



RISK & HAZARD MANAGEMENT

# 010 - Emissions Monitoring

Unifrax, Line 4 Permit Variation



Safety Risk



Business Risk



Environment Risk

## Document History

Version	Issue	Date	Notes	Author	Reviewer
1	-	23/03/22	Working draft with client	J. Carroll R. Nibbs	C. Nicholls
2	-	15/06/23	Revised draft	R. D'Souza	P. Williams

## Contents

	Document History .....	1
1	Introduction .....	2
2	Emissions to air .....	3
2.1	HCl Emission Control.....	3
2.2	VOC Emission Control .....	4
2.3	Dioxin Emission Control .....	7
2.4	Boiler Controls .....	9
2.5	Emissions Monitoring .....	9
3	Wastewater emissions monitoring.....	12
4	Waste Emissions .....	15
4.1	Monitoring procedures, controls and quality check .....	15
4.2	Environmental monitoring offsite (beyond the installation) .....	15

# 1 Introduction

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This document provides the information required on Form C3 Section 4.

Please note that this document refers to the site as Unifrax Widnes and to the owning company as Unifrax. Unifrax was the name of the American company that owns Widnes site. A further complexity is added because due to a recent merger, Unifrax has changed its name to Alkegen. So, it is possible in correspondence or discussions that the site may be referred to as Alkegen.

The legal entity that owns the site at Widnes is however called Saffil Ltd and remains so despite the name changes to Unifrax and now Alkegen – and it is in this name that the EPR application is made on the accompanying forms.

## 2 Emissions to air

For BAT assessment, to abate the emissions generated by the process, the site has considered candidate technologies based on site operating experience and trials. Possible new technologies have been evaluated and relevant Environmental Agency and European IPPC Bureau guidance has been considered for the following pollutants: HCl emissions – EPR 4.03 Inorganic Chemicals VOC emissions (including ethylene oxide and acetaldehyde). EPR 4.01 Large Volume Organic Chemicals

### 2.1 HCl Emission Control

The following Table shows technologies considered for Line 2, 3 and 4 and why certain techniques were dismissed.

Technique	Description	Advantages	Disadvantages	Dismissed?
Plate scrubber	Plate disperses gas into bubbles creating surface area for mass transfer by absorption.	Good for gases which have higher particulates and when fluctuations in flow can exist.	Plugging and channelling of scrubber liquor is possible High pressure drop. Taller column for same removal efficiency	Diameter of scrubber vessel ~3m. Materials of construction GRP. Support and fabrication of plates at this diameter could be a problem. Saffil 1 plant uses packed tower.
Packed scrubber.	Packed bed provides surface area for mass transfer by absorption.	Good for high gas removal efficiency and more effective with particle free gas.	Easy construction with chemical resistant materials.	Not very effective for VOC and dioxin abatement on its own Suitable for size of column and materials of construction.
Spray Tower	Liquid atomised through nozzles to enable mass transfer.	Inexpensive and good removal rates for HCl.  Low energy requirements.	Nozzles can be prone to clogging Poor approach between circulating acid & low HCl conc. in vent gas. Possible gas bypassing.	For a large column redistribution of liquor and effective contact with gas stream can be a problem.
Wet Mop Scrubber / Rotaclones.	Absorbent injected into impeller casing to atomise for mass transfer.	Relatively cheap and efficient.	Build-up of dust deposits and abrasion of particles on impeller.	Moving parts in a corrosive environment is not advisable.

Line 2 and 3 use 2 circulated packed beds in series to ensure HCl in the gas passing through is reduced to below the current benchmark concentration (10mg/m<sup>3</sup>). Line 4 will use the same equipment.

## 2.2 VOC Emission Control

Line 1 used a single stage packed bed scrubber column with a dilute aqueous acid scrubbing liquor. This system was improved upon for Line 2 to reduce VOC emissions below benchmark levels. Appendix 1 Summary Of Past Improvements In Air Emissions documents improvements made to reduce VOC emissions.

The following Table shows the technologies that were considered for Line 3 and why certain techniques were dismissed. Pre-filtration plus quench followed by regenerative thermal oxidation was selected for the new line to ensure compliance with emissions criteria provided in EPR 4.02 Speciality Organic Chemicals.

Technique	Description	Advantages	Disadvantages	Dismissed?
Thermal Incineration	Complete thermal breakdown of VOCs.	Self-supporting – just a small amount of support fuel. Possible destruction of dioxins.	High temperatures required for destruction, therefore high energy costs. Filter required to prevent fouling.	No - further investigation of various methods required.
Adsorption	Removal of VOCs by adhering surface of solid material (e.g. carbon bed).	Typically used as a polishing stage after condensers or scrubbers.	Poor results for aldehydes. Adsorbers don't operate above 55°C. Hot spots can be created within the carbon bed. High C consumption. C effluent to be disposed of.	Yes - preferential adsorption of water vapour can occur after quenching.
Cryogenic Condensation	Forcing VOCs to condense at high pressure or low temperature.	VOCs can be recovered and reused. Cheap and simple technique which is suitable for high concentrations.	Temperature reduction required is expensive. No need for N <sub>2</sub> on site. Cocktail of VOCs needs further treatment.	Yes - too expensive.
Absorption	Removal of VOC gas by mass	Requires low temperatures for good absorption.	Saffil 1 scrubber unit shows that wet scrubbing	No. Can be used in conjunction with thermal

	transfer into scrubbing liquor.		alone is not effective for VOCs.	incineration and quenching.
Bio-oxidation	Destruction of VOCs by aerobic micro-organisms on a substrate.	Fast bio-degradation for aldehydes.	High investment costs. High risk technology. Inhibited by acid gases and toxic gases. Depends on absorption of VOCs into water, which is poor.	Yes. Not suitable for this mixture of gases.
Plasma destruction/RF Microwaves	Use of RF/microwaves or high voltage plasma to destroy VOCs	Clean.	High capital and energy cost. Complex equipment. Immature technology.	Yes. Technical risk and high cost.

Thermal oxidation technology was selected on the basis of satisfying the following criteria:

- High VOC destruction efficiency required.
- Low impact on the Saffil process.
- High reliability.
- Tolerance of corrosive and dusty gas stream (pre-filter to be used in conjunction with the technology).

Techniques	Advantages	Disadvantages	Dismissed?
Direct Fired Thermal Oxidation	Well-established, robust technology. Two second residence time will ensure destruction of VOCs and dioxins. Can achieve <0.1ng I-TEQ/Nm <sup>3</sup> of dioxins.	Significant quantities of natural gas required to ensure high temperatures - this will increase NO <sub>x</sub> levels on plant. Quench of gas required before scrubbing. Large swings in VOC content of feed may lead to unit tripping. Will require a filter on the inlet to prevent particulate build up in regenerators.	No. Can be used with downstream quenching to prevent dioxins forming due to <i>de novo</i> mechanism. Heat regenerators/recuperators can be used to improve thermal efficiency.
Flameless Thermal Oxidation	No support fuel required. Process gas stream at low	Ceramic bed is prone to fouling with particulates. Valves	No.

	enough temperature for scrubbers. Low NO <sub>x</sub> levels. Large ceramic bed ensures robust enough for swings in VOC.	controlling flow direction through unit could be prone to blockage or leakage. Controlled amount of oxygen required.	
Catalytic Thermal Oxidation	Small amount of support fuel required. Compact unit.	Catalyst poisoning and fouling reduces life to approx.. 3 years. No guarantee on dioxin destruction - higher risk technology.	Yes. Components in the vent stream are potential catalyst poisons.

On this basis, direct fired Thermal Oxidation has been used on Line 2 to treat the low volume high concentration streams from the decomposition ovens and the Low Temperature Furnace. These streams are directed through a quench system and thermal oxidiser.

Since 2004, further work has been carried out to evaluate options for VOC abatement at the Saffil plant.

In 2008, further work was undertaken to investigate best available techniques to reduce emissions of Class A VOCs on Line 2.

A number of possible technologies are listed in the Chemical Sector BREF:

- Membrane separation;
- Condensation;
- Adsorption on activated carbon or other reagents;
- Biofiltration/Bioscrubbing;
- Thermal oxidation;
- Catalytic oxidation; and
- Wet scrubbing.

These options have been evaluated and discussed and the conclusion reached is that the most effective form of abatement for Class A VOCs on Line 2 is through the continued improvement of the current abatement techniques, based on thermal oxidation of oven flue gas followed by wet scrubbing. (URS report 49306611).

It is therefore proposed that the VOC treatment for Line 4 is based on the existing abatement for Lines 2 and 3.

## 2.3 Dioxin Emission Control

A system involving the use of a thermal oxidiser and wet scrubbers was installed on Lines 2 and 3 in order to reduce dioxin emissions towards benchmark levels.

Aliphatic compounds arising from the thermal degradation of siloxanes in the Decomposition Oven and LT Furnace are believed to be converted to simple ring molecules which later evolve into complex aromatic precursors. Dioxins are then formed from these intermediate aromatic compounds together with chlorine from the decomposition of aluminium chlorohydrate. Particulate bound carbon is suggested as the primary reagent in the *de novo* synthesis pathway. *De novo* synthesis involves heterogeneous reactions on dust (containing transition metal catalyst) in the presence of oxygen, hydrogen and chlorine. *De novo* synthesis takes place in the temperature range 200 to 500 °C.

As dioxin formation cannot be totally prevented a number of techniques have been invented to reduce dioxin emissions. The table below shows the technologies considered for Line 4 and why certain techniques were dismissed. The table below shows why thermal oxidation was selected as the preferred technology.

Technique	Description	Advantage	Disadvantage	Dismissed?
Wet scrubbers	Removal of dioxins by mass transfer into scrubbing liquor.	None for dioxin removal.	Analysis has shown that the dioxins are not effectively destroyed or removed in the wet scrubber.	Yes for dioxin removal, but effective for HCl
Bag filters	Achieve particulate release of 10mg/m <sup>3</sup> .	Used in combination with an activated carbon system to capture dioxins up to 99% removal of dioxins. Concentrations of treated gas are <0.1 ng I-TEQ/Nm <sup>3</sup> /hr	Needs to be used in combination with a scrubber. After the wet scrubbing stage the gas is saturated. The operation of bag-filters in this situation can be problematic. Contaminated dust requires disposal.	Yes
Activated carbon injections	Dioxins are removed from flue gas by adsorption onto carbon.	Up to 99% removal of dioxins. Concentrations of treated gas are <0.1 ng I-TEQ/Nm <sup>3</sup> /hr	Installation after scrubber and bag filter. High operational costs as bed must be replaced regularly. Spent	Yes - preferential adsorption of water vapour can occur after quenching.



			carbon requires incineration. Hot spots can be created within the carbon bed.	
Selective Catalytic Oxidation or Reduction	Catalysts on an SCO or SCR unit breakdown the dioxins.	Can remove 62-96% dioxins. Catalysts break down dioxins. Can also destroy N <sub>2</sub> O.	Install downstream of scrubber and bag filter. Dust can reduce activity of catalyst. Reheating of flue gas after filter may be required.	Components in the vent stream are potential catalyst poisons.
Ammonia or Urea injection (SNCR)	Converts NO and NO <sub>2</sub> into nitrogen and water.	<0.1ng/m <sup>3</sup> dioxins. Inhibits the formation of dioxins in cooler areas of circuit.	Could lead to production of N <sub>2</sub> O and ammonia slip. Large quantity of NH <sub>3</sub> or urea must be added to neutralise HCl. NH <sub>3</sub> or urea in liquid effluent.	The dioxins are formed in the oven and associated ductwork. Injection of urea into the process oven system is not practical.
Plasma, RF / Microwaves	Use of RF / Microwaves or high voltage plasma to destroy VOCs	Clean	High capital and energy cost. Complex equipment. Immature technology.	Yes- Technical risk and high cost.
Thermal Incineration	Complete thermal breakdown of VOCs and dioxins.	Compatible with VOC destruction	Rapid quenching required to drop flue gas from 450 to 200°C.	No further investigation required (see VOC Emission Control).

Prior to 2004, further evaluation of the thermal oxidation route was carried out with vendors of the technology. This has included visits to reference plants to see the technology in operation. Vendors are confident that better than 99% destruction of dioxins is possible using this technology and that temperature control can be achieved to prevent reformation.

The Dioxin concentration measured in the Line 2 stack has been at or around long term ELV of 0.1ng/m<sup>3</sup> since Line 2 was commissioned in 2004. Reliability of the thermal oxidiser post commissioning has proved to be excellent. This justifies the approach as outlined above involving the treatment of the low flow high concentration vent streams from Lines 2 and 3 and the repetition of this approach on Line 4.

## 2.4 Boiler Controls

New boiler equipment would be specified to use the following features to meet the BAT:

- Application of low-NOX burners. The conditions for low NOX emissions are a low temperature in the primary combustion zone and a sufficiently long residence time of the flue-gases in the furnace for a complete burnout. This reduces the flame temperature.
- Flue-gas recirculation. It reduces both the flame temperature and the concentration of oxygen.
- Two-stage combustion. This reduces the reaction between oxygen and nitrogen in the air during the combustion process. Substantially lower NOX emissions can be achieved by supplying the air at three stages around the individual burner, and supplementing the air above the individual burners, together with a precise dosing of these air streams.

## 2.5 Emissions Monitoring

The following table describes the measures used for monitoring emissions from each of the emission points listed in Table 2 of Form C3. Sampling locations are carried out in accordance with BS 15259. Recent monitoring reports carried out by MCERTS qualified contractors for each of the current emission points to air on site are available on request and contain the details of the sampling processes that are used. The same contractors/approach will be utilised for the new emission points.

It should be noted in summary that a number of monitoring frequencies and the current continuous monitoring philosophy for some pollutants are not conducted at as high a frequency as the BREF would suggest. However, the following justifications are provided for this:

- Monitoring of speciated VOC components and hydrogen chloride was carried out monthly for many years under previous IPC/IPPC permits, notably BT1614IW (August 2005) and earlier IPC permits. The Line 3 EPR permit variation process XP3533CB (May 2012) recognised that a large database of results demonstrated good compliance with emission limit values (ELVs) and monitoring frequency was changed in agreement with the EA to quarterly within the EPR permit.
- Similar reasoning was used to agree with the EA the retention of dioxin monitoring frequency as annual and particulates monitoring at quarterly within the Line 3 EPR permit. (May 2012).
- The use of continuous monitoring for hydrogen chloride emissions has also been reviewed with the EA in the past. It was concluded that the additional costs of continuous hydrogen chloride monitoring were not justified given that water scrubbing was considered BAT and there was a large amount of historical data demonstrating

compliance with benchmark ELVs. While continuous monitoring of VOCs has not been formally considered, it is likely that the same conclusion would be reached on cost vs benefit.

**Table 1 Air emissions monitoring**

Parameter	Emission point	Monitoring frequency	Monitoring standard/method	Sampling and analysis carried out by	Sampling and equipment standard
Hydrogen Chloride	A3, A5 and A11	Quarterly	BS EN 1911	Socotec	MCERTS
Vinyl Chloride	A3, A5 and A11	Quarterly	PD CEN-TS 13649	Socotec	MCERTS
Ethylene Oxide	A3, A5 and A11	Quarterly	PD CEN-TS 13649	Socotec	MCERTS
Class A and Class B VOCs	A3, A5 and A11	Quarterly	PD CEN-TS 13649	Socotec	MCERTS
Dioxins	A3, A5 and A11	Annual	BS EN 1948	Socotec	MCERTS
Particulates	A2, A4, A6 and A12a/A12b	Quarterly	BS EN 13284-1	Socotec	MCERTS
Nitrogen Dioxide	A7, A9, A13 and A14	Annual	BS EN 14792	Socotec	MCERTS

All the sampling points for Line 4 will be constructed to meet the requirements set out in TGN M1 and BS EN 15259:2007, including consideration of:

- Location of sample points
- Orientation of sample points
- Access to sample points
- Fall prevention

This in order to ensure that MCERTS standards are achieved.

### 3 Wastewater emissions monitoring

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Table 2 describes the measures used for monitoring emissions to water and sewer from each of the emission points listed in Table 2 of Form C3.

It should be noted in summary that a number of monitoring frequencies are not strictly in line with BREF requirements. However, the following justifications are provided for this:

- W2 is a very small flow from a cooling tower purge and other than low levels of water treatment chemicals can be considered a 'clean' stream. Due to the relatively low flow and the distance travelled from the cooling tower to the site boundary, the risk of the temperature of this flow affecting the receiving body would be low. This combined with levels of suspended solids and COD below benchmark means that more frequent monitoring is not required.
- The proposed design for L4 will alter the current open loop cooling tower system that emits to W2 to a closed loop system, reducing the volume of emissions from this source. As the discharge temperature should remain the same, we would anticipate the (already low risk) of a change in the temperature at the receiving body to be decreased.
- W1/W3 are relatively very small flows, discharging (after mixing with other run off and drainage from other sites in the area) into a very large estuarine receiving water. Benchmark levels are achieved for all components except suspended solids. Control of suspended solids is difficult due to the nature of these flows being primarily storm water run-off. Environmental impact has been modelled and is insignificant. Increased monitoring frequency of suspended solids is therefore not required.
- Addition of Line 4 will make minimal difference to flow or composition of W1 and W3 because they are primarily used for storm water drainage from the site. Monitoring frequency has proved appropriate over more than twenty years so increase in frequency not required.
- A project was completed in 2001 to connect Line 1 to sewer. Previously process effluent discharge had been direct to controlled waters. At this time other action was also taken, by reconfiguring and removing or stopping drains and the installation of containment areas, in order to eliminate fugitive process emissions to controlled waters. Lines 2 and 3 were also connected to sewer when they were built in 2004 and 2013 respectively.
- Emissions to sewer have been effectively regulated since that time under consents with the sewerage provider (United Utilities). Compliance with consent limits has been good with sampling and analysis of effluent undertaken by United Utilities. Frequency of monitoring is considered appropriate given the level of compliance, relatively small flows and low impact of the effluent on the receiving treatment works.
- Deviation of recommended monitoring frequency vs guidance is principally on COD and suspended solids. These are areas of minor concern, given the relatively very low effluent flows and impact. United Utilities have suggested removing the COD limit from the consent because it is of minor concern and difficult to measure.

**Table 2 Water emissions monitoring**

Parameter	Emission point	Monitoring frequency	Monitoring method/ standard	Sampling carried out by	Analysis carried out by:
Dry Weather flow	W1, W2, W3	Monthly	Calculation	N/A	Not measured
pH	W1	Monthly	Grab sample BS ISO 10523	Unifrax	United Utilities
Temperature	W1	Monthly	Grab sample	Unifrax	Unifrax
Suspended solids	W1	Monthly	Grab sample BS EN 872	Unifrax	United Utilities
COD	W1	Monthly	Grab sample BS 6068	Unifrax	United Utilities
Mercury	W1	Monthly	Grab sample BS EN 1483	Unifrax	United Utilities
Cadmium	W1	Monthly	Grab sample BS EN 5961	Unifrax	United Utilities
pH	W2	Monthly	Grab sample BS ISO 10523	Aquaserv (contract cooling tower management service company)	Severn Trent Services
Temperature	W2	Monthly	Grab sample	Aquaserv	Severn Trent Services
Suspended solids	W2	Monthly	Grab sample BS EN 872	Aquaserv	Severn Trent Services
COD	W2	Monthly	Grab sample BS 6068	Aquaserv	Severn Trent Services
Mercury	W2	Monthly	Grab sample BS EN 1483	Unifrax	United Utilities
Cadmium	W2	Monthly	Grab sample BS EN 5961	Unifrax	United Utilities
pH	W3	Monthly	Grab sample BS ISO 10523	Unifrax	United Utilities
Temperature	W3	Monthly	Grab sample	Unifrax	Unifrax

Parameter	Emission point	Monitoring frequency	Monitoring method/standard	Sampling carried out by	Analysis carried out by:
Suspended solids	W3	Monthly	Grab sample BS EN 872	Unifrax	United Utilities
COD	W3	Monthly	Grab sample BS 6068	Unifrax	United Utilities
Mercury	W3	Monthly	Grab sample BS EN 1483	Unifrax	United Utilities
Cadmium	W3	Monthly	Grab sample BS EN 5961	Unifrax	United Utilities

**Table 3 Sewer emissions monitoring**

Parameter	Emission point	Monitoring frequency	Monitoring method/standard	Sampling carried out by	Analysis carried out by:
pH	S2, S3, S4 and S5	Continuous by instrument and quarterly by analysis	Grab sample BS ISO 10523	United Utilities	United Utilities
Mercury	S2, S3 and S5	Quarterly	Grab sample BS EN 1483	United Utilities	United Utilities
1,2 dichloro ethane	S2, S3 and S5	Quarterly	Grab sample BS EN ISO 10301	United Utilities	United Utilities

## 4 Waste Emissions

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### 4.1 Monitoring procedures, controls and quality check

Wastes are managed and recorded in line with site SHE procedures. This ensures that waste disposal routes and carriers are selected in line with current legislation.

Significant recycling of packaging, pallets and drums is undertaken. Returnable packaging is used for our major internal customer. Unifrax is a member of VALPAK in order to ensure obligations under the Packaging Waste Regulations are met. An annual report is submitted to VALPAK as part of these obligations.

Details of waste quantities and disposal/recycling routes are given in document 009 section 4.

### 4.2 Environmental monitoring offsite (beyond the installation)

No offsite monitoring is carried out.