DRY CLEANING

SYNOPSIS SHEET

Prepared in the framework of EGTEI

1. Activity description and EGTEI contribution - summary

Dry cleaning involves the cleaning of fabrics with organic solvents. The dry cleaning process can be divided into 6 steps: washing the fabric in solvent, spinning to extract excess solvent, drying by tumbling in a hot air stream and recovery of solvent, deodorization, cleaning of the drying circuit and regeneration of used solvent in case of activated carbon adsorber. Different types of machines are in operation. These machines differ from the type of solvents used (hydrocarbon or chlorinated solvent) and on the way solvents are tackled. They are more or less efficient in terms of NMVOC emission reduction.

This activity emits NMVOC originating from the use of organic solvents (hydrocarbons and perchloroethylene). NMVOC emissions from this sector may vary significantly from country to country according to the rate of use of the different machines. At a EU25 level for the year 2000 [6], NMVOC emissions were 46 kt representing 0.43% of total NMVOC emissions (according to the scenario CP_CLE_Aug04 (Nov04)). Total activity being estimated to 1131 kt of textiles cleaned, average emission factor is about 40 g NMVOC/kg textile cleaned, meaning that emissions from this sector are partly treated in the EU25 (these data are provisional and could be modified in a near future after bilateral consultations scheduled in 2005).

Dry cleaning is addressed by the European Directive 1999/13/EC (SED) [1] related to the reduction of NMVOC emissions from solvent uses in some industrial activities. In order to be able to better represent the impact of this Directive in terms of emission reduction and costs, **dry cleaning has been considered as an individual activity by EGTEI [2]**. This sector was already considered separately in the previous version of RAINS [5] but **EGTEI has been able to provide updated data for cost estimation**.

The methodology for this sector was developed in close cooperation with the International committee of textile care (CINET) [3] and the French technical center for teinture and cleaning (CTTN) [4]. RAINS module for dry cleaning has been modified and integrates EGTEI proposals.

Data provided by EGTEI (emission factors) have been implemented in the new version of the RAINS model for the modelling work carried out in the scope of the CAFÉ programme and the revision of the Gothenburg Protocol and national emission ceiling Directive.

The representative unit used is the amount of textiles cleaned annually (t/year). Two reference installations (RIC) have been defined with CTTN [4] and CINET [3] to represent the typical installation sizes encountered in Europe. Each size is typical from a group of countries.

Five primary measures are considered based on different machine types: open circuit machines, conventional closed circuit machines, new generation closed circuit machines, hydrocarbon machines and wet cleaning machines. Open circuit machines have been slowly replaced by conventional closed circuit machines but these machines can still survive in some countries. According to countries, open circuit machines or closed circuit machines can represent the reference situation.
Activated carbon adsorber may equip both open circuit machines and conventional closed circuit machines. It has been considered as the unique secondary measure for this sector. This technique is adapted to the flow rates and NMVOC concentrations in exhaust gases encountered in dry cleaning.
EGTEI provides default emission factors (EF) with abatement efficiencies, investments and variable and fixed operating costs (OC) as well as unit costs (€/t NMVOC abated and €/t textile) for five primary measures and two combination primary and secondary measures according to two installation sizes.
On average due to solvent saving, costs per tonne of NMVOC non emitted are negative except for the use of hydrocarbon machines.

National experts have only to collect 3 country and sector specific parameters (costs of perchloroethylene, of hydrocarbons and water in wet cleaning machines) and no country and sector specific parameters. These parameters can be defined with the help of national dry cleaner association. EGTEI provides default costs for country and sector specific parameters which can be used if no better data exist. National experts have also to provide the trends in activity level from 2000 to 2020, the activity shares according to the different RI as well as the application and applicability rates of each abatement technique.

As the representation of this sector in RAINS is based on the EGTEI proposal, it is recommended to national experts to complete ECODAT with country specific parameters which are not known from CIAM.
EGTEI proposals for the representation of dry cleaning and definitions of abatement techniques have been considered in the last update of RAINS [6]. In the future however, any new technology which could be developed, as cleaning with supercritical CO_2, should be considered by EGTEI in the background document to continuously improve the sector representation and the EGTEI capacity to describe new technologies.

2. European regulation

As mentioned above, the European Directive 99/13/EC [1] applies to this sector (annex IIA, n°11).
The SED applies to all installations as no threshold for solvent consumption is considered. Emission limit values defined in the SED are presented in table 2.1. All obligations are not described in this chapter.

Table 2.1: Emission limit values for dry cleaning

Solvent consumption threshold [t / y]	NMVOC emission limit value [g solvent / kg textile cleaned]	Fugitive emissions [% of solvent input*]
No threshold	20	No limit

The compliance date for existing installations is October 30th, 2007. Following the transcription of the Directive in Member States, this date can be different from country to country. For example, in France, the compliance date is October 30th, 2005.

3. Methodology developed within EGTEI to represent the sector

3.1 Definition of reference installations

Two reference installations (RI, but RIC for reference installation code in table 3.1.1) were defined with CINET [3]. The representative unit used is the fabric mass cleaned per year. The installation's size depends on the size of the machines used. The two reference installations considered enable to represent the typical size of installations in Europe. The smallest one is representative of 8 Member states, the largest ones of another group of Member states. Table 3.1.1 presents the RI considered.

Table 3.1.1: Reference installations

Reference Installation Code RIC	Description	Capacity [kg textiles cleaned/load]
01	Small installation with 15.5 t/year textile cleaned	11
02	Small installation with 35.4 t/year textile cleaned	20

3.2 Definition of emission abatement techniques

3.2.1 Primary measures

The main primary measures are the switch from open-circuit machines towards conventional and new generation closed circuit machines.
Open-circuit machines and main closed-circuit machines use perchloroethylene (PER). PER is the main solvent used but it is classified R40 (suspected carcinogenic effect – insufficient proof).

Conventional closed-circuit PER machines
These machines are equipped with a heating pump and with integral refrigerated condensers (deodorisation using the cooling exchanger in the last step of the drying phase). They allow a more efficient solvent recovery than open-circuit machines and have therefore relatively low solvent emissions.

New generation closed-circuit PER machines
These machines are equipped with a heating pump, and with integral refrigerated condensers (deodorisation using only the cooling exchanger in the last step of the drying phase), with a much more efficient drying circuit, with one drying control and additionally, with an activated carbon filter,

reducing during the final step of the drying process the last traces of solvent prior to unloading (concentration < 300 ppm inside the drum). This new machine type has lower solvent emissions than conventional closed circuit machine.

Hydrocarbon machines
Hydrocarbon solvents can substitute PER in closed-circuit machines (But these solvents are flammable).

Wet Cleaning
One alternative to any type of organic solvent is wet cleaning. It uses a minimum of water together with some detergents. Wet cleaning is made at low temperature. Nevertheless it can only be applied without risk for textiles that have to be washed at temperature lower than 40°C (a maximum of 40% of textiles can be treated with this technique depending of the care label "W inside a circle" (W for wet cleaning, standard to be published)).

Table 3.2.1.1: Primary measures

Primary Measure Code PMC	Description
00	Open-circuit machine
01	Conventional closed circuit PER machine
02	New generation closed-circuit PER machine
03	Hydrocarbon machine
04	Wet cleaning

To be in compliance with the SED, conventional and new generation closed circuit machines can be used as hydrocarbon machines.

3.2.2 Secondary measures

Emissions from open circuit machines can be reduced by the use of activated carbon adsorption.

Table 3.2.2.1: Secondary measures

Secondary Measure Code SMC	Description
00	No secondary measure
01	Activated carbon filter

4. Country specific data to be collected

Different types of country specific data have to be collected to give a clear picture of the situation in each Party. EGTEI proposes default values for the economical parameters which can be modified by the national expert if better data are available.
For this activity on contrary to other NMVOC sectors, country specific economical parameters are not used to calculate variable operating costs. However some country and sector specific parameters are necessary to calculate variable operating costs. They correspond to costs of different types of cleaning solvents. Default costs proposed by EGTEI are presented in table 4.1.

Table 4.2: Country and sector specific economic parameters

Parameters	Default costs provided by EGTEI [€ net of taxes/kg]	Country and sector specific costs [€ net of taxes/kg]
Perclhoroethylene	0.664	To be provided by national experts
Hydrocarbon solvent	2.08	To be provided by national experts
Water	0.000856	To be provided by national experts

The best source of information for the determination of costs of country and sector specific parameters is the national association of dry cleaners or solvent producers and it is recommended to national experts to contact them. The CINET web site provides also useful information [3].
Default data have been used to calculate variable and annual abatement costs presented in table 5.1.
Information concerning activity levels from 2000 to 2020 as well as the description of the control strategy is also required (these data can be directly entered in the database ECODAT). A full definition of the work to be done by national experts is provided in the general EGTEI methodology [8].

National experts can also modify the default unabated emission factor proposed by EGTEI to represent the reference situation for all Parties, in a range of ± 10% (with appropriate explanations).

Table 4.3: Unabated emission factor [g of NMVOC / kg of textiles]

Default data mean	User input mean
177	To be provided by national experts

5. Default emission factors and cost data defined with the EGTEI methodology

Table 5.1 presents an overview of all data provided by EGTEI for dry cleaning: default emission factors (EF) with abatement efficiencies, investments, and variable and fixed operating costs (OC) as well as unit costs per t NMVOC abated and unit costs per unit of activity.
Negative variable costs account for solvent saving. Fixed operating costs are only considered for secondary measures and correspond to 5% of the activated carbon adsorber investment (for maintenance and insurance). As no data are available, fixed operating costs for the different machines types are assumed to be the same and zero consequently.
Technical characteristics of the reference installations are given in table 3.1.1.

Table 5.1: Default emission factors (EF), abatement efficiencies, investments, fixed and variable operating costs (OC) and unit costs for each combination

RIC PMC SMC	NMVOC EF [g NMVOC / kg textile]	Abatement efficiency [%]	Investment [€]	Variable OC [k€ / year]	Fixed OC [k€/y]	Unit cost [€/t NMVOC abated]	Unit cost [€/t textiles]
01 00 00	177	0	0	0	-		
01 00 01	55	70	4000	-1256	200	-297	-36
01 01 00	20	89	6850	-1616	-	-317	-50
01 01 01	15	91	10850	-1667	200	-52	-8
01 02 00	10	95	12700	-1719	-	-59	-10
01 03 00	10	95	20650	-1258	-	498	83
01 04 00	0	100	6850	-1547	-	-256	-45
02 00 00	177	0	0	0	-	0	0
02 00 01	55	70	5000	-2868	250	-463	-57
02 01 00	20	89	7050	-3690	-	-508	-80
02 01 01	15	91	12050	-3808	250	-361	-59
02 02 00	10	95	15600	-3925	-	-339	-57
02 03 00	10	95	21350	-2873	-	-41	-7
02 04 00	0	100	7050	-3534	-	-425	-75

Investments correspond to the additional costs of conventional or new generation closed circuit machines, of new generation closed circuit machines with hydrocarbons and wet cleaning machines compared to open circuit machines. Negative operating costs indicate that savings are obtained with the considered machines.
Unit costs [k€/t of NMVOC abated] are obtained by dividing the total annual additional cost of a measure by the amount of NMVOC abated (costs and emissions are compared to the uncontrolled measure PMC 00/SMC 00).
As presented in table 5.1, all unit costs are negative except for small hydrocarbon machines. Solvent savings counter balance investments and operating costs in this activity. It has to be kept in mind that the reference is based on open circuit machines emitting large solvent amounts and this explains the theoretical solvent savings.

Unit costs are not so different from one reference installation to another one. Consequently, if the structure of this activity in a given country cannot be defined, only one type of reference installation can be considered. Here again CINET web site can be used to derive the best estimation.
In France, for information, 100% of dry cleaning is carried out on the smallest installation considered RIC 01.

6. Relevance of EGTEI information for Integrated Assessment Modelling (IAM)

In the previous RAINS version [5], dry cleaning was already considered separately. EGTEI provides updated costs to consider in this sector. Data provided by EGTEI (emission factors and costs) have been implemented in the new version of the RAINS model [6] for the modelling work carried out in the scope of the CAFÉ programme and the revision of the Gothenburg protocol.
For this activity, data provided by national experts through ECODAT can then be directly used by IIASA for introduction in the RAINS model.

7. Perspective for the future

In the future, any new technology which could be developed or become wide spread as supercritical machines should be considered by EGTEI in the background document to continuously improve the sector representation and the EGTEI capacity to consider new techniques.

8. Bibliography

[1] Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations.
[2] EGEI background document. http://www.citepa.org/forums/egtei/dry-cleaning-version2-22-0405.pdf
[3] INTERNATIONAL COMMITTEE OF TEXTILE CARE ("CINET"), Brusselsesteenweg Web site: www.cinet-online.net, Nadine Van Gestel
[4] Mr Pageray - CTTN (Centre Technique de la Teinture et du Nettoyage). Personal communication – results of a measure investigation during production. May 2003.
[5] KLIMONT; M. AMANN; J. COFALA. Estimating costs for Controlling Emissions of Volatile Organic Compounds (NMVOC) from Stationary Sources in Europe. Interim Report IR-00-51. IIASA. August 1. 2000. http://www.iiasa.ac.at/~rains/voc_review/voc_ir-00-51.pdf
[6] Review of data used in RAINS-VOC model http://www.iiasa.ac.at/web-apps/tap/RainsWeb/
[7] Rapport d'inventaire national au format UNECE/NFR et NEC Rapport d'étude du CITEPA - Décembre 2003
[8] Methodology [to be completed]
[9] CITEPA: National reference centre for emission inventories

ANNEXE: Example of data collection and use of EGTEI data – Case of France

A. Country specific data collection and scenario CLE developed

The French national expert has been able to complete ECODAT for the dry cleaning sector with the help of CITEPA [9] and consultation of the CTTN [4].

All data have been provided to CIAM for the bilateral consultation France – IIASA in March 2004.

Country and sector specific parameter costs have been defined from information provided by CTTN [4].

Country and sector specific parameters

Table A.1: French and sector specific costs

Parameters	French and sector specific costs
Perchloroethylene [€ net of taxes/kg]	0.8
Hydrocarbon solvents [€ net of taxes/kg]	2.08
Water [€ net of taxes/kg]	0.00216

The French costs for halogenated solvents and water are slightly different from EGTEI default costs for country and sector specific parameters.

Activity level

The quantity of textiles cleaned in 2000 has been estimated with help of CTTN [4] and knowing also the halogenated solvents sold to dry cleaners [7].

The trend of dry cleaning activity from 2000 to 2020 has been defined by the French national expert. They have not been validated by industry yet and are consequently provisional.

Respective shares (kt textiles/year) of total activity level carried out on each reference installation in 2000, 2005, 2010, 2015, 2020 is provided by CTTN. In fact in France only reference installation 01 is used. The trends in dry cleaning activity and shares of the activity are presented in table A.2.

Table A.2: Activity levels on Reference Installations (kt textiles / year)

RIC	2000	2005	2010	2015	2020
01	125.0	140.0	156.2	171.9	187.5
02	0	0	0	0	0

Unabated emission factor

Default emission factors are adapted to the French situation.

Current legislation control scenario (CLE)

In the current legislation control scenario (CLE), the application rates of the different abatement techniques depend on the regulation implemented and on the compliance dates.

For 2000, the rates of use of the different reduction techniques have been determined in close cooperation with CTTN [4].

The application rates and applicability factors for the CLE scenario are presented in table A.3.

Table A.3: Definitions of the CLE scenario

RIC PMC SMC	Application rate in 2000 [%]	Application rate in 2005 [%]	Appl. [%]	Application rate in 2010 [%]	Appl. [%]	Application rate in 2015 [%]	Appl. [%]	Application rate in 2020 [%]	Appl. [%]
01 00 00			0		0		0		0
01 00 01			0		0		0		0
01 01 00	50	50	100	40	100	30	100	30	100
01 01 01	30	30	100	30	100	35	100	35	100
01 02 00	10	10	100	15	100	20	100	20	100
01 03 00			80		80		80		80
01 04 00	10	10	40	15	40	15	40	15	40
Total RIC 01	100	100	-	100	-	100	-	100	-

Appl.: applicability factor

B. Trends in emissions and total costs of the CLE scenario

Data presented in the table below are directly provided by ECODAT and based on input parameters defined in chapter A.

Table B.1 presents NMVOC emissions from 2000 to 2020 and total annual costs of emissions reduction for the CLE scenario.

Table B.1: Trends in emissions and total annual costs of emission reductions in the CLE scenario

	2000	2005	2010	2015	2020
NMVOC emissions	**t NMVOC**	**t NMVOC**	**t NMVOC**	**t NMVOC**	**t NMVOC**
CLE scenario	1938	2180	2188	2277	2484
Annual total costs	**k€/year**	**k€/year**	**k€/year**	**K€/year**	**K€/year**
CLE scenario	-6402	-7202	-7403	-7462	-8140

EGTEI approach allows representing NMVOC emissions from dry cleaning very well. With EGTEI methodology, emissions estimated in 2000 in the CLE scenario are totally consistent with those defined in the French emission inventory [7].