



SOLVENT MANAGEMENT PLAN – 2017 DEESIDE PACKAGING COATINGS

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1.0 INTRODUCTION

1.1 Background

This annual solvent emissions report for 2017 has been written 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 Natural Resources Wales (NRW) in EPR Compliance Assessment Report reference BU7545IM/0221994. The relevant inputs and calculations are detailed within this report.

2.0 METHODOLOGY

2.1 Scope

As required by the Environmental Permit for the installation, the solvent emissions calculations only consider releases from the Coatings Plant. However, it should be noted that all materials manufactured in the Resin Plant are used in the Coatings 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/m³ 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:

$$(O1 + O2 + O4 + O9) \leq 3 \text{ (Purchases of solvents (I1) + solvent recovered and reused in the installation (I2)) / 100}$$

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 aol AF Type	42,658.70
n-Butanol	357,467.30
IPA	27,840.10
isobutanol	4,101.40
IMS99	20,521.80
Propylene glycol	160,631.30
1° amyl aol	3,640.60
Tridecanol	20,446.30
Isoamyl Alcohol	12,403.20
Glycol ether DE-LG	1,362,632.70
Butyl di glycol acetate	6,376.00
Glycol ether EB	719,208.70
Butyl acetate	32,610.30
Diethylene glycol butyl ether	47,783.30
Dowanol PM	23,957.10
Buyl cellosolve acetate type	98,792.00
Glycol ether EP	71,729.80
PM acdetate	79,807.20
Methyl carbitol	50.00

Solvent	Usage (kg)
Dibasic ester solvent	4,025.40
MIBK	23,839.80
cyclo Hexanone	21,488.90
MEK	218,742.00
Mineral spirits	7,522.00
Solvent 60	6,864.00
Xylene	325,475.30
Aromatic 100	658,625.30
Aromatic 150	204,653.90
TOTAL	4,563,894.40

As shown in Table 2 4,563,894.40 kg of solvent was used in 2017.

The majority of the resins used in the Coatings Plant are manufactured on site. However, other bought in resins containing solvents were used in 2017. Table 3 details calculated solvent based on suppliers MSDS data.

Table 3 Solvent in bought in resins usage

Resin	Usage (kg)	% Solvent content	Calculated solvent usage (kg)
Cymel 303	224207	2	4,484
RESIN G 515 (A)	2089697	39.70	829,609.7
CYMEL 5010	238610	36.20	86,376.8
CYMEL 1130	2734	100	2,734
CYMEL 325	45502	24.75	11,261.7
SOLVENT BASED ACRYLIC INTERMEDIATE	10819	50	5,409.5
RESIN CX4600Q	147554	48.62	71,740.7
ACRYLIC RESIN CE4481Q	97751	41.50	40,566.6
TOTAL			1,052,183

As such, **I1.2 (solvent in bought-in resins) = 1,052,183kg.**

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 =5,616,077.4 kg.**

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:

The emission points associated with the Coatings Plant:

- 3.3.1 Emission point A5 and A37 - Coatings plant vessels; and,
- 3.3.2 Coatings plant fugitive emissions local exhaust ventilation system (LEV).

Emissions from these points are calculated below.

Emission Points A5 and A37:

Quarterly monitoring of VOC emissions from A5 and A37 was undertaken for each quarter of 2017 to show compliance with the relevant condition included within the site's Environmental Permit. A summary of 2017 monitoring results is provided in Table 4.

Table 4 Monitoring Results - VOC Concentrations

Emission Point	Total VOC (kg/hr)				
	Q1	Q2	Q3	Q4	Mean
A5	0.0034	0.0216	0.0995	0.0163	0.0352
A37	0.0034	0.0312	0.0014	0.014	0.0125

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:

- n-Butanol
- Butoxyethanol
- Isobutanol
- Trimethylbenzenes
- Xylene
- Other hydrocarbons

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 as it consists of 41% carbon.

The Coatings Plant operates 24-hours per day, 362-days per year. The annual mass emission from A5

and A37 was therefore calculated as follows:

$$0.0477/41 \times 100 \times 24 \times 362 = 1,010.76 \text{ kg VOC/year}$$

Local Exhaust Ventilation System (Fugitive Emissions)

Annual workplace exposure monitoring of various VOCs is undertaken within the Coatings Plant.ⁱ The results have been normalized to mg/m³ and are summarised in Table 5. These were utilised to represent solvent concentrations within the Coatings Plant in lieu of direct monitoring of the LEV system.

Table 5 Ambient VOC Concentrations

Species	Average molecular mass (g/mole)	Monitored Concentration (ppm)	Monitored Concentration (mg/m ³)
n-Butanol	74.12	1.9	5.76
Butoxyethanol	118.17	0.03	0.14
Isobutanol	74.12	0.09	0.27
Trimethylbenzenes	120.195	0.3	1.47
Xylene	106.16	6.4	27.79
Other hydrocarbons			12
Total			47.43

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 from fugitive emissions within the Coatings Plant.

The flow rate within the LEV system has been measured by an external consultant and when combined with the volume of the Coatings Plant the total volume discharged by the LEV system is as follows:

$$10,571 \times 2.85 = 30,127 \text{ m}^3/\text{hr.}$$

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

$$30,127 \times 24 \times 362 = 261,746,417 \text{ m}^3/\text{year.}$$

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

$$(261,746,417 \times 47.43) / 1,000,000 = 12,415 \text{ kg VOC/year}$$

Total Powered Vent Losses

Based on the above calculations, **O1.1 = 13,425.36 kg**

3.3.2 O1.2 - Non-Powered Process Vessel Vents

Any releases through non-powered process vessel vents are collected by the LEV system as fugitive emissions to the building 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:

- 3.3.3 Vapour displacement on filling (F); or,
- 3.3.4 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	1362632.70	0.989	1378	134.1	0.024	1.87
Tank 3	Solvesso 100/Naptha TR1002B	658625.30	0.878	750	127	0.194	7.81
Tank 4	Xylene TR0004A	325475.30	0.87	374	106	0.74	12.40
Tank 5	Epikote 828 RE0276B	636503.00	1.16	549	374	0.00	0.00
Tank 6	Dowanol PM TE0036A	23957.10	0.921	26	90.1	1.33	1.31
Tank 7 & 13	MEK TK0012A	218742.00	0.806	271	72.1	9.459	78.19
Tank 8	Dowanol PMA TE0055A	79807.20	0.966	83	132.2	0.337	1.55
Tank 9	Normal Butanol TC0003A	357467.30	0.81	441	74.1	0.566	7.82
Tank 10	Butyl Glycol Ether TE0003A	719208.70	0.902	797	118.2	0.118	4.71

Release Point	Species	Annual Usage (kg)	Specific Gravity	Annual Usage (m ³)	Mol. Weight	Vapour Press @20C (kPa)	Filling Losses (kg per year)
Tank 18	Methacrylic Acid MQ0025A	76344.10	1.01	76	86.09	0.13	0.36
Tank 12	DMEA CM0564A	110294.80	1.01	109	86.09	0.13	0.52
Tank 14	Wash Solvent	1071007	0.82784	1295	83.983	3.585	164.54
Tank 16	Butyl DiGlycol TE0027A	47783.30	0.887	54	89.1	0.56	1.14
Tank 17	BCA - TE0047A	98,792	0.972	102	160.21	0.03	0.34
ST 8	Ethyl Acrylate MQ0037A	249317.80	0.923	270	100	3.9	44.51
TOTAL							327.07

As shown in Table 6, F = **327.07** kg.

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 = 327.07 kg.

Total Bulk Storage Losses

Based on the above calculations, **O1.4 = 654.14 kg.**

3.3.5 O1.5 - Abatement Plant Discharges

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

3.4 O2 - Solvents Lost in Water

The Coatings 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 2017. 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	4,563.894	-	-
I1.2	Solvent in bought-in resins	1,052.183	-	-
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		5,616.077		
O1.1	Powered vents	-	13.425	0.24
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	-	0.654	0.01
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			14.079	0.25

As shown in Table 7:

$$O1 + O2 + O4 + O9 = 14.074t$$

And:

$$3 \times (I1 + I2) / 100 = 168.48t$$

As such, solvent emissions are less than 3% of the input and the facility is compliant with the relevant emission limit and there is no requirement to formally plan further solvent emission reductions.

ⁱ Workplace exposure monitoring was undertaken by Genesis Environmental Ltd.