CAR COATING

SYNOPSIS SHEET

Prepared in the framework of EGTEI

1. ACTIVITY DESCRIPTION AND EGTEI CONTRIBUTION - SUMMARY 3

2. EUROPEAN REGULATION 4

3. METHODOLOGY DEVELOPED WITHIN EGTEI TO REPRESENT THE SECTOR 4

3.1 DEFINITION OF THE REFERENCE INSTALLATION 4
3.2 DEFINITION OF EMISSION ABATEMENT TECHNIQUES 4
3.2.1 Primary measures 4
3.2.2 Secondary measures 5

4. COUNTRY SPECIFIC DATA TO BE COLLECTED 5

5. DEFAULT EMISSION FACTORS AND COST DATA DEFINED WITH THE EGTEI METHODOLOGY 6

6. RELEVANCE OF EGTEI INFORMATION FOR INTEGRATED ASSESSMENT MODELLING (IAM) 7

7. PERSPECTIVE FOR THE FUTURE 7

8. BIBLIOGRAPHY 7

A. COUNTRY SPECIFIC DATA COLLECTION AND SCENARIO CLE DEVELOPED 8

B. TRENDS IN EMISSIONS AND TOTAL COSTS OF DIFFERENT THE CLE SCENARIO 9

1. Activity description and EGTEI contribution - summary

This sector covers the coating of cars as part of production and assembly. The automobile body is assembled from a number of welded metal sections. The body and the parts to be coated all pass through the same metal preparation process.

Surface coating of an automobile body is a multi-step operation carried out on an assembly line conveyor system. Although finishing processes vary from plant to plant, they have some common characteristics. Major steps of such processes may include: preliminary cleaning, phosphating, electrophoretic coating (also called electrocoating or electrodeposition); application of primer, curing of primer; application of topcoat(s), curing of topcoat(s); under body sealing and sealing of seams, cavity corrosion protection, and repair painting before assembly.

It is increasingly common to use a two-coat topcoat consisting of a basecoat and a clear coat instead of a one-coat topcoat. Within the paint process, NMVOC-emissions are emitted from the application of electrophoretic coating to the application of clear coat.

Application of a coating takes place in a dip tank or via spray booths. The air flow balance in the spray booth must be such that the solvent concentration does not exceed the prescribed maximum values for the personnel working there. The spray mist is withdrawn in order to avoid uncontrolled deposition.

Drying/curing occurs in the flash-off area and bake oven. The term ”drying” is used for the evaporation of solvent from the applied coat and the ”curing” of the paint coat by chemical reactions. The typical facilities for application and curing are contiguous in order to prevent exposure of the wet body to the ambient environment before the coating is cured.

This activity emits NMVOC originating from the spray booths, the drying ovens and the cleaning of application equipments. NMVOC emissions from this sector may vary significantly from country to country. At a EU25 level for the year 2000 (according to the RAINS model: version CP_CLE_Aug04(Nov04)), NMVOC emissions were 74.2 kt representing 0.7% of total NMVOC emissions. Total activity being, 18,367,150 vehicles coated, average emission factor is about 4 kg NMVOC/vehicle meaning that emissions from this sector are already partly treated in EU25 (unabated emission factor is country specific but can be as high as 10 kg/vehicle). These estimations could be modified in a near future due to information delivered by national experts during the bilateral consultation in 2005.

The coating of cars **is addressed by the European Directive 1999/13/EC** (SED) [1] related to the reduction of NMVOC emissions from the use of solvents in some industrial activities. In order to be able to better represent the impact of this Directive in term of emission reduction and costs, **this sector has been considered as an individual activity by EGTEI [2]**. The background document was carried out in close cooperation with the European Automobile Manufacturer Association (ACEA) [3] which has delivered specific data for this sector.

In the previous RAINS version [4], the coating of cars was already studied “as a separate sector”. In fact, it was considered together with the coating of busses, trucks and truck cabins but data are based on the coating of cars. In the new RAINS version [5] it is still studied with the other sub-sectors but data were reviewed according to the EGTEI background document [2].

Fewer measures than in the EGTEI document are defined: this is because this sector is very little in terms of total VOC emissions. Thus, four measures have been introduced in the RAINS model (instead of a dozen in the EGTEI document): the unabated situation (which is country specific according to the shares of each type of vehicles), an intermediate measure (corresponding to the substitution of solvent-based coatings), a measure to be in compliance with the SED requirements and a measure to reduce emissions further. As the unabated situation is country specific, the sector representation in RAINS is very flexible.

In EGTEI, the representative unit used is the number of cars coated annually (cars/year). Three reference installations (RI) have been defined with ACEA to take into account the differences in secondary measure’s costs.

EGTEI provides default emission factors (EF) with abatement efficiencies, investments, variable and fixed operating costs (OC) as well as additional unit costs (€/t NMVOC abated and €/activity unit) for all the abatement measures defined.

In RAINS [5], two installation sizes are defined (the medium and the large one) instead of three in the EGTEI document. Emission factors and costs are directly derived from the EGTEI document.

In the future however, any new technology which could be developed, such as the use of powder in the coating of cars, should be considered by EGTEI in the background document to continuously improve the representation of the sector and the capacity of EGTEI to describe new technologies.

2. European regulation

As mentioned above, the European Directive 99/13/EC [1] applies to this sector (annex IIA, part II).

Directive applies to installations with a solvent consumption above 15 t per year. Emission limit values defined in the Directive are presented in table 2.1. All obligations are not described in this chapter.

Table 2.1: Emission limit values

Activity (type of vehicle)	Production threshold [number of vehicles]	Total emission limit values	
	Annual production	New installations	Existing installations
M1 vehicle coating	> 5,000	45 g / m^2 or 1.3 kg/vehicle body + 33 g / m^2	60 g / m^2 or 1.9 kg/ vehicle body + 41 g/m^2
	≤ 5,000 monocoque or > 3,500 chassis-built	90 g / m^2 or 1.5 kg/vehicle body + 70 g / m^2	90 g / m^2 or 1.5 kg/vehicle body + 70 g / m^2

The compliance date for existing installations is 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 the reference installation

Three installations have been defined according to the number of cars produced. Reference installations are defined as **lines of production.**

Table 3.1.1: Reference installations

Reference Installation Code RIC	Description	Technical characteristics
01	Small Installation: **output/line**: 5,000 cars/y	Solvent input: 38 t/y Average surface per vehicle: 80 m²
02	Medium Installation: **output/line**: 20,000 cars/y	Solvent input: 152 t/y Average surface per vehicle: 80 m²
03	Large Installation: **output/line**: 100,000 cars/y	Solvent input: 760 t/y Average surface per vehicle: 80 m²

3.2 Definition of emission abatement techniques

3.2.1 Primary measures

Relevant primary measures are:

- increase of transfer efficiency of the application technique,
- use of low-solvent paints (incl. water-based paints),
- Good housekeeping, solvent management.

These different measures can be combined to reach different emission levels as shown in the table bellow.

Table 3.2.1.1: Primary measures

Primary Measure Code PMC	Description
00	20 % one-coat topcoat (solids coat); 80 % two-coat topcoat (basecoat/clearcoat) • Electrocoat: water-based (5 wt.-% solvent content) • Primer: solvent-based (45 wt.-% solvent content) - electrostatic application • Topcoat : - High solid coat (45 wt.-% solvent content) - electrostatic application, **and** - solvent-based basecoat (75 wt.-% solvent content) – pneumatic application (50 %) and electrostatic application (50 %) – and solvent-based clear coat (45 wt.-% solvent content) - electrostatic application • Solvent management plan, recovery of purge solvent
01	20 % one-coat topcoat (solids coat); 80 % two-coat topcoat (basecoat/clearcoat) • MC 00 + water-based (8 wt.-% solvent content) - electrostatic application
02	20 % one-coat topcoat (solids coat); 80 % two-coat topcoat (basecoat/clearcoat) • MC 00 + water-based basecoat (13 wt.-% solvent content) – electrostatic application
03	20 % one-coat topcoat (solids coat); 80 % two-coat topcoat (basecoat/clearcoat) • MC 00 + water-based (8 wt.-% solvent content) - electrostatic application + water-based basecoat (15 wt.-% solvent content) – electrostatic application

3.2.2 Secondary measures

Two secondary emission reduction measures are used in vehicle paint operations:

- Thermal oxidation on ovens with efficiency of 95 %. Between 5 and 30 % of the total solvent input is emitted inside the oven, higher rates only for waterborne coatings.
- Activated carbon adsorption on spray booth exhaust (concentration step) followed by thermal incineration. In carbon adsorption, the solvents in the exhaust air are first concentrated on the activated carbon and afterwards recovered; the concentrated solvents are destroyed, in most cases in an incinerator.

Table 3.2.2.1: Secondary measures

Secondary Measure Code SMC	Description
00	No secondary measure
01	Thermal oxidation on drying oven
02	Thermal oxidation on drying oven and activated carbon adsorption on spray booth combined with thermal incineration

Table 3.2.2.2: Parts of the coating process where secondary measures are applied

PMC SMC	Part of Coating Process where Secondary Measures are Applied
01 02	application zone of electrophoresis, primer surfacer, basecoat and clearcoat
02 02	application zone of electrophoresis, basecoat and clearcoat
03 02	application zone of electrophoresis, primer surfacer and clearcoat
04 02	application zone of electrophoresis and clearcoat

4. Country specific data to be collected

Very few country specific data have to be collected to represent this sector. Costs have been developed at a European level on field observations so no economic parameter is necessary.

Information concerning activity levels from 2000 to 2020 as well as the description of the control strategy are 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 [6].

The national expert can also modify the default unabated emission factor proposed by EGTEI to represent the reference situation for all Parties in a range of ± 10%. If the modification is higher than 10%, then appropriate explanations are required.

Table 4.1: Unabated emission factor [kg of VOC / car coated]

Default emission factor	User specific emission factor
7.6	To be provided by national experts

In RAINS, this emission factor is country specific as all types of vehicles to be coated are considered together.

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

Table 5.1 gives an overview of all data provided by the EGTEI methodology for the coating of cars sector: default emission factors with abatement efficiencies, investments, and variable and fixed operating costs as well as unit costs.

Investments and variable costs have been provided by an ACEA representative [3]. They are based on field observations.

Fixed operating costs are only considered for secondary measures and correspond to 5% of the investment (for maintenance and insurance). As no economic data are available, it is assumed that fixed operating costs are the same for all primary measures (that is why fixed operating costs appear as 0 costs in the table bellow).

Table 5.1: Emission factors (EF), abatement efficiencies and costs for each combination

RIC PMC SMC	NMVOC EF [kg VOC / car]	Abatement efficiency [%]	Investment [k€]	Variable Operating Cost [k€ / year]	Fixed OC [k€/y]	Unit cost [k€/t VOC abated]	Unit cost [k€/ '000 cars]
01 00 00	7.6	0	0	0	0	0	0
01 00 01	6.8	11	300	30	15	20.6	16.4
01 00 02	4.2	45	6,900	490	345	97.9	337.1
01 01 00	6.8	11	900	5.1	0	17.9	14.3
01 01 01	6.2	19	1,212.5	35.1	15.625	21.7	31.1
01 01 02	3.8	51	7,012.5	433.8	305.625	81.3	311.8
01 02 00	4.5	41	3,300	121	0	23.3	72.8
01 02 01	3.9	48	3,650	152	17.5	24.8	91.1
01 02 02	2.9	62	7,650	440.7	217.5	60.9	287.4
01 03 00	3.6	53	4,500	126	0	22.9	91.4
01 03 01	3.2	58	4,875	159	18.75	25.2	111.0
01 03 02	2.4	68	7,575	360	153.75	47.1	244.8
02 00 00	7.6	0	0	0	0	0	0
02 00 01	6.8	11	410	52	20.5	7.7	6.2
02 00 02	4.2	45	10,910	820	545.5	39.4	135.5
02 01 00	6.8	11	2,100	20.5	0	11.0	8.8
02 01 01	6.2	19	2,520	73.5	21	10.5	15.0
02 01 02	3.8	51	11,720	743.5	481	33.4	128.2
02 02 00	4.5	41	7,600	483.9	0	16.7	52.2
02 02 01	3.9	48	8,090	973.9	24.5	22.2	81.6
02 02 02	2.9	62	14,390	1,451.9	339.5	33.8	159.4
02 03 00	3.6	53	10,400	504.4	0	15.9	63.5
02 03 01	3.2	58	10,910	562.4	25.5	16.1	70.8
02 03 02	2.4	68	15,110	895.4	235.5	23.8	123.9
03 00 00	7.6	0	0	0	0	0	0
03 00 01	6.8	11	600	157	30	3.3	2.6
03 00 02	4.2	45	18,800	1,589	940	14.1	48.5
03 01 00	6.8	11	5,500	102.4	0	6.4	5.1
03 01 01	6.2	19	6,125	261.4	31.25	5.4	7.7
03 01 02	3.8	51	22,125	1,516.4	831.25	12.5	48.0
03 02 00	4.5	41	20,000	2,419.5	0	12.5	38.9
03 02 01	3.9	48	20,715	2,583.5	35.75	11.4	41.8
03 02 02	2.9	62	31,215	3,481.5	580.75	14.8	69.7
03 03 00	3.6	53	27,300	2,522	0	11.3	45.3
03 03 01	3.2	58	28,050	2,688	37.5	11.0	48.3
03 03 02	2.4	68	35,350	3,323	402.5	13.0	67.8

Investments correspond to the cost of new application lines and booths and use of secondary measures when it is appropriate. Variable operating costs are derived from the use of alternative coatings and secondary measures (as defined in tables 3.2.2.1 and 3.2.2.2).

Additional unit costs are obtained by dividing the additional annual cost of the measure considered by the amount of VOC abated (compared to the reference case MC 00).

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

In the previous RAINS version [4], the coating of cars was considered with the coating of buses, trucks and truck cabins. According to ACEA, techniques used in theses different sectors are not the same so a specific sector has been treated separately within EGTEI.

EGTEI provides now an approach to consider this sector and to test the impact of the current legislation.

Data provided in the EGTEI approach (emission factors and costs) will be partly introduced in RAINS (only four measures and two reference installations are considered for simplification reasons) to represent the coating of all types of vehicles in the coming discussion for the revision of the NEC Directive.

The sector representation will be flexible enough to enable all country specific situations to be taken into account in RAINS. It is still interesting for national experts to fill in ECODAT with detail information to correctly represent it at a more aggregated level.

7. Perspective for the future

In the future, any new technology such as the use of powder coatings should be considered by EGTEI in the background document to continuously improve the representation of the sector.

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] EGTEI background document. http://citepa.org/forums/egtei/car_coating_300603%2Bcorrection_021203.pdf
[3] Automobile Manufacturers Association (ACEA). http://www.acea.be/ASB/ASBv1_1.nsf
[4] KLIMONT; M. AMANN; J. COFALA. Estimating costs for Controlling Emissions of Volatile Organic Compounds (VOC) 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
[5] Review of data used in RAINS-VOC model http://www.iiasa.ac.at/web-apps/tap/RainsWeb/
[6] EGTEI methodology http://citepa.org/forums/egtei/egtei_index.htm
[7] EGTEI background document. http://citepa.org/forums/egtei/car_coating_300603%2Bcorrection_021203.pdf
[8] CITEPA: National reference centre for emission inventories
[9] Rapport d'inventaire national au format UNECE/NFR et NEC
Rapport d'étude du CITEPA - Décembre 2003

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 production of cars with the help of CITEPA [8] and consultation of the French car manufacturers (i.e. PSA and Renault).

All collected data have been provided to CIAM for the bilateral consultation France – CIAM in March 2004. As mentioned before, this sector is not considered separately in RAINS. This exercise helps estimating VOC emissions from the aggregated sector corresponding to the coating of vehicles.

Activity level

Activity levels per reference installation in 2000 are derived from the annual industrial reports. Very few installations exist in France so this treatment is easily done. The activity forecast from 2000 to 2020 comes from data provided by the French national expert. It is based on the international production trend (in volume) from 1995 to 2001 available in the statistics. This corresponds to an annual increase of 1.93% of the production from 2000 to 2020.

Table A.1: Activity levels from 2000 to 2020 (cars / year)

RIC	2000	2005	2010	2015	2020
01	0.0	0.0	0.0	0.0	0.0
02	74,216.3	81,660.1	89,850.4	98,866.2	108,777.7
03	3,152,580.7	3,468,776.9	3,816,686.6	4,199,665.8	4,620,688.3
Total (number of cars)	3,226,797.0	3,550,437.0	3,906,537.0	4,298,532.0	4,729,466.0

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 dates of compliance.

Application rates in 2000 have been deduced from annual industrial reports. From 2005 onwards, all installations in France will have to respect the emission limit values defined in the SED. The shares of measures for the different reference installations were discussed with the French constructors.

Table A.2: Definition 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. [%]
02 00 00	100	0	100	0	100	0	100	0	100
02 00 01	0	0	100	0	100	0	100	0	100
02 00 02	0	100	100	100	100	100	100	100	100
Total RIC 02	**100**	**100**		**100**		**100**		**100**	
03 00 01	43.3	0.0	100	0.0	100	0.0	100	0.0	100
03 00 02	14.7	0.0	100	0.0	100	0.0	100	0.0	100
03 01 00	7.3	21.2	100	12.0	100	12.0	100	12.0	100
03 01 01	0.0	0.0	100	0.0	100	0.0	100	0.0	100
03 01 02	13.0	12.0	100	11.4	100	11.4	100	11.4	100
03 02 00	0.0	0.0	100	0.0	100	0.0	100	0.0	100
03 02 01	12.5	25.3	100	23.4	100	23.4	100	23.4	100
03 02 02	0.0	16.1	100	16.8	100	16.8	100	16.8	100
03 03 00	0.0	0.0	100	0.0	100	0.0	100	0.0	100
03 03 01	0.0	0.0	100	0.0	100	0.0	100	0.0	100
03 03 02	9.2	20.0	100	30.9	100	30.9	100	30.9	100
03 00 01	0.0	5.3	100	5.3	100	5.3	100	5.3	100
Total RIC 03	**100**	**100**		**100**		**100**		**100**	

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	20,300	14,814	15,811	17,398	19,142
Annual total costs	**k€/year**	**k€/year**	**k€/year**	**k€/year**	**k€/year**
CLE scenario	44,866	153,406	170,098	187,166	205,930

Emissions shown in table B.1 for the year 2000 according to the CLE scenario have been calculated with EGTEI emission factors. They are consistent with VOC emissions deduced from the industrial reports which are reported in the French inventory: 19.4kt in 2000.