

Chemical Dry Cleaning:
Annual Solvent mass balance – Demonstration of compliance with total emission limit value
To be filled out for each dry-cleaning machine

1. Determination of total input of solvent

Solvent stock at the start of the year of year (incl. solvent in the machine)		kg
+ Solvent quantity purchased under the year		kg
+ Solvent content in auxiliaries (see MSDS)		kg
- Solvent stock at the end of the year (incl. solvent in the machine)		kg
= Total input of the solvent (VOC)		kg

2. Determination of disposed solvent quantities (waste)

Total of weight of disposed residues		kg
Content of residual VOC solvent		kg
= Remaining quantity of solvent		kg

3. Determination of solvent emission

Total input of solvent (VOC) (from No 1)		kg
- Disposed quantity of VOC (from No 2)		kg
= Solvent emission		kg

4. Determination of cleaned textile goods

(Total weight of textiles to be entered directly or calculated from number of charges and load weight of machine)

Number of charges (according to counter of charges)		x 0,8[2]
x Load weight of machine		kg
= Total of quantity of cleaned textile goods		kg

5. Assessment of compliance to total emission limit value

Total input of solvent (VOC) (from No 1)		kg x1000
/ Divided by total of cleaned textile good		kg
= Total emission of installation (g emitted VOC solvent per kg cleaned textile good)		kg

The total emission limit value according to IED and VOC Regulation to chemical dry-cleaning in-stallations is complied with if the total emission of the installation is ≤ 20 g/kg.

[2]*Total quantity can alternatively be calculated if number of textile parts to be cleaned is known:*
*Kg weight of textiles = number of parts * average weight of textile parts (0.6 kg)*

Determination of solvent consumption and emission factor

Note: The assessment of compliance with total emissions E per total weight of textile goods must be carried out with the **annual total quantities** for both parameters! The annual average of column "H" would give the precise value. The weekly control of the emission limit value serves in first order to control if discrepancies occur, and a problem can exist for example by leakage of the machine.

Weekly report

A - Solvent volume in machine at begin-ning of week [litres]
B - Solvent added to machine during week [litres]
C - Solvent volume in machine at end of week [litres]
D - Solvent used during week[3] [kg]: D = A + B - C
E - Weight of textile goods to be cleaned in week [kg]
F - Total weight of solvent containing waste in week [kg]
G - Weight of VOC in waste in week [kg]
H - VOC emission per kg textile good [g VOC/kg textile good] in week: [(D - G) *1000]/(G)

Week:	A	B	C	D	E	F	G	H
January:								
Total January:								
February:								
Total January:								
March:								
Total March:								

[3]To convert litres into kg, multiply by density: 1.6 if the solvent is Perc

April:								
Total April:								
May:								
Total May:								
June:								
Total June:								
July:								
Total July:								
August:								
Total August:								

September:								
Total September:								
October:								
Total October:								
November:								
Total November:								
December:								
Total December:								
Total year:								

Annex 2: Example of a Checklist for Daily Control of the Machine

Chemical Dry Cleaning: Daily checklist for good house keeping
To be filled out for each dry-cleaning machine by a qualified person

Note: This checklist is only an example. Generally, the manufacturers are offering checklists according to the control of operation of the machine that should be taken into account primary.

Reference: Checklist based on checklist published from German BG ETM
https://medien.bgetem.de/medienportal/artikel/U1owMTI-

Scope of control (has to be adapted according instruction manual of manufacturer)	✓ in order; X fault; O fault corrected					
	Mon	**Tue**	**Wed**	**Thur**	**Fri**	**Sat**
1. When entering the operation room:						
Smell of Perc? – if yes, check reason:						
Perc in the base plate of the machine?						
Points of drops on machine?						
Open container with Perc or with Perc containing waste?						
Insufficient dried textile good stored in operation room?						
Leakages at the machine?						
2. Before switching on the machine						
a) Base plates of the machine						
• Cleanness (no lints etc.)						
• No water, oil, or Perc?						
b) Machines						
• Points of drops, liquid on tanks or on other areas?						
• Liquid visible at tubes?						
• Ventilation grid of electro motors clean?						
• Maintenance work carried out according to instruction of manufacturer?						

Scope of control (has to be adapted according to instruction manual of manufacturer)	✓ in order; X fault; O fault corrected					
	Mon	Tue	Wed	Thur	Fri	Sat
Ventilation equipment						
• Check the efficiency of air extraction openings						
1. During the first cleaning						
a) Unfamiliar noise:						
• At pumping of solvent?						
• At turning of the drum (e.g. grinding noise)?						
• At spinning?						
2. During first drying						
a) Unfamiliar sounds (e.g. fan, refrigerator unit etc.)?						
b) Tightness check (with sniffling device):						
• Charging door of machine						
• Button trap						
• Lint filter						
• Water separator						
• Inspection glasses at tubes, containers/tanks, distillation unit etc.						
• Maintenance cover at drum chassis						
• Opening for cleaning of distillation still						
• Joints of exhaust gas lines in case of old blowing-off machines						
c) Measurement of exhaust gas concentration in case of blowing-off machines (reference: < 20 mg/m^3 (2,9 ppm)						

Signature of qualified person:

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www.norway.no/en/serbia