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EMISSION LIMITS RELEASED INTO THE ATMOSPHERE

USI ITALIA SPRAY BOOTHS

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1 DEFINITION

Spray booths for partial or total painting of vehicles carried out by hand-held spray gun.
The emission limits determined for this kind of activity are the following:

- **3 mg/m^3** for powders (paint particles)
- **50 mg/m^3** for volatile organic components (V.O.C.) expressed as total carbon.

2 TECHNOLOGICAL CYCLE

In order to quantify the emissions of these substances, a complete work cycle of the booth is determined, taking into account the duration of the various phases, the method of application and quantity of product used, the volume and temperature of the air expelled together with these substances during the work phases.

In order not to exceed the **"TLV"** (Threshold Limit Value) of the paint-vapour mixture inside the booth, the booth identification plate indicates **the maximum quantity of flammable solvent** contained in the amount of painting product applied in one hour.

3 TYPE OF PAINTING PRODUCT

For the type of painting product to use, reference is made to **Directive 2004/42/CE** concerning the emission limits for volatile organic components (V.O.C.) arising from the use of solvents in some paints and varnishes declared for use in the body shop.

The limit of V.O.C. content envisaged by the European Directive for body shop products in the finishing category (**category: IIB.d**), ready for use, is max. **420 g/l.**

Normally the quantity of painting product necessary for a work cycle is smaller than the calculated value, but for safety's sake all the subsequent calculations are made using in any case the maximum quantity.

4 WORK CYCLE

The work cycle for the type of application is defined as below:

Work phase	Emission duration min.	Hour fraction		Air volume on work phase mc/hr		Handled air volume mc
Paint	60'	1,00	x	29.300	=	29.300
Flash-off	15'	0,25	x	29.300	=	7.325
Bake	30'	0,50	x	4.395	=	2.198
Total cycle	**105'**					**38.823**

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5 CALCULATION QUANTITY OF VOLATILE ORGANIC SUBSTANCES

The quantity of painting product is based on a hypothesis of spraying **120 g** of product for every **1000 m³/hr** of air handled**.**

The quantity **3516 g** is the maximum permissible amount of painting product that may be sprayed inside the spray booth in one hour with a solvent composition of **420 g/l.**

The specific weight of the painting product ready for use is considered as **0,950 g/cm³** and therefore the total amount of volatile organic components (V.O.C.) released during the whole cycle is **1554 g.**

6 ANALYSIS OF THE EMISSIONS

We must consider that during painting by hand, using a HVLP spray gun the efficiency is about **85** %, that is to say, **85** % of the painting product actually adheres to the surface of the vehicle, while the remaining **15**% becomes overspray and is expelled with the ventilation air.

Total solvent	**1554**	g
Solvent on painted part	1321	g
Solvent overspray	233	g
Solid product on painted part	1962	g
Solid product overspray	**294**	g

The value **294 g** represents the dry residue called **'total powders'** which is expelled with the outgoing air during the paint phase.

The real emission value will actually be lower, because part of the dry residue remains attached to the grating and to the walls of the pit and tunnel during the outflow of the air from the system.

Bearing in mind the chemical-physical nature of the components (vapour tension, speed of evaporation, etc.), even at the end of the paint phase you can consider that, in addition to overspray, also the most volatile components of the paint have completely evaporated in a percentage equal to about **40**% of the V.O.C. residue.

We can assume that another **40**% will evaporate during the flash-off cycle, before the reticulation of the enamel deposited on the car body; a further **10**% will also evaporate during the subsequent bake and cool-down cycles. The remaining 10% will be released very slowly during the 24 hours following the work cycle completion.

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Here below the calculated emission values are shown considering the spray booth without any abatement system before releasing the air into the atmosphere.

V.O.C. CONCENTRATION AND MASS FLOW DIVIDED PER WORK PHASE

Work phase	Solvent emission per work phase[g]					Air Volume mc/h	Emission Duration min.	Mass Concentr. mg/mc	Mass Flow gr/h
Paint									**762**
On painted part	1.321	x	40%	=	529				
Overspray	233			=	233				
			tot.	=	**762**	29.300	60'	**26**	
Flash-off	1.321	x	40%	=	**529**	29.300	15'	**72**	**2114**
Bake (cool-down)	1.321	x	10%	=	**132**	4.395	30'	**60**	**264**
Next 24 hrs.	1.321	x	10%	=	**132**	/////	/////	/////	/////

Table 1 **Mass V.O.C. concentration divided per work phase**

TOTAL QUANTITY OF POWDERS AND V.O.C. DIVIDED PER WORK PHASE

Work phase	Emission duration min.	Hour fraction		Air volume on work phase mc/hr		Handled air volume mc	**Quantity tot. V.O.C.** g	**Quantity Powders** g
Paint	60'	1,00	x	29.300	=	29.300	762	**294**
Flash-off	15'	0,25	x	29.300	=	7.325	529	/////
Bake	30'	0,50	x	4.395	=	2.198	132	/////
Total cycle	**105'**					**38.823**	**1.422**	

Table 2 Theoretical concentration of V.O.C. components and total powders without abatement system.

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7 CONCLUSIONS

In the case of spray booths for body shops the most effective means of suppressing the **'total powders'** (dry overspray residue) is by using dry filters placed progressively along the exhaust air circuit
Using the figures obtained in Table 2, considering the entire work cycle and the total amount of substances emitted, the results shown below can be obtained.

With reference to the nature of the solvent and thinner components contained in the painting product, it is the user's responsibility to check that the products used are among those allowed by standards currently in force.

7.1 EMISSIONS OF POWDERS

CONCENTRATION OF TOTAL POWDERS IN RELATION TO THE ENTIRE WORK CYCLE

$$\frac{294.234 \text{ mg}}{38.823 \text{ mc}} = \textbf{7,58 mg/mc}$$

These concentrations will vary, in order to fall within the limits required by local regulations, if an exhaust air filter unit is installed, which allows **90%** of powders to be retained. The emission values may therefore be recalculated as follows:

CONCENTRATION OF TOTAL V.O.C. IN RELATION TO THE ENTIRE WORK CYCLE WITH USE OF EXHAUST AIR FILTER UNIT

7,58 - (	7,58	x	0,90	)=	**0,76 mg/mc**

7.2 EMISSIONS OF VOLATILE ORGANIC COMPONENTS

CONCENTRATION OF TOTAL V.O.C. IN RELATION TO THE ENTIRE WORK CYCLE

$$\frac{1.422.315 \text{ mg}}{38.823 \text{ mc}} = \textbf{36,64 mg/mc}$$

As can be seen, the concentration of solvents is below the allowed limits.