Final Background Document
on the sector

Vehicle refinishing

Prepared in the framework of EGTEI

Prepared by CITEPA, Paris

Summary

Vehicle Refinishing

SNAP 06-01-02-00 or NFR 3A Paint application

This sector covers the painting of cars, trucks or other vehicles, partly or totally, and of single parts of vehicles, often after mechanical or coachwork repairing. Vehicle refinishing is usually carried out by hand, using spray guns.

ACTIVITY: total amount of coatings used (t/y)
POLLUTANT CONSIDERED: VOC

1 Data from the bibliography

Following data are displayed for comparison reason

1.1 Data currently used in the RAINS model [8] , [9]

In the present stage of development of RAINS, vehicle refinishing is considered separately. The main reason for distinguishing this sector from other industrial painting is the fact that it has a uniform application method (spraying), and that costs and efficiencies of the control options are distinctively different from the other industrial paint applications.

1.1.1 Control options

In the RAINS model, the following control options are considered:

- NoC : Reference case (use of conventional solvent based coatings);
- HAMP : Good housekeeping and other primary measures : use of high volume low pressure spray gun (HVLP), Solvent management plan, enclosed gun wash (efficiency : 24%; applicability : almost 100%);
- HAMP + SUB1 :substitution of 50% of the conventional coatings by 25% of water-based products and 25% of high solid coatings (efficiency : 45%);
- HAMP + SUB2 : Measure 01 + substitution of 100% of the conventional coatings by 60% of water-based products and 40% of high solid coatings (efficiency : 72%).

It is also assumed that measure HAMP is standard for new workshops.

1.1.2 Abatement costs

Examples for three countries are displayed below :

No comments are made on the figures displayed in the following tables because no further information is available.

Data on the other countries are downloadable on
http://www.iiasa.ac.at/~rains/voc_review/single.html

Table 1.1.2.1 : French situation

Activity level 1990 : 20,751 kt paint (existing installations);
2010 : 23,614 kt paint (new installations)
VOC emission scenario business as usual : 1990 : 17,64 kt VOC (existing installations);
2010 : 6,17 kt VOC (new installations)

Measure	Emission factor [kt VOC / kt of paint]	Efficiency [%]	Technical Eff, [%]	Applicability [%]	Unit cost [€$_{1990}$/t VOC]
NoC	0,8500	0	0	0	0
HAMP	0,6500	24	24	100	- 12 718
HAMP+SUB1	0,4631	46	46	100	- 2 090
HAMP+SUB2	0,2390	72	72	100	764
NoC NEW*	0,4631	0	0	0	0
SUB2 NEW*	0,2390	48	48	100	3 100

* different estimations are made for new workshops (measure 02 is considered as the reference situation)

Table 1.1.2.2 : German situation (Old Laender)

Activity level 1990 : 33,000 kt paint (existing installations);
2010 : 39,600 kt paint (new installations)
VOC emission scenario business as usual : 1990 : 28,05 kt VOC (existing installations);
2010 : 10,35 kt VOC (new installations)

Measure	Emission factor [kt VOC / kt of paint]	Efficiency [%]	Technical Eff, [%]	Applicability [%]	Unit cost [€$_{1990}$/t VOC]
NoC	0,8500	0	0	0	0
HAMP	0,6500	24	24	100	- 12 961
HAMP+SUB1	0,4631	46	46	100	- 2 215
HAMP+SUB2	0,2390	72	72	100	684
NoC NEW*	0,4631	0	0	0	0
SUB2 NEW*	0,2390	48	48	100	3 100

* different estimations are made for new workshops (measure 02 is considered as the reference situation)

Table 1.1.2.3 : German situation (New Laender)

Activity level 1990 : 7,000 kt paint (existing installations);
2010 : 8,400 kt paint (new installations)
VOC emission scenario business as usual : 1990 : 5,95 kt VOC (existing installations);
2010 : 2,38 kt VOC (new installations)

Measure	Emission factor [kt VOC / kt of paint]	Efficiency [%]	Technical Eff, [%]	Applicability [%]	Unit cost [€$_{1990}$/t VOC]
NoC	0,8500	0	0	0	0
HAMP	0,6500	24	24	100	- 12 666
HAMP+SUB1	0,4631	46	46	100	- 2 063
HAMP+SUB2	0,2390	72	72	100	780
NoC NEW*	0,4631	0	0	0	0
SUB2 NEW*	0,2390	48	48	100	3 100

* different estimations are made for new workshops (measure 02 is considered as the reference situation)

Table 1.1.2.3 : Hungarian situation

Activity level 1990 : 1,500 kt paint (existing installations);
2010 : 1,125 kt paint (old installations) + 1,125 kt paint (new installations)
VOC emission scenario business as usual : 1990 : 1,28 kt VOC (existing installations);
2010 : 0,96 kt VOC (new installations) + 0,52 kt VOC (new installations)

Measure	Emission factor [kt VOC / kt of paint]	Efficiency [%]	Technical Eff, [%]	Applicability [%]	Unit cost [€$_{1990}$/t VOC]
NoC	0,8500	0	0	0	0
HAMP	0,6500	24	24	100	- 16 289
HAMP+SUB1	0,4631	46	46	100	- 3 936
HAMP+SUB2	0,2390	72	72	100	- 405
NoC NEW*	0,4631	0	0	0	0
SUB2 NEW*	0,2390	48	48	100	3 100

* different estimations are made for new workshops (measure 02 is considered as the reference situation)

1.2 Situation in the UK [10]

There are currently estimated to be 5 890 bodyshops in the UK. Of this total, 73% are small (1 to 5 employees); 15% are medium sized (6 to 10 employees) and 12% are large (greater than 10 employees). By 2007 there are estimated to be 5 000 bodyshops in the UK. Of this total, 58% are small, 29% are medium and 13% are large [3].

Compliance to the Directive will be achieved through :

- the use of HVLP spray guns (10-30% paint saving : investment is rewarded in the first year but training for operators will lead to additional costs)
- the use of enclosed gun wash machines and recovery of cleaning solvents;
- substitution coatings (high solid (HS) coatings and water-based coatings);

End-of-pipe treatment is unlikely to be used.

Table 1.2.1 : VOC unit reduction costs (for installations with a solvent input between 0.5 and 1 t/y)

	Investment [€]	OC [€/y]	Savings [€] (4)	Total annual costs [€]	Efficiency [%]
Gunwash	2 500	0	115	370	80
HVLP + HS paint	1 600 (1)	3 900	3 900	430	42
HVLP + Water-based paint	4 650 (2)	6 000 (3)	6 000	4 100	66

(1) 380 € for HVLP guns + 1 220 € for high solids systems
(2) 380 € for HVLP guns + 4 270 € for high solids systems
(3) Additional operating costs assumed to be 50% offset by savings
(4) 5 year depreciation period for new paint systems, and 2 years for HVLP guns

The average costs of reducing emissions (for installations with a solvent input between 0.5 and 1 t/y) is estimated around **1 830 €/t of VOC**.
Other installations with higher solvent input are not considered in [10] as they already have to comply with the UK regulation which should be sufficient, with small modifications, to comply with the EC Directive's requirements.

2 Short technology description [1]

Three basic types of vehicle refinishing can be distinguished:

- the total car repair (the whole car is coated) contributes to about 3,5 % of private car repair paint use, and 75% of commercial vehicle painting;
- the part car repair (only certain parts of the car are coated, mostly doors and wings) represents about 95 % of private car repair paint use, and 25% of commercial vehicle painting;
- the spot-repair (small coating damages are repaired such as stone chipping) covers 1,5 % of repair paint use.

Almost all installations are equipped with closed, ventilated and heated spray booths. The use of spray booths does not reduce VOC-emissions. Spray booths are used in order to ensure safe working conditions for operatives. They disperse emissions by venting them through a stack, and thereby rendering them harmless to the local community.

The majority of the coating activities in vehicle refinishing were traditionally carried out by pneumatic spraying with application efficiency estimated at approximately 30 %. Increasingly, application with high transfer efficiency guns (e.g. High Volume, Low Pressure - HVLP) is used. This leads to an increase of the application efficiency by 10 – 20 % compared to conventional spraying guns.
Electrostatic application is not practicable in the car refinishing sector, because its use results in damage to the engine management system and other electronic components.

Different types of products are used in the vehicle refinishing sector [4] :

- Gun wash: cleaning product for sprayguns and other equipment.
- Recliner: cleaning product to prepare the surface prior to the coating material deposition.
- Wash primer: any coating that contain at least 0,5 wt.% of phosphoric acid. This product provides corrosion resistance and adhesion.
- Recoat (primer): applied prior to deposition of a primer surfacer to provide corrosion protection.
- Stopper: a heavy-bodied compound used to fill deep surface imperfection.
- Primer surfacer: Deposited prior to the application of the top coat to promote a uniform surface finish.
- Surfacer: applied over a primer and ensures adhesion of the top coat. Surfacers can be of three types: “sanding”, “non-sanding” or “wet-on-wet”, depending on the application process for which they are intended.
- Body filler: a heavy bodied compound, designed for knife application in thick layers to fill major imperfections in panels.
- One layer Topcoat: pigmented coat that doesn’t require additional coats of clear to be applied.
- Basecoat: pigmented coating designed to provide the colour and any desired optical effect but not the gloss or the surface resistance.
- Clearcoat: transparent coating design to provide resistance properties to the coating system.
- Special products: small amounts of additives or special coatings are needed for some repair work.

3 EU regulation: Directive 2004/42/EC [2] amending Directive 1999/13/EC [6]

The European Directive 2004/42/EC [2] applies to this sector.

The Directive applies to all the installations because it fixes solvent limit contents for each product category used in this sector.

Table 3.1: Maximum VOC content limit values for vehicle refinishing products as defined in the Directive

Product subcategory	Coatings	VOC g/l of ready to use product
Preparatory and cleaning	Preparatory Pre-cleaner	850 200
Bodyfiller/stopper	All types	250
Primer	Surfacer/filler and general primer Wash primer	540 780
Topcoat	All types	420
Special finishes	All types	840

The compliance date is 01.01.2007.

4 Definition of Reference Installation

Installations of all sizes will use very similar processes. As costs of abatement techniques are proportional to the production of the body shop, only one "typical" installation is defined according to its production in table 4.1.

Table 4.1: Reference installations

Reference Installation Code RIC	Description
01	Medium Installation: 1 500 refinished vehicles/y, representative for the range 750 < refinished vehicles/y < 2 500 20 % one-coat topcoat; 80 % two-coat topcoat (basecoat/clearcoat)

5 Emission abatement techniques and costs

The main VOC emission sources in this sector are the application of paint, the drying operations, the cleaning of equipment, and the cleaning operations before the coating and between the application of different layers.

5.1 Definitions of primary measures

Three options to reduce VOC emissions are of relevance in this sector:
- improvement of application efficiency;
- switching to low solvent products, especially to water-based paints;
- good housekeeping / solvent management.

Primary measures are derived from [1] and reviewed by [7]:
- Primary measure 01 corresponds to a reduction of surfcaer consumption compared to PMC 00.
- Primary measure 02 VOC values are all slightly lower than the limits defined in the Directive [2]. This is inevitable because real products must be designed so that in all cases they do not exceed the limits [7].
- Primary measure 03 is not yet a fully applicable option, but it is however included to get a reliable cost curve.

Table 5.1.1: Primary measures

Primary Measure Code PMC	Description
00	• Putty: conventional (VOC content: 250 g VOC/l) • Primer: conventional (VOC content: 712 g VOC/l) - pneumatic application • Surfacer: low solid (VOC content: 518 g VOC/l) - pneumatic application • Topcoat: - **one-coat topcoat**: conventional (VOC content: 565 g VOC/l) - pneumatic application, **or** - **two-coat topcoat**: conventional (VOC content: 767 g VOC/l) - pneumatic application - and conventional (VOC content: 584 g VOC/l) - pneumatic application • Cleaning agent: 100 wt.-% solvent content for all coating layers
01	• Putty: conventional (VOC content: 250 g VOC/l) • Primer: conventional (VOC content: 712 g VOC/l) - pneumatic application • Surfacer: high solid (VOC content: 518 g VOC/l) - pneumatic application • Topcoat: - **one-coat topcoat**: conventional (VOC content: 565 g VOC/l) - pneumatic application, **or** - **two-coat topcoat**: conventional (VOC content: 767 g VOC/l) - pneumatic application - and conventional (VOC content: 584 g VOC/l) - pneumatic application • Cleaning agent: 100 wt.-% solvent content for all coating layers
02	• Putty: conventional (VOC content: 250 g VOC/l) • Primer: conventional (VOC content: 712 g VOC/l) - HVLP application • Surfacer: high solid (VOC content: 518 g VOC/l) - HVLP application • Topcoat: - **one-coat topcoat**: improved (VOC content: 410 g VOC/l) - HVLP application, **or** - **two-coat topcoat**: improved (VOC content: 99 g VOC/l) - pneumatic application - and high solid (VOC content: 417 g VOC/l) - HVLP application • Cleaning agent: 70 % with a solvent content of 100 wt.-%, 30 % with a solvent content of 15 wt.-%
03	• Putty: conventional (VOC content: 250 g VOC/l) • Primer: conventional (VOC content: 712 g VOC/l) - HVLP application • Surfacer: very high solid (VOC content: 221 g VOC/l) - HVLP application • Topcoat: - **one-coat topcoat**: improved (VOC content: 410 g VOC/l) - pneumatic application, **or** - **two-coat topcoat**: improved (VOC content: 99 g VOC/l) – HVLP application - and high solid (VOC content: 417 g VOC/l)- HVLP application • Cleaning agent: 40 % with a solvent content of 100 wt.-%, 60 % with a solvent content of 15 wt.-%

5.2 Definition of secondary measures

No secondary measures are described.

5.3 Emission factors and costs data for the different combinations

Table 5.3.1: Emission factors (EF) and abatement efficiencies for each relevant combination

RIC PMC	EF [g VOC/kg coating]	Abatement efficiency [%]	Q	CI %
01 00	720	0		
01 01	666	7,5	5	5
01 02	280	61,1	5	5
01 03	197	72,6	5	5

Investments are given in €/t VOC abated and have to be taken into account 2007 onwards for the first 10 years

Table 5.3.2: Investments and variable operating costs

RIC PMC	R&D [€/t VOC] For 10 years only	Q	CI %	Variable OC [€ / y]	Q	CI %
01 00	0	-		0	-	-
01 01	0	4		90	5	15
01 02	270	4		1 701	5	15
01 03	NA	-		13 696	4	20

NA: Not Available

6 Data to be provided by national experts for the completion of the database for their own country

The following tasks are required:

6.1 Validation work

National expert is invited to comment costs defined in this background document.

Comments have to be sent to the Secretariat in the two weeks after having received the document.

6.2 Provision of specific data

Tables to be filled in by national experts

- Total activity (t of coatings used/y) level in 2000, 2005, 2010, 2015, 2020. Some default values for the confidence interval are given. They can be used by the Party if no data are available.

The methodology used in Rains for estimating the future activity level will be described in the Methodology. This methodology can be used or information can be obtained fro the industry.

Table 6.2.1: Total activity (t coatings / year)

RIC	2000	CI%	2005	CI%	2010	CI%	2015	CI%	2020	CI%
01										
Default values proposed for CI		10		20		50		100		100

For explanations on the confidence interval (CI), refer to the Methodology.

- Total activity (t coatings/y) has to be estimated from 2000 to 2020.

- Definition of the respective percentage of combinations of reduction measures in 2000 to 2020 due to the VOC Directive, proposal of new Directive and national regulations and applicability according to the definition used in the RAINS model.

Table 6.2.2: Application and Applicability rates

RIC PMC	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									
01 01									
01 02									
01 03									
Total RIC 01	**100**	**100**		**100**		**100**		**100**	

Table 6.2.3: Unabated emission factor [g VOC / kg of paint]

Default data mean	CI %	User input mean	CI %
720	5		

The "default data mean" can be modified in a range of ± 10%.
If a measure is missing in the document, national experts have to contact the Secretariat to add it in the background documents.

7 Explanatory notes

Emission factors are calculated in g VOC per refinished vehicle and then they are transformed into g of VOC per kg of coating.

7.1 Composition of different coating systems

Table 7.1.1: Composition of different coating systems (hardener and thinner included) ready for use

PMC	Coating System/Layer	Volume Solids [vol.-%]	Solvent Content [g VOC/l]*
00	Putty	- **	250
00	Primer	14,7	712
00	Surfacer	40,6	518
00	One-coat topcoat	39,0	565
00	Two-coat topcoat		
00	Basecoat	14,6	767
00	Clearcoat	40,1	584
01	Putty	- **	250
01	Primer	14,7	712
01	Surfacer	40,6	518
01	One-coat topcoat	39,0	565
01	Two-coat topcoat		
01	Basecoat	14,6	767
01	Clearcoat	40,1	584
02	Putty	- **	250
02	Primer	14,7	712
02	Surfacer	40,6	518
02	One-coat topcoat	51,8	410
02	Two-coat topcoat		
02	Basecoat	18,8	99
02	Clearcoat	51,5	417
03	Putty	- **	250
03	Primer	14,7	712
03	Surfacer	79,7	221
03	One-coat topcoat	51,8	410
03	Two-coat topcoat		
03	Basecoat	18,8	99
03	Clearcoat	51,5	417

* water included.
** the whole range of products are sold by volume, except the putty.

7.2 Coating Consumption Factor (CCF)

Paints are sold in volume, mixed for use in volume, and the usage comparison is generally made in terms of volume solids. Therefore, the coating consumption factors for the different coating layers given in the table below are expressed in volume. According to [1], cleaning devices reduce gun wash solvent consumption by 80% and the use of HVLP reduce the paint consumption by 20% compared to pneumatic application modes.

Coating consumption factors are derived from [1].

Consumption factors displayed bellow relate to an arbitrary "typical" repair. In any actual example, total consumption may be greater or less, but the ratios between the layers will be very similar [7].

Table 7.2.1: Coating consumption factors for the different coating layers [1].

Coating layer	Coating consumption factor (l coatings / refinished vehicle)			
	PMC 00	**PMC 01**	**PMC 02**	**PMC 03**
Putty	0,07	0,07	0,07	0,07
Primer (20% of applications)	0,14	0,14	0,12	0,12
Surfacer (80% of application)	0,83	0,58	0,46	0,24
One-coat topcoat (20% of applications)	1,03 × 0,2	1,03 × 0,2	0,78 × 0,2	0,78 × 0,2
Two-coat topcoat (80% of applications)				
Basecoat	1,0 ×0,8	1,0 ×0,8	0,62 × 0,8	0,62 × 0,8
Clearcoat	0,86 × 0,8	0,86 × 0,8	0,53 × 0,8	0,53 × 0,8
Total	2,734	2,484	1,726	1,506

As activity is given in tonnes of coatings used per year, consumption factors have to be transformed in kg of coatings / refinished vehicles.

According to [7], PMC 00 has an average specific gravity of 0,88 ± 0,03, PMC 01 of 0,97 ± 0,03, PMC 02 1,05 ± 0,03 and PMC 02 would be around 1,07 ± 0,03. These figures enable calculating coating consumption factors in kg/refinished vehicle.

Table 7.2.2: Total coating consumption factors (kg of coatings / refinished vehicle) [7].

Coating consumption factor (kg coatings / refinished vehicle)			
PMC 00	**PMC 01**	**PMC 02**	**PMC 03**
2,734 × 0,88 = 2,41	2,484 × 0,97 = 2,41	1,726 × 1,05 = 1,81	1,506 × 1,07 = 1,61

7.3 Emission factors determination

7.3.1 Application Efficiency

Table 7.3.1.1: Transfer efficiencies for different types of application techniques and coating layers

Application Technique	Type of Coating Layer	Application Efficiency [%]
Conventional pneumatic spray gun	Primer	40
	Topcoat	35
HVLP spray gun and similar	Primer	50
	Topcoat	43

7.3.2 Emission factors relative to vehicle refinished

Ø Application and drying stages

Table 7.3.2.1: Emission factors for different primary measures for the application and drying stages

Coating Layers	VOC Emission Factors * [g solvent / refinished vehicle]			
	PMC 00	**PMC 01**	**PMC 02**	**PMC 03**
Putty	17,5	17,5	17,5	17,5
Primer (20 % of applications)	99,68	99,68	85,44	85,44
Surfacer (80 % of applications)	430,00	300,44	238,28	53,04
One-coat topcoat (20 % of applications)	116,39	116,39	63,96	63,96
Two-coat topcoat (80 % of applications)				
Basecoat	613,6	613,6	49,10	49,10
Clearcoat	401,79	401,79	176,81	176,81
TOTAL	**1 679,4**	**1 549,4**	**631,09**	**445,85**

* It is assumed that solvents contained in the applied coatings evaporate by 100 %.

Ø Cleaning activities

Spray guns have to be cleaned after each application of coating; it is assumed that:

- about 0,2 kg of 100 % organic solvent-based cleaning agent is necessary for the cleaning of a spray gun used for the application of solvent-based and high solid coatings,
- about 0,2 kg of a mixture of 85 % of demineralised water and 15 % of organic solvent is necessary for the cleaning of a spray gun used for the application of water-based coating,
- 10 % of the solvent in use for cleaning is released into the atmosphere (the rest undergoing recycling).

2,8 cleaning steps per refinished vehicle are necessary on average.

Primary measures 00 and 01:
0,56 kg of 100 % organic solvent-based cleaning agent per vehicle are necessary; if 10 % of the solvent is assumed to be released into the atmosphere, the emission factor related to cleaning activities is **56 g VOC/refinished vehicle**.

Primary measure 02:
For the cleaning of the spray guns used for the application of primer, surfacer, one-coat topcoat and clearcoat, 2 cleaning steps per vehicle are carried out with 100 % organic solvent-based cleaning agent, representing 0,4 kg/vehicle; since 10 % is released into the atmosphere, 40 g VOC/vehicle are emitted; on the other hand, 0,8 cleaning steps per vehicle are carried out with a mixture of 85 % of demineralised water and 15 % of organic solvent for the cleaning of a spray gun used for the application of the water-based basecoat, representing 136 g demineralised water and 24 g organic solvent. The total emission factor for cleaning activities is therefore about **42 g VOC/refinished vehicle**.

Primary measure 03:
For the cleaning of the spray guns used for the application of primer, one-coat topcoat and clearcoat, 1,2 cleaning steps per vehicle are carried out with 100 % organic solvent-based cleaning agent, representing 0,24 kg/vehicle; since 10 % is released into the atmosphere, 24 g VOC/vehicle are emitted; on the other hand, 1.6 cleaning steps per vehicle are carried out with a mixture of 85 % of demineralised water and 15 % of organic solvent for the cleaning of a spray gun used for the

application of the water-based basecoat, representing 272 g demineralised water and 48 g organic solvent. The total emission factor for cleaning activities is therefore about **29 g VOC/refinished vehicle**.

Table 7.3.2.2: Total emission factors for different primary measures

Coating Layers	Emission Factors [g VOC / refinished vehicle]			
	PMC 00	**PMC 01**	**PMC 02**	**PMC 03**
Application and drying stages	1 679	1 549	632	446
Cleaning activities	56	56	42	29
Total	**1 735**	**1 605**	**674**	**475**

7.3.3 Emission factors relative to consumption of coatings (g VOC / kg coatings)

Emission factors (g VOC / refinished vehicle) are easily derived from the quantities of coatings consumed per refinished vehicle (table 7.2.2) and the amounts of VOC emitted per refinished vehicle (table 7.3.2.2),

Table 7.3.3.1: Emission factors (g VOC / kg coatings)

RIC PMC	Emission Factors [g VOC / kg coatings]	Efficiency [%]
01 00	1 735 / 2,41 = 720	0
01 01	1 605 / 2,41 = 666	7,5
01 02	674 / 1,81 = 372	48,3
01 03	475 / 1,61 = 295	59,0

In the methodology used in RAINS, all measures have to be compared to the same reference case. This means that all emission factors are defined according to the consumption of coatings corresponding to the primary measure 00. Recalculated emission factors are the following:

Table 7.3.3.2: Emission factors (g VOC / kg coatings)

RIC PMC	Emission Factors [g VOC / kg coatings]	Efficiency [%]
01 00	1 735 / 2,41 = 720	0
01 01	1 605 / 2,41 = 666	7,5
01 02	674 / 2,41 = 280	61,1
01 03	475 / 2,41 = 197	72,6

7.4 Derivation of Cost Data

Primary measures [1]

7.4.1 Costs of the coating systems

Table 7.4.1.1: Prices for the coating systems (hardener and thinner included) ready for use

Coating Layers	Price [€ / l coating]			
	PMC 00	PMC 01	PMC 02	PMC 03
Putty	19,49	19,49	19,49	19,49
Primer	13,26	13,26	13,26	13,26
Surfacer	17,3	24,86	24,86	55,61
One-coat topcoat	36,78	36,78	42,77	42,77
Two-coat topcoat				
Basecoat	30,38	30,38	49,10	49,10
Clearcoat	26,74	26,74	31,79	31,79

Table 7.4.1.2: Additional coating consumption costs for different primary measures

RIC	Operating Costs [€ / y]			
	PMC 00	PMC 01	PMC 02	PMC 03
01	0	90	-13 442	- 10 590

7.4.2 Costs of application techniques

The price of a high pressure spray gun is about 225 € and of a HVLP spray gun about 255 €.

Table 7.4.2.1: Costs for conventional high pressure spray guns and HVLP spray guns

Technology	Investment [€]	Maintenance Costs [%]	Maintenance Costs [€ / y]	Energy Costs [€ / y]	Total Operating Costs[€ / y]
High pressure	225	33	75	135	210
HVLP	255	33	85	155	240

Investments and additional operating costs for a HVLP gun are negligible compared to a conventional high pressure spray gun, and are thus not taken into consideration in the following.

7.4.3 Costs for cleaning activities

The price of one kg 100 % organic solvent-based cleaning agent is about 1 € and of one kg demineralised water about 1,7 € .

Table 7.4.3.1: Costs for the cleaning activities

RIC	Operating Costs [€ / y]			
	PMC 00	**PMC 01**	**PMC 02**	**PMC 03**
01				
Organic solvent	0,56× 1 500 = 840	0,56× 1 500 = 840	(0,4+0,024)× 1 500 = 636	(0,24+0,048)×1 500 = 432
Water	0	0	347	393
Total	**840**	**840**	**983**	**1 126**
Additional costs	**0**	**0**	**143**	**286**

7.4.4 Total additional operating costs

According to [7], costs incurred by paint and cleaning activities are not sufficient to well represent this sector. There is a large consensus that the total costs of PMC 01 and 02 are very close.
PMC 03 is not practical for all types of repair, but it certainly increases costs. These costs arise from the need to cure the very high solids surfacer in an oven prior to over-coating, and from the increased difficulty of application, especially in thin films. Costs have been assessed by [7] from work carried out by [11].

Table 7.4.4.1: Additional operating costs

RIC	Variable operating costs [€ / y]			
	Cost Item	**PMC 01**	**PMC 02**	**PMC 03**
01	Paint consumption	90	-13 442	- 10 590
	Cleaning activities	0	143	286
	Labour and productivity	0	15 000	24 000
	Total	**90**	**1 701**	**13 696**

7.4.5 R&D and training investments [7]

These costs have been estimated by [7] at a European level which means that they will be presented in €/ t of VOC abated and not in €/installation/year. This is a different approach which is complementary for this sector.

The EC Directive [2] will lead to the development of new product R&D that would not have been done otherwise. Suppliers incur significant costs to develop and bring to market the necessary new products.

Ø PMC 02 investments

- R&D costs :

Overall costs can be estimated as not less than € 130 million [7]. This investment accounts for new resin development, paints development and colour development plus new literature, product labels etc. The development of high solid one-coat topcoats and of high solids clear coats can be considered to be around €50 million.

- Training :

Because of the characteristics of high solids and waterborne products, training of operators is required. Training sessions will be paid either by body shops or by the coating suppliers. By 2007, it is estimated that 200 000 operatives will have required retraining (an average of 2 per installation). If retraining takes on average one day, and labour costs are €120 per day, then total cost is about €24 million.

A total cost of €204 million for R&D and trading sessions for the implementation of PMC 01 is considered by [7]. CEPE estimates that this measure should lead to a VOC emission reduction in the EU15 states of 93000 tonnes/year.

These costs have to be considered as an investment on ten years with a real interest rate of 4%. This leads to a 25.15 M€/year on 10 years. Divided by a 93 000 tonnes of VOC reduction per year, this gives an efficiency cost of **270 €/t of VOC**.

This cost has to be considered 2007 onwards for the first 10 years

Ø PMC 03 investments

As products corresponding to PMC 02 have not been developed to their full potential, investments for R&D and training can not be derived. However, compared to operating costs defined in chapter 7.4.4, these costs should be minority.

8 References

[1] IFARE. Task force on the assessment of abatement options and techniques for VOC from stationary sources. Draft background document prepared for UN/ECE-May 1999.

[2] Council Directive 2004/42/EC of the European Parliament and the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in decorative paints and varnishes and vehicle refinishing products (amending Directive 1999/13/EC).

[3] Entec UK. Reduction VOC emissions from the Vehicle Refinishing Sector, Draft Final Report, December 1999.

[4] CEPE. Technology guidelines for vehicle refinishes, 1998.

[5] ALLEMAND N. BOUSCAREN R. Impact économique de la directive européenne sur la limitation des émissions de COV en provenance de l'utilisation des solvants en France. Tome II. Février 2000. CITEPA.

[6] 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

[7] B. GIORDAN. CEPE representative. Personal communication to CITEPA. December 2002 and 2004 (for the revision of the document and the definition of a new unabated case PMC 00).

[8] Z. 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

[9] Review of data used in RAINS-VOC model.
http://www.iiasa.ac.at/~rains/voc_review/single.html

[10] Regulatory and Environmental Impact Assessment for the Implementation of the EC Solvent Emissions Directive. Final Report. Entec UK Limited. 20 December 1999.

[11] Work carried out by F. BLÜMEL; J.P. LONJARET. IFARE. 1999.

9. Modifications compared to the draft document

9.1 Modification of Chapter 5

- Investments have to be taken into account from 2007 onwards (instead of 2010.) 2007 corresponds to the date given in the new Directive's proposal.

Investments are given in €/t VOC abated and have to be taken into account 2007 onwards for the first 10 years. These investments will not appear in the Tool but will be added directly in RAINS.

- Variable costs have been modified (see explanations about cleaning activities in tables 7.4.3.1 and 7.4.4.1).

Coating systems costs are not considered as country specific in this sector. They have been assessed at a European level. Even if costs are different among the countries, total over costs between the different measures should remain similar.

9.2 Modification of Chapter 7

A new primary measure has been added to define a new unabated case (PMC 00). This measure has been defined with a CEPE representative. Variable costs and emission factors have then been updated to take into account the new parameters. This measure is already introduced in the new RAINS version.
The methodology presented in the document "Addendum 24-07-03" has been introduced in this document: this concerns the definition of the emission factors which are effectively used in the calculations.