Final Background Document
on the sector

Coil Coating

Prepared in the framework of EGTEI

Prepared by CITEPA, Paris

Summary

1. Data from the bibliography (p.3)

Data currently used in RAINS are displayed in this paragraph for three different countries. Data for other countries are downloadable on http://www.iiasa.ac.at/~rains/voc_review/single.html

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Four reference installations are defined according to the annual aluminium or steel coil production (m^2 of coated coil/y).

5. Emission abatement techniques and costs (p.7)

Three primary and two secondary measures are defined.
Table 5.3.1 summarizes the emission factors with the corresponding abatement efficiencies for each combination measure.
Table 5.3.2 summarizes investments and operating costs for each combination.

If a measure is missing in the document, national experts have to contact the Secretariat to add it in the background document.

6. Data to be provided by national experts for the completion of the database for their own country (p.9)

Tables to be filled in by national experts are displayed :
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- Total activity (m^2/y) has to be estimated from 2000 to 2020 and distributed according to the different installations.
- If no detailed information is available in 2000, total activity can be divided equally between all RI (i.e.: 25% for each one).
- If no prevision on the structure of this sector is available (for 2005 to 2020), the proportions used in 2000 can be used. But total activity (m^2/y) should evolve.

Table 6.2.4 : Application rate and applicability.

- If detailed information is available, table 6.2.3 can be filled in.
- If only sparse information is available, then table 6.2.3 can be filled in with the same "Application rates" for all RI (this corresponds to the filling of table 6.2.4).

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The default data mean can be modified in a range of ± 10%.

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Investments and operating costs of primary measures have been provided by industrial experts. For secondary measures, costs are calculated from the equations of the document "Methodology".

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Sector : Coil Coating

SNAP 06 01 05 or NFR 3 A Paint application

This sector covers the coating of coils (aluminium and steel), where large metal surfaces are treated. The coating of wire is dealt with in SNAP 06 01 08 (Other industrial paint application). Coil coating is characterised by an homogeneous structure with a relatively small number of large plants [1].

ACTIVITY : production in surface of product (aluminium and steel) in m^2 / year.
POLLUTANT CONSIDERED : VOC

1 Data from the bibliography

Following data are displayed for comparison reasons

1.1 Data currently used in the RAINS model [8], [10]

In the RAINS model, coil coating is not considered as a separated sector. This sub-sector is studied as a part of "Industrial Use of Paints in Other Industrial Use of Paints". This sector encompasses the ship building industry, manufacture of plastic and metal articles, wood products industry.

1.1.1 Control options

In RAINS, the following groups of control options are considered :

- NoC : Reference case.
- HAM : Package of good housekeeping and other primary measures (solvent management plans, modification of spray application techniques to improve transfer efficiency) (applicability 40-45%; reduction efficiency : around 65%).
- SUB : Substitution with alternative coatings (applicability : 80%; reduction efficiency : 77 to 88% depending of solvent contents of alternative coating).
- A_INC : Add-on techniques : thermal and catalytic incineration (application potential is limited; reduction efficiency : 95%). Activated carbon adsorption and biological bed are not currently studied.

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 : 194,954 kt paint used; 2010 : 220,688 kt paint used, **VOC emission scenario business as usual :** 1990 : 83,32 kt VOC; 2010 : 50,27 kt VOC,					
Measure	**Emission factor [kt VOC / kt of paint]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [€$_{1990}$/t VOC]**
NoC	0,6311	0	0	0	0
HAM	0,4334	31	67	47	56
SUB	0,3555	44	87	50	902
A_INC	0,2414	62	95	65	2 068
HAM+SUB	0,3305	48	48	100	863
HAM+A_INC	0,2315	63	63	100	2 044
HAM+A_INC-SUB	0,1396	78	78	100	1 771

Table 1.1.2.2 : German situation (Old Laender)

Activity level 1990 : 350,000 kt paint used; 2010 : 398,475 kt paint used, **VOC emission scenario business as usual :** 1990 : 211,76 kt VOC; 2010 : 107,61 kt VOC,					
Measure	**Emission factor [kt VOC / kt of paint]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [€$_{1990}$/t VOC]**
NoC	0,7200	0	0	0	0
HAM	0,5040	30	68	44	-136
SUB	0,2144	70	88	80	791
A_INC	0,2754	62	95	65	1 812
HAM+SUB	0,1880	74	74	100	6 97
HAM+A_INC	0,2646	63	63	100	1 705
HAM+A_INC-SUB	0,1698	76	76	100	1 630

Table 1.1.2.3 : German situation (New Laender)

Activity level 1990 : 69,000 kt paint used; 2010 : 78,557 kt paint used, **VOC emission scenario business as usual :** 1990 : 49,68 kt VOC; 2010 : 29,09 kt VOC,					
Measure	**Emission factor [kt VOC / kt of paint]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [€$_{1990}$/t VOC]**
NoC	0,7200	0	0	0	0
HAM	0,5040	30	68	44	-136
SUB	0,2144	70	88	80	791
A_INC	0,2754	62	95	65	1 812
HAM+SUB	0,1880	74	74	100	6 97
HAM+A_INC	0,2646	63	63	100	1 705
HAM+A_INC-SUB	0,1698	76	76	100	1 630

Table 1.1.2.4 : Hungarian situation

Activity level 1990 : 3,542 kt paint used; 2010 : 3,925 kt paint used, **VOC emission scenario business as usual :** 1990 : 2,36 kt VOC; 2010 : 2,60 kt VOC,					
Measure	**Emission factor [kt VOC / kt of paint]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [€$_{1990}$/t VOC]**
NoC	0,7288	0	0	0	0
HAM	0,5047	31	68	45	27
SUB	0,2190	70	87	80	773
A_INC	0,2787	62	95	65	1 791
HAM+SUB	0,1908	74	74	100	744
HAM+A_INC	0,2675	63	63	100	1 760
HAM+A_INC-SUB	0,1720	76	76	100	1 664

1.2 Situation in the UK [6]

There are estimated to be 30 to 40 coil coating companies in Europe of which 4 are in UK. According to [6] there are 8 coating lines plus 2 for printing sectors in the UK. British Steel at Shotton is the largest coil coater in the UK and is also one of the largest in Europe. The three other operators are small in comparison.
Most or all plants in the UK have been fitted with thermal oxidizers on ovens. To comply with the Directive, additional emission controls will be necessary on the coating process or the entire extracted air from the coating room. This will require substantial investment in either new abatement equipment or ducting and pre-treatment prior to the existing thermal oxidation units.

Additional investment would be between 50 to 100% of the costs of the thermal oxidation units already installed. These incinerators are estimated by the industry at 750 000 € (£0,5 million) per coating line. Additional operating costs would typically be in the order of 10 % capital costs. The corresponding unit costs of reducing VOCs is 1 900 – 3 800 € / tonne of VOC.

1.3 Situation in Norway [7]

This sector is studied with the Mechanical Industry, Use of Paints and Varnishes. Companies in the shipbuilding, steel and offshore industries are included.
According to [7], this is not very likely that these companies will use substitution products to reduce their VOC emissions (because of stringent requirements on quality). However, substitution products exist on the market but their impact is difficult to estimate.
Costs have been estimated for the implementation of end-of-pipe devices in the largest companies allowing to reduce their VOC emissions by 90%.
This measure would have a cost effectiveness of NOK (Norway Kroner) 5,7 / kg NMVOC (≈ 740 €/tonne NMVOC).

2 Short technology description

Metal coil surface coating (coil coating) is a linear process by which protective and/or decorative organic coatings are applied to flat metal sheets or strips packaged in rolls or coils.
Metal strip is uncoiled at the entry to a coating line and is passed through a wet section, where the metal is thoroughly cleaned and is given a chemical treatment to inhibit rust and to promote coatings adhesion to the metal surface. In some installations, the wet section contains an electro-galvanising operation. Then the metal strip is dried and sent through a coating application station, where rollers coat one or both sides of the metal strip. The strip then passes through an oven where the coatings are dried and cured. As the strip exits the oven, it is cooled by water spray and again dried. If the line is a

tandem line, there is first the application of a primer, followed by another of topcoat. The second coat is also dried and cured in an oven, and the strip is again cooled and dried before being rewound into a coil and packaged for shipment or further processing.

Three types of products can be used : conventional solvent based systems, water based systems and powder coating products.
The powder coil coating installations are equipped with electrostatic spraying guns and infrared dryers. An application with a roller technique is not feasible [9].
Water-based paints are not applicable for a wide-range use. If process water-based coatings are used, the application is mostly limited to ground coating [9].

According to [3], a majority of installations in Europe is equipped with incinerators.

3 EU regulation : Directive 1999/13/EC of 11 March 1999 [4]

Operators concerned can conform to the Directive in either of the following ways:
- by complying with the canalised and fugitive emission limit values;
- by introducing a reduction scheme to obtain an equivalent emission level, (in particular by replacing conventional products which are high in solvents with low-solvent or solvent-free products).

Directive applies to installations with a solvent consumption above 25 t per year.

Emission limits for application of the directive are presented in table 3.1.

Table 3.1 : Emission limits

Solvent consumption threshold [t / y]	VOC emission limit value in residual gases [mg C / Nm^3]	Fugitive emissions [% of solvent input*]
> 25	50 150 if use of a regenerative technique	New installations : 5 Existing Installations : 10

* Solvent input : quantity of organic solvents used as input into the process in the time frame over which the mass balance is being calculated (purchased solvent) + quantity of organic solvents recovered and reused as solvent input into the process (recycled solvents are counted every time they are put back into the process cycle).

All obligations of the Directive are not described in this chapter.

4 Definition of Reference Installations

Reference installations are defined according to their output of metal coated per year.

According to [2], the following reference installations can be defined :
- For steel : a medium installation has a capacity of production of 21 millions of m^2 per year (100000 t / y) and a large one, a production of 42 millions of m^2 / year (200 000 t / y).
- For aluminium : a small installation has a capacity of production of 7 millions of m^2 per year (8000 t/ y), a medium, a production of 13 millions of m^2 per year (15 000 t / y) and a large one, a production of 27 millions of m^2 per year (30 000 t / y).

To treat steel and aluminium coatings together, four reference installations have been defined. For the medium one, the output of 24 Mm^2 / y corresponds to the average of 21 Mm^2 (steel) and 27 Mm^2 (aluminium).

Reference installations are presented in table 4.1.

Table 4.1 : Reference installations

Reference Installation Code RIC	Description
01	Very Small Installation: one coating line with an output 7 millions m^2/y coated steel or aluminium Range : 5 to 9 millions m² / y
02	Small Installation: one coating line with an output 13 millions m^2/y coated steel or aluminium Range : 10 to 17 millions m² / y
03	Medium Installation: one coating line with an output 24 millions m^2/y coated steel or aluminium Range : 18 to 30 millions m² / y
04	Large Installation: one coating line with an output 42 millions m^2/y coated steel or aluminium Range : > 30 millions m² / y

5 Emission abatement techniques and costs

5.1 Definitions of primary measures

- Products used :

Solvent based products are widely used in this sector. According to [3], water-based coating systems almost disappeared in the early 80s with the apparition of incinerators. Water-based varnish systems have represented 0,2% of varnish consumption in Western Europe in 1999 [9].
The use of powder coating systems is slowed down because its application is still technologically and economically difficult. Layers are twice thicker than those obtained with conventional solvent coating systems which leads to very high operating costs. Research is carried out to reduce the quantity of deposited coatings. Currently, only three installations using powder exist in Europe.

- Techniques of application:

Varnishes are applied by rolling with an efficiency of almost 100% because the surplus coating material of the varnish tub is recycled completely [9]. That is why, improvement of the application efficiency is not considered in the primary measure definitions.

Table 5.1.1 : Primary measures

Primary Measure Code PMC	Description
00	Operation of coil coating line with solvent-based coatings (40 wt.-% solvent content) [2]
01	Operation of coil coating line with water-based coatings (10 wt.-% solvent content)
02	Operation of coil coating line with powder coating systems (solvent free)

5.2 Definitions of secondary measures

In this sector, only incinerators are used as end-of-pipe techniques.
Incinerators may be either thermal or catalytic, both of which have been demonstrated to achieve a NMVOC destruction efficiency of 95 % or even greater. If incinerators are installed on ovens, overall emissions can be reduced by 90 % or more.
Emission share is considered as follows : 95% from ovens and 5% from coaters.

Table 5.2.1 : Secondary measures

Secondary Measure Code SMC	Description
00	No secondary measure
01	Thermal oxidation

5.3 Emission factors and costs data for the different combinations

Combination PMC 01-SMC 01 is not studied hereafter because it seems unrealistic.

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

RIC PMC SMC	NMVOC EF [g VOC / m² coated]	Abatement efficiency [%]	Q	CI %
01 00 00	43,2	0	5	20
01 00 01	4,2	90	5	20
01 01 00	10,8	75	5	20
01 02 00	0	100	5	20
02 00 00	43,2	0	5	20
02 00 01	4,2	90	5	20
02 01 00	10,8	75	5	20
02 02 00	0	100	5	20
03 00 00	43,2	0	5	20
03 00 01	4,2	90	5	20
03 01 00	10,8	75	5	20
03 02 00	0	100	5	20
04 00 00	43,2	0	5	20
04 00 01	4,2	90	5	20
04 01 00	10,8	75	5	20
04 02 00	0	100	5	20

Table 5.3.2 : Investments and operating costs

RIC PMC SMC	Investment [€]	Q	CI %	Variable OC [€ / year]	Q	CI %	Fixed OC [€/y]	Q	CI %
01 00 00	10 000 000	-	20	2 464 467	4	25	-	-	-
01 00 01	10 480 000	4	25	2 480 497	4	25	24 000	4	25
01 01 00	8 000 000	-	20	2 718 682	4	25	-	-	-
01 02 00	6 000 000	4	35	4 742 080	4	25	-	-	-
02 00 00	12 000 000	-	20	4 576 867	4	25	-	-	-
02 00 01	12 674 000	4	25	4 601 087	4	25	33 700	4	25
02 01 00	9 600 000	-	20	5 048 982	4	25	-	-	-
02 02 00	12 000 000	4	35	8 806 720	4	25	-	-	-
03 00 00	14 000 000	-	20	8 449 600	4	25	-	-	-
03 00 01	14 944 700	4	25	8 488 830	4	25	47 200	4	25
03 01 00	11 200 000	-	20	9 321 197	4	25	-	-	-
03 02 00	18 000 000	4	35	16 258 560	4	25	-	-	-
04 00 00	17 000 000	-	20	14 786 800	4	25	-	-	-
04 00 01	18 285 700	4	25	14 850 600	4	25	64 300	4	25
04 01 00	13 600 000	-	20	16 312 094	4	25	-	-	-
04 02 00	36 000 000	4	35	28 452 480	4	25	-	-	-

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

For representing costs in this sector, the national expert is invited to comment the methodology defined by the Secretariat.

- Validate investments provided and,
- Validate the method of derivation of operating costs.

Or

- Provide other costs for the same combination of techniques and justify them.

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

- Determination of country specific data to calculate variable costs (they are valid for all VOC sectors and only have to be entered in the tool once).

Table 6.2.1 : Country-specific data

Parameters	Default values	Country specific costs
Electricity [€/kWh] (net of taxes)	0,0686	
Natural gas [€/kWh] (net of taxes)	0,0192	
Wages [€/h]	25,9	

Table 6.2.2 : Country and sector specific data

Parameters	Default costs [€/kg]	Country specific costs [€/kg]
Conventional high solvent-based paint	3,5	
Water-based paint	4,0	
Powder paint	6,5	
Cleaning solvent	1,7	

- Respective shares (m² coil/y) of the total activity level carried out on each reference installation 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.

Table 6.2.3 : Activity levels on Reference Installations (m² coil / year)

RIC	2000	CI%	2005	CI%	2010	CI%	2015	CI%	2020	CI%
01										
02										
03										
04										
Default values for CI		10		20		50		100		100
Total	Calculated automatically by the tool									

For explanations on the coefficient of variation (CI), please refer to the “Methodology”.

- Total activity (m² coil/y) has to be estimated from 2000 to 2020 and distributed according to the different installations.
- If no detailed information is available in 2000, total activity can be divided equally between all RI (i.e.: 25% for each one).
- If no prevision on the structure of this sector is available (for 2005 to 2020), the proportions used in 2000 can be used. But total activity (m² coil/y) should evolve.

- Respective percentage of combinations of reduction measures in 2000 for each reference installation as well as if possible, the percentage of use in 2005, 2010, 2015, 2020 due to the VOC Directive or national regulations and applicability according to the definition used in the RAINS model.

Table 6.2.4 : Application rate and Applicability for each combination of reduction measures

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									
01 00 01									
01 01 00									
01 02 00									
Total RIC 01	**100**	**100**		**100**		**100**		**100**	
02 00 00									
02 00 01									
02 01 00									
02 02 00									
Total RIC 02	**100**	**100**		**100**		**100**		**100**	
03 00 00									
03 00 01									
03 01 00									
03 02 00									
Total RIC 03	**100**	**100**		**100**		**100**		**100**	
04 00 00									
04 00 01									
04 01 00									
04 02 00									
Total RIC 04	**100**	**100**		**100**		**100**		**100**	

If detailed information is available, table 6.2.4 can be filled in.
If only sparse information is available, then table 6.2.4 can be filled in with the same “Application rates” for all RI (this corresponds to the filing of table 6.2.5).

Table 6.2.5 : Aggregated table (this table does not appear in the tool)

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. [%]
Aggreg. 00 00									
Aggreg. 00 01									
Aggreg. 01 00									
Aggreg. 02 00									
Total aggreg.	**100**	**100**		**100**		**100**		**100**	

Aggreg. : Aggregation

Table 6.2.5 : Unabated emission factor [g / m² coil coated]

Default data mean	CI %	User input mean	CI %
43,2	20		

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 document.

7 Explanatory notes

7.1 Consumption and emission factors

Consumption factors (CF) :

- 90 g of coating material/m^2 for liquid based coating systems [2] and 100 g/m^2 for powder system [5];
- the application technique used in the coil coating industry is the roller coating with an application efficiency of 98 %;
- According to [11], the quantity of cleaning agents represents about 20 % of the total quantity of solvents used.
- With water based products, solvents are still used. They are usually mixed with water for pre-cleaning followed by a cleaning with hot water.

Table 7.1.1 : Solvent consumption factors

Type of coating	Product consumption factor [g of paint /m² coated]	NMVOC content [g solvent/g paint]	Solvent Consumption Factor [g VOC / m^2 coated]
Conventional high solvent-based coating	90 [2]	0,4	90 × 0,4 × (1 + 0,2) = 43,2
Water-based coating	90 [2]	0,1	90 × 0,1 × (1 + 0,2) = 10,8
Powder coating	100 [5]	0	100 × 0 = 0

Emission factors (EF) :

- In installations without enclosure of the application and drying processes and without end-of-pipe devices, all solvents used are emitted into the air. Therefore, the corresponding emission factor related to g solvent consumed is EF = 1 g solvent/g solvent consumed.

- In installations with secondary abatement measures where the drying process is enclosed, only fugitive emissions occur. According to [1], emissions from the coil coating process originate to :
  - 95 % from ovens,
  - 5 % from coaters.

The efficiency of an incinerator fitted to the ovens can be estimated to be 95 %.

As a first estimate, we consider that 95% of total emissions are routed to the thermal oxidizer.

The combination “water product use / incinerator” is not considered because it seems unrealistic.

Table 7.1.2 : VOC emission factor for the use of an incinerator

PMC SMC	Product consumption factor [g of paint /m² coated]	Solvent concentration [%]	Emission factor [g VOC /m² coated]
00 01	90	40	(0,95×0,05 + 0,05)×43,2 = 4,2

7.2 Derivation of cost data

7.2.1 Primary Measures

- Operating costs

- As regards to the operating costs, a general estimate is related to the fact that water-based coatings are about 20 % more expensive than solvent-based ones, due to the required special binding agents [2] as presented in table 5.1.1.

Table 7.2.1.1 : Different paint costs [2]

Type of Paint	Price [€ / kg]
Conventional high solvent-based paint	3,5
Water-based paint	4,0
Powder paint	6,5
Cleaning solvent	1,7

Assumptions for the calculation of operating costs are presented hereafter.

Table 7.2.1.2 : Product consumption costs

RIC PMC SMC	Paint Consumption [t / year]	Paint Costs [€ / year]	Cleaning solvent consumption [t / year]	Cleaning solvent costs [€ / year]
010000	630	2 205 000	630 × 0,4 × 0,2 =50,4	85 680
010100	630	2 520 000	630 × 0,1 × 0,2 =12,6	21 420
010200	700	4 550 000	0	0
020000	1 170	4 095 000	93,6	159 120
020100	1 170	4 680 000	23,4	39 780
020200	1 300	8 450 000	0	0
030000	2 160	7 560 000	172,8	293 760
030100	2 160	8 640 000	43,2	73 440
030200	2 400	15 600 000	0	0
040000	3 780	13 230 000	302,4	514 080
040100	3 780	15 120 000	75,6	128 520
040200	4 200	27 300 000	0	0

Energy consumptions for liquid coating use have been provided by [11]. For powder coating, energy consumptions come from [5].

- A consumption of 0,076 kWh/kg of steel for liquid paints is assumed. This corresponds to :
  4,76 [kg/m²] × 0,076 kWh/kg = 0,36 kWh/m²
- An electrical power of 350 kW is installed on a line producing 3,6 Mm² of aluminium with powder coating. For 7 Mm², we have considered an electrical power of 700 kW. This line is running 16 h/day (we have assumed an annual working time of 4000 h) [5].

Table 7.2.1.3 : Energy costs [5], [11]

RIC PMC SMC	Electricity consumption [kWh / year]	Electricity costs [€ / year]
010000	2 533 333	173 787
010100	2 584 000	177 262
010200	2 800 000	192 080
020000	4 704 762	322 747
020100	4 798 857	329 202
020200	5 200 000	356 720
030000	8 685 714	595 840
030100	8 859 429	607 757
030200	9 600 000	658 560
040000	15 200 000	1 042 720
040100	15 504 000	1 063 574
040200	16 800 000	1 152 480

Table 7.2.2.4 : Total operating costs including paint coating costs, solvent costs and energy costs

RIC PMC SMC	Total variable operating costs [€ / year]
010000	2 464 467
010100	2 718 682
010200	4 742 080
020000	4 576 867
020100	5 048 982
020200	8 806 720
030000	8 449 600
030100	9 321 197
030200	16 258 560
040000	14 786 800
040100	16 312 094
040200	28 452 480

- Investments

Investments for solvent based coating lines have been provided by [11]. They are displayed in the following table :

Table 7.2.1.5 : Solvent based coatings lines

Type of line	Investment [M€]
Very small	10
Small	12
Medium	14
Large	17

According to [11], investments are reduced by 20% for water based coating lines.

Investments for powder coating lines have been provided by [5] : a line manufacturing 3 600 000 m² of aluminum per year costs 3 M€. Two lines are necessary to manufacture 7 000 000 m² and so on.

Table 7.2.1.6 : Emission factors, investments, operating costs, abatement efficiencies and technical lifetime for primary measures

RIC PMC SMC	NMVOC Emission Factor [g / m^2 coated]	Investment [€]	Variable Operating Costs [€/y]	Abatement efficiency [%]	Tech. Lifetime [y]
010000	43,2	10 000 000	2 464 467	0	20
010100	10,8	8 000 000	2 718 682	75	20
010200	0	6 000 000	4 742 080	100	20
020000	43,2	12 000 000	4 576 867	0	20
020100	10,8	9 600 000	5 048 982	75	20
020200	0	12 000 000	8 806 720	100	20
030000	43,2	14 000 000	8 449 600	0	20
030100	10,8	11 200 000	9 321 197	75	20
030200	0	18 000 000	16 258 560	100	20
040000	43,2	17 000 000	14 786 800	0	20
040100	10,8	13 600 000	16 312 094	75	20
040200	0	36 000 000	28 452 480	100	20

Secondary measures

Investments and operating costs are calculated from equations displayed in the Methodology and depend directly on the flow rate and VOC concentration in the exhaust gas. The following assumptions on annual working time and VOC concentration in the waste gas streams have been used

Working time for all installations : 4 000 h/y
VOC concentration : 8,25 g/m^3.

Flow rates are calculated with the following equation :

$$\textbf{Flow rate } [m^3/h] = 0{,}95 \times [(\text{g COV / m² coated}) \times (\text{m² coated/y})] / [(\text{g VOC/m}^3) \times (\text{h/y})]$$

Table 7.2.7 : Emission factors, flow rates, investments, operating costs an technical lifetime for secondary measures

RIC PMC SMC	NMVOC Emission Factor [g / m² coated]	Flow rate [m^3/h]	Investment [€]	Variable OC [€/y]	Fixed OC [€/y]	Tech. Lifetime [y]
01 00 01	4,2	8 700	480 000	16 030	24 000	10
02 00 01	4,2	16 170	674 000	24 220	33 700	10
03 00 01	4,2	29 850	944 700	39 230	47 200	10
04 00 01	4,2	52 230	1 285 700	63 800	64 300	10

8 References

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9. Modifications compared to the draft document

9.1 Modification of chapter 5

Emission factors as well as investments and energy consumptions have been modified.

9.2 Modification of chapter 6

Country and sector specific parameters have been added. These data can be modified by national experts.

9.3 Modification of chapter 7

New data have been provided by the Industry [11]. Consequently, some parameters have been modified.