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SOLVENT EMISSIONS - 2014
DEESIDE PACKAGING COATINGS

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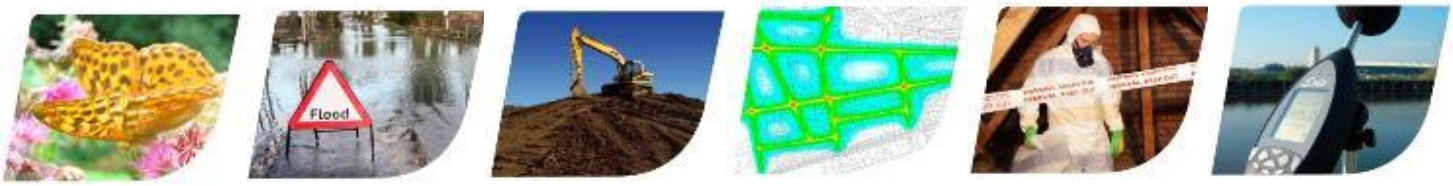

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1.0 INTRODUCTION

1.1 Background

Resource and Environmental Consultants (REC) Ltd was commissioned by Valspar Corporation (UK) Ltd to produce the annual solvent emissions report for 2014. This was to address the relevant annual compliance requirements of Environmental Permit reference BU7545IM.

The calculation of solvent emissions has been undertaken in accordance with the methodology outlined in 'The BCF VOC Workbook', as requested by the Environment Agency (EA) in EPR Compliance Assessment Report reference BU7545IM/0221994. The relevant inputs and calculations are detailed within this report.

1.2 Limitations

This report has been produced in accordance with REC's standard terms of engagement. REC has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from REC; a charge may be levied against such approval.

2.0 METHODOLOGY

2.1 Scope

As required by the Environmental Permit for the installation, the solvent emissions calculations only consider releases from the Paint Plant. However, it should be noted that all materials manufactured in the Resin Plant are used in the Paint Plant and therefore the Volatile Organic Compound (VOC) input to the process can be considered as all solvents used on site.

2.2 Assessment Criteria

There are two solvent emission limit Options outlined in the BCF VOC Workbook. These are summarised in Table 1.

Table 1 VOC Emission Limits for Coatings Manufacture

Solvent Consumption (tonnes per annum)		Option 1	Option 2	
		Total Emissions	Fugitive Emissions	Waste Gas Emissions
Band 0	< 100	Not in scope	Not in scope	
Band 1	100 - 1,000	< 5% of solvent inputs	< 5% of solvent inputs	< 150mg carbon/m^3
Band 2	> 1,000	< 3% of solvent inputs	< 3% of solvent inputs	< 150mg carbon/m^3

The Deeside Packaging Coatings facility consumes in excess of 1,000-tonnes of solvent per annum and is therefore classified as a Band 2 installation. Stack monitoring has shown carbon concentrations greater than 150mg/m^3 in the exhaust gases. As such, the emission limit provided in Option 1 has been selected for use in this assessment.

2.3 Emission Calculation

As stated in the BCF VOC Workbook:

Total emission = waste gases emissions + fugitive emissions
= final discharge from a stack + any other emissions to air, soil or water, excluding solvent in product
= Solvent emissions in waste gases (O1) + (uncaptured emissions (O4) + solvents lost in water (O2) + solvent contamination or residues in products (O3) + solvent released in other ways (O9))

It should be noted that O3 is not applicable to coatings manufacturing processes as solvents in products are deliberately present.

The installation is shown to conform to the emission limit if:

(O1 + O2 + O4 +O9) ≤ 3 (Purchases of solvents (I1) + solvent recovered and reused in the installation (I2)) / 100

3.0 SOLVENT EMISSIONS CALCULATIONS

3.1 I1 - Purchase of Solvents

Solvent usage at the facility was obtained from delivery and usage records. The results are summarised in Table 2.

Table 2 Solvent Usage

Solvent	Usage (kg)
DIACETONE ALCOHOL AF TYPE	36,459
BUTANOL NORMAL TYPE	399,582
ISOPROPANOL 99% TYPE	39,922
ISOBUTYL ALCOHOL TYPE	2,996
IMS 99	22,934
PROPYLENE GLYCOL	163,697
PRIMARY AMYL ALCOHOL	3,331
TRIDECANOL	25,639
GLYCOL ETHER DE-LG	1,621,283
BUTYL DIGLYCOL ACETATE	11,136
GLYCOL ETHER EB	355,996
BUTYL ACETATE NORMAL	26,811
DIETHYLENE GLYCOL BUTYL ETHER	127,524
DOWANOL PM TYPE	29,907
BUTYL CELLOSOLVE ACETATE TYPE	153,434
PM ACETATE TYPE	223,433
METHYL CARBITOL TYPE	400
DIBASIC ESTER SOLVENT	62,873
METHYL ISOBUTYL KETONE TYPE	24,825
CYCLOHEXANONE TYPE	63,754
METHYL ETHYL KETONE TYPE	304,235
MINERAL SPIRITS NON-EXEMPT	12,137
SOLVENT 60 (SPB6)	11,351
XYLENE TYPE	398,220

Solvent	Usage (kg)
AROMATIC 100 - EUROPEAN	258,127
EUROPEAN AROMATIC 150 MAX 1% NAPHTHALENE	5,676
ETHYL ACRYLATE	301,715
TOTAL	**4,687,397**

As shown in Table 2, 4,687,397kg of solvent was used in 2014.

The majority of the resins used in the Paint Plant are manufactured on site. However, 304,604kg of CYMEL 303 was used in 2014. Data from the supplier indicated this has a maximum solvent content of 2%. As such, **I1.2 (solvent in bought-in resins) = 6,092kg.**

No other solvents in addition to those shown in Table 2 are used on site. As such, I1.3 (Solvent in other bought-in materials) = 0kg.

Based on the above values, **I1 = 4,693,489kg**.

3.2 I2 - Solvent Recovered and Reused in the Installation

There are no recovered solvents bought in to the facility. As such, I2.1 (bought-in recovered solvent) = 0kg.

There are no solvents recovered on site. As such, I2.2 (on-site recovered solvent) = 0kg.

Based on the above values, **I2 = 0kg.**

3.3 O1 - Solvent Emissions in Waste Gases

The amount of solvent emissions in waste gases has been calculated for the relevant routes in the following Sections.

3.3.1 O1.1 - Powered Vents

There are two emission points associated with the Paint Plant:

- Emission point A5 - paint plant vessels; and,
- Paint plant local exhaust ventilation system (LEV).

Emissions from these points are calculated below.

Emission Point A5

Quarterly monitoring of VOC emissions is undertaken to show compliance with the relevant condition included within the site's Environmental Permit. A summary of 2014 monitoring results is provided in Table 3.

Table 3 Monitoring Results - VOC Concentrations

Emission Point	Total VOC Concentration as Carbon (mg/m^3)				
	Q1	Q2	Q3	Q4	Mean
A5	1,048.1	1,779.0	456.9	786.2	1,017.6

A summary of the monitored flows rates is provided in Table 4.

Table 4 Monitoring Results - Flow Rates

Emission Point	Measured Flow Rate (Nm^3/hr)				
	Q1	Q2	Q3	Q4	Mean
A5	452	474	452	449	457

The calculation requires the monitored VOC concentration as carbon to be converted to mass of VOC. This requires speciation of the emission. However, this was not undertaken during 2014. As such, reference was made to the Speciation Monitoring included in the Environmental Permit Application for the site. This indicated the following species were present in the exhaust gases:

- Toluene;
- Xylene;
- MEK;
- N-butanol; and,
- Styrene.

The BCF VOC Workbook states that for the simplified approach it should be assumed that all of the emission consists of the species with the lowest proportion of carbon. As such, butanol was selected for the purpose of the assessment at it consists of 41% carbon.

The averaged concentration emission from the monitoring results was calculated as follows:

$$1,017.6 / (41 / 100) = 2,481.8 mgVOC/m^3$$

This was converted into a mass emission by multiplying by the measured air flow:

$$(2,481.8 \times 457) / 1,000,000 = 1.13 kgVOC/hr$$

The Paint Plant operates 24-hours per day, 362-days per year. The annual mass emission from A5 was therefore calculated as follows:

$$1.13 \times 24 \times 362 = 9,848.5 kgVOC/year$$

Local Exhaust Ventilation System

Annual workplace exposure monitoring of various VOCs is undertaken within the Paint Plant. The results are summarised in Table 5. These were utilised to represent solvent concentrations within

the Paint Plant in lieu of direct monitoring of the LEV system.

Table 5 Ambient VOC Concentrations

Species	Monitored Concentration (mg/m^3)	Notes
Triethylamine	0.17	Less than
n-butyl acetate	12.00	Highest concentration
n-butyl alcohol	1.80	Highest concentration
Cyclohexanone	0.40	Less than
Ethyl acrylate	-	Not monitored in Paint Plant
Ethylbenzene	6.00	-
Ethylene glycol monobutyl ether	1.30	Highest concentration
Methyl isobutyl ketone	26.00	-
Propylene glycol methyl ether	44.00	Less than
Styrene	-	Not monitored in Paint Plant
Toluene	3.00	Less than
Trichloroethylene	0.60	Less than
Vinyl chloride	0.40	Less than
Xylene	25.00	Less than
Total	**120.67**	

It should be noted that the workplace exposure monitoring recorded VOC concentrations whilst workers undertook specific activities with a high risk of solvent release. As such, the results are considered to provide a worst-case representation of VOC concentrations within the Paint Plant.

The flow rate within the LEV system was not known at the time of this assessment. As such, the airflow was estimated as follows based on the volume of the Paint Plant and the default number of airchanges per hour stated in the BCF VOC Workbook of 5:

$$5{,}400 \times 5 = 27{,}000 m^3/hr$$

This was converted into the airflow per year by multiplying by the number of operational hours:

$$27{,}000 \times 24 \times 362 = 234{,}576{,}000 m^3/year$$

This was multiplied by the monitored VOC concentration to determine the annual mass release:

$$(234{,}576{,}000 \times 120.67) / 1{,}000{,}000 = 28{,}306.3 kgVOC/year$$

Total Powered Vent Losses

Based on the above calculations, **O1.1 = 38,154.79kg.**

3.3.2 O1.2 - Non-Powered Process Vessel Vents

Any releases through non-powered process vessel vents are collected by the LEV system and have been accounted for in O1.1. As such, O1.2 (non-powered process vessel vents (e.g. breather vents)) = 0kg.

3.3.3 O1.3 - General Extraction and Building Ventilation Systems

Ventilation is provided by the LEV system outlined in Section 3.3.1. As such, O1.3 (general extraction and building ventilation systems) = 0kg.

3.3.4 O1.4 - Bulk Storage Vessel Breather Vents

Tank solvent losses occur through either:

- Vapour displacement on filling (F); or,
- Vapour breathing losses (B) due to the volume changes as a result of the daily rise and fall in temperature.

F - Filling Losses

Filling losses have been calculated using the equation provided in the BCF VOC Workbook. The results are summarised in Table 6.

Table 6 Filling Losses

Release Point	Species	Annual Usage (kg)	Specific Gravity	Annual Usage (m^3)	Mol. Weight	Vapour Press @20C (kPa)	Filling Losses (kg per year)
Tank 1 & 2	Ethyl Diglycol TE0001A	1,621,283	0.989	1,639	134.1	0.024	2.23
Tank 3	Solvesso 100/Naptha TR1002B	258,127	0.878	294	127	0.194	3.06
Tank 4	Xylene TR0004A	398,220	0.87	458	106	0.74	15.17
Tank 5	Epikote 828 RE0276B	1,569,725	1.16	1,353	374	0.00	0.00
Tank 6	Dowanol PM TE0036A	29,907	0.921	32	90.1	1.33	1.64
Tank 7 & 13	MEK TK0012A	304,235	0.806	377	72.1	9.459	108.75

Release Point	Species	Annual Usage (kg)	Specific Gravity	Annual Usage (m^3)	Mol. Weight	Vapour Press @20C (kPa)	Filling Losses (kg per year)
Tank 8	Dowanol PMA TE0055A	223,433	0.966	231	132.2	0.337	4.35
Tank 9	Normal Butanol TC0003A	399,582	0.81	493	74.1	0.566	8.74
Tank 10	Butyl Glycol Ether TE0003A	355,996	0.902	395	118.2	0.118	2.33
Tank 11	Methacrylic Acid MQ0025A	82,317	1.01	82	86.09	0.13	0.39
Tank 12	DMEA CM0564A	149,827	1.01	148	86.09	0.13	0.70
Tank 14	Wash Solvent	996,321	0.82784	1,204	83.983	3.585	153.07
Tank 16	Butyl DiGlycol TE0027A	127,524	0.887	144	89.1	0.56	3.03
Tank 17	BCA - TE0047A	153,434	0.972	158	160.21	0.03	0.32
ST 8	Ethyl Acrylate MQ0037A	301,705	0.923	327	100	3.9	53.86
						TOTAL	**358**

As shown in Table 6, F =358kg.

It should be noted that the vapour pressures have been used at 20˚C as a worst-case, as described in the BCF VOC Workbook.

B - Breathing Losses

As stated in the BCF VOC Workbook, the calculation of breathing losses is complex and laborious. As such, they can be approximated by adopting the value determined for F. Evaluation of data shows these to be similar in magnitude and if the worst case is used for filling losses (as utilised in this assessment), this compensates for any reduction in breathing losses.

As such, B = 358kg.

Total Bulk Storage Losses

Based on the above calculations, **O1.4 = 715kg.**

3.3.5 01.5 - Abatement Plant Discharges

The Paint Plant does not include any solvent abatement equipment. As such, O1.5 (abatement plant discharges) = 0kg.

3.4 O2 - Solvents Lost in Water

The Paint Plant does not have any associated effluent releases. As such, O2 (solvents lost in water) = 0kg.

3.5 O4 - Uncaptured Emissions

3.5.1 O4.1 - Natural Ventilation of Buildings

Ventilation is provided by the LEV system outlined in Section 3.3.1. As such, O4.1 (natural ventilation of buildings) = 0kg.

3.5.2 O4. 2 - Outside Emptied Drum Storage

All solvents are delivered directly to the tank farm. Resins are delivered in sealed IBCs and returned to the supplier in a closed state. Given the very high solids content of the resin used on site it is considered the amount of residual VOCs in the IBCs is likely to be negligible. Therefore, O4.2 (outside emptied drum storage) = 0kg.

3.5.3 O4.3 - Outside Container Crushing Plant

The facility does not include a container crushing plant. As such, O4.3 (outside container crushing plant) = 0kg.

3.6 O9 - Solvent Released in Other Ways

It is confirmed that there were no exceptional solvent releases in 2014. As such, O9 (solvent released in other ways) = 0kg.

4.0 SUMMARY REPORT

A summary of solvent emissions is provided in Table 7.

Table 7 Summary Report

I/O Code	Activity	Solvent Input (tonnes)	VOC Emission (tonnes)	VOC Emission (% input)
I1.1	Bought-in 'new' solvents	4,687.40	-	-
I1.2	Solvent in bought-in resins	6.09	-	-
I1.3	Solvent in other bought in materials	0.00	-	-
I2.1	Bought-in recovered solvent	0.00	-	-
I2.2	On-site recovered solvent	0.00	-	-
	Total Inputs	**4,693.49**		
O1.1	Powered vents	-	38.15	0.81
O1.2	Non-powered process vessel vents	-	0.00	0.00
O1.3	General extraction and building ventilation systems	-	0.00	0.00
O1.4	Bulk storage vessel breather vents	-	0.72	0.02
O1.5	Abatement plant discharges	-	0.00	0.00
O2.1	Solvents in final discharges to sewers and drains	-	0.00	0.00
O4.1	Natural ventilation of buildings	-	0.00	0.00
O4.2	Outside open emptied drum storage	-	0.00	0.00
O4.3	Outside container crushing plant	-	0.00	0.00
O9.1	Releases in other ways	-	0.00	0.00
	Total Emissions		**38.87**	**0.83**

As shown in Table 7:

O1 + O2 + O4 +O9 = 38.87t (38,870kg)

And:

3 x (I1 + I2) / 100 = 140.62t

As such, solvent emissions are less than 3% of the input and the facility is compliant with the relevant emission limit.