Exposure Scenario

Use: Trichloroethylene as an extraction solvent for removal of process oil and formation of the porous structure in polyethylene based separators used in lead-acid batteries.

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9 EXPOSURE ASSESSMENT (AND RELATED RISK CHARACTERISATION)

Sections 9 and 10 of this CSR have been generated with Chesar 3.5.

9.0 INTRODUCTION

This exposure scenario is presented as part of the review report for an application for authorisation under UK REACH. A site-specific exposure assessment for the ENTEK Newcastle upon Tyne (UK) facility is presented in the following sections for **use of trichloroethylene as an extraction solvent for removal of process oil and formation of the porous structure in polyethylene based separators used in leadacid batteries**. This scenario covers the use of trichloroethylene as a process solvent in a semi-closed process. Trichloroethylene is used as a solvent for the removal of process oil from the oil filled separator sheet. The process oil is essential to the process as it solvates or gels the ultrahigh molecular weight polyethylene (UHMWPE), making extensional flow of the polymer possible. The process oil also is essential to the formation of microporous structure of the separator sheet and remaining oil in the separator final product enhances its oxidation resistance.

The assessment sets out the information in the accepted format of an exposure scenario for authorisation in accordance with the REACH Regulation, and where relevant this has been adapted in order to facilitate the reader's understanding. Since this is a site-based assessment, measured data are used to assess exposure and perform risk quantification. The assessment does not include any review or investigation into the acceptability of the measured data compared to the requirements set out in ECHA Guidance R.14 and EN 689. However, these measurements are also compared to modelled data for reference. This being the case, relevant REACH descriptors such as process codes (PROCs) and environmental release categories (ERCs) have been referred to when necessary (REACH Technical Guidance R.12).

The remainder of this introductory section provides an overview of the process. Section 9.0.1 presents an overview of uses and the scope of the exposure assessment within the context of the application for authorisation, while sections 9.0.3 and 9.0.4 introduce the approaches used for the assessment of exposure of the environment and workers, respectively, following the standard layout of the Chemical Safety Report generated from Chesar v3.5. Section 9.1 of this report contains the exposure scenario and corresponding risk quantification values.

Overview of the process

ENTEK is a producer of polyethylene separators that are made of ultrahigh molecular weight polyethylene (UHMWPE), precipitated non-crystalline silica and a process oil. The separators are used by ENTEK's customers in flooded lead-acid batteries which are used in motor vehicles¹ to provide power for starting, lighting and ignition (SLI). The Newcastle plant produces two types of battery separator sheet, namely Standard (STD) and Low Resistance (LR). The STD separator is used in traditional lead acid batteries, whereas LR separator was developed specifically for use with start-stop engine technology (extended flooded batteries). Due to the increased load on a start-stop battery, the LR separator has a higher porosity, modified pore size distribution, greater puncture strength and a 35-50% lower electrical resistance (ER) compared to STD separator.

Production of LR separator began in April 2014, with no substantive changes required to production process. Process flow diagrams for the two separator products are included in Annex 2.

The substance of interest, trichloroethylene, is used as an extraction solvent within a semiclosed system as part of this production process. Efficient recovery and recycling process are in place and so although the volume of trichloroethylene processed in the system overall is in the order of 10,000-100,000 Blank 1,tonnes the volume in the system at any one time is 10-110 tonnes Blank 2, and the volume replaced on an annual basis is in the range 10-100 Blank 3 tonnes per year

Trichloroethylene is delivered to the ENTEK site via road tanker and off-loading from the tanker to on-site storage tanks is controlled via a standard operating procedure. All venting which is undertaken during tanker delivery is routed through fixed lines direct to the carbon beds for solvent capture / recovery.

During the manufacture of ENTEK's polyethylene separators, precipitated silica and UHMWPE are combined with a process oil and various minor ingredients to form a mixture that is extruded at elevated temperature to form an oil-filled sheet. ENTEK utilizes a twin screw extruder to compound a mixture of UHMWPE, silica, minor ingredients, and process oil at elevated temperature. The extrudate passes through a sheet die into a calender stack where a rib pattern is embossed. The oil-laden sheet is called 'black-sheet', resulting

¹ As well as petrol and diesel fuelled cars and vans, most electric cars have a lead acid battery in them as well as the Li-ion (which provide the driving power). This is because the lead acid battery high charge is needed power Li-ion batteries if they are low on charge and can also run the lights and wipers etc.

from the amount of process oil content prior to extraction (approximately Blank 4% by weight).

The black-sheet enters and leaves a solvent extraction unit through a narrow opening. All processes involving trichloroethylene are housed in additional enclosed areas. The enclosures are held under a negative pressure of 75Pa, from which extracted air is treated (in activated carbon absorption beds) to remove and capture the trichloroethylene which is then recycled within the process. The solvent extraction unit for lines 7 and 8 each have a 30,000 litre capacity tank of welded 316 grade stainless steel divided into 20 or more discrete zones. A zone is a sub-division of the trichloroethylene liquid-containing part of the solvent extraction unit. Sub-dividing the extraction tank into sequential zones allows ENTEK to set and maintain an oil-trichloroethylene concentration profile in the solvent extraction unit. Trichloroethylene flows from zone to zone in the direction opposite to the battery separator sheet (counter-current extraction). The concentration of oil is highest in the first zone of the solvent extraction unit where the sheet enters the extraction process; the concentration of oil is lowest where the sheet exits the tank after leaving the final zone. For a given sheet speed, the concentration of oil in trichloroethylene in each zone of the solvent extraction unit is adjusted to result in the correct level of extraction of oil, leaving behind the amount of residual oil in the sheet that is required to meet the battery manufacturers' specification (i.e., ENTEK's customers), approximately Blank 5% by weight; this is referred to as 'grey sheet'.

The solvent extraction unit is fitted with two rolls for each zone; one roll to guide the sheet in the zone's liquid trichloroethylene and one roll to guide the sheet to the next zone. The roll submerged in trichloroethylene is completely contained within the solvent extraction unit. The shaft for the upper roll penetrates the side of the solvent extraction unit and is supported by a bearing. Mechanical seals associated with the drive shafts and fixed and free running rollers are sealed prevent the escape of trichloroethylene vapour through the bearing housing, and locally extracted.

The top of the solvent extraction unit can be lifted to allow operations and maintenance personnel access to the inside of the solvent extraction unit. To prevent the escape of trichloroethylene vapour from the solvent extraction unit, the cover is formed with a rolled lip. This lip sits in a formed channel that encircles the entire top perimeter of the solvent extraction unit. The channel is filled with water, creating a water seal around the solvent extraction unit's top perimeter. The separator sheet (grey sheet) then passes from the solvent extraction unit into a solvent recovery vessel.

Depending upon the final product, ENTEK removes the solvent from the sheet in two different ways. In the production of STD separator, steam is used to evaporate the

trichloroethylene. The resultant gaseous mixture is then largely condensed into liquid using cooling coils at the bottom of the dryer. The liquid trichloroethylene and water are readily separated and re-used as they form two immiscible layers. Apart from the inlet and exit of the dryer, which include chilled water around the openings to suppress vapour release, the system is essentially a closed system. Where feasible, mechanical seals associated with the drive shafts and fixed and free running rollers are sealed and locally extracted. Next, the sheet is passed through a hot air oven where any residual trichloroethylene is evaporated and sent as vapour to an activated carbon bed system. The trichloroethylene adsorbs to the carbon and is eventually recovered.

In the production of LR separator, hot air only is used to evaporate trichloroethylene from the sheet and the vapour is then passed through a heat exchanger operating at low temperature (approximately -38°C) such that trichloroethylene "ice" is formed. A duplex system allows for the trichloroethylene "ice" to be recovered as liquid after warming back to room temperature. In this system, a small amount of residual trichloroethylene vapour still travels to the activated carbon bed system. This process imparts higher porosity and a slightly larger average pore size in the LR separator such that it has lower ionic resistance compared to the STD separator.

Finally, the sheet is cut at multiple positions and formed into rolls of separator sheet that have the appropriate profile² for customers' battery designs. The term "profile" refers to the width, backweb thickness, number of ribs, rib height, and shoulder design of the separator (as shown in Annex 4).

ENTEK operates four processing lines in two pairs (referred to as Lines 1 and 2 and Lines 7 and 8) at its facility in Newcastle upon Tyne, UK, which are operated continuously for the manufacture of polyethylene battery separators. Figure 9.0.1 is a simple schematic of the process of separator manufacture at ENTEK, showing a single processing line.

 $^{^2}$ Width, backweb thickness, number of ribs, rib height, and shoulder design of the separator (as shown in Annex 3).



Figure 9.0.1 Simple schematic of the ENTEK separator manufacturing process, showing a single processing line.

A more detailed schematic diagram of a single production line is presented in Annex 2.

The parts of the process in which trichloroethylene is used to extract process oil from the polyethylene sheet are subject to specific control measures that are intended to capture as much trichloroethylene as possible

All processes involving trichloroethylene are housed in additional enclosed areas. These enclosed areas are held under a negative pressure of 75Pa, from which extracted air is treated (in activated carbon absorption beds) to remove and capture the trichloroethylene which is then recycled within the process (see purple arrows in process diagram in Annex 2). Workers are excluded from the enclosed area, except for limited periods³ and only then with additional respiratory protective equipment (RPE, see Annex 6).

For essential process checks, a worker would typically spend less than 10 minutes within the enclosure during a 12 hour shift and longer for any engineering/maintenance activity. Access to the enclosures is, however, controlled in relation to use of respiratory protective

³ See SOP 140-039 included in Annex 6.

equipment and maximum time that a worker can spend within enclosure. Note that work is per the Safe Working Procedure referred to in Annex 6.

Outside the enclosure, where workers spend almost their entire working-shift (see **Table 9.1.1**); workers are exposed to only background or fugitive emissions of trichloroethylene.

9.0.1 Overview on uses

In line with Article 62 (d) of the REACH Regulation (and the equivalent UK legislation), the assessment should cover the risks to human health and/or the environment from the use of the substance(s) arising from the intrinsic properties specified in Annex XIV. In the case of trichloroethylene, the listing on Annex XIV indicated the intrinsic property referred to in Article 57 as carcinogenic (category 1B), which is associated with exposure and risk to humans. Therefore, this exposure scenario is limited to:

- 1) exposures that are relevant to humans (i.e., workers and the general public) and
- 2) the life cycle stages of the substance from which there is possible exposure to humans.

9.0.1.1 Justification for focus on exposure from applied-for use only

The applied for use is of trichloroethylene as an extraction solvent for removal of process oil and formation of the porous structure in polyethylene based separators used in lead-acid batteries.

The battery separator sheet produced by ENTEK meets the definition of an article in REACH. Placing an article on the UK or EU market is not relevant to Authorisation i.e., there is no obligation to apply for authorisation to place an article on the UK or EU market even if it contains an Annex XIV substance. Further, the concentration of trichloroethylene in the article is well below the threshold (<0.1% by weight) that needs to be notified to ECHA/HSE for a substance of very high concern (SVHC). Nevertheless, an exposure scenario should consider the relevant exposure to the substance from the whole life cycle of the substance and this is done in Sections 9.0.1.1.1 and 9.0.1.1.2. Calculation of the concentration (% w/w) in the separator product can be found at section 9.0.1.1.2; research on the measurement of residual trichloroethylene in the finished product is presented at Annex 3.

9.0.1.1.1 Use of separators in battery manufacture

The final separator sheet product leaves ENTEK in large rolls. The separator sheet is cut to the final width specified by the battery manufacturer and the resulting lanes of material are wound onto continuous rolls of approximately 1500 metres in length. The rolls are packed in cardboard boxes and shipped to customers. Manufacture of the actual separators by the lead-acid battery manufacturers (i.e., ENTEK's customers) involves constructing envelopes that fit over the lead plates of the battery. In European-based lead-acid battery manufacturing facilities, this is an automated process in which there is very little physical contact between workers and the separator sheet. The only contact with the separator could be in the loading of the separator rolls onto winders. The potential for exposure to workers by either dermal or inhalation routes is negligible because of a) the very limited physical contact with the polyethylene separators and b) the low levels of trichloroethylene present in the separator (as evidenced by the analytical data in Annex 3 and the mass balance calculations in Section 9.1.1).

9.0.1.1.2 Use and end of life of lead-acid batteries containing polyethylene separators in automobiles

Lead-acid batteries are essentially sealed units that are placed in automotive vehicles. It should be noted that the residual trichloroethylene in the separator is strongly bound to the oil, and that the separator is covering the lead plates in the battery. The plates themselves are immersed in electrolyte solution within the battery and the whole unit is sealed in a plastic housing. The possible exposure of humans to residual amounts of trichloroethylene from handling battery units for the purposes of fitting and removing the batteries from vehicles as well as during vehicle operation, is therefore considered to be negligible because of a) there is no direct contact with the polyethylene separators within the battery and b) the low levels of trichloroethylene present in the battery separator (see Annex 3 and the estimate below).

It is estimated from the mass balance calculation (see section 9.1.1) that an annual total of <1tpa Blank 6 tonnes of trichloroethylene remains in the 10,000-100,000 Blank 7 tonnes of separator product produced per year (2019 figures). This means that the residual trichloroethylene in product is Blank 8. This information can be used to estimate the total amount of trichloroethylene in a single battery.

As an estimation, a typical lead-acid battery contains 1.5 m^2 of separator and the typical density of separator product is 0.165 kg/m^2 . Therefore, a typical battery contains 0.2475 kg of separator ($1.5 \times 0.165 = 0.2475$), of that 0.0025% by weight is trichloroethylene.

Based on this estimation as a worst case a typical battery might contain 4-8 mg of trichloroethylene (Blank 9 mg).

The disposal and recycling of lead-acid batteries is controlled by Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC (commonly known as the Battery Directive) which is implemented in the UK by the Batteries and Accumulators (Placing on the Market) Regulations 2008⁴ (as amended). Article 7 of that Directive requires Member States to maximize the separation of batteries from municipal waste and requires spent batteries to be collected separately. The objective is that fewer batteries reach landfills, and that recycling and collection targets are needed. Member states set their own country's standards using the Battery Directive as a guide for minimum levels. These levels are stated in terms of percentage of prior annual sales. Member States are also required to provide collection sites that are accessible and free of charge to the public (Art. 8). Battery distributors may be required to provide this at Member States' discretion (Art. 8(2)(a)). Battery manufacturers may not refuse to take back waste batteries from end-consumers, irrespective of their chemical composition or origin (Art. 8(3)).

Waste battery collection rate targets are specified in Article 10. Minimum targets of 25% of battery sales and 45% of battery sales by 26 September 2012 and 2016 respectively (Art. 10(2)). Collection rates are to be monitored annually, with yearly reporting to the Commission.

Given the market price of metals such as lead and the legislative targets for battery recycling it is assumed that a large proportion of spent batteries are recycled for the lead content. For disposal, spent lead-acid batteries should be handled as hazardous waste in the UK and EU Member States as a result of the lead content. It is therefore assumed that spent batteries are disposed of and recycled only by professional licensed operatives. At the end of a battery's life i.e., at the point of disposal or recycling, the separator within the battery would not be recycled, but disposed of. The likelihood of exposure of operatives to trichloroethylene during this part of the life cycle, and to the environment from landfill leachate etc., is considered to be negligible owing to the very low levels of trichloroethylene present within the battery separator.

⁴ Statutory Instrument 2008 No 2164.

9.0.2 Assessment entity groups

Not applicable.

9.0.3 Introduction to the assessment for the environment

9.0.3.1 Tonnage

The use tonnages assumed in the original application, along with the current use tonnages and the expected future use tonnages are summarised in Table 9.0.1 .

Table 9.0.1 Summary of tonnages

Year	Tonnage	% Change from	Comment
	(tonnes/year) ^a	previous year	
2009	207	-	Original application
2010	188	-9	Original application
2011	189	0	Original application
2012	162	-14	Original application
2013	42	-74	Original application
2014	10-100 tonnes per	Blank 10	Review report
	annum Blank 10		
2015	10-100 tonnes per	-34% - purchased	Review report
	annum Blank 10	-31% - consumed	
2016	10-100 tonnes per	+68% - purchased	Review report
	annum Blank 10	+55% - consumed	
2017	10-100 tonnes per	+5% - purchased	Review report
	annum Blank 10	-16% - consumed	
2018	10-100 tonnes per	-33% - purchased	Review report
	annum Blank 10	-24% - consumed	
2019	10-100 tonnes per	-16% - purchased	Review report
	annum Blank 10	-7.3% - consumed	

Year	Tonnage (tonnes/year)ª	% Change from previous year	Comment
2021	10-100 tonnes per annum Blank 10		Estimated future annual purchase of trichloroethylene
2022	10-100 tonnes per annum Blank 10		Estimated future annual purchase of trichloroethylene
2023	10-100 tonnes per annum Blank 10		Estimated future annual purchase of trichloroethylene
2024	10-100 tonnes per annum Blank 10		Estimated future annual purchase of trichloroethylene
2025	10-100 tonnes per annum Blank 10		Estimated future annual purchase of trichloroethylene

Note: a) The tonnage purchased each year is used to replace the tonnage consumed (or lost) from the process. In some years the amount purchased is slightly different to the amount consumed and these are indicated in the Table. The site holds a stock of trichloroethylene and these differences between the purchased amount and the consumed amount translate to a small increase or small decrease in the total amount of trichloroethylene held at the site.

A strategic business objective at the ENTEK Newcastle upon Tyne (UK) facility is minimisation of trichloroethylene usage. Substantial investment had been made prior to the 2014 application in new carbon beds, enclosures and extraction systems, a comprehensive trichloroethylene monitoring system and a full time Environmental Manager position. The reduction in trichloroethylene use in Table 9.0.1 between 2009 and 2013 reflects the operation of the equipment to reduce fugitive trichloroethylene losses. Since 2014 further investment and changes have been made in order to further reduce the trichloroethylene losses from the process. A brief summary of some of the major improvements made is given below. **The full log of all improvements at the site since 2014 is given in Annex 11.**

• Substantial investment was made in 2019 to further enclosure large parts of the

production process. Enclosures have been constructed around the winders for Lines 1 & 2, Lines 7 & 8 and the Zerma grinder, with extraction of fugitive trichloroethylene to the carbon beds. The enclosures are held under a negative pressure of 75 Pa.

- Use of a forward-looking infrared (FLIR) camera to identify sources of fugitive emissions (September 2017, April 2018, April 2019 and October 2020).
- Improvements to the data management systems, including new sequencers and software allowing more accurate data on the trichloroethylene emissions to be obtained (May 2017), more accurate air flow monitoring from ducts (February 2017), creating control charts of trichloroethylene consumption per profile roll (2014 - current), 6 hourly reporting of winder, stack and ambient emissions (June 2019).
- Secondary condensing box for lines 7 and 8. This reduces the solvent laden air being sent to the carbon beds, provides more control on fugitive emissions and reduces the stack emission (2017).
- Comprehensive tracking charts for each work area and stack (May 2017).
- Surveying of mechanical seals was implemented (February 2015 current).
- Cleaning of solvent laden air grids to prevent oil mists reaching the carbon beds, thereby increasing their lifespan and reducing trichloroethylene loss via the stack (December 2014). New equipment installed to prevent oil mist being taken back to the carbon beds (May 2018).
- Daily review of trichloroethylene data from the previous 24 hours. This allows easier identification of anomalies (January 2016).
- Increased the amounts of carbon in the carbon beds (February 2015).
- Regular monitoring of carbon activity to help identify when the carbon needs replacing (June 2015).
- Checks for leaks including carbon beds and vapour lines and conditions of condensers; replaced/repaired failing components (August-September 2016).
- Changed out the vapour line valve seals from the carbon beds and ensured that the seals were closing properly (May 2017).
- Improved performance of the condensing system for trichlorethylene in solvent laden air from the central vacuum system (10% reduction) (March 2018).
- Partial change of carbon bed media (January 2018 and May 2020).
- Introduce new heat exchangers to condenser to reduce the quantity of trichloroethylene being sent to the carbon beds. Improved design of the filter to reduce the possibility of liquid entering the vacuum pumps and prolonging their life (September 2020).
- Large knock-out pot/tank installed on the central vacuum system to capture solvent

reducing the main stack emissions (May 2020).

The applied for use is a continuous process and the trichloroethylene in the system is continuously recycled and reused. The resident trichloroethylene in the system is approximately Blank.11

this is reprocessed continually as the trichloroethylene used to extract the oil from the separator sheet is recycled. The total volume that is processed in a year is the volume that is recycled and reused within the system; this total use volume was <115,000 Blank 11 approximately tonnes per year in the original application and <90,000 Blank 11 tonnes per year in 2019. The volume of substance that is purchased within a year is the approximate volume that is required to replace the volume of substance that is lost from the system; there are yearly small differences between the actual volume purchased and the actual volume consumed (lost from the system) and this translates into small yearly fluctuations in the total volume held at the site. The volume consumed was approximately <50 Blank 11 tonnes in the original application and <50 Blank 11 tonnes in 2019 (the amount purchased in 2019 was <50 Blank 11 tonnes). In terms of efficiency of reprocessing, the recycling of trichloroethylene at the ENTEK site was estimated to be 98.00 - 99.99% Blank 11 efficient in the original application, since <45 Blank 11 tonnes was the amount lost from a total use of <115,000 Blank 11 tonnes processed. A similar calculation for the 2019 data (<50 Blank 11 tonnes loss from a total use of <90,000 Blank 11 tonnes processed gives an estimated 98.00 - 99.98% Blank 11 efficiency for the recycling process. The detail for this is presented in 9.1.1 Env CS1: Use as process solvent in semi-closed systems (ERC 4).

The quantity of trichloroethylene processed and lost is based on the operation and production of the plant. These are detailed in the following exposure scenario.

Assessed tonnage: <50 Blank 11 tonnes/year based on: <50 Blank 11 tonnes/year lost (2019) and <90,000 Blank 11 tonnes/year processed.

The following table provides the tonnage per use and the local tonnages used in the assessment for each environmental contributing activity. The local tonnage corresponds to a tonnage at the site.

but

Table 9.0.2	Tonnage fo	r assessment
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ES#	Exposure scenario (ES) name and related environmental contributing scenarios	Tonnage per use (t/year)	Daily local tonnage (t/day)	Annual local tonnage (t/year)
ES1 (IS)	Use as process solvent in semi-closed systems	<90,000 Blank 12		
	Use as process solvent in semi-closed systems (ERC 4)		<260 Blank 12	<90,000 Blank 12

9.0.3.2 Scope and type of assessment for the environment

The scope of exposure assessment and type of risk characterisation required for the environment are described in the following table based on the hazard conclusions presented in Section 7 of the Chemical Safety Report attached to the latest EU REACH Registration dossier (as of January 2021).

Table 9.0.3	Type of risk	characterisation	required fo	or the	environment
	i ype of fisk	characterisation	i cquii cu i c		

Protection target	Risk characterisation type	Hazard conclusion
Fresh water	Quantitative	PNEC aqua (freshwater) = 0.576 mg/L
Sediment (freshwater)	Quantitative	PNEC sediment (freshwater) = 10.2 mg/kg sediment dw
Marine water	Quantitative	PNEC aqua (marine water) = 0.0115 mg/L
Sediment (marine water)	Quantitative	PNEC sediment (marine water) = 0.204 mg/kg sediment dw
Sewage Treatment Plant	Quantitative	PNEC STP = 2.6 mg/L
Air	Not needed	No hazard identified

Protection target	Risk characterisation type	Hazard conclusion
Agricultural soil	Quantitative	PNEC soil = 1.7 mg/kg soil dw
Predator's prey (freshwater)	Quantitative	PNEC oral = 13.8 mg/kg food
Predator's prey (marine water)	Quantitative	PNEC oral = 13.8 mg/kg food
Top predator's prey (marine water)	Quantitative	PNEC oral = 13.8 mg/kg food
Predator's prey (terrestrial)	Quantitative	PNEC oral = 13.8 mg/kg food

9.0.3.3 Fate and distribution parameters

Physicochemical properties used for exposure estimation

The following substance properties are used in the fate estimation done by EUSES. The data are as reported in the Chemical Safety Report attached to the latest EU REACH Registration dossier (as of January 2021).

Table 9.0.4 Substance key physico-chemical and fate properties

Substance property	Value
Molecular weight	≥ 131.3
Molecular weight used for the assessment	131.3
Melting point at 101 325 Pa	-84.8 °C
Vapour pressure	9.9 kPa at 25 °C
Partition coefficient (Log Kow)	2.53 at 20 °C
Water solubility	1.1 g/L at 20 °C
Henry's law constant (in Pa m ³ /mol)	1.03E3 at 20 °C

Substance property	Value
Biodegradation in water: screening tests	not biodegradable
Bioaccumulation: BCF (aquatic species)	17 dimensionless
Half-life in air (phototransformation)	13.29 d
Adsorption/Desorption: K_{oc} at 20 °C	141

Fate (release percentage) in the modelled biological sewage treatment plant

In a standard (modelled) biological STP, the emissions are distributed in the following way:

Release to water	10.39%
Release to air	88.31%
Release to sludge	1.289%
Release degraded	0%

The above fractions are calculated by the SIMPLETREAT model integrated in EUSES.

9.0.3.4 Comments on assessment approach for the environment

The regional concentrations are reported in section 10.2.1.1. The local Predicted Exposure Concentrations (PECs) reported for each contributing scenario correspond to the sum of the local concentrations (Clocal) and the regional concentrations (PEC regional).

In order to understand the dispersion of trichloroethylene released to air from the Newcastle facility (stack and fugitive emissions), detailed air dispersion modelling has been conducted by ENTEK in 202.1^{5} . This modelling allows an estimation of the concentrations of trichloroethylene in the air in the vicinity of the factory to be estimated. The assessment for this exposure scenario in terms of the exposure of man via the

⁵ Redmore environmental (2021). Dispersion Modelling Assessment, Entek, Killingworth. Reference: 3924r1. Report Prepared For: Entek International Ltd 13th April 2021.

environment takes into account the exposure of human beings in the general population that may be exposed to trichloroethylene from the ENTEK site by inhalation – i.e. ground level airborne concentrations - and through food and water intake.

For the airborne concentrations, the ENTEK dispersion modelling data are used to estimate this at the local scale i.e. the predicted environmental concentration (PEC) of the substance in air. The CHESAR v.3.5 model has been used to calculate the daily human intake of trichloroethylene (released to the environment) via food and water consumption. The air dispersion modelling results were used to 'overwrite' local PECair calculated in CHESAR as it was considered to be more representative of concentrations of the substance in air (based on present knowledge) for any potential exposure of man via the environment. The uptake from food and drinking water calculated in CHESAR is a conservative estimation, since it assumes that the food and water ingested are all from local sources (i.e. near to the site). The reality is that this is very unlikely to be the case. The Regional PECair estimates are based on CHESAR estimates as a 'worst case'.

The concentrations in air have been estimated using site-specific air dispersion modelling. The predicted annual mean trichlorethylene concentration in air was estimated to be between $0.22 \ \mu g/m^3$ and $12.24 \ \mu g/m^3$ over the years 2015 to 2019. The dispersion modelling indicated that the highest concentrations of trichloroethylene in air are predicted to be to the east of the site boundary as a result of the prevailing wind direction at the facility. This area consists of predominantly industrial land use rather than residential properties.

9.0.3.5 Scope and type of assessment for man via environment

The scope of exposure assessment and type of risk characterisation required for man via the environment are described in the following table.

Route of exposure and type of effects	Risk characterisation type	Hazard conclusion
Inhalation: Long term, Systemic	Semi-quantitative	DMEL (Derived Minimum Effect Level) = 6.2 mg/m ³
Inhalation: Long term, Local	Not needed	No hazard identified
Oral: Long term, Systemic	Semi-quantitative	DMEL (Derived Minimum Effect Level) = 0.92 mg/kg bw/day

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Tahle 9 0 5	Type of	rick char:	acterication	required for	' man via	a the e	nvironment
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9.0.3.6 Comments on assessment approach for man via the environment

The concentrations in air for exposure of man via the environment have been estimated using site-specific air dispersion modelling (see Section 9.0.3.4). The predicted annual mean trichlorethylene concentration in air was estimated to be between 0.22 μ g/m³ and 12.24 μ g/m³ over the years 2015 to 2019.

The concentrations in drinking water and food have been estimated using Chesar v3.5.

A long-term oral DMEL value of 0.92 mg/kg bw/day is used for risk quantification, based on the dose-response curve for kidney cancer risk. See Section 9.0.4.2 for further information.

9.0.4 Introduction to the assessment for workers

9.0.4.1 Scope and type of assessment for workers

The scope of exposure assessment and type of risk characterisation required for workers are described in the following table based on the hazard conclusions presented in Section 5.11 of the Chemical Safety Report attached to the EU REACH Registration dossier (short-

term systemic toxicity and local effects) and the conclusions of the EU Risk Assessment Committee (long-term systemic toxicity).

Route	Type of effect	Risk characterisation type	Hazard conclusion (see section 5.11)
	Systemic effects - long term	Semi-quantitative	DMEL (Derived Minimum Effect Level) = 33 mg/m ³
Inhalation	Systemic effects - acute	Quantitative	DNEL (Derived No Effect Level) = 164.1 mg/m ³
	Local effects - long term	Not needed	No hazard identified
	Local effects - acute	Quantitative	DNEL (Derived No Effect Level) = 164.1 mg/m ³
	Systemic effects - long term	Semi-quantitative	DMEL (Derived Minimum Effect Level) = 4.72 mg/kg bw/day
Dermal	Systemic effects - acute	Not needed	No hazard identified
	Local effects - long term	Qualitative	Medium hazard (no threshold derived)
	Local effects - acute	Qualitative	Medium hazard (no threshold derived)
Еуе	Local effects	Qualitative	Medium hazard (no threshold derived)

Table 9.0.6 Type of risk characterisation required for worker

9.0.4.2 Comments on assessment approach for workers

For risk quantification purposes, exposure values for workers are based on measured data from an ongoing campaign of badge monitoring studies (see Annex 9 for badge monitoring protocol at ENTEK).

Typically, each worker wore two badges (one from IOM and one from Cirrus), and one sampling pump in the breathing zone (from Cirrus) at the same time. In some instances, however, either only two measurement devices have been used (either two badges or one badge and a sampling pump), or data could only be retrieved from two of the used devices. As the data points from these two or three measurement devices all reflect the same exposure event, the geometric mean value of the available data points per worker and shift was used in the subsequent exposure assessment. Measured values were discarded and not used in the subsequent compliance assessment if one the following two conditions was met:

1) In case two or three data points were available for one worker for the same shift: If the geometric standard deviation (GSD) of the available two or three data points was above two, the complete data set for this one worker and one shift has been considered unreliable and discarded. The high variation strongly indicates that a problem occurred either during sampling, analysis, or data processing.

2) Based on the expertise of the authors, a limited number of data points was determined to be unreliable and discarded. In such cases, only one data point of a given worker was discarded. The remaining data point(s) for this worker that have been collected during the same shift have been used in any further assessment.

Reported personnel trichloroethylene monitoring data were evaluated against commonly used standard measurement protocols. To this end, protocols for an active sampling technique (NIOSH method 1022; NIOSH, 1994) and a passive sampling technique (3M Technical Data Bulletin 1028; 3M, 2019) were used. Additionally, the trichloroethylene monitoring data were assessed against good occupational hygiene practice (e.g., AIHA, 2015; EN, 2018).

To ensure comparability of the data provided by Cirrus and IOM, the same approach was used for both data sets for the calculation of the trichloroethylene workplace concentration. To this end, the total amounts of trichloroethylene provided in the Cirrus and IOM reports for each measurement event were converted into an 8-hour time weighted average (TWA) workplace concentration using the equations discussed below.

For the passive sampling technique (hereinafter referred to as badge) the following equation was used (3M, 2019):

$$C = \frac{W * A}{r * t}$$

Equation 1

where C is the trichloroethylene workplace concentration [mg/m3], W is the amount of trichloroethylene recovered from the charcoal adsorbent pad [μ g], A is the substance specific calculation constant [mg/m³], r is the recovery coefficient [-], and t is the exposure time [min]. For trichloroethylene, a value of 32.2 mg/m³ and 1.01 has been reported for A and r, respectively (3M, 2019).

For the active sampling technique (hereinafter referred to as sampling pump) the following equation was used:

$$C = \frac{W*0.001}{SR*0.001*t}$$
 Equation 2

where C is the trichloroethylene workplace concentration $[mg/m^3]$, W is the amount of trichloroethylene recovered from the charcoal in the solid sorbent tube $[\mu g]$, 0.001 is the conversion factor from μg to mg, SR is the sampling rate [L/min], 0.001 is the conversion factor from L to m³, and t is the exposure time [min].

Since the ENTEK site operates with 12-hour shifts, the calculated trichloroethylene workplace concentrations were further adjusted to 8-hour TWA concentrations using the following equation:

$$C_{8h TWA} = C \frac{t_{shift}}{t_{OEL}}$$
 Equation 3

where C8h TWA is the 8-hour TWA trichloroethylene workplace concentration [mg/m³], C is the trichloroethylene workplace concentration calculated with Equation 1 or Equation 2 [mg/m³], ^tshift is the duration of the shift (i.e. 720 min) [min], and ^tOEL is the exposure duration on which the regulatory threshold values are based on (i.e. 480 min) [min].

The adjustment to an 8-hour TWA trichloroethylene concentration is required to allow the comparison of the determined trichloroethylene workplace concentration to the UK workplace exposure limit (WEL) and the worker DMEL value (see Section 9.0.4), which are both based on an occupational exposure of eight hours.

For Winder 1/2 and Extruder 1/2 high trichloroethylene exposures can be observed on the 8th of March 2017 and 29th of November 2016, respectively. In the respective Cirrus reports it is speculated that Extruder 1/2 on the 29th of November 2016 entered the enclosure without wearing a full positive pressure hood and that Winder 1/2 on the 8th of March 2017 was exposed to high levels of trichloroethylene that have deposited outside

the enclosure during start-up activities. However, as detailed activity protocols are missing, a detailed evaluation of these high peaks is not possible. As these high peaks are considered to have happened during normal operations, and there is no other evidence of errors in the measurements, they have been taken into consideration in the assessment. Therefore, it is deemed more appropriate to use the 75th percentile of the measured exposure distribution, since it is considered that in reality there will be fewer than 25% of the exposure measurement that are higher than the 75th percentile. The 75th percentile rather than the 90th percentile is therefore considered to be a reasonable worst case for worker exposure from badge-monitoring studies.

Assessment approach related to toxicological hazard:

For this exposure scenario there is a need to consider the status of the substance as a threshold or non-threshold carcinogen. This exposure scenario is a supplement to a Chemical Safety Report (CSR) that has been produced by the EU registrants of trichloroethylene. That CSR is presented along with other documents including this exposure scenario (for which the relevant preceding CSR Sections 1 to 8 are covered) as part of the application for authorisation, and it sets out hazard assessment of trichloroethylene in terms of the toxicological evidence.

The hazard conclusions for systemic effects for human health contained in the last submitted version of the EU Lead Registrant REACH dossier are presented as Derived No Effect Levels (DNELs) for threshold effects, which in turn are based on the 8-hour Time Weighted Average (TWA) long-term and 15-minute short term exposure limits for workplace exposure as determined by the EU Scientific Committee for Occupational Exposure Limits (SCOEL)⁶. In the context of this exposure assessment, it is appropriate to retain the short-term DNELs from the registration dossier and also the qualitative conclusions for local effects on skin and eyes which are based on existing classifications for these endpoints.

The long-term inhalation DNEL for an 8-hour shift is based on an 8-hour TWA iOEL of 10 ppm (53.71 mg/m³ at 25°C); while the long-term inhalation DNEL for a 12 hour shift is derived from a pro-rated 12 hour TWA iOEL of 6.7 ppm (23.99 mg/m³ at 25°C).

However, the exposure levels can also be assessed without comparison to safe levels, and in the context of a non-threshold carcinogen these levels can also be compared to the dose-response cancer risk curve as communicated by ECHA's Risk Assessment Committee

⁶ Scientific Committee on Occupational Exposure Limits (SCOEL) Report No. SCOEL/SUM/142

(see footnote⁷). In the context of cancer risk as set out in ECHA's approach to assessment of trichloroethylene, the worker risk estimates are based on the assumption of 8-hour exposure for 5 days/week over 40 years. This is a 40-hour week over 40 years. At ENTEK the shifts are 12 hours, of which 10.67 hours are on the factory floor. Each factory floor worker works a 42-hour week based on 3.5 shifts; of this 42 hours, some 37.33 hours are spent on the factory floor.

The *de facto* Derived Minimal Effect Level (DMEL) for the long-term inhalation route, as calculated by ECHA based on the dose-response curve for kidney cancer risk, is 33 mg/m³ (6 ppm), for which the excess cancer risk is calculated to be 4*10⁻⁴. Likewise, a DMEL value of 4.72 mg/kg bw/day is calculated for long-term dermal exposure.

The exposure scenario for the ECHA risk estimate could be considered sufficiently similar in terms of working time to the exposure scenario for ENTEK workers. This cancer risk approach feeds into and supports the approach to assessing impacts on human health in the socio-economic analysis (SEA) that is part of this application. In the combined AoA/SEA document the impact of human health in terms of cancer risk to workers and to the general public is assessed in the context of quantifying the impact of continued use of the substance. In this ES the comparison is in the context of the application of risk management measures to control exposure. For the purposes of this ES the long-term risk quantification values presented in Sections 9.1.(1-12).2) are calculated based on the DMEL values described above. Since these values are more conservative than the conventional DNELs present in the registration dossier, then it can be assumed that any semi-quantitative RCR below one based on the DMEL will lead to RCRs <1 based on the DNELs.

General information on risk management related to toxicological hazard:

A hierarchy of control (COSHH 2002) has been considered and implemented at the site. In particular these controls;

- Limit the quantity of the trichloroethylene used;
 - \circ $\;$ trichloroethylene is captured and recycled within the system.
- Keep the number of workers exposed as low as possible;

⁷ ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship For Carcinogenicity of Trichloroethylene.

- enclosed areas are used where higher concentrations of trichloroethylene could occur and the nimber of personnel entering into these areas is limited.
- Work processes are designed to minimise substance release (i.e. collective prevention measures are deployed);
 - use of Standard Oppertating Procedures (SOPs) (see Annex 6).
- Remove trichloroethylene by extraction ventilation at source;
 - \circ $\;$ use of enclosed areas with extraction to carbon beds.
- Use appropriate procedures to measure trichloroetheylene (for early detection of abnormal exposures in the event of unforeseeable events or accidents, see SOP of monitoring system in Annex 10);
 - \circ $\;$ use of alarm systems to warn of elevated trichloroethylene leves.
- Use individual protection measures where collective protection measures are not sufficient;
 - \circ $\;$ use of RPE in enclosures (see Annex 6).

The following safety measures to minimise worker exposure to trichloroethylene during use of the substance are implemented at the site and considered for the exposure assessment:

- Entry to the enclosures in which the bulk of the trichloroethylene is handled is restricted to essential process checks and essential maintenance.
- As part of the Safe Working Procedure (SWP), respirators (Sundstrom SR 100 Half Mask Respirator with A2 organic respirators) or powered air respirators are mandatory when entering the enclosures and the trichloroethylene concentration *is* <30 ppm to 500 ppm. A powered air respirator (3M Juniper model) must be used if the trichloroethylene concentration within the enclosure is >500 ppm, (see Annex 6 for details).

The length of time a worker can remain in the enclosure is also restricted. This is in line with current guidelines for maximum working time. The maximum allowed time a worker can spend in the enclosure is 90 minutes with a half face respirator, or 180 minutes with a powered air respirator, with a minimum break time (i.e. leaving the enclosure) of 15 minutes before another entry or work within the enclosure (half face mask) – see Annex 6 for details of Standard Operating Procedures.

The trichloroethylene concentration level within the enclosure is continuously monitored and data recorded at 15-minute intervals. The trichloroethylene level measured is used to determine the length of time a person can work in the enclosure even with respiratory protection.

- Internal limits / alarms are set for the solvent level within the enclosure. The air extraction system flow rate is monitored and if the flow drops below a set level this activates a two stage alarm system.
- Outside of the enclosure trichloroethylene concentrations are monitored continuously at relevant line positions. Data are recorded at 15 minute intervals. Emission limit levels at these locations are set at 7 ppm; for any reading above this an alarm is activated. If required, appropriate measures are taken to bring emissions back into compliance.
- There are two Tiger hand held monitoring devices which are specifically set up for measuring trichloroethylene concentration. The following improvements to human health exposure control have been made since 2014:
 - Training on PPE use for all employees. Air fed hoods required for higher concentrations - Implemented for operatives working in areas with potential higher concentrations.
 - Long sleeve tops in the enclosure, plus gloves to cover skin that may potentially be splashed by trichloroethylene.
 - Lift button was moved further away from extractor lids As the extractor releases steam with trace amounts of trichloroethylene, relocating this extractor button eliminates exposure of operatives to the steam.
 - New 3M masks that have an indicator level. Clean shaven policy for perfect fit of masks. (see Annex 6).

9.0.5 Introduction to the assessment for consumers

Exposure assessment is not applicable as there are no consumer-related uses for the substance.

9.1 EXPOSURE SCENARIO 1: USE AT INDUSTRIAL SITES - USE AS PROCESS SOLVENT IN SEMI-CLOSED SYSTEMS

Product category used: PC 40: Extraction agents

Sector of use: SU 12: Manufacture of plastics products, including compounding and conversion

Environment contributing scenario(s):				
CS 1	Use as process solvent in semi-closed systems	ERC 4		
Worker contrib	uting scenario(s):			
CS 2	Winder 1/2	PROC 0		
CS 3	Extruder 1/2	PROC 0		
CS 4	Winder 7/8	PROC 0		
CS 5	Extruder 7/8	PROC 0		
CS 6	Pelletiser	PROC 0		
CS 7	Laminator	PROC 0		
CS 8	Supervisor	PROC 0		
CS 9	Laboratory Technician	PROC 0		
CS 10	Engineer / Maintenance / General Tasks	PROC 0		
CS 11	Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions	PROC 2		
CS 12	Transfer of substance or mixture (charging/discharging) at dedicated facilities	PROC 8b		
CS 13	Treatment of articles by dipping and pouring	PROC 13		

Further description of the use:

The process is described in Section 9.0.

Explanation on the approach taken for the ES:

The exposure scenario is based on measured data for the environment, and both measured and modelled exposure concentrations for workers.

At the ENTEK Newcastle site there is a total of 96 workers who are based on or around the factory floor. So that the plant can operate continuously 24 hours a day, seven days a week throughout the whole year, there are four teams (*crews*) comprising 22 workers each. Each crew works a 12-hour shift and a 42-hour week (i.e. 3.5 shifts a week). In each day there is a 12-hour day shift and a 12-hour night shift.

Each crew consists of:

•	Supervisor	1
•	Lead Hand	1
•	Production Operators	19
•	Utility Forklift Driver	1
•	Lab Tech	1
•	Maintenance Mechanical	1
•	Maintenance Electrical	1
•	Total per shift =	24
•	Total of the 4 shifts =	96 Total on factory floor
•	Admin, Sales and Warehouse staff	28 Office/Warehouse based
•	Production Managers/ Maintenance Engineers	10 Split between office/factory
	floor (marked in orange on attachment)	
•	Vara Technician	1
•	Total =	135

In total, therefore, there are 96 workers who are routinely based on the factory floor.

In addition to the shift crews, there are additional workers on day shifts: who also work the same hours as the other crew; one Vara technicians and one electrical maintenance technician. (The Vara is the system of continuous measurement of trichloroethylene around the factory (see Annex 8 on static monitoring)).

Each crew member works a 12-hour shift. Within that shift 1 hour and 20 mins per person per shift is spent on breaks (non-working time), during which it is compulsory to leave the factory floor.

In addition to the factory floor workers, there are 28 administration and management staff who do not spend time on the factory floor. The total head count for the ENTEK Newcastle plant is 135 people.

Table 9.1.1 summarises the tasks that are performed at the ENTEK UK factory (on the factory floor) and the amount of time that workers spend doing each task. This relates to the assessment of exposure of workers performing these different tasks.

Worker position/work area	Worker activity/functions	How many workers at ENTEK do this?	How long do they spend doing this?
Extruder/Extractor	The extruder	2 extruder operators	10.67 hours
lines 1 &2	operators monitor and manage the	per shift. During a start-up of an	
The extruders are a high-volume manufacturing	extrusion process, in addition to the extractors.	extruder, additional winder operators and Supervisors will assist.	
materials are melted and formed into a continuous battery separator profile.	The extruder operators control the start-up and shut down of a line.		

Table 9.1.1 F	Factory floor	workers at ENTE	K tasks and	durations
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Worker position/work area	Worker activity/functions	How many workers at ENTEK do this?	How long do they spend doing this?
	In the event of a product failure, the extruder operators may lift extractor and drier lids wearing the appropriate PPE.		
Extruder/Extractor lines 7&8 The extruders are a high-volume manufacturing process in which raw materials are melted and formed into a continuous battery separator profile.	The extruder operators monitor and manage the extrusion process, in addition to the extractors. The extruder operators control the start-up and shut down of a line. In the event of a product failure, the extruder operators may lift extractor and drier lids wearing the appropriate PPE.	2 extruder operators per shift. During a start-up of an extruder, additional winder operators and Supervisors will assist. Two operators manage the extruder, one operator maintains the extractor (roles are rotated).	10.67 hours

Worker position/work area	Worker activity/functions	How many workers at ENTEK do this?	How long do they spend doing this?
Winder lines 1&2 The winders slit the finished sheet to the desired widths and wind the material onto a cardboard core using a series of mandrels.	The winder operators monitor the parameters of the material for quality and package the finished product into boxes. During the start-up of an extruder, the winder operators will assist. Should the sheet snap in the extractor, the winder operators will assist with the rethreading of the line.	2 winder operators per shift.	10.67 hours
	Both winder operators will work together to manage the material whether end product or recycle		

Worker position/work area	Worker activity/functions	How many workers at ENTEK do this?	How long do they spend doing this?
Winder lines 7&8 The winders slit the finished sheet to the desired widths and wind the material onto cardboard cores using a series of mandrels.	The winder operators monitor the parameters of the material for quality and package the finished product into boxes.	3 winder operators per shift.	10.67 hours
Lines 7 & 8 are larger than Lines 1 & 2, therefore, have an additional operator.	During the start-up of an extruder, the winder operators will assist.		
	snap in the extractor, the winder operators will assist with the rethreading of the line.		
	Two of the three winders will generally work together to manage the material whether end product or recycle.		

Worker position/work area	Worker activity/functions	How many workers at ENTEK do this?	How long do they spend doing this?
Laminator winder Combines battery separator material with glass matt for heavy duty applications.	The laminator operator loads rolls of battery separator and glass matt material onto the laminator line. The second operator winds finished laminated product onto rolls and loads the rolls into boxes. If failures occur, the material will be packaged as waste and placed in the designated waste container. The operators are also responsible for the cleaning down of the line at the end of a production run.	2 laminator operators per shift.	10.67 hours
Laminator unwind	Loads materials on to laminator	4	10.67 hours
Pelletiser	Feeds waste polyethylene sheet to granulator, operates extruder making pellets	4	10.67 hours
Worker position/work area	Worker activity/functions	How many workers at ENTEK do this?	How long do they spend doing this?
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Laboratory The laboratory carries out designated tasks to monitor the quality of the manufactured battery separator. Exposure to Trichloroethylene in the QC lab is very limited, as testing is completed inside a forced ventilated fume cupboard.	The Quality Technician carries out routine testing of manufactured product in accordance with ENTEK's Quality Control Work instructions. Communication site wide if 'not right first-time' product is identified in the QC Lab.	1 QC Technician per shift.	10.67 hours
Maintenance Operate and maintain the plant's maintenance management system	The maintenance staff monitor and maintain the production lines and ancillary equipment. Conduct preventative and reactive electrical or mechanical maintenance of equipment. Routine changes in production tooling etc.	2 - One electrical, one mechanical per shift.	10.67 hours

Worker position/work area	Worker activity/functions	How many workers at ENTEK do this?	How long do they spend doing this?
Supervisory Team Monitor H&S of operators, quality of production and condition of plant.	Overall responsibility for H&S, the personnel and production of finished product.	2 - One Supervisor, One Lead Hand.	10.67 hours
Break/rest time (not on factory floor)	Rest time	91	1.33 hours per person per shift

Measured inhalation exposure concentrations have been recorded for each position on the factory floor using both personal sampling (badge monitoring) and static monitoring techniques. Contributing Scenarios (CS# 2 to 9) have therefore been defined as follows, to allow individual risk quantification values (inhalation route) to be presented for each role:

- Winder 1/2
- Extruder 1/2
- Winder 7/8
- Extruder 7/8
- Pelletiser
- Laminator
- Supervisor
- Laboratory Technician
- Engineer / Maintenance / General Tasks

In addition, estimated (modelled) exposure values for both the inhalation and dermal routes are presented in Contributing Scenarios 11, 12 and 13, using ECETOC TRA v 3.0 for the process categories (PROCs) that most closely represent the tasks undertaken at ENTEK UK, although it should be noted that none of these descriptors is an accurate reflection of the activities.

Badge monitoring

Personal monitoring campaigns have been carried out since August 2012 as part of occupational health and safety practices. These monitoring studies are set up and carried

out according to British Standard EN 482:2012 standard (Workplace exposure. General requirements for the performance of procedures for the measurement of chemical agents).

In each campaign specific workers in different working positions wear two badge monitors and one sampling pump in the breathing zone of the worker at the same time, during day and night shifts. The monitoring measurements include exposures to workers during various activities outside the enclosed area (where they spend almost all their working shift) and inside the enclosure where workers typically spend less than 10 minutes during a shift.

The samples are sent to an external laboratory for analysis and the exposure per 12-hour shift for each worker is calculated based on the method described in Section 9.0.4.2. Workers that may enter enclosed parts of the factory (in which trichloroethylene concentrations may be elevated), must wear respiratory protective equipment (RPE) and wear two badges. One badge is covered upon entering the enclosure to simulate the use of RPE. The badges are worn throughout the shift (including breaks), so that exposure throughout the full 12-hour shift is represented (See SOP in Annex 10).

Static monitoring

Specific sampling points around the factory take samples every 15 minutes, 24 hours a day and 365 days a year. The samples are analysed in the Smart Extruder monitoring system utilising 7 analysers, most being equipped to sample 8 locations and a number of sample points are indicative of worker locations (see Annex 5). There is therefore a comprehensive dataset of concentration of trichloroethylene at these specific locations on the factory floor.

The badge monitoring data cover the total exposure (peak and background exposure levels) of a given worker to trichloroethylene at the site during a 12-hour shift period, while the static monitoring data do not take into account any movement of the worker around the factory floor, break times, or differentiation between time spent inside or outside enclosed areas. Therefore, in terms of representativeness of actual exposure of workers to trichloroethylene at the site and for the purpose of risk quantification for inhalation exposure, the following exposure data are presented in these assessments:

- 1. Badge monitoring data Representative of actual worker exposure
- 2. Static monitoring data Representative of actual worker exposure in specific locations.
- 3. ECETOC TRA exposure modelling Estimation of actual worker exposure

Modelled Exposure

Exposure of workers to trichloroethylene during normal operating conditions has been modelled using the ECETOC TRA3 (2012) as implemented in CHESAR v.3.5. The modelling does not cover entry into enclosed areas since this is outside the scope of ECETOC TRA.

The following operating conditions or risk management measures have been considered and applied according in the exposure modelling:

- Local exhaust ventilation (LEV): Mechanical seals associated with the drive shafts and fixed and free running rollers are sealed and the air is locally extracted to remove and capture the trichloroethylene. The extracted air from the oven and mechanical seal covers are all sent to the carbon beds for solvent capture / recovery of solvent.
- Enhanced ventilation: 5-10 air exchanges per hour as per company information
- Respiratory protective equipment (RPE).
- Dermal protection Use of chemically resistant gloves with specific employee training.

9.1.1 Env CS 1: Use as process solvent in semi-closed systems (ERC 4)

Trichloroethylene is delivered to the Newcastle site via road tanker. At the current usage rate three tanker deliveries per year are required (maximum delivery accepted 18 tonnes). Offloading from road tanker is controlled via a standard operating procedure (see Annex 7). All venting which is undertaken during tanker delivery is routed to the carbon beds. This is through fixed lines direct to the carbon beds for solvent capture / recovery. Minor fugitive releases may be encountered upon disconnecting the transfer hose from the tanker to the offloading point and during sampling for quality control purposes. The double skinned bulk storage tanks containing trichloroethylene, which are sited within a sealed bund, are all vented to the carbon beds for solvent capture / recovery. The main equipment containing trichloroethylene is within a sealed system. The air from the oven is extracted to carbon beds for capture and recovery. Fugitive emissions from the processing equipment are either captured through local exhaust ventilation (LEV) or from the air extracted from within the enclosure. Both of these air streams pass to the carbon beds for solvent capture / recovery.

The quantity of trichloroethylene processed and lost is based on the operation and production of the plant. These are detailed in the following tables.

Table 9.1.2 below shows the plant capabilities.

Plant operation	Quantity	Unit		
	Original application	Average 2017-2019	2019	
Days in Operation	348	355.4	352.5	days/year
Overall equipment effectiveness (OEE)	80	76.9	76.5	%
Total Plant Hours per Year	8,352	8,530	8,460	hour/year
Line Hours per Year (OEE x Plant Hours)	6,682	6,559	6,472	hour/year/line

Table 9.	1.2 ENT	EK UK I	plant o	peration
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The overall equipment effectiveness estimated for 2017-2019 is similar to, but slightly lower than estimated in the original application. It is known that the efficiency of the carbon beds reduces over time and, for this reason, the carbon beds are replaced every two years. The carbon beds were replaced in 2018 and again in 2020 and so it is possible that the 2019 figures represent a slight reduction in efficiency prior to renewal of the carbon beds. The mean efficiency of the carbon beds in 2020 was 99.2% (range 80.6 to 99.9%) showing an increased efficiency following renewal of the carbon beds.

Table 9.1.3 indicates the values that are used to calculate use and losses of trichloroethylene.

	Quantity	Unit	
	Original application	2019	
Densities			
Trichloroethylene	1.4a	1.457a	kg/l
Oil	0.9	0.917	kg/l
Oil Content in Product			
Blacksheet	65	67	%
Greysheet	15	14.5	%

Table 9.1.3 Trichloroethylene and oil properties

	Quantity		Unit
	Original application	2019	
Densities			
% Oil in Flow to Line	20	24	%w/w
Distillation			

Note: a) Density values assumed by ENTEK in their calculations. The latest registration dossier (as of January 2021) gives the key value for the density of trichloroethylene as 1.465 kg/l at 20°C. These differences will lead to only minor differences in the resulting calculations.

Table 9.1.4 indicates the flow of trichloroethylene in the ENTEK system.

Carbon Beds	Quantity		Unit	
	Original application	2019		
SLA* Flow	1,500	1,295	m³/min	
Trichloroethylene Concentration in SLA	1,345	1,041	ppm	
Trichloroethylene Concentration in Stack Emissions	4.5	5.5	ppm	
Trichloroethylene in Air Conversion	5.11E-06	5.11E-06	kg/m ³ (ppm)	
Trichloroethylene in SLA	619	414	kg/hour	
Trichloroethylene in Stack Emissions	2.0	2.2	kg/hour	

Table 9.1.4 trichloroethylene flow in the ENTEK system

*SLA = solvent (trichloroethylene) laden air

The overall trichloroethylene in stack emissions for 2019 is similar to, but slightly higher than estimated in the original application. The reason for this is unclear but may be related to the renewal of the carbon beds at intervals. Table 9.1.5 sets out the product throughput by production line.

Line	Oil Extract (kg/hour)	ed	trichloroethylene to Line Distillation (kg/hour)		trichloroethy lene in Sheet to Dryer & Oven (kg/hour)		trichloroethylen e from Ovens to SLA (kg/hour)	
	Original applicati on	2019	Original applicat ion	2019	Origi nal appli catio n	2019	Original applicat ion	2019
Line 1	412	306	1,648	969	641	486	84	45
Line 2	412	316	1,648	1,002	641	503	84	45
Line 7	1,106	1,130	4,424	3,578	1,720	1,795	226	162
Line 8	1,106	1,130	4,424	3,578	1,720	1,795	226	162
Totals	3,036	2,882	12,143	9,126	4,722	4,579	619	414

Table 9.1.5 Calculation of product throughput by production line

Table 9.1.6 shows the calculation of trichloroethylene use and losses based onthroughput.

Yearly Estimates	Quantity		Unit	Comment
	Original application	2019	-	
Fugitive trichloroethylene Losses from the Plant Site	24.9	10-100 Blank 13	tonnes/year	
Carbon Bed Stack Trichloroethylene Emissions	17.0	10-100 Blank 13	tonnes/year	
Total trichloroethylene Losses from the Plant Site	41.9	10-100 Blank 13	tonnes/year	
Trichloroethylene to Distillation Systems	81,132	10,000- 100,000 Blank 13	tonnes/yer	Line hours per year (Table 9.1.2) × trichloroethylene to line distillation ÷ 1000
Trichloroethylene to Dryer Waste Water	27,415	10,000- 100,000 Blank 13	tonnes/year	Line hours per year (Table 9.1.2) × difference between trichloroethylene in Sheet to Dryer & Oven and trichloroethylene from Ovens to SLA (Table 9.1.5) ÷ 1000

Table 9.1.6 Calculation of trichloroethylene use and losses based on throughput

Yearly Estimates	Quantity		Unit	Comment
	Original application	2019		
Trichloroethylene to	4,136	<3,000 Blank 13	tonnes/year	Line hours per
Ovens (=				year Table 9.1.2
trichloroethylene to				×
Carbon Beds in SLA Air)				trichloroethylene
				from Ovens to
				SLA (Table
				9.1.5) ÷ 1000
Total trichloroethylene	112,683	<90,000 Blank	tonnes/year	Sum of
Processed by Plant's		13		trichloroethylene
trichloroethylene				to Distillation
Recovery Systems				Systems,
				trichloroethylene
				to Dryer Waste
				Water and
				trichloroethylene
				to Ovens

Note: a) Based on the average line hours over 2017-2019. As this figure is slightly higher than the 2019 figure, it is used as the basis of the assessment as a worst case.

b) Based on the line hours for 2019.

Assessed tonnage: <90,000 Blank 14 tonnes/year based on:

<90,000 Blank 14 tonnes/year – is the average (2017-2019) annual <u>turnover</u> of trichloroethylene 'processed' (i.e., circulating recovered and recycled within the plant's trichloroethylene system). The volume of trichloroethylene in the system at any one time is <55 Blank 14 tonnes (allocated as follows: Lines 1 and 2 have 7.5 t in each; Lines 7 and 8 have 15 t each and there is 5 t in storage). The estimate based on the 2019 data alone is similar to, but slightly lower than this figure at <90,000 Blank 14 tonnes/year. The higher estimate has been used as the basis of the assessment.</p>

<50,000 Blank 14 tonnes/year – is actual annual amount of trichloroethylene lost from the system during processing through point source and fugitive emissions.

The <50,000 Blank 14 tonnes per year lost comprise <30 Blank 14 tonnes lost as controlled emissions (via the stack), <30 Blank 14 tonnes of fugitive emissions and the remaining <1 Blank 14 tonnes assumed to be residual in the product (equivalent to <0.005 Blank 14 % by weight in UHMWPE).

The steps used in the process, and the associated potential for emission, are discussed in detail below.

Processes and the associated potential for release to the environment

Mixing

The mixing process combines silica, UHMWPE, process oil, and minor ingredients in a ribbon blender equipped with high intensity chopper blades. The mixing process ensures that the raw material feed to the extruder is consistent in composition.

The amorphous silica used in the process has a particle size of 10 to 20 μ m and a bulk density of less than 200 kg/m³. The UHMWPE is a larger particle with a bulk density of circa 500 kg/m³. The mixing process uses process oil to 'wet-out' the silica and UHMWPE. This improves the feeding consistency of the mix, greatly reduces dusting between the mixer and the extruder, and starts the process of solvating (gelling) the UHMW PE by the process oil. The mix has an oil content of approximately 50% by weight.

The process oil is a mixture of oil recovered from the extraction process (description below) and virgin oil from bulk storage. The ratio of recycled oil to virgin oil is approximately 9:1.

The recycled oil is recovered by multi-stage distillation and air-stripping (description below). The oil distillate typically contains 0.005% by weight trichloroethylene after vacuum distillation at 150°C and 10000 Pascals (Pa) followed by air stripping in a packed column.

Feeding Systems

A series of conveyors takes the silica/UHMWPE/oil mixture from the mixer to a holding vessel above the extrusion line called a blender. The blender is agitated and holds enough material to run the production line for several hours. The blender re-fills a feeder. The feeder introduces the silica/UHMWPE/oil mixture into an extruder.

Extrusion

The extruder takes the mix from the feeder and starts to compress and heat the silica/UHMWPE/oil. The total oil content of the material in the extruder is raised to approximately 65% by weight by injecting additional process oil into the extruder. A melt temperature of 200°C is achieved through electrical heating and shear imparted to the mix in the extruder by two intermeshing, rotating screws.

Polyethylene melts at 130-135°C, so the extrusion temperature is sufficient for the UHMWPE to flow. The process oil solvates or gels the UHMWPE, making extensional flow of this polymer possible. If a gelling agent is not used, the UHMWPE has an essentially infinite melt viscosity and cannot be processed in a continuous extrusion process.

Battery separator grade amorphous silica is an agglomerate of smaller silica particles. The shearing action of the extruder screws breaks down the silica agglomerates to the ultimate silica particle size. This same shearing action mixes the silica/UHMWPE/oil thoroughly to a sub-micron length scale. This mixing is critically important to the properties of the finished battery separator.

Silica has a high affinity for water⁸. Residual water in the battery separator sheet leaving the extruder at 200°C would immediately flash to steam and create voids in the sheet. Vacuum applied to a section of the extruder removes the water from the melt in the extruder. The vapours are condensed to recover a mixture of water and process oil that is carried out of the extruder as an aerosol. The extruder raises the pressure of the melt to 2.0×10^7 Pa to force the melt through a sheet die.

Calendering

A calender is a stack of heated and/or cooled rolls that sizes an extruded sheet. ENTEK's calendering process also embosses the battery separator sheet with a pattern of ribs.

The first two calender rolls are closely spaced (0.15 to 0.4 mm gap) and held in close spacing by hydraulic pressure. The rolls are steam-heated. The rolls rotate in opposite directions so that the battery separator sheet leaving the die is "pumped" through the nip between the rolls. This pumping action meters the flow of the sheet precisely. Precise

 $^{^{8}}$ The extrusion process heats the silica and other ingredients to 170°C or higher. The extruder has a vacuum section where water vapor and other volatiles are removed.

metering helps to achieve consistent sheet thickness and speed through the downstream processes.

ENTEK's process oil has an initial boiling point of 276°C. At the extrusion temperature of 200°C, the process oil has significant vapour pressure as is evident in the oil smoke that evolves from the sheet at the die exit and in the calender. A collection hood above the calender collects the oil smoke at the die exit and off the calender. An extraction fan pulls the air laden with oil smoke through an oil coalescing filter.

The last major roll on the calender is a cooling roll. A large volumetric flow of cooling tower water at 18°C keeps this roll at a roughly room temperature. Cooling the battery separator sheet increases its tensile strength so that it can withstand the pulling necessary to move the sheet through the downstream processes.

The sheet leaving the calender contains about 65% process oil and 25% silica by weight. The tensile strength of the sheet comes from the 10% of UHMWPE in the sheet.

Extraction (of process oil from the sheet with trichloroethylene)

The extraction process reduces the oil content of the battery separator from about 65% by weight to about 15% by weight. As indicated above, the amount of oil remaining in the finished sheet must meet both a minimum and a maximum specification. Missing the oil target concentration in the finished sheet will result in the product being out of specification and not acceptable for the battery manufacturer.

Extraction is a diffusion process in which trichloroethylene displaces the oil through the full thickness of the sheet. This process of removing the oil creates the pore network that is needed for the separator to function in the lead-acid battery. Since the oil phase is 65% of the mass of the oil-filled sheet, and an even greater fraction on a volume percentage basis, removing 90% of the oil creates a large void fraction in the sheet.

An extractor vessel contains approximately 20 extraction zones and a battery separator line has two to three extractors. The extractor is maintained at ambient temperature. Higher temperatures speed up the extraction rate of oil but result in higher trichloroethylene vapour emissions from the extractor vessel.

The amount of process oil left in the finished battery separator is controlled by modulating the rate at which trichloroethylene and oil flow out of the extractor to the trichloroethylene /oil distillation system (description below). Reducing the flow of trichloroethylene and oil out of the extractor increases the amount of oil in the extractor. Higher oil content in the extractor slows down the rate of extraction and raises the oil content of the sheet exiting the extractor. Conversely, raising the flow of trichloroethylene and oil out of the extractor decreases the amount of oil in the extractor. Lower oil content speeds up the rate of extraction and lowers the oil content of the sheet.

Vapour emissions from the extractor vessel are controlled in the following ways:

- Cooling coils mounted inside the tank around the tank perimeter. The perimeter coils are supplied with cooling tower water and create a vapour "blanket" over the surface of the tank.
- Water-sealed lid over the extractor. A lid that sits in a water-seal encloses the top of the extractor. trichloroethylene has sparing solubility in water, so the water acts as an effective seal to prevent vapour loss from the top of the extractor tank.
- Elevated sheet entrance with chilled water coils for vapour condensation. The sheet enters the extractor at a considerable elevation above the liquid trichloroethylene level in the tank. Trichloroethylene vapour is 4.5 times heavier than air, so the elevation helps control trichloroethylene fugitive emissions. In addition, the entrance box is equipped with chilled water coils (6°C) to condense trichloroethylene vapours.
- Shaft seals for the sheet drive and support rolls that penetrate the extractor tank wall. The shaft seals are designed to prevent fugitive trichloroethylene vapours from escaping from the tank.
- Vapours collected at the entrance of the extractor are collected in the solvent laden air (SLA) system for treatment in the carbon beds (trichloroethylene capture from air – description below).
- Vapour collection above the extractor vessel within enclosure. It is sometimes necessary to raise the water-sealed lid on the top of the extractor for maintenance or operational reasons. The lid is raised into an enclosed space above the tank that is under negative pressure from the SLA system. trichloroethylene vapours collected in this space are captured on the carbon beds.
- Water-capping the trichloroethylene/oil solution in the extractor within enclosure. If the water-sealed lid needs to be raised for an extended period, the trichloroethylene/oil liquid in the tank can be capped with a layer of water to minimize vapour emissions. The water layer has to be removed to run the process.

Although the trichloroethylene vapour controls on the tank are effective, some fugitive emissions from the extraction vessel are inevitable. The entire extraction process is, therefore, housed in enclosures with extraction of fugitive trichloroethylene to the carbon beds which is maintained under negative pressure. Extracting a wide, flat sheet requires a tank with a large surface area.

The sheet moves at speeds of 20 to 75 metres per minute, so some 'drag-out' of liquid and/or vapour trichloroethylene in the boundary layer at the surface of the sheet may occur. Also, the shaft seals cannot provide a 100% vapour-tight barrier.

Oil Recovery

Approximately 90% of the oil leaving the extruder die is removed from the sheet in the extractor and leaves the extractor as a solution of oil and trichloroethylene. The cost of the process oil necessitates the separation and re-use of the oil to have an economically viable business.

The oil/trichloroethylene stream leaving the extractor has a nominal composition of 85% trichloroethylene and 15% oil by weight. An atmospheric distillation stage produces an overhead stream of 100% trichloroethylene and a bottoms stream of 15% trichloroethylene and 85% oil by weight. The pure trichloroethylene distillate is pumped backed to the last zone of the extractor. The bottoms stream is distilled further.

A vacuum distillation stage produces an overhead stream of 100% trichloroethylene and a bottoms stream of oil with 0.5% to 2.0% residual trichloroethylene by weight. The overhead stream is partially condensed in a chilled water condenser. Complete condensation is not possible because the vacuum stage operates at 10000 Pa absolute pressure. The trichloroethylene recovered as condensate is pumped back to the extractor.

The bottoms from the vacuum distillation stage – a mixture of \geq 98% oil and \leq 2% trichloroethylene- is pumped to a central holding tank to feed an air stripper. The air stripper is a packed column operating at atmospheric pressure. Fresh air is blown up through the column as the hot trichloroethylene and oil mixture trickles down the column packing. The large surface area of the column packing, high temperature of the oil, and low concentration of trichloroethylene in the air result in very efficient mass transfer of trichloroethylene from the oil to the air stream. The oil exiting the column contains less than 0.005% trichloroethylene by weight. The air leaving the column contains 1500 to 3500 ppm of trichloroethylene and is sent to a carbon bed adsorption system for trichloroethylene recovery.

"Dryer" – Recovery of Trichloroethylene from the Sheet

The sheet leaving the extractor is heavily laden with trichloroethylene. Depending upon the final product, ENTEK removes the solvent from the sheet in two different ways. In the production of Standard (STD) separator, a steam dryer is used to evaporate the trichloroethylene followed by an oven. In the production of LR separator, a hot air oven only is used to evaporate trichloroethylene from the sheet.

For standard separator, the ENTEK steam dryer uses impingement of live steam and contact with heated rolls to vaporize trichloroethylene from the pore network inside the sheet. Excess steam is injected into the dryer vessel to exclude air and create a condensable atmosphere. Cooling coils in the bottom of the dryer, supplied with cooling tower water, condense the steam/trichloroethylene vapour in the dyer vessel. The two-phase liquid leaving the dryer consists of an essentially pure trichloroethylene phase and a water phase saturated with trichloroethylene (saturation is approximately 1 part per thousand trichloroethylene in water). This liquid is pumped to a phase separator to effect separation of the phases. The trichloroethylene phase is pumped back to the extraction vessel. The water phase is pumped to the wastewater distillation column (description to follow) for further treatment.

The melting point of polyethylene (130-135°C) limits the temperature of the dryers. Exceeding the melting point destroys the pore network in the sheet. There is evidence that trichloroethylene depresses the melting point of polyethylene, so the ultimate temperature limit in the dryer is somewhat lower than the standard polyethylene melting point. Pressure inside the dryer is atmospheric, so the temperature of the saturated steam impinging on the sheet is within a few degrees of 100°C.

Trichloroethylene fugitive emissions from the dryer are controlled using the same systems in place on the extractor

- Cooling coils mounted inside the tank around the tank perimeter.
- Water-sealed lid over the dryer.
- Elevated sheet exit with chilled water coils for vapour condensation.
- Shaft seals for the sheet drive and support rolls that penetrate the dryer tank wall.
- Vapours collected at the exit of the dryer are collected in the solvent laden air (SLA) system for treatment in the carbon beds.
- Vapour collection above the dryer vessel.
- Water capping the dryer is not required for prolonged maintenance because the

vessel is pumped dry when the lids over the vessel are raised.

• The extractor, ovens and dryers are all within the enclosure – see Process Equipment Containment below.

Ovens

Hot Air Ovens

The ovens are coupled to a side stream fan which draws solvent laden air out of the ovens. The solvent laden air is condensed on a chilled water condensing coil at ~ 8°C, followed by a cryogenic condensing skid at ~-32°C. A duplex system allows for the Trichloroethylene "ice" to be recovered as liquid after warming back to room temperature. In this system, a small amount of residual Trichloroethylene vapour still travels to the activated carbon bed system. This process imparts higher porosity and a slightly larger average pore size in the LR separator such that it has lower ionic resistance compared to the STD separator. The recovered solvent is pumped to a phase separator, which gravity feeds back to the extractor.

Glenro Oven

For standard separator, the oven uses forced convection of steam-heated air onto the surface of the sheet to reduce the moisture content of the sheet to 4% or less water by weight and evaporate remaining trichloroethylene out of the pore network of the sheet.

The melting point of polyethylene (130-135°C) limits the temperature of the dryer. Exceeding the melting point destroys the pore network in the sheet. The oven temperature is typically 110-120°C. The atmosphere inside the oven is typically 500 to 1,500 ppm trichloroethylene. The oven is connected to the plant solvent laden air (SLA) system and 30 to 60 m³/minute of air/trichloroethylene is withdrawn from the oven to keep it under negative pressure and to keep the concentration of trichloroethylene in the oven reasonably low.

Both types of oven are kept under negative pressure to control fugitive emissions. The connection to the SLA system accomplishes this goal. "Drag-out" of trichloroethylene vapours in the laminar boundary layer at the surface of the sheet from the atmosphere inside the oven results in some fugitive emissions. Abnormal operating conditions in the process - especially "fold-overs" where the sheet is not flat as it travels through the dryer

and oven – may occasionally result in increased fugitive emissions because trichloroethylene cannot be effectively removed from the folded sheet⁹.

Slitting

The sheet exiting the oven is slit (cut) into four lanes of material. The customer specifies the width of the lane.

Winding

A winder that controls tension winds the lanes of material onto individual lane cores. Each lane of material is approximately 160 mm wide. There may be 1500 metres or more of material wrapped onto each core.

Ancillary Equipment

The process description above covers one battery separator line. The Newcastle facility has four active battery separator lines. In addition, there are ancillary systems in the plant that support the battery separator process. These include:

- Silica bulk handling, mechanical screening, and storage.
- Polymer bulk handling, mechanical screening, and storage.
- Air compressors.
- Vacuum pumps.
- Cooling towers.
- Chillers.
- Steam boilers.
- Grinding and pelletizing system for reclaiming battery separator scrap.

Pollution Abatement Systems

Baghouses

 $^{^{9}}$ It is not possible to predict how often this will happen, but it can be from several times an hour in the worst case to not for a number of days in the best case.

The mixing operations on the production lines produce silica and polyethylene dust. Two high efficiency particulate air (HEPA) filter bag houses collect the dust from the mixing operations.

Oil Coalescing Filters

The battery separator sheet leaving the extruder dies and on the calenders is hot enough to evolve a significant amount of oil smoke. Oil smoke is collected by the suction of extraction fans installed on two oil coalescing filters. Coalesced oil is recovered and reused in the process.

Water Treatment

There is considerable water-trichloroethylene contact in the battery separator process. Trichloroethylene has sparing solubility in water – roughly 1 part trichloroethylene per thousand at room temperature – so phase separation can be used to obtain a nearly pure trichloroethylene phase and a water phase saturated with trichloroethylene. ENTEK distils the trichloroethylene-saturated water phase in a 20-tray distillation column.

The distillation column feed is at the top of the stripping section. There are no enriching trays above the feed, so any trichloroethylene condensed overhead is returned back to the phase separation vessel that feeds the column (i.e., the distillation column is not designed to recover trichloroethylene; its only purpose is to purify water). The bottom of the column typically contains 20 parts per billion (20 ppb) or less of trichloroethylene.

The bottoms water contains enough oil that it cannot be re-used in the steam generating boilers. Projects to specify polishing equipment to further reduce the oil content have not been economically feasible. Most of the water is used for cooling tower make-up; a small amount is discharged to the sanitary sewer.

Carbon Beds – Solvent Laden Air (SLA) Treatment

There are 1,295-1,500 cubic metres per minute of air withdrawn from the production building to a carbon bed system for trichloroethylene recovery. Trichloroethylene concentration in the air is in the air is typically 1000 to 1500ppm, depending on the process conditions in the plant. Three 112 kilowatt blowers – two operating and one in standby – provide the motive force.

There are four carbon beds, each containing approximately 15 tonnes of carbon. Three of the beds adsorb while the fourth bed is regenerated by steam-induced thermal swing desorption. The beds have a down-flow design.

The beds are desorbed on a fixed time schedule and one bed is always in desorption mode. The time schedule is set so that trichloroethylene breakthrough does not occur.

The condensed steam collected at the bottom of the adsorber vessels is pumped to the wastewater treatment system for phase separation and subsequent water purification by distillation. Steam and trichloroethylene vapours leaving the desorbing bed are condensed and gravity transferred to the wastewater treatment system. Non-condensable vapours are recycled back to the carbon bed inlet for re-adsorption of trichloroethylene.

The carbon is subject to oil contamination and attrition from frequent thermal cycling and mechanical stress from high inter-particle air velocity. Typical carbon usable life in the battery separator process is circa two years.

The carbon bed trichloroethylene capture efficiency is 98% or better and the beds have significantly better than 99% operational availability (not including planned downtime) over the course of a typical year. The carbon bed system has provided 100% operational availability in some years – a remarkable reliability record and critically important for a 24-hour/7-day facility that operates for an average of 355 days per year (2017-2019).

The carbon beds are replaced at 2-year intervals (replaced in 2018 and 2020). Since 2014, a number of further improvements have been made to the site to reduce the potential for release of trichloroethylene to the environment. These include the following (see Annex 11 for a full log of all site improvements).

Secondary condensing box for lines 7 and 8. This reduces the solvent laden air being sent to the carbon beds, provides more control on fugitive emissions and reduces the stack emission (2017).

Cleaning of solvent laden air grids to prevent oil mists reaching the carbon beds, thereby increasing their lifespan and reducing trichloroethylene loss via the stack (2014). New equipment installed to prevent oil mist being taken back to the carbon beds (2018).

Increased the amounts of carbon in the carbon beds (2015).

Regular monitoring of carbon activity to help identify when the carbon needs replacing (2015).

Checks for leaks including carbon beds and vapour lines and conditions of condensers; replaced/repaired failing components (2016).

Changed out the vapour line valve seals from the carbon beds and ensured that the seals were closing properly (2017).

Improved performance of the condensing system for trichlorethylene in solvent laden air from the central vacuum system (10% reduction) (2018).

Introduce new heat exchangers to condenser to reduce the quantity of trichloroethylene being sent to the carbon beds. Improved design of the filter to reduce the possibility of liquid entering the vacuum pumps and prolonging their life (2020).

Process Equipment Containment

In August 2011 the Newcastle facility installed a containment system around the process line extractors, dryers, and ovens. These are fully enclosed rooms within the larger room comprising the production facility. There are two containment rooms: one enclosing the trichloroethylene-containing process equipment of Lines 1 and 2, the other enclosing the same equipment of Lines 7 and 8. Note that Lines 3, 4, 5 and 6 have been dismantled and have been removed from site. In 2019, the containment rooms were supplemented with additional enclosures to the winders and the Zerma grinder, effectively enclosing the entire production process under negative pressure.

Since 2014, a number of further improvements have been made to the containment at the site. This includes the following (see Annex 11 for a full log of site improvements).

Comprehensive tracking charts for each work area and stack (2017).

Installation of an enclosure to the winder areas with extraction of fugitive trichloroethylene to the carbon beds (2019).

Installation of an enclosure to the Zerma grinder enclosure with extraction of fugitive trichloroethylene to the carbon beds. This captures any trichloroethylene associated with grinding of scrap sheet (October 2019)

The containment rooms are kept under negative pressure relative to the larger production facility by withdrawing air from the containment room to the carbon beds. The oil-filled battery separator sheet enters the containment area through a narrow slit just downstream of the calendar, and then enters the first extractor vessel. The extracted and dried sheet exits the containment area through a narrow slit just downstream of the containment area through a narrow slit pust.

Operators entering the containment area are required to wear respiratory protective equipment because the trichloroethylene concentration in the air of the containment room may exceed the EU SCOEL's recommended Occupational Exposure Level of 10 ppm (8 hour TWA)¹⁰.

Trichloroethylene concentrations in the plant air outside of the containment areas are significantly less than 10 ppm. This is because all significant sources of fugitive emissions are enclosed and held under negative pressure, with extraction of trichloroethylene emissions to the carbon beds. A hierarchy of control is implemented to ensure worker safety (See Section 9.0.4.2).

Monitoring Equipment

The ENTEK plant has installed infrared analytical instruments tuned for the carbon-chlorine bond stretch frequency to monitor trichloroethylene fugitive and stack emissions. Seven instruments continuously monitor a number of sample points in the plant including:

- Solvent laden air (SLA) concentration (inlet concentration to carbon beds).
- Carbon bed discharge stack.
- Oven exhausts on the individual or paired, on production lines total of three.
- Sheet leaving the ovens on the individual production lines total of four. These act as a check on trichloroethylene removal efficiency in the process line dryer (steam impingement) and oven.
- Various sampling points inside the plant to monitor worker exposure to trichloroethylene fugitive vapour (see Annex 3)

The data collected by the infrared monitors is logged and trended. Production supervisors can access the data on the plant floor to gauge the effectiveness of trichloroethylene containment measures at any time.

Trichloroethylene Loss – Point Sources and Fugatives

Point emission sources for trichloroethylene on the Newcastle plant site are:

- Carbon bed discharge stack.
- Oil coalescing filter discharge stacks two uncontrolled point sources.

¹⁰ The UK Workplace Exposure Limit (WEL) is higher at 100 ppm (8 hour TWA).

• Dust bag houses – two uncontrolled point sources.

Potential sources for trichloroethylene fugitive emissions are numerous. A list of fugitive sources is:

- Fugitive trichloroethylene vapour escaping from the sheet during normal operation. Some out-gassing of trichloroethylene from the finished battery separator must occur if there is residual trichloroethylene remaining in the oil of the sheet. The total mass of fugitive trichloroethylene emissions from this source is small.
- Fugitive trichloroethylene vapour escaping from the sheet during process upsets. "Fold-overs," where the sheet is not flat in the trichloroethylene recovery equipment on the production line, compromises the trichloroethylene recovery efficiency of the process equipment. There can be fugitive trichloroethylene lost into the atmosphere of the production facility when these upsets occur. Operationally, fold-overs result in 100% scrap generation, so there is a strong economic incentive to correct the cause of a fold-over as quickly as possible.
- Fugitive vapours escaping from process equipment normal operation. Potential sources include pumps, rotating shaft seals, and inlets/outlets of extractors, dryers, and ovens. 100% effective vapour containment is difficult when dealing with a porous sheet that moves through the process equipment continuously at speeds of 30 to 75 metres per minute.
 - The 2011and 2019 installation of containment around the extractor, dryer, oven process, and winder equipment was a measure taken to further control these fugitive emissions.
- Fugitive vapours escaping from process equipment maintenance. Raising the water-sealed lids on the process equipment, especially the extractor, potential exposes a large surface area of heated liquid trichloroethylene to the atmosphere. The process equipment includes design provisions for capturing fugitives, but the length and breadth of the vessels makes perfect fugitive emissions control very difficult.
 - The August 2011 installation of containment around the extractor, dryer, and oven process equipment was a measure taken to further control these fugitive emissions.

Trichloroethylene reversibly and irreversibly adsorbed onto the carbon in the carbon beds. Irreversible adsorption of trichloroethylene onto the carbon is expected to be a one-time event for all practical purposes. The time scale of the loss would be days since the carbon is thermally cycled five times or more per day every day the plant operates. Over the multi-year operational lifetime of the carbon, this loss would not be significant.

• Reversible adsorption, or the "heel" of the beds, is a response to a changing

point of equilibrium as the bed inlet concentration fluctuates. Over a long enough period, the average mass of trichloroethylene mass locked up in the carbon beds will be constant, or nearly so.

Trichloroethylene lost in waste disposal shipments. Waste profiling can estimate the loss of trichloroethylene and ensure proper disposal.

Trichloroethylene remaining in waste water after distillation. The loss of trichloroethylene in waste water is small, less than one kilogram per year in 2019, because of the high recovery efficiency of the waste water distillation system.

Residual trichloroethylene in the finished battery separator sheet. Oil content in the finished sheet is 15% by weight. Trichloroethylene recovery from the sheet must take place at temperatures below 130°C. There must be some residual trichloroethylene content in the oil phase of the finished sheet (see Annex 3).

Uncontrolled Point Sources

Bag Houses

There are two bag houses connected to the mixing processes on the battery separator lines. "Typical" conditions in each bag house stream are shown in Table 9.1.7:

Parameter	2013 (original application)	Average 2015- 2019	2019	Unit	Comment
Air Flow	130	111	111	m³/min	
Trichloroethylene concentration	<2	1.19	0.7	ppm	
Trichloroethylene mass flow	<0.7		0.35	tonnes/year	

Table 9.1.7	Bag house	Trichloroethylene	Mass Flow	(estimates)
	Dag nouse	incluoi de lingiene	11033 11000	(estimates)

The figures in **Table 9.1.7** above are for one bag house. Total trichloroethylene mass flow in the combined bag house streams is approximately twice the figure in the Table. The obstacles to controlling this source in the carbon beds system are: Dust by-passing the bag house filters contaminates the carbon and reduces the efficiency of the carbon bed system.

The total design airflow of the carbon bed system is theoretically 800 m³/min/bed. A four (4) bed system has three beds adsorbing at all times, so the theoretical capacity of the carbon beds is 2400 m³/min. Processing 250 m³/min from the bag houses reduces the amount of trichloroethylene-laden air that can be processed from other, higher trichloroethylene concentration, sources.

Most importantly, because the trichloroethylene concentration in the bag house discharge is less than or equal to the minimum outlet concentration from the carbon beds, it is not practical or desirable to process this air stream in the carbon beds.

Oil Coalescing Filters

Typical conditions in the oil coalescing streams are shown in **Table 9.1.8**:

Parameter	2013 (original application)	Average 2015- 2019	2019	Unit	Comment
Air Flow	130	140	140	m³/min	See note a).
Trichloroethy lene concentratio n	<2	2	1.45	ppm	
Trichloroethy lene mass flow	<0.7		0.79	tonnes/year	Assuming 1 ppm = 5.1 mg/m ³

Table 9.1.8 Oil Coalescing Filters – Trichloroethylene Mass Flow (estimates)

Note: a) The measured flow rate through each filter is dependent upon the condition of the filter (the cleaner the filter the high the flow rate). The condition of the filters is monitored via magnahelic gauges. These gauges measure the pressure drop across each side of the filer media. The scale of the gauges reads between 0 and 10 inches of water; the filters are change out at a reading of 6 inches of water. Flow rates are measured every 14 months by a third party contractor.

The figures in **Table 9.1.8** are for one coalescing filter. The coalescing filters discharge to atmosphere. The obstacles to controlling this source in the carbon bed system are:

Oil by-passing the coalescing filters irreversibly adsorbs onto carbon and gradually poisons the beds.

The total design airflow of the carbon bed system is theoretically 800 m³/ min per bed. A four bed system has three beds adsorbing at all times, so the theoretical capacity of the carbon beds is 2400 cubic metres per minute. Processing 260 m³/min from the oil coalescing filters reduces the amount of trichloroethylene-laden air that can be processed from other, higher trichloroethylene concentration, sources.

Since 2014 and number of improvements have been made to limit the potential for oil entering the carbon beds. These include the following (Annex 11 contains a full log of all site improvements):

Cleaning of solvent laden air grids to prevent oil mists reaching the carbon beds, thereby increasing their lifespan and reducing trichloroethylene loss via the stack (2014). New equipment installed to prevent oil mist being taken back to the carbon beds (2018).

Regular monitoring of carbon activity to help identify when the carbon needs replacing (2015).

Controlled Point Sources

Carbon Bed Discharge

In the original application, the typical measured trichloroethylene concentration in the carbon bed discharges during 2013 was 3 to 6 ppm, which equates to 17 tonnes of trichloroethylene being discharged for the year.

The concentration of trichloroethylene measured in the carbon bed discharges over the years 2015 to 2019 was between 2.6 to 8.7 ppm (6.8 ppm in 2019). The average concentration over 2015 to 2019 was 5.52 ppm, which equates to 24.8 tonnes of trichloroethylene being discharged per year (see **Table 9.1.6**).

Fugitive Emissions

Fugitive trichloroethylene emissions are calculated by subtracting known trichloroethylene losses from total trichloroethylene usage.

In the original submission, ENTEK required about 42 tonnes per annum to replace losses (2013); 17 tonnes per annum is stack emissions and 0.12 tonnes per annum is lost in product. It was therefore estimated that 24.88 tonnes of trichloroethylene per annum was lost is as fugitive emissions.

For 2019, ENTEK required 46.1 tonnes per annum to replace loss; 24.8 tonnes per annum is stack emission and 21.0 tonnes per annum was lost as fugitive emissions (see **Table 9.1.6**), with 0.338 tonnes assumed to be residual in the final product.

The estimates for the site fugitive emissions are summarised in **Table 9.1.9**.

Table 9.1.9 Estimated trichloroethylene losses for 2013 (original application) and2019

Parameter	2013 (original application)	2019	Unit
Total trichloroethylene usage	42	<50 Blank 15	tonnes/year
Estimated trichloroethylene loss – Point Sources	17	<25 Blank 15	tonnes/year
Estimated trichloroethylene loss – Fugitive	24.878	<25 Blank 15	tonnes/year
Estimated trichloroethylene loss - Product	0.122	<0.5 Blank 15	tonnes/year

9.1.1.1 Conditions of use

Amount used, frequency and duration of use (or from service life)

• Daily use amount at site: <= <260 Blank 16 tonnes/day

Total amount (re)processed.

• Annual use amount at site: <= Blank 17 tonnes/year

Note that the final release factors for water and for air are the release as a percent of the total assessed volume of <90,000 Blank 18 tonnes/year (the total amount (re)processed. This is considered a worst case assessment as the <0.5 Blank 19 tonnes of the substance assumed to be in the end product is not excluded for the environmental exposure assessment.

• Emission days : >= 355 (days/year)

Based on the number of working days in 2019.

• Percentage of EU tonnage used at regional scale: = 100 %

Technical and organisational conditions and measures

• Exhaust air treatment

Use of four carbon beds for solvent capture, three for adsorption and one for desorption (99.5-99.9 Blank 20 % efficiency).

Uncaptured trichloroethylene is released to the atmosphere via a stack with a permit set limit at 100 mg/m³ (17 ppm). There is an internal site operating limit for the stack set at 12 ppm.

Conditions and measures related to biological sewage treatment plant

• Biological STP: Site specific [Effectiveness Water: 89.60%]

• Discharge rate of STP: >= 3.89

>= 3.89+E05 m³/day

The discharge rate is obtained from Northumbrian Water, UK. The sewage is treated at Howden treatment works which is operated by Northumbrian Water.

• Application of the STP sludge on agricultural soil: Yes

The sludge from the Howden STP is sent for anaerobic digestion. The resulting sludge from the anaerobic digestion process can then be used on agricultural soil or other soil improvements. Conditions and measures related to external treatment of waste (including article waste)

• Particular considerations on the waste treatment operations: No (low risk)

ERC based assessment demonstrating control of risk with default conditions. Low risk assumed for waste life stage. Waste disposal according to national/local legislation is sufficient.

Other conditions affecting environmental exposure

• Dilution factor to freshwater: <= 40

A larger than standard dilution factor is used as it is known that the discharge of the STP is to semi-estuarine river.

• Dilution factor to marine water: <= 100

Default dilution factor for a marine environment. It is known that the discharge of the STP is to a semi-estuarine river and so both freshwater and marine environments are considered.

Fate (release percentage) in the biological sewage treatment plant

The biological STP is site specific and the releases to the various compartments have been set by the assessor. They are distributed in the following way:

Release to water	10.39%
Release to air	88.31%
Release to sludge	1.289%
Release degraded	0%

Explanation:

Default EUSES settings as implemented in Chesar 3.5.

9.1.1.2 Releases

The local releases to the environment are reported in the following table. Note that the releases reported do not account for the removal in the modelled biological STP.

Release	Release estimation method	Explanations
Water	Measured release	Release factor after on site RMM: 1.11E-6%
	rate	Local release rate: 2.8E-3 kg/day
		Explanation:
		The daily release rate is based on measured monthly discharges in 2019 (<1 kg/year) and operating days of 355 days/year.
Air	Measured release	Release factor after on site RMM: 0.051%
	rate	Local release rate: 130 kg/day
		Explanation:
		The daily release rate to air has been estimated from the annual amount of <50 Blank 21 tonnes purchased to replace 'lost' trichloroethylene within the system and operating days of 355 days/year. The release factor has been estimated from the daily use rate assessed and the estimated daily release rate. The final release factor to air is a combination of release to air after treatment of waste gas containing trichloroethylene in carbon beds and fugitive loses/releases. The estimated annual contribution to release to air from the stack (after cleaning of waste gas) is <26 Blank 22 tonnes and from fugitive releases is <23 Blank 23 tonnes (based on site data for 2019).
Non agricultural soil	Estimated release factor	Release factor after on site RMM: 0% Explanation: There is no direct release of the substance to soil at the site.

Table 9.1.10 Local releases to the environment

9.1.1.3 Exposure and risks for the environment and man via the environment

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table. The exposure estimates have been obtained with EUSES 2.1.2 unless stated otherwise.

Table 9.1.11 Exposure concentrations and risks for the environment and man viathe environment

Protection target	Exposure concentration	Risk quantification
Fresh water	Local PEC: 2.9E-8 mg/L	RCR < 0.01
Sediment (freshwater)	Local PEC: 5.1E-7 mg/kg dw	RCR < 0.01
Marine water	Local PEC: 1.0E-8 mg/L	RCR < 0.01
Sediment (marine water)	Local PEC: 1.8E-7 mg/kg dw	RCR < 0.01
Sewage Treatment Plant	Local PEC: 7.5E-7 mg/L	RCR < 0.01
Agricultural soil	Local PEC: 0.106 mg/kg dw	RCR = 0.062
Predator's prey (freshwater)	Local PEC: 3.3E-7 mg/kg ww	RCR < 0.01
Predator's prey (marine water)	Local PEC: 1.1E-7 mg/kg ww	RCR < 0.01
Top predator's prey (marine water)	Local PEC: 5.7E-8 mg/kg ww	RCR < 0.01
Predator's prey (terrestrial)	Local PEC: 0.083 mg/kg ww	RCR < 0.01
Man via environment - Inhalation (systemic effects)	Local PEC: 0.012 mg/m ³ Highest annual mean concentration based on site specific air dispersion modelling (see remarks below) 9.0.3.4)	
Man via environment - Oral	Exposure via food consumption: 1.91E-3 mg/kg bw/day	

Protection target	Exposure concentration	Risk quantification
Man via environment - combined routes		RCR < 0.01

Remarks on exposure data from external estimation tools:

Dispersion modelling other: Redmore environmental (2021). Dispersion Modelling Assessment, Entek, Killingworth. Reference: 3924r1. Report Prepared For: Entek International Ltd 13th April 2021.

Explanation: Concentration in air has been estimated by site-specific dispersion modelling. The predicted annual mean trichlorethylene concentration in air was estimated to be between $0.22 \ \mu g/m^3$ and $12.24 \ \mu g/m^3$ over the years 2015 to 2019. The dispersion modelling indicated that the highest concentrations of trichloroethylene in air are predicted to be to the east of the site boundary as a result of the prevailing wind direction at the facility. This area consists of predominantly industrial land use rather than residential properties.

Risk characterisation

Qualitative risk characterisation (Man via environment - Inhalation (systemic effects), Man via environment - Oral, Man via environment - combined routes):

Semi-quantitative risk characterisation ratios for man via the environment have been estimated based on the general population DMELs for inhalation and oral exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application For Authorisation: Establishing A Reference Dose Response Relationship For Carcinogenicity of Trichloroethylene:

For inhalation exposure:

At 6.2 mg/m³ and above: Excess risk = $6.9 \times 10^{-4} (mg/m^3)^{-1} \times concentration (mg/m^3) - 0.0039$

Below 6.2 mg/m³: Excess risk = $6.4 \times 10^{-5} (mg/m^3)^{-1} \times concentration (mg/m^3)$

For oral exposure:

- At 0.92 mg/kg bw/d and above: Excess risk = $4.66 \times 10^{-3} (mg/kg bw/d)^{-1} \times dose (mg/kg bw/d) 0.0039$
- Below 0.92 mg/kg bw/d: Excess risk = $4.32 \times 10^{-4} \text{ (mg/kg bw/d)}^{-1} \times \text{dose (mg/kg bw/d)}$

Dermal exposure is not relevant for humans exposed via the environment.

The excess cancer risk is estimated as follows:

Route	Exposure	Excess risk
Inhalation	0.012 mg/m ³	7.7E-7
Oral	1.91E-3 mg/kg bw/day	8.2E-7
Combined routes		1.6E-6

9.1.2 Worker CS 2: Winder 1/2 (PROC 0)

The final separator sheet product leaves ENTEK in large rolls. The separator sheet is cut to the final width specified by the battery manufacturer and the resulting lanes of material are wound onto continuous rolls of approximately 1500 metres in length. The rolls are packed in cardboard boxes and shipped to customers. The only contact with the separator could be in the loading of the separator rolls onto winders. It is therefore the assumption in this assessment that dermal exposure of workers to trichloroethylene from polyethylene separators in the manufacture of batteries is negligible.

9.1.2.1 Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	
 Physical form of the used product: Liquid 	
Amount used (or contained in articles), frequency and duration of use/	exposure/
 Duration of activity: <= 8 h/day 	
8-hour Time-weighted average (TWA) is used for the assessment. In	
practice, the 12-hour shift with breaks would mean the worker	
spends on average 10.67 hours on the factory floor.	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes	
per hour) [Effectiveness Inhalation: 70%]	
Expected SLA Draw: 418 m^3/min	
Total Volume Winder Enclosure (theoretical): 854 m ³	
Theoretical Air Turns/hour (Winder 1-2 Enclosure): 29	
Other conditions affecting workers exposure	
Place of use: Indoor	
• Operating temperature: <= 25 °C	

	Method
Average temperature for the measured data at the factory is	
20.3°C therefore 25°C is considered a conservative estimate of	
average ambient temperatures for the location of the factory.	

9.1.2.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long	7.52 mg/m ³ (Measured data:	Exposure/DMEL =
term	Geometric mean of two sampling	0.228
	badges and static sampling pump	
	monitoring studies located at Winder	
	1/2)	

Table 9.1.12 Exposure concentrations and risks for workers

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies results **located at Winder 1/2**:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 29; GSD: 4.23

Explanation: Measured data is 75th percentile only (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELs for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

For inhalation exposure:

At 6 ppm and above:

Excess risk (kidney cancer) = 7.2×10^{-4} ppm⁻¹ × concentration (ppm) – 0.0039

Below 6 ppm:

Excess risk (kidney cancer) = 6.7×10^{-5} ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Winder 1/2
Concentration (ppm) - Overall Geometric mean	1.09
Excess Cancer Risk	7.30E-05

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to skin and eye irritation. Recommended general risk management measures and personal protective equipment include:

- Minimisation of manual phases/work tasks.
- Work procedures minimising of splashes and spills.
- Avoidance of contact with contaminated tools and objects.
- Regular cleaning of equipment and work area.
- Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed.
- Training for staff on good practice.
- Good standard of personal hygiene.
- Substance/task appropriate gloves.
- Full skin coverage with appropriate light-weight barrier material.

See the standard operating procedures at the Entek Newcastle facility detailed in Annex 6 for more details. When the appropriate measures are applied there is no unacceptable risk to human health.
9.1.3 Worker CS 3: Extruder 1/2 (PROC 0)

9.1.3.1 Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	
• Physical form of the used product: Liquid	
Amount used (or contained in articles), frequency and duration of use/	exposure/
 Duration of activity: <= 8 h/day 	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes per hour)	
Other conditions affecting workers exposure	
Place of use: Indoor	
• Operating temperature: <= 25 °C	
Average temperature for the measured data at the factory is	
20.3°C therefore 25°C is considered a conservative estimate of	
average ambient temperatures for the location of the factory. The	
process temperature within the extruder is 130-135°C.	

9.1.3.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long	13.44 mg/m ³ (Measured data:	Exposure/DMEL =
term	Geometric mean of two sampling	0.407
	badges and static sampling pump	
	monitoring studies located at Extruder	
	1/2)	

Table 9.1.13 Exposure concentrations and risks for workers

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies located at Extruder 1/2:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 22; GSD: 4.41

Explanation: Measured data is 75th percentile only (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

At 6 ppm and above:

Excess risk (kidney cancer) = $7.2 \times 10-4 \text{ ppm}^{-1} \times \text{concentration (ppm)} - 0.0039$

Below 6 ppm:

Excess risk (kidney cancer) = $6.7 \times 10-5$ ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Extruder 1/2
Concentration (ppm) - Overall Geometric mean	1.5
Excess Cancer Risk	1.01E-04

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. See the standard operating procedures at the Entek Newcastle facility detailed in Annex 6 for more details. When the appropriate measures are applied there is no unacceptable risk to human health.

9.1.4 Worker CS 4: Winder 7/8 (PROC 0)

Refer to CS 2 in Section 9.1.2 for a description of the Winder activity.

9.1.4.1 Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 $\%$	
 Physical form of the used product: Liquid 	
Amount used (or contained in articles), frequency and duration of use/	exposure/
 Duration of activity: <= 8 h/day 	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes per hour) [Effectiveness Inhalation: 70%]	
Expected SLA Draw 439 m^3/min	
Total Volume Winder Enclosure (theoretical): 752m ³	
Theoretical Air Turns/hour (Winder 7-8 Enclosure): 35	
Other conditions affecting workers exposure	
• Place of use: Indoor	
 Operating temperature: <= 25 °C 	
Average temperature for the measured data at the factory is 20.3°C therefore 25°C is considered a conservative estimate of average ambient temperatures for the location of the factory.	

9.1.4.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long term	31.93 mg/m ³ (Measured data: Geometric mean two sampling badges and static sampling pump monitoring studies located at Winder 7/8)	Exposure/DMEL = 0.968

Table 9.1.14 Exposure concentrations and risks for workers

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies **located at Winder 7/8**:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 26; GSD: 2.31

Explanation: Measured data is 75th percentile only (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

At 6 ppm and above:

Excess risk (kidney cancer) = $7.2 \times 10^{-4} \text{ ppm}^{-1} \times \text{concentration (ppm)} - 0.0039$

Below 6 ppm:

Excess risk (kidney cancer) = 6.7×10^{-5} ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Winder 7/8
Concentration (ppm) - Overall Geometric mean	2.82
Excess Cancer Risk	1.89E-04

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. See the standard operating procedures at the Entek Newcastle facility detailed in Annex 6 for more details. When the appropriate measures are applied there is no unacceptable risk to human health.

9.1.5 Worker CS 5: Extruder 7/8 (PROC 0)

Refer to CS 3 in Section 9.1.3 for a description of the Extruder activity.

9.1.5.1 Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	
Physical form of the used product: Liquid	
Amount used (or contained in articles), frequency and duration of use/	exposure/
 Duration of activity: <= 8 h/day 	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes per hour)	
Other conditions affecting workers exposure	
Place of use: Indoor	
 Operating temperature: <= 25 °C Average temperature for the measured data at the factory is 20.3°C therefore 25°C is considered a conservative estimate of 	
process temperature within the extruder is 130-135°C.	

9.1.5.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long term	14.52 mg/m ³ (Measured data: Geometric mean two sampling badges and static sampling pump monitoring	Exposure/DMEL = 0.44
	studies located at Extruder 7/8)	

Table 9.1.15 Exposure concentrations and risks for workers

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies **located at Extruder 7/8**:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 28; GSD: 2.61

Explanation: Measured data is 75th percentile only (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

At 6 ppm and above:

Excess risk (kidney cancer) = $7.2 \times 10-4 \text{ ppm}^{-1} \times \text{concentration (ppm)} - 0.0039$

Below 6 ppm:

Excess risk (kidney cancer) = $6.7 \times 10-5$ ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Extruder 7/8
Concentration (ppm) - Overall Geometric mean	1.47
Excess Cancer Risk	9.85E-05

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. See the standard operating procedures at the Entek Newcastle facility detailed in Annex 6 for more details. When the appropriate measures are applied there is no unacceptable risk to human health.

9.1.6 Worker CS 6: Pelletiser (PROC 0)

Feeds waste sheet to granulator and operates extruder making pellets.

9.1.6.1 Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 $\%$	
 Physical form of the used product: Liquid 	
Amount used (or contained in articles), frequency and duration of use/	'exposure
• Duration of activity: <= 8 h/day	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes per hour)	
Other conditions affecting workers exposure	
• Place of use: Indoor	
• Operating temperature: <= 25 °C	
Average temperature for the measured data at the factory is	
20.3°C therefore 25°C is considered a conservative estimate of	
average ambient temperatures for the location of the factory.	

9.1.6.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long term	14.45 mg/m ³ (Measured data: Geometric mean two sampling badges and static sampling pump monitoring studies located at Winder 1/2)	Exposure/DMEL = 0.438

Table 9.1.16 Exposure concentrations and risks for workers

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies **located at Winder 1/2**:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 21; GSD: 2.88

Explanation: Measured data is 75th percentile only (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

At 6 ppm and above:

Excess risk (kidney cancer) = $7.2 \times 10-4 \text{ ppm}^{-1} \times \text{concentration (ppm)} - 0.0039$

Below 6 ppm:

Excess risk (kidney cancer) = $6.7 \times 10-5$ ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Pelletiser
Concentration (ppm) - Overall Geometric mean	1.2
Excess Cancer Risk	8.04E-05

See "General toxicological risk management measures" for more information on the semiquantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. See the standard operating procedures at the Entek Newcastle facility detailed in Annex 6 for more details. When the appropriate measures are applied there is no unacceptable risk to human health.

9.1.7 Worker CS 7: Laminator (PROC 0)

The laminator combines battery separator material with a glass matt for heavy duty applications.

The laminator operator loads rolls of battery separator and glass matt material onto the laminator line. The second operator winds finished laminated product onto rolls and loads the rolls into boxes.

If failures occur, the material will be packaged as waste and placed in the designated waste container. The operators are also responsible for the cleaning down of the line at the end of a production run.

9.1.7.1 Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	
Physical form of the used product: Liquid	
Amount used (or contained in articles), frequency and duration of use/	'exposure
 Duration of activity: <= 8 h/day 	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes per hour)	
Other conditions affecting workers exposure	
Place of use: Indoor	
• Operating temperature: <= 25 °C	
Average temperature for the measured data at the factory is	
20.3°C therefore 25°C is considered a conservative estimate of	
average ambient temperatures for the location of the factory.	

9.1.7.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 9 1 17	Fynosure	concentrations	and	risks for	workers
I aDIE 3.1.1/	Exposure	concentrations	anu	11565 101	WUIKEIS

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long	16.6 mg/m ³ (Measured data:	Exposure/DMEL =
term	Geometric mean of two sampling	0.503
	badges and static sampling pump	
	monitoring studies located at	
	Laminator)	

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies located at Laminator:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 23; GSD: 2.82

Explanation: Measured data is 75th percentile only. (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation:

Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

For inhalation exposure:

At 6 ppm and above:

Excess risk (kidney cancer) = $7.2 \times 10-4 \text{ ppm}^{-1} \times \text{concentration (ppm)} - 0.0039$

Below 6 ppm:

Excess risk (kidney cancer) = $6.7 \times 10-5$ ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Laminator
Concentration (ppm) - Overall Geometric mean	1.54
Excess Cancer Risk	1.03E-04

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. See the standard operating procedures at the Entek Newcastle facility detailed in Annex 6 for more details. When the appropriate measures are applied there is no unacceptable risk to human health.

9.1.8 Worker CS 8: Supervisor (PROC 0)

The supervisor has the overall responsibility for health and safety of all personnel on the factory floor and for quality of the finished product. They will likely spend a short period during each working shift at each station ensuring Standard Operating Procedures are followed and quality standards are met.

9.1.8.1 Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	
Physical form of the used product: Liquid	
Amount used (or contained in articles), frequency and duration of use/	'exposure
 Duration of activity: <= 8 h/day 	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes per hour)	
Other conditions affecting workers exposure	
Place of use: Indoor	
• Operating temperature: <= 25 °C	
Average temperature for the measured data at the factory is	
20.3°C therefore 25°C is considered a conservative estimate of	
average ambient temperatures for the location of the factory.	

9.1.8.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long term	8.36 mg/m ³ (Measured data: Geometric mean two sampling badges and static sampling pump monitoring studies results located at Supervisor)	Exposure/DMEL = 0.253

Table 9.1.18 Exposure concentrations and risks for workers

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies **located at Supervisor**:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 24; GSD: 1.93

Explanation: Measured data is 75th percentile only (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

The reported exposure for activities carried out within the enclosure and outside the enclosure (e.g., Extractor 1 & 2 - Outside and within the enclosure) are not the actual exposure of workers for the whole shift, as workers wear respiratory protective equipment within the enclosure and the actual total exposure for a shift would be lower.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

At 6 ppm and above:

Excess risk (kidney cancer) = $7.2 \times 10-4 \text{ ppm}^{-1} \times \text{concentration (ppm)} - 0.0039$

Below 6 ppm:

Excess risk (kidney cancer) = $6.7 \times 10-5$ ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Supervisor
Concentration (ppm) - Overall Geometric mean	1.08
Excess Cancer Risk	7.24E-05

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. See the standard operating procedures at the Entek Newcastle facility detailed in Annex 6 for more details. When the appropriate measures are applied there is no unacceptable risk to human health from storage or handling of trichloroethylene.

9.1.9 Worker CS 9: Laboratory Technician (PROC 0)

The laboratory technician carries out designated tasks to monitor the quality of the manufactured battery separator.

Exposure to trichloroethylene in the Quality Control laboratory is very limited, as testing is completed inside a forced ventilation fume cupboard. The whole task also takes into account the sampling which would not be under the same conditions as within the laboratory. This scenario is considering the whole task thus the forced ventilation fume cupboard is not presented in the following conditions as it is not considered the worst case for this application.

9.1.9.1 Conditions of use

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 $\%$	
• Physical form of the used product: Liquid	
Amount used (or contained in articles), frequency and duration of use/	exposure/
 Duration of activity: <= 8 h/day 	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes per hour)	
Other conditions affecting workers exposure	
• Place of use: Indoor	
 Operating temperature: <= 25 °C 	
Average temperature for the measured data at the factory is 20.3 C	
therefore 25 C is considered a conservative estimate of average	
temperatures for the location of the factory.	

9.1.9.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

T-I-I- 0 4 40 F			
Table 9.1.19 Exposure cond	centrations and	i risks for	workers

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long	16.9 mg/m ³ (Measured data:	Exposure/DMEL =
term	Geometric mean of two sampling	0.512
	badges and static sampling pump	
	monitoring studies located at	
	Laboratory Technician)	

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies **located at Laboratory Technician**:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 29; GSD: 2.05

Explanation: Measured data is 75th percentile only. (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

Recent measurements since 2018 show reduction in exposure. This has been attributed to the purchase of a new convection oven.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

For inhalation exposure:

At 6 ppm and above:

Excess risk (kidney cancer) = $7.2 \times 10-4 \text{ ppm}^{-1} \times \text{concentration (ppm)} - 0.0039$

Below 6 ppm:

Excess risk (kidney cancer) = $6.7 \times 10-5$ ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Laboratory Technician
Concentration (ppm) - Overall Geometric mean	1.73
Excess Cancer Risk	1.16E-04

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. When the appropriate measures are applied there is no unacceptable risk to human health.

9.1.10 Worker CS 10: Engineer / Maintenance / General Tasks (PROC 0)

The maintenance staff monitor and maintain the production lines and ancillary equipment. Conduct preventative and reactive electrical or mechanical maintenance of equipment. Conduct routine changes in production tooling etc.

	Method
Product (article) characteristics	
• Percentage (w/w) of substance in mixture/article: <= 100 %	
Physical form of the used product: Liquid	
Amount used (or contained in articles), frequency and duration of use/	/exposure
 Duration of activity: <= 8 h/day 	
Technical and organisational conditions and measures	
• General ventilation: Enhanced general ventilation (5-10 air changes per hour)	
Other conditions affecting workers exposure	
Place of use: Indoor	
• Operating temperature: <= 25 °C	
Average temperature for the measured data at the factory is	
20.3°C therefore 25°C is considered a conservative estimate of	
average temperatures for the location of the factory.	

9.1.10.1 Conditions of use

9.1.10.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 0 1 20	Evpocuro	concontrations	and	ricks for	workorg
Table 9.1.20	Exposure	concentrations	anu	LISKS IOL	workers

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long	5.76 mg/m ³ (Measured data:	Exposure/DMEL =
term	Geometric mean of two sampling	0.175
	badges and static sampling pump	
	monitoring studies for Engineering /	
	maintenance and general tasks)	

Remarks on measured exposure:

Geometric mean of two sampling badges and static sampling pump monitoring studies for Engineering / maintenance and general tasks:

Identity of the substance used: trichloroethylene

<u>Inhalation exposure, long term concentration</u>: Number of measured data points: 18; GSD: 2.2

Explanation: Measured data is 75th percentile only (see Section 9.0.4.2.).

Analysis of the results of six monitoring studies conducted quarterly and consolidated yearly in the period from 28/04/2016 to 13/08/2020.

The reported exposure for activities carried out within the enclosure and outside the enclosure (e.g. Extractor 1 &2 - Outside and within the enclosure) are not the actual exposure of workers for the whole shift, as workers wear respiratory protective equipment within the enclosure and the actual total exposure for a shift would be lower.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

For inhalation exposure:

At 6 ppm and above:

Excess risk (kidney cancer) = $7.2 \times 10-4 \text{ ppm}^{-1} \times \text{concentration (ppm)} - 0.0039$

Below 6 ppm:

Excess risk (kidney cancer) = $6.7 \times 10-5$ ppm⁻¹ × concentration (ppm)

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Engineer / Maintenance / General Tasks
Concentration (ppm) -Overall Geometric mean	0.52
Excess Cancer Risk	3.48E-05

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. When the appropriate measures are applied there is no unacceptable risk to human health.

9.1.11 Worker CS 11: Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC 2)

Drying operations in enclosed systems

PROC 2 (as defined in REACH Technical Guidance Chapter R.12) has been selected as the most representative activity for drying operations in enclosed systems. The worker exposure model within ECETOC TRA 3 (2012) and available measured exposure data have been used for the exposure assessment. The estimated inhalation and dermal worker exposures for the activities associated with the use of trichloroethylene at ENTEK have been based on available physicochemical data (vapour pressure and molecular weight). Predicted/modelled (ECETOC TRA) exposure concentrations are reported,

9.1.11.1 Conditions of use

	Method	
Product (article) characteristics		
• Percentage (w/w) of substance in mixture/article: <= 100 %	TRA Workers 3.0	
Physical form of the used product: Liquid	TRA Workers 3.0	
Amount used (or contained in articles), frequency and duration of use/exposure		
• Duration of activity: <= 8 h/day	TRA Workers 3.0	
Technical and organisational conditions and measures		
• General ventilation: enhanced general ventilation (5-10 air changes per hour)	TRA Workers 3.0	

	Method
Mechanical seals associated with the drive shafts and fixed and free	
running rollers are sealed and locally extracted. The removal of	
solvent from the product in the dryer is within a sealed system.	
Where feasible Mechanical seals associated with the drive shafts and	
fixed and free running rollers are sealed and locally extracted. The	
next stage of the process in which the product passes through an	
oven is a virtually sealed system. Just prior to the product exiting the	
process material passes through an accumulator, this is a small	
enclosure with rollers. The sheet passes over the rollers, and then	
factory air is drawn into the accumulator to remove any residual	
Trichloroethylene. The air is then sent to carbon beds for solvent	
capture / recovery of solvent. This captures any solvent carryover	
from the oven so as to minimise solvent carryover towards workers.	
The equipment described above is all located within an enclosure in	
which air from the factory is drawn into the room to maintain a	
negative pressure within the enclosure. This air then goes to the	
carbon beds for solvent capture recovery. The extraction from the	
oven and mechanical seal covers are all sent to the carbon beds for	
solvent capture / recovery of solvent. Trichloroethylene within the air	
extracted from the process is measured continuously and recorded at	
15 minute intervals. These data are used for in-process performance	
and internal limits / alarms are used to ensure solvent concentrations	
to the carbon beds are controlled.	
Occupational Health and Safety Management System: Advanced	TRA Workers 3.0
Local exhaust ventilation: Yes (TRA effectiveness) [Effectiveness	TRA Workers 3.0
Inhalation: 90%, Dermal: 0%]	
Ducting of ambient air to workers outside of enclosed parts of	
production line. The air extraction system flow rate is monitored and	
if the flow drops below a set level this activates a two stage alarm.	
The first stage all personnel must put on respiratory protection and	
all other non-essential personnel vacate the production area. At the	
second stage all personnel must evacuate the area.	

	Method	
Conditions and measures related to personal protection, hygiene, and health evaluation		
• Respiratory protection: Yes (Respirator with APF of 10) [Effectiveness Inhalation: 90%]	TRA Workers 3.0	
• Dermal protection: Yes (Chemically resistant gloves conforming to EN374 with basic employee training) and (other) appropriate dermal protection [Effectiveness Dermal: 90%]	TRA Workers 3.0	
Other conditions affecting workers exposure		
Place of use: Indoor	TRA Workers 3.0	
 Operating temperature: <= 100 °C The temperature of the enclosed drying operation is <100°C which has been used as a worst case for this exposure assessment. In reality the average ambient temperature for the factory is 20.3°C based on measured data. 	TRA Workers 3.0	

9.1.11.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Table 9.1.21 Exposure concentrations and risks for workers

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long term	1.369 mg/m ³ (TRA Workers)	Exposure/DMEL = 0.041
Inhalation, systemic, acute	5.475 mg/m ³ (TRA Workers)	RCR = 0.033
Inhalation, local, acute	5.475 mg/m ³ (TRA Workers)	RCR = 0.033
Dermal, systemic, long term	0.137 mg/kg bw/day (TRA Workers)	Exposure/DMEL = 0.029

Route of exposure and type of effects	Exposure concentration	Risk quantification
Dermal, local, long term	0.02 mg/cm ² (TRA Workers)	Qualitative risk
Dermal, local, acute	0.02 mg/cm ² (TRA Workers)	Qualitative risk

Remarks on exposure dataset obtained with ECETOC TRA

The vapour pressure at the operating temperature (100°C) used for the calculation is 1E4 Pa, which is the highest vapour pressure band within the scope of the TRA model.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship For Carcinogenicity of Trichloroethylene:

For inhalation exposure:

At 33 mg/m³ and above:

Excess risk (kidney cancer) = $1.3 \times 10^{-4} (mg/m^3)^{-1} \times concentration (mg/m^3) - 0.0039$

Below 33 mg/m³:

Excess risk (kidney cancer) = $1.2 \times 10-5 (mg/m^3)^{-1} \times concentration (mg/m^3)$

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Drying operations in enclosed systems
Concentration - Overall Geometric mean	1.369 mg/m ³
Excess Cancer Risk	1.16E-05

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. When the appropriate measures are applied there is no unacceptable risk to human health from storage or handling of trichloroethylene.

9.1.12 Worker CS 12: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC 8b)

Unloading of the tanker. PROC 8b (as defined in REACH Technical Guidance Chapter R.12) has been selected as the most representative activity for transfer operations, palletising and winder operations)

The worker exposure model within ECETOC TRA 3 (2012) and available measured exposure data have been used for the exposure assessment. The estimated inhalation and dermal worker exposures for the activities associated with the use of trichloroethylene at ENTEK have been based on available physicochemical data (vapour pressure from the EU Risk Assessment Report and molecular weight from the registration CSR). Predicted/modelled (ECETOC TRA) and measured/calculated exposure concentrations are reported, but only the worst case (measured) exposure concentrations, which are

representative of actual worker exposure, are used for risk characterisation.

9.1.12.1 Conditions of use

	Method	
Product (article) characteristics		
• Percentage (w/w) of substance in mixture/article: <= 100 %	TRA Workers 3.0	
Physical form of the used product: Liquid	TRA Workers 3.0	
Amount used (or contained in articles), frequency and duration of use/	/exposure	
 Duration of activity: <= 8 h/day 	TRA Workers 3.0	
Technical and organisational conditions and measures		
 General ventilation: Basic general ventilation (1-3 air changes per hour) [Effectiveness Inhalation: 0%] ECETOC TRA assumes worst case is outdoor as basic general ventilation 	TRA Workers 3.0	
 Occupational Health and Safety Management System: Advanced 	TRA Workers 3.0	
• Local exhaust ventilation: Yes (TRA effectiveness) [Effectiveness Inhalation: 95%, Dermal: 0%]	TRA Workers 3.0	
Conditions and measures related to personal protection, hygiene, and	health evaluation	
• Respiratory protection: No [Effectiveness Inhalation: 0%]	TRA Workers 3.0	
• Dermal protection: Yes (Chemically resistant gloves conforming to EN374 with basic employee training) and (other) appropriate dermal protection [Effectiveness Dermal: 90%]	TRA Workers 3.0	
Other conditions affecting workers exposure		
Place of use: Indoor and outdoor	TRA Workers 3.0	
 Operating temperature: <= 25 °C 	TRA Workers 3.0	

9.1.12.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long term	6.843 mg/m ³ (TRA Workers)	Exposure/DMEL = 0.207
Inhalation, systemic, acute	27.37 mg/m ³ (TRA Workers)	RCR = 0.167
Inhalation, local, acute	27.37 mg/m ³ (TRA Workers)	RCR = 0.167
Dermal, systemic, long term	1.371 mg/kg bw/day (TRA Workers)	Exposure/DMEL = 0.29
Dermal, local, long term	0.1 mg/cm ² (TRA Workers)	Qualitative risk
Dermal, local, acute	0.1 mg/cm ² (TRA Workers)	Qualitative risk

Remarks on exposure dataset obtained with ECETOC TRA

The vapour pressure at operating temperature (25°C) used for the calculation is 9.9E3 Pa.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship For Carcinogenicity of Trichloroethylene:

At 33 mg/m³ and above:

Excess risk (kidney cancer) = $1.3 \times 10^{-4} (mg/m^3)^{-1} \times concentration (mg/m^3) - 0.0039$

Below 33 mg/m³:

Excess risk (kidney cancer) = $1.2 \times 10-5 (mg/m^3)^{-1} \times concentration (mg/m^3)$

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Transfer operations, pelletising and winder operations
Concentration - Overall Geometric mean	6.843 mg/m ³
Excess Cancer Risk	8.21E-05

See Section 9.0.4.2 "General information on risk management related to toxicological hazard", for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. When the appropriate measures are applied there is no unacceptable risk to human health from storage or handling of trichloroethylene.

9.1.13 Worker CS 13: Treatment of articles by dipping and pouring (PROC 13)

Solvent extraction in an enclosed bath.

PROC 13 (as defined in REACH Technical Guidance Chapter R.12) has been selected as the most representative activity for solvent extraction in an enclosed bath and maintenance activities in an enclosure). The worker exposure model within ECETOC TRA 3 (2012) and available measured exposure data have been used for the exposure assessment. The estimated inhalation and dermal worker exposures for the activities associated with the use of trichloroethylene at ENTEK have been based on available physicochemical data (vapour pressure from the EU Risk Assessment Report and molecular weight from the registration CSR). Predicted/modelled (ECETOC TRA) and measured/calculated exposure concentrations are reported, but only the worst case (measured) exposure concentrations, which are representative of actual worker exposure, are used for risk characterisation.

9.1.13.1	Conditions	of use
----------	------------	--------

	Method	
Product (article) characteristics		
• Percentage (w/w) of substance in mixture/article: <= 100 %	TRA Workers 3.0	
Physical form of the used product: Liquid	TRA Workers 3.0	
Amount used (or contained in articles), frequency and duration of use/exposure		
 Duration of activity: <= 8 h/day 	TRA Workers 3.0	
Technical and organisational conditions and measures		
• General ventilation: Enhanced general ventilation (5-10 air changes per hour) [Effectiveness Inhalation: 0%]	TRA Workers 3.0	
Occupational Health and Safety Management System: Advanced	TRA Workers 3.0	
• Local exhaust ventilation: Yes (TRA effectiveness) [Effectiveness Inhalation: 90%, Dermal: 0%]	TRA Workers 3.0	
Conditions and measures related to personal protection, hygiene, and	health evaluation	

	Method	
• Respiratory protection: Yes (Respirator with APF of 10) [Effectiveness Inhalation: 90%]	TRA Workers 3.0	
• Dermal protection: Yes (Chemically resistant gloves conforming to EN374 with basic employee training) and (other) appropriate dermal protection [Effectiveness Dermal: 90%]	TRA Workers 3.0	
Other conditions affecting workers exposure		
Place of use: Indoor	TRA Workers 3.0	
 Operating temperature: <= 25 °C Average temperature for the measured data at the factory is 20.3°C therefore 25°C is considered a conservative estimate of average temperatures for the location of the factory. 	TRA Workers 3.0	

9.1.13.2 Exposure and risks for workers

The exposure concentrations and risk characterisation ratios (RCR) are reported in the following table.

Route of exposure and type of effects	Exposure concentration	Risk quantification
Inhalation, systemic, long term	2.737 mg/m ³ (TRA Workers)	Exposure/DMEL = 0.083
Inhalation, systemic, acute	10.94 mg/m ³ (TRA Workers)	RCR = 0.067
Inhalation, local, acute	10.94 mg/m ³ (TRA Workers)	RCR = 0.067
Dermal, systemic, long term	1.371 mg/kg bw/day (TRA Workers)	Exposure/DMEL = 0.29
Dermal, local, long term	0.2 mg/cm ² (TRA Workers)	Qualitative risk
Dermal, local, acute	0.2 mg/cm ² (TRA Workers)	Qualitative risk

Remarks on exposure dataset obtained with ECETOC TRA

The vapour pressure at operating temperature (25°C) used for the calculation is 9.9E3 Pa.

Risk characterisation

Qualitative risk characterisation (Inhalation, systemic, long term, Dermal, systemic, long term, Dermal, local, long term, Dermal, local, acute, Eye, local, Combined, systemic, long term):

Semi quantitative approach:

Semi-quantitative risk characterisation ratios for inhalation have been estimated based on the DMELS for inhalation exposure. The cancer risk is also calculated in line with the document ECHA 10 April 2014, RAC/28/2014/07 rev 2 Final. Application for Authorisation: Establishing A Reference Dose Response Relationship for Carcinogenicity of Trichloroethylene:

At 33 mg/m³ and above:

Excess risk (kidney cancer) = $1.3 \times 10^{-4} (mg/m^3)^{-1} \times concentration (mg/m^3) - 0.0039$

Below 33 mg/m³:

Excess risk (kidney cancer) = $1.2 \times 10-5 (mg/m^3)^{-1} \times concentration (mg/m^3)$

The excess cancer risk for inhalation is estimated as follows:

Worker Location	Solvent extraction in an enclosed bath and maintenance activities in an enclosure
Concentration- Overall Geometric mean	2.737 mg/m ³
Excess Cancer Risk	3.28E-05

See Section 9.0.4.2 "General information on risk management related to toxicological hazard" for more information on the semi-quantitative approach.

Dermal and eye irritancy:

The hazard conclusion (for workers) and classification of trichloroethylene is categorised as 'moderate hazard', according to ECHA Guidance on, Part E, Table E.3-1 with respect to irritancy. Recommended general risk management measures and personal protective equipment includes: Minimisation of manual phases/work tasks. Work procedures minimising of splashes and spills Avoidance of contact with contaminated tools and objects. Regular cleaning of equipment and work area. Management/supervision in place to check that the RMMs in place are being used correctly and OCs followed. Training for staff on good practice. Good standard of personal hygiene. Substance/task appropriate gloves; Full skin coverage with appropriate light-weight barrier material. When the appropriate measures are applied there is no unacceptable risk to human health from storage or handling of trichloroethylene.
10 RISK CHARACTERISATION RELATED TO COMBINED EXPOSURE

10.1 HUMAN HEALTH

10.1.1 Workers

Table 10.1.1 provides a short summary of all the exposure geometric mean exposure concentrations with a combined overall average for that year. Some data sets were discarded due to unacceptable variation in sampling methods. Those data are highlighted in grey in the table.

Combined worker exposure with exposure via the environment is deemed safe since all risk quantification values for humans via the environment are <0.01 and thus would not add any significant exposure to a worker.

Job type	Winder	Extruder	Winder	Extruder	Pelletis	Laminat	Supervis	Lab	Engine
	1/2	1/2	7/8	7/8	er	or	or	Tech	er
Date	mg/m ³	mg/m ³	mg/m ³	mg/m ³	mg/m ³	mg/m ³	mg/m ³	mg/m ³	mg/m ³
2016 04 28	27.42	7.67	35.32	16.54	20.47	19.90	*	17.10	
2016 08 08	5.53	2.66	19.99	2.27	5.85	5.29	5.56	16.29	2.56
2016 11 29	16 11 29 7.78 153.32		15.51	8.24	12.44	15.51	12.24	10.19	5.14
2017 03 08	122.98	10.99	49.45	8.47	3.86	37.20	8.36	24.80	7.62
2017 05 25	2.74	2.85	*	18.35	*	*	3.44	9.67	7.97
2017 11 23	6.73	1.49	4.70	2.24	5.96	*	3.14	22.19	*
2018 03 22	5.43	3.78	31.93	3.94	20.63	5.51	4.71	7.67	4.52
2018 08 22	1.08	20.78	11.27	47.77		6.28	14.57	4.98	1.55
2019 12 12	2.45	*	4.43	7.03	2.73	7.60	7.74	3.23	2.56
2020 08 13	0.82	*	11.35	5.62	0.80	2.57	2.30	3.57	0.79
75th percentile	7.52	13.44	31.93	14.52	14.45	16.60	8.36	16.90	5.76
Risk quantification									
value	0.23	0.41	0.97	0.44	0.44	0.50	0.25	0.51	0.17

Table 10.1.1 Summary of exposure values with 75th percentile values used for the assessments (badge monitoring data)

*Data set discarded. Variation between different sampling methods is not acceptable. As no specific data point can be identified as erroneous, the complete data set is discarded

10.1.2 Consumer

There are no consumer uses of trichloroethylene

10.2 ENVIRONMENT (COMBINED FOR ALL EMISSION SOURCES)

10.2.1 All uses (regional scale)

10.2.1.1 Total releases

The total releases to the environment from all the exposure scenarios covered are presented in the table below. This is the sum of the releases to the environments from all exposure scenarios addressed.

Table 10.2.1 Total releases to the environmen	nt per year from all life cycle stages
---	--

Release route	Total releases per year
Water	0.994 kg/year
Air	4.61E4 kg/year
Soil	0 kg/year

10.2.2 Regional assessment

The regional predicted environmental concentration (PEC regional) and the related risk characterisation ratios when a PNEC is available are presented in the table below. The exposure to man via the environment from regional exposure and the related risk characterisation ratios are also provided (when relevant). The exposure concentration for human via inhalation is equal to the PEC air.

The exposure estimates have been obtained with EUSES 2.1.2 unless stated otherwise.

Protection target	Regional PEC	Risk characterisation
Fresh water	Regional PEC: 1.01E-8 mg/L	RCR < 0.01
Sediment (freshwater)	Regional PEC: 1.87E-7 mg/kg dw	RCR < 0.01
Marine water	Regional PEC: 2.73E-9 mg/L	RCR < 0.01
Sediment (marine water)	Regional PEC: 4.86E-8 mg/kg dw	RCR < 0.01
Air	Regional PEC: 2.19E-6 mg/m ³	
Agricultural soil	Regional PEC: 2.88E-8 mg/kg dw	RCR < 0.01
Man via environment - Inhalation (systemic effects)	Concentration in air: 2.19E-6 mg/m ³	RCR < 0.01
Man via environment - Oral	Exposure via food consumption: 1.39E-9 mg/kg bw/day	RCR < 0.01
Man via environment - combined routes		RCR < 0.01

Table	10.2.2	Predicted	regional	exposure	concentrations	(Regional	PEC)	and
risks f	for the e	environme	nt					

Remarks on risk characterisation for regional concentrations:

The regional RCRs are all <1 indicating that the risks are adequately controlled.

10.2.3 Local exposure due to all widespread uses

Not relevant as there are not several widespread uses covered in this CSR.

10.2.4 Local exposure due to combined uses at a site

Not relevant.

ANNEX – JUSTIFICATIONS FOR CONFIDENTIALITY CLAIMS





ANNEX 1 UHMWPE FIBRILS IDENTIFIED IN THE SCANNING ELECTRON MICROGRAPH

Remaining oil resides within the UHMWPE fibrils identified in the scanning electron micrograph shown in Figure A1. The UHMWPE fibrils can be thought of as "sponges" that absorb about 60% oil based on their own mass in the finished separator. It is this residual oil trapped within the UHMWPE fibrils that can *potentially* contain trichloroethylene.



Figure A1 Scanning electron micrograph that highlights UHMWPE fibrils in the battery separator. Residual oil is purposefully left behind and trapped within the fibrils.

ANNEX 2 SCHEMATICS OF THE ENTEK SEPARATOR MANUFACTURING PROCESS

Process diagram for STD separators



Process diagram for LR separators:



ANNEX 3 MEASUREMENT OF TRICHLOROETHYLENE IN FINISHED PRODUCT

Standard laboratory tests for measuring trichloroethylene in waste streams often use methanol extraction followed by gas chromatography/ mass spectrometry. Although such test procedures have been applied to battery separators, the results are inconclusive since methanol is not fully miscible with the process oil left behind in the separator. As such, one cannot be sure that any residual trichloroethylene is fully extracted. More recently, ENTEK has worked with the CH2M Hill Test Laboratory to develop a method is which carbon disulfide is used to extract all of the residual oil from the separator. The carbon disulfide /oil mixture is then further diluted and then injected into a gas chromatograph column with a Flame Ionization Detector (FID) to determine if any trichloroethylene is present. Calibration of the system for trichloroethylene has shown that threshold detection limits of 20 ppm can be achieved.

As a first step, virgin ENTEK process oil was analysed using the above procedure and no trichloroethylene was detected. Next, a CH2M Hill technician purposefully doped (spiked) the virgin oil with a known amount of trichloroethylene and two separate aliquots were analysed as shown in **Table A3.1.** The recovery was 70% and 100% of the theoretical trichloroethylene value for the first and second aliquots, respectively. This degree of recovery is typical and considered acceptable for gas chromatography / FID.

TableA3.1Carbondisulfideextractionandanalysisofvirginandtrichloroethylene-dopedENTEK oil

				Initial	Final	Extraction	Instrumental	Final	True	
	Analysis			Mass	Mass	Volume	Result	Result	Value	Recovery
Date	Time	Sample ID	Client Sample ID	(g)	(g)	(mL)	(mg/L)	(mg/kg)	(mg/kg)	(%)
6/2/2014	16:17	N194303	Entek Oil	5.08	NA	20	ND	ND	ND	NA
6/2/2014	16:30	N194303MS ¹	Entek Oil	5.52	NA	20	257	931	1322	70
6/2/2014	16:43	N194303MSD	Entek Oil	5.49	NA	20	366	1333	1330	100

1 = Entek 800 Oil spiked with 5 uL of neat TCE. Matrix Spike Duplicate (MSD) analysis performed on a second aliquot of the oil.

Using this same procedure, CH2M Hill analysed four separators manufactured at the UK plant during June 2014. A sample was taken from each production line, immediately sealed in a metal container, and then the containers were shipped on dry ice to the CH2M Hill test laboratory in Corvallis, Oregon, USA. The test results are shown in **Table A3.2**.

Table A3.2 Carbon disulfide extraction and analysis of ENTEK separators from UKplant (June 2014)

					Initial	Final	Extraction	Instrumental	Final	Final		
	Analysis				Mass	Mass	Volume	Result	Result	Result	Mass	Recovery
Date	Time	Sample ID	Client Sample ID	Separator Profile	(g)	(g)	(mL)	(mg/L)	(mg/kg)	(%)	Loss (%) ¹	(%)
6/19/2014	16:59	N208601	L217JY81 LTD 1	162-0.15-0.70 GE	6.06	5.29	60	<2	< 19.8	ND	12.8	NA
6/19/2014	17:13	N208602	L217HJ71 LTD 2	162-0.15-1.2 GE	6.18	5.41	60	<2	<19.4	ND	12.5	NA
6/19/2014	17:26	N208603	L215D321 LTD 3	161-0.2-1.4 GE	6.12	5.21	60	6.21	60.9	0.0006	14.9	NA
6/19/2014	17:39	N208604	L2157211 LTD 4	117-0.2-0.8 GE	6.30	5.36	60	< 2	< 19.1	ND	14.9	NA
6/20/2014	14:11	N208603MS ²	L215D321 LTD 3	161-0.20-0.8 GE	6.28	5.43	60	122	1166	0.01	13.5	100%

Carbon Disulfide Extraction of TCE from Battery Separators 6/19/14¹

1 = Analysis performed after a 30 min extraction and again after 18 hr of extraction. Similar results obtained. The 30 min results have been reported.

2 = Both samples labeled "MS" spiked with 5 uL of neat TCE. TV = 122 ug/L

The separator mass was recorded both before and after carbon disulfide extraction to determine the percentage of oil that was extracted. The mass losses shown in **Table A3.2** are within the specification range; therefore, it is expected that any potential trichloroethylene was transferred to the carbon disulfide solution. Trichloroethylene was detected in only one of the four UK separators and at a very low level (~ 61 ppm). As a further check on the validity of this analytical procedure, a separator was purposefully doped with 5 microlitres of trichloroethylene and then analysed after carbon disulfide extraction. As shown at the bottom of **Table A3.2**, trichloroethylene was detected at the expected level (i.e., 100% recovery).

Based upon these initial results, the CH2M Hill laboratory further validated the test method for a detection limit of 10 ppm trichloroethylene in the separator. **Table A3.3** shows the results for a variety of separator profiles manufactured at the ENTEK-UK plant during July 2014. In all cases, there was no measurable trichloroethylene in any of the samples even at the lower detection limit.

Table A3.3 Carbon disulfide extraction and analysis of ENTEK separators from UKplant (July 2014)

				Initial	Final	Extraction	Instrumental	Final	Final	Mass	
	Analysis			Mass	Mass	Volume	Result	Result	Result	Loss	Recovery
Date	Time	Sample ID	Client Sample ID	(g)	(g)	(mL)	(mg/L)	(mg/kg)	(%)	(%)	(%)
7/22/2014	16:59	N228501	L2157211 117x0.8x0.2 GE	6.24	5.64	60	<1	< 9.6	ND	9.6	NA
7/22/2014	17:13	N228502	L2195T71 162x0.9x0.15 GE	6.23	5.48	60	<1	<9.6	ND	12.0	NA
7/22/2014	17:26	N228503	L2169E11 161x0.8x0.25 GE	6.20	5.45	60	<1	<9.7	ND	12.1	NA
7/22/2014	17:39	N228504	L216HL21 161x1.3x0.2 GE	6.13	5.28	60	<1	< 9.8	ND	13.9	NA
7/22/2014	18:06	N208606	L219BP81 162x0.8x0.15 GE	6.13	5.44	60	<1	<9.8	ND	11.3	NA

Carbon Disulfide Extraction of TCE from Battery Separators 7/22/14¹

1 = Analysis performed after a 30 min extraction and again after 4 hr of extraction. Similar results obtained. The 30 min results have been reported.

While further measurements will be made to better understand the impact of process conditions (e.g., drying oven temperature and residence time) and separator ageing on residual trichloroethylene, it is reassuring that the quantities measured to date have been low. Furthermore, because the trichloroethylene is dissolved in the oil that is trapped within the UHMWPE fibrils of the polymer matrix, exposure/release of trichloroethylene from the finished product is very limited (see Annex 1 for scanning electron micrograph of the finished product).

ANNEX 4 ILLUSTRATION OF A LEAD-ACID BATTERY SEPARATOR.



ANNEX 5 - SCHEMATIC OF THE ENTEK FACTORY SHOWING LOCATION OF STATIC SEMI-CONTINUOUS (VARA) AND BADGED MONITORING WORKER POSITIONS.



Table A5.1 Badge location names and height from the factory floor

Sampling point name	Analyse r	Port number	ID number on map	height from floor (inches)	height from floor (cm)	
Line 1 Slitter Rack	А	1	1,1	38	96	
Line 2 Slitter Rack	А	2				
Line 7 Slitter Rack	А	3				
Line 8 Slitter Rack	А	4				
Line 1 & 2 Enclosure	А	5	1,2	34	86	
Line 7 & 8 Enclosure	А	6	1,3	12	30.5	
Oven exit line 1	А	8	1,4	12	30.5	
Enclosure 7 & 8 SLA Duct	А	10				
Pelletiser (above gray silo)	В	1	1,7	263	668	
L7 Distillation Skid	В	2				
L8 Dsitialltion Skid	В	3				
Lines 1&2 extruder	В	5	2,5	240	609	
Lines 7&8 extruder	В	6	2,6	94	238	

Sampling point name	Analyse Port		ID number on	height from floor	height from floor	
	r	number	map	(inches)	(cm)	
Dust collection extraction (DCE) 1;A10	В	7	2,7	120	304	
Dust collection extraction (DCE)2;A9	В	8	2,8	96	243	
PAQ oil mist lines 1&2; A6	В	9	2,9	264	670	
PAQ oil mist lines 7&8;A5	В	10	2,10	264	670	
Laminator unwind	В	11	2,11	63	160	
SLA L1	С	1				
SLA L2	С	2				
Air Stripper	С	3				
SLA 7 & 8	С	4				
Drier Condensor L7 & L8 combined	С	5				
SLA Before fans	С	6				
SLA After Vacuum Plant	С	7				
SLA After Fans	С	8				
SLA L7	С	9				
SLA L8	С	10				
Main Stack; A12	D	1	4,1	429	1089	

Sampling point name	Analyse r	Port number	ID number on map	height from floor (inches)	height from floor (cm)
lab	F	1	6,3	67	1701
Line 1 winder	F	2	6,1	81	254
Line 2 winder	F	3	6,2	81	254
Zerma Enclosure	F	4			
Line 7 winder	F	5	5,1	78	198
Line 8 winder	F	6	5,2	79	200
Above Lines 7&8 winders	F	7	5,4	115	292
Above lines 1&2 winders	F	8	2,1	158	401

Key:

sampling point and ID number outside building sampling point

ANNEX 6 – DETAILS OF OPERATING PROCEDURES FOR RESPIRATORY PROTECTIVE EQUIPMENT AT ENTEK NEWCASTLE FACILITY

Updated procedure for the use and requirements of Respiratory Protective Equipment (RPE):

OHSAS Management System			Process Reference	HSP080 HSE Manager	
			Process Owners		
9				Pages	Page 1 of 3
Revision	Dute	Revised By	Process	Initial Release Date	31/10/14
2	15 Nov 2017	J McManus	Respiratory Protective Equipment	Originator	A Rennie

PROCESS

Uncontrolled when printed or saved onto personal hard drive/ USB stick. It is the employee's responsibility to ensure use of the correct version

1. PURPOSE

This procedure explains the health and safety arrangements for the use and control of respiratory protective equipment (RPE) for protection against airborne contaminants including:

- Organic Vapour (Trichloroethylene)
- Oil Mist/Smoke
- Dust Particulate (Silica\Additive\Polymer\General Dust)

2. SCOPE

The Entek International Ltd plant in Killingworth, Tyne & Wear.

3. RESPONSIBILITIES

Plant Manager is responsible for ensuring suitable and sufficient resources are available with respect to RPE to minimise risk to employees, contractors & visitors.

Managers/Supervisors are responsible for ensuring their direct reports, inc. contractors and visitors, wear the appropriate RPE.

Health & Safety Manager is responsible for conducting documented monthly inspections and calibrations of all powered air respirators (PAR) on site.

All Employees are responsible for following RPE training they have been provided and ensuring they inspect & maintain their RPE and report any issues both with their individual RPE or any shared RPE e.g. PAR.

4. PROCEDURE

4.1. General

Only respirators approved and supplied by Entek International Ltd are to be used by employees. The selection of respirator will depend on the individual employees duties, as will the life expectancy and limitations of the respirator cartridges (as identified by the respirator manufacturer). Each employee that requires a respirator will be issued one at the company's expense with replacement parts, cartridges and filters upon request.

All employees must wear approved RPE, properly fitted, at all times whilst performing hazardous operations or working in, or in the immediate vicinity of, hazardous environments.

The following operations/areas are considered hazardous and so require a form of RPE:

- Working in "Enclosures" for Lines 1/2 or Lines 7/8 (half face respirator with A2 filter or PAR)
- When SLA/Environmental Alarm sounds (half face respirator with A2 filter or PAR)

OHSAS Management System			Process Reference	HSP080	
			Process Owners	HSE Manager	
5	CIVIER	•		Pages	Page 2 of 3
Revision	Dute	Revised By	Process	Initial Release Date	31/10/14
2	15 Nov 2017	J McManus	Respiratory Protective Equipment	Originator	A Rennie

- Entering the Carbon Beds (half face respirator with A2 AND P3 filter or PAR)
- Whenever specific areas are identified as having TCE levels above 6.7ppm (half face respirator with A2 filter or PAR)
- Charging hoppers etc. by hand with silica/polymer (half face respirator with P3 filter, disposable P2/3 mask or PAR)
- · Handling/working with open containers of additive (PAR)

Other operations/areas which may require RPE depending on the conditions;

- Chemical Spill Clean-Up (half face respirator with A2 filter or PAR)
- Repair of TCE Piping and Equipment (half face respirator with A2 filter or PAR)
- Bag-House Bags Changing (half face respirator with P3 filter/or disposable P2/3 mask)
- Silica Sampling (half face respirator with P3 filter or disposable P2/3 mask)

4.2. Training Of Employees

Where appropriate all employees will be trained in the selection, use and maintenance of the various forms of RPE. Records of which will be retained.

4.3. Fitting of Respirators

Proper fitting of respirators is essential if employees are to receive the necessary protection. Air which passes around the edges of the respirator, rather than through it, is not filtered air. In order to ensure a good face seal, the following rules must be followed:

- The respirator and straps must be in place and worn in the appropriate position. All straps shall be secure.
- 2. Modification to the respirator or straps shall not be made.
- Proper fit must be checked each time that the respirator is worn according to the manufacturer's instructions.
- 4. Half/full face respirators and disposable masks require a full face seal in order to work effectively. Therefore all Entek Killingworth personnel MUST be clean shaven. This will include beards, goatees and stubble. Moustaches and sideburns are permitted provided they do not encroach on the seal of the mask.
- To ensure RPE is effective for all individuals formal quantitative fit tests will be conducted for all relevant Entek employees when they first join the company and then at routine intervals, the standard being every 3 years. Records of quantitative fit tests will be retained. Additional fit tests will be conducted if an employee;
 - o Loses or gain significant amounts of weight
 - Undergoes substantial dental work
 - Develops any facial changes around the seal of the mask e.g. moles, scars etc.
 - In the event an employee is unable to obtain a satisfactory fit with the type of respirator furnished, Entek will make efforts to correct the problem.

OHSAS Management System			Process Reference	HSP080 HSE Manager	
			Process Owners		
5	CIVIER	•		Pages	Page 3 of 3
Revision	Dute	Revised By	Process	Initial Release Date	31/10/14
2	15 Nov 2017	J McManus	Respiratory Protective Equipment	Originator	A Rennie

6. Contractors who require respirators given the nature of their activity or the area they are to work in will be responsible for providing their own respirators and suitable filters. Contractors will also be required to provide evidence of qualitative/quantitative fit tests for the RPE to be used. It is the responsibility of the Entek contact to ensure this is the case.
NB If Contractors de pathematication of the test of the test.

H Contractors do not/cannot provide evidence of fit tests or do not have RPE Entek may choose to provide PAR which does not require fit tests due to the positive pressure, or Entek may conduct internal qualitative fit tests and provide the relevant half face masks & filters

4.4. Maintenance of Respirators

RPE must inspected prior to each use to ensure they are still in good order. If faults are found with the RPE they are not to be used and instead quarantined/disposed of a replacements sought.

RPE must be cleaned as per HSP86 Full & Half Face Mask and Air Fed Hood Cleaning Instructions.

RPE must be stored in a manner that will prevent damage and contamination.

Poster of Personal Protective Equipment (PPE) requirements when entering the enclosures:

ENTEK

ENTERING THE ENCLOSURES – ENTEK EMPLOYEES Personal Protective Equipment (PPE) Requirements



THESE ARE MINIMUM REQUIREMENTS. OBSERVE SAFE WORKING PROCEDURE FOR ENTERING ENCLOSURES WITH RESPECT TO WHEN TO USE POWERED AIR RESPIRATORS

ENTEK EMPLOYEES MUST KEEP THEIR HALF FACE MASK AT THEIR WORKSTATION AT ALL TIMES.

Locations; Enclosure Doors – Winders, Extruders & Side Doors

ENTERING THE ENCLOSURES – VISITORS/CONTRACTORS Personal Protective Equipment (PPE) Requirements



Locations; Enclosure Doors – Winders, Extruders & Side Doors

Procedure for the use, care and maintenance of masks:

	Line Number / Position:	ALL			
Revision Date	Revised By	SOP #	SOP NAME	Initial Release Date:	10/02/10
07/09/18	J McManus	140-004	PROCEDURES FOR THE USE, CARE AND MAINTENANCE OF POWERED AIR RESPIRATORS	Originator:	B Trum
Purpose	To ensure po	wered air respir	ators are used and maintained accordingly		
Scope Site			222413		
	Responsibilities All personnel				

1.1 The following PPE is mandatory whilst completing this task:

	Powered Air Respirators required; - In enclosure for extended periods/elevated levels of TCE (A2P3 filter) - When handling additive (A2P3 filter) - Investigating ammonia leak in chiller room (A2BEK1P filter)	3	Safety Footwear Required; - In Production areas - In Warehouse - In Laboratory - In all Yard areas
0	Ear Defenders Required; - In Production areas inc. internal ancillary areas – Boiler room, Day Bins, Silos etc. - In external ancillary equipment areas e.g. Vara When hearing protection is used in conjunction with powered air respirator hoods the use of ear plugs is permitted		

2.0 KEY POINTS & NOTES

:

2.1 Health & Safety Key Points

- H&S: Ensure you use PPE as detailed in this SOP as appropriate. H&S: Ensure that all H&S Control measures are followed.
- 2.2 Environmental Key Points
 - ENV: Small spills should be dealt with immediately using appropriate PPE and rags. Used rags containing oil should be placed in the oily rag bin. Other used rags should be placed in a general waste skip. ENV: Larger spills are to be contained with the use of the site spill kits and inform supervisory team immediately .
 - .
- 2.3 Quality Key Points
 - QUAL: Quality Control is the responsibility of ALL Entek employees and as such removes risk to our customers. •

2.4 Notes

. Notes can be used within the procedure to aid understanding.

PROCEDURE 3.0

Jupiter Powered Air Turbo Respirators are found in the Respirator Protection Equipment lockers (Photo 1) at various locations across site and also the Supervisors' Office (Photo 2). 3.1



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Jon Hollance	Jos Hollasus	Dennis Herrist
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STANDARD OPERATING PROCEDURE			Line Number / Position:	ALL	
Revision Date	Revised By	SOP #	SOP NAME	Initial Release Date:	10/02/10
07/09/18	J McManus	140-004	PROCEDURES FOR THE USE, CARE AND MAINTENANCE OF POWERED AIR RESPIRATORS	Originator:	B Trump

Key components (Photo 3) of the 3M Jupiter Powered Air Turbo Respirator MUST remain together in the Respirator Protective Equipment (RPE) 3.2 storage locations at all times



Powered air respirators are available to use for all personnel in conjunction with a powered air respirator hood (Photo 4). They are positive pressure and so no face fit test is required for their use. 3.3



- 3.4 Main filter types for use with powered air respirators;
- A2P3 (brown and white banding) (Photo 5) Suitable for working with additive, working in enclosures, working in dusty environments (list not exhaustive) Protect against solvent vapour, i.e. trichloroethylene (TCE) and dusts H&S: A2P3 filters MUST NOT be used where TCE levels are above 1000ppm

 - .
- A2B1E1K1P (brown, grey, yellow, green & white banding) (Photo 6)

 Suitable for working in chiller room investigating ammonia leaks (list not exhaustive)
 Protect against solvent vapour, i.e. trichloroethylene (TCE), ammonia and dusts
 H&S: A2B1E1K1P filters MUST NOT be used where TCE levels are above 1000ppm or ammonia levels above 300ppm





- 3.5 Prior to use all parts and fittings MUST be inspected for wear/tear & damage
- H&S: If any parts are found to be faulty they MUST NOT be used. The Supervisor MUST be informed and parts replaced 3.6
- 3.7 Hose - (Photos 7 & 8)

(Photo 7)

.

- Insert bayonet end of hose into pack. Turn clockwise to lock into place.
- .



- 3.8 Filters (Photos 9 & 10)
 - Remove plastic cover of A2P3 filter and place pre filters on top Replace plastic cover .
 - . Insert filters into pack

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_	STANDARD OPERATING PROCEDURE						ALL
evisio	on Date	Revised By	SOP #	SOP NAM	ЛЕ	Initial Release Date:	10/02/1
07/0	9/18	J McManus	140-004	PROCEDURES FOR THE	USE, CARE AND	Originator:	B Trum
	(Photo 9)		(Phot				
3.9	Battery – (f	Photo 11) sert battery into bottom	of the pack until i	clicks into place			
3.10	Turn Unit C • Pi • G • H)n ress power button once reen power light should &S: If it does not or b:	– (Photo 12) appear – (Photo attery alarm appe	13) ars the battery requires chargin	ıg – (Photo 14)		
	(Photo 12)	() ()	(Phot	9 13) 	(Photo 14)		
3.11	Test Air Flo W TI	w Alarm hilst the unit is running he filter alarm should so &S: If the alarm flashe tters. If the alarm still	cover the open er ound and flash – (f s without coveri sounds quarantin	d of the hose with your hand – (P Photo 16) ng the hose try replacing the pr le the unit and inform your Supe	hoto 15) e filters. If the alarm sti ervisor	ill sounds try replaci	ng the Al
	(Photo 15)	5	(Phot				
3.12	Check Filte	r lith the unit turned on sr &S: If you detect the s	nell the air leaving mell of a contam	the end of the hose inant dispose of the filters and	replace with new filters		
3.13	Attach pow	ered air respirator hood	l by clipping it on t	o the open end of the hose			
3.14	After Use R R Pi Pi	emove powered air res emove the battery by lif lace battery on charge r lace rest of unit in RPE	pirator hood ting retaining clip eady for the next Locker.	- (Photo 17) Jse			
5	OP Proc	ess Owner	Heal	th, Safety & Environment	Chang	e Manageme <u>nt I</u>	eader
	Jer He	Marca		Jos- Mollas-ca		Dennis Herrist	
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STANDARD OPERATING PROCEDURE				Line Number / Position:	ALL
Revision Date	Revised By	SOP #	SOP NAME	Initial Release Date:	10/02/10
07/09/18	J McManus	140-004	PROCEDURES FOR THE USE, CARE AND MAINTENANCE OF POWERED AIR RESPIRATORS	Originator:	B Trump



- 3.15
 Location of replacement parts;

 •
 Hood PPE stores

 •
 A2P3 filters PPE stores

 •
 A2P3 filters see H&S Manager

 •
 Pre filters PPE stores

 •
 Hose see H&S Manager or Purchasing/Warehouse Supervisor

 •
 Battery see H&S Manager or Purchasing/Warehouse Supervisor

 •
 Charger see H&S Manager or Purchasing/Warehouse Supervisor

 •
 Belt see H&S Manager or Purchasing/Warehouse Supervisor

 •
 Powered air respirator unit see H&S Manager or Purchasing/Warehouse Supervisor

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Procedure to reduce exposure through the correct use of respirators

S	TANDARD OF	Line Number / Position:	ALL Winder & Extruder		
Revision Date	Revised By	SOP#	SOP NAME	Initial Release Date:	26/06/18
07/09/18	J McManus	140-020	3M Half Face Respirator – Use	Originator:	J McManus
Purpose	To ensure mini	mise exposure to ha	zardous airborne contaminants through the c	orrect us of 3M haif face res	pirators
Scope 3M Half Face R		tespirators			
Responsibilities All Employees					

PPE REQUIREMENTS 1.0

1.1 The following PPE is mandatory whilst completing this task:

•	Half face mask respirators required; - When entering the enclosures - When solvent laden sheet is at the winders - When manually loading powered ingredients to hoppers - List not exhaustive	Safety Footwear Required; - In Production areas - In Warehouse - In Laboratory - In all Yard areas
0	Ear Defenders Required; - In Production areas inc. Internal ancillary areas – Boiler room, Day Bins, Silos etc. - In external ancillary equipment areas e.g. Vara Ear plugs permitted when conducting non routine tasks in the enclosure e.g. roller change outs etc.	

2.0 **KEY POINTS & NOTES**

2.1 Health & Safety Key Points

- H&S: Ensure you use PPE as detailed in this SOP as appropriate. H&S: Ensure that all H&S Control measures are followed. ٠

2.2 Environmental Key Points

- ENV: Small spills should be dealt with Immediately using appropriate PPE and rags. Used rags containing oil should be placed In the oily rag bin. Other used rags should be placed in a general waste skip. ENV: Larger spills are to be contained with the use of the site spill kits and inform supervisory team immediately . .
- 2.3 Quality Key Points
 - . QUAL: Quality Control is the responsibility of ALL Entek employees and as such removes risk to our customers.

2.4 Notes

. Notes can be used within the procedure to aid understanding.

3.0 SETUP

- 3.1 Standard Issue components of a 3M filter respirator include;
 - Half face mask (Photo 1) ٠
 - 2 x A2 organic vapour filters (Photo 2) 2 x P3 particulate filters (Photo 3) .
 - ٠ . 2 x P3 filter retainers (Photo 4)

Photo 1 Photo 2 Photo 3 Photo 4 11

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	ST	ANDARD OF	PERATING	PROCEDURE	Position:	& Extrude
vision D	late	Revised By	SOP#	SOP NAME	Initial Release Date:	26/06/18
07/09/18	3	J McManus	140-020	3M Half Face Respirator – Use	Originator:	J McManu
	• A2 0 0	Protect against (Suitable up to required at elev Mandadory, whe solvent alarm so H&S: A2 filters	Photo 2) solvent vapour e.g. t 1000ppm however e ated TCE levels- SC en entering the encl ounds, when winder MUST NOT be use	fichioroethylene re inflation may occur at a lower level an IP 140-004) osures, during startups at the Winders emissions exceed 10ppm – list not exhau d where TCE levels are above 1000pp r	d so powered air respirators w with solvent laden sheet, when stive n	ith hoods may
	• P3 0 0 0	Paroculate Fitters (Photo Protect against Mandatory; Ma polymer station, exhaustive Disposable dusi H&S: P3 fitters must be used -	10 3) fine dusts and mists nually adding powd , emptying dust colle t filters also optional with haif face mas - see SOP 140-004	ered ingredients e.g. polymer, silica et ctors, draining sprinkier system (due to r k MUST NOT be used when handling	:. to hoppers, changing buik isk of legionella bacteria in wat addittive. Powered alr reapira	polymer bags er mist) – list tors with hoo
3.3 /	Attaching F	liters				
	• P3 0	filter to A2 filter Place P3 partice Place retainer o	ulate filter on top to A wer top of P3 filter an	2 filter – Blank side up (Photos 5 & 6) Id clip into place	nk Side Un	
	• A2	filter to mask Align notches o Push filter on to % Clockwise tur Do both sides (i	n filter (Photo 7) to fr bayonet fitting (Phot in to lock filter in plac	ont of mask (Photo 8) o 9) e – filter will "click" when in place		
		Do boar aldes (Dhoto 8	Dhoto 0	Photo 10	
		04 +A12008 A2	R		R	7
HOW	TO FIT					
the second s						

NEVER hold you mask in place. ALWAYS fit correctly.

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Les Partieres-	Jos Hillionso	Derais Hassist
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& Extruder	Line Number / Position:	STANDARD OPERATING PROCEDURE					
ase Date: 26/06/18	Initial Release Date	SOP NAME	SOP#	Revised By	Revision Date		
J McManus	Originator:	3M Half Face Respirator – Use	140-020	J McManus	07/09/18		
	Initial Relea	SOP NAME 3M Half Face Respirator – Use	SOP # 140-020	Revised By J McManus	Revision Date 07/09/18		



4.2 When first fitting the half face respirator loosen all 4 straps

4.3 Make sure the "quick release" mechanism is in the down position (Photo 11 & 12)



4.4 Place cradie on the crown of the head (Photo 15.1) - cradie can be adjusted to sult (Photo 13 & 14)



- 4.5 Place face piece over nose & mouth
- 4.6 Attach "bottom" straps behind the neck (15.2)
- 4.7 Tighten top straps (15.4) first so top of mask rests on the bridge of the nose (15.4)
- 4.8 Tighten straps behind neck so mask fits firmly but comfortably



5.0 FIT CHECK

- 5.1 H&S: Fit checks MUST be conducted each time a mask is put on to ensure there is a good seal
- 5.2 Place paim of hand over exhalation valve careful not to move the mask and thus breaking the seal (Photo 16)

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STANDARD OPERATING PROCEDURE				Line Number / Position:	ALL Winder & Extruder
Revision Date	Revised By	SOP#	SOP NAME	Initial Release Date:	26/06/18
07/09/18	J McManus	140-020	3M Half Face Respirator – Use	Originator:	J McManus

5.3 Exhale gently

- 5.4 Proper seal; Face piece should buige slightly No air leaks should be detected between face and face piece

5.5 If not;

- Reposition respirator Adjust tension on straps Recheck .
- .

5.6 If still no seal DO NOT enter hazardous area – Inform Supervisor/ Health & Safety Manager



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Procedure to clean and maintain RPE:

OHSAS I	Managen	nent System	Process Reference	HSP086	
PENTEK				Process Owners	HSE Manager
9 EITTER				Pages	Page 1 of 2
Revision	Date	Revised By	Process	initial Release Date	17/11/16
1			Full & Half Face Mask and Air Fed Hood Cleaning Instructions	Originator	J McManus

1. Scope & Purpose

To ensure reusable respiratory protective equipment (RPE) is cleaned and maintained as per manufacture instructions reducing the likelihood of any hygiene issues occurring through its use.

2. Responsibility

All employees are responsible for the routine inspection and cleaning of their own RPE.

3. Procedure

3.1. Interim Cleaning Schedule

•	Antibacterial wipes are suitable for regular, e.g. start or end of each shift, cleaning of full/half face masks and air fed hoods.	
•	Wipe parts of face piece, cartridges & filters do not need wiping.	

3.2. Monthly Cleaning Schedule

- All full & half face masks and air fed hoods should undergo a thorough monthly clean
- NEVER CLEAN WITH ORGANIC SOLVENTS

3.2.1.Full & Half Face Masks

ALL CATRIDGES & FILTERS MUST BE REMOVED BEFORE A THOROUGH CLEAN

	Make up a 0.5% solution of disinfectant with warm (no greater than 50°C) water e.g. 50ml per 10ltr.	10
•	Once cartridges and filters have been removed, immerse the face mask/hood in the cleaning solution and clean gentle with a soft brush.	
•	Rinse the mask in fresh warm (no greater than 50°C) water and leave to air dry.	
•	MB If mask has significant soiling a pre-hand wash may be required with a neutral household soap and soft brush.	

OHSAS Management System				Process Reference	HSP086
				Process Owners	HSE Manager
				Pages	Page 2 of 2
Revision	Date	Revised By	Precess	initial Release Date	17/11/16
1			Full & Half Face Mask and Air Fed Hood Cleaning Instructions	Originator	J McManus

3.2.2. Powered Air Respirator Hoods

SWEATBAND MUST BE REMOVED BEFORE A THOROUGH CLEAN

 Make up a 0.1% solution of neutral household soap with warm (no greater than 50°C) water e.g. 10ml per 10ltr. 	
Wipe, DO NOT SUBMERGE, with a clean cloth laced	

3.3. Storage

•	When not in use full & half face masks and air fed hoods should be stored in designated PPE bags or other suitable storage container to prevent contamination between uses.	
		1
Use of timers for timed work inside enclosures.

s	TANDAR		ATING PROCEDURE	Line Number / Position:	SHAREPOINT
Revision Date	Revised By	SOP #	SOP NAME	Initial Release Date:	29/04/21
29/04/21	Jack Dixon	140-039	Entering and Working in Enclosures	Originator:	Jack Dixon
	51 65				

 The table below indicates acceptable levels based on time spent inside enclosures and the TCE emission levels measured. Maximum work times must
be adhered to by recording the time in which the enclosures are entered using the clocks displayed at either end of each enclosure. Personnel must exit the

	Maximum Work Time	PPM (Parts Per Million)	RPE Type (Respiratory Protective Equipment)	Minimum Break Time	Maximum Repeat Exposure
	< 90 minutes	< 500	Half Mask & A2 Vapour Filters	15 Minutes	Unlimited
>	90 - 180 minutes	500 - 999	Powered Air Respirator	15 Minutes	Unlimited
	> 180 minutes (Prohibited without a minimum break of 15 minutes)	> 1000	Enclosure Access Er	Prohibited - Leave Imm ngineering / Manageme	ediately & Notify nt

enclosures once the maximum working times are reached.

The above relates to normal circumstances only. You should immediately remove yourself from the danger area to fresh air and change your A2 vapour filters should you experience odour breakthrough at any time.

3.2 Post Task:

- Personnel must inform a colleague that they have left the enclosure
 The Line Manager or Supervisor in charge must also be notified of the completion of tasks
 All powered air respirators should be disinfected and returned to storage lockers and the battery placed on charge
- 3.3 TCE Monitoring Protocol:
 - Work Instruction 140-034 Exposure Monitoring Protocol will be carried out periodically to ensure that the workplace exposure limits are not exceeded when entering the enclosures.
- Visitors & Contractors: 3.4
 - Visitors and contractors are permitted to enter the enclosures wearing a half face mask as long as they are in possession of both:

 A half face mask fitted with A2 vapour filters
 A valid face fit test certificate
 Those not in possession of either of the above MUST enter the enclosures wearing an air powered respirator.

 ENTEK International Ltd may choose to subject 'resident' contractors to a face fit test and supply a half mask to work in the enclosures. This will be at the discretion of the SMT.

SOP Process Owner	Health, Safety & Environment	Change Management Leader
Jack Diego	Jack Diecor / Paul Steadman	Dennis Herritt
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Safe Working Practices Entering and Working in Enclosures

5	TANDA	Line Number / Position:	SHAREPOINT		
Revision Date	Revised By	d By SOP # SOP NAME		Initial Release Date:	29/04/21
29/04/21	Jack Dixor	140-039	Entering and Working in Enclosures	Originator:	Jack Dixon
Purpose To ensure employee/contractor/visitor exposure to TCE emissions is cont enclosures			o when entering and working	Inside	
Purpose	en	Scope Line 1&2 and 7&8 enclosures			
Purpose Scope	en Lir	e 1&2 and 7&8 enck	osures		

1.1 The following PPE is mandatory whilst completing this task:

	Foot protection is a requirement in all production areas	Eye protection is a requirement in all production areas
0	Hearing protection must be worn inside enclosures	Nitrile gloves must be worn inside enclosures
B	A half face mask fitted with A2 vapour filters must be worn as a minimum at all times inside enclosures	Powered air respirators must be worn on certain occasions as detailed in section 3.1 inside enclosures
	Full Length Sleeves such as loose sleeves (work jacket) or Tyvek sleeves must be worn at all times inside enclosures	

2.0 KEY POINTS & NOTES

- 2.1 Health & Safety Key Points

 Ensure that Personal Protective Equipment (PPE) & Respiratory Protective Equipment (RPE) are worn as detailed in this SOP
 regardless of duration spent within enclosures.

 Ensure that all times.
- 2.2 Environmental Key Points
 - Small spills should be dealt with immediately using appropriate PPE and rags. Used rags containing oil should be placed in a hi-pod. Other used rags should be placed in a general waste skip. Larger spills are to be contained with the use of the site spill kits and inform supervisory team immediately.

2.3 Quality Key Points

Quality Control is the responsibility of ALL Entek employees and as such removes risk to our customers.

3.1 Before Task:

3.0 PROCEDURE

- The Personal Protective Equipment (PPE) / Respiratory Protective Equipment listed (RPE) in section 1.1 must be worn by all personnel when entering the enclosures regardless of duration. A visual inspection of all PPE/RPE must be carried out before use to ensure it is in sound working order. Replace any damaged or defective items before entering enclosures.
- Managers, Supervisors and Lead Hands are responsible for organising extended tasks within the enclosures and must ensure all personnel involved fully understand the work schedule.
- The TCE concentration levels within the enclosure must be determined prior to entry. This will indicate the level of RPE required for the task. The TCE levels will be measured in Parts Per Million (PPM) and can be viewed using the monitor at the extruder and winder entrance to each enclosure. The levels are displayed on the following HMI screens (shown below):
 - Line 1&2 extruders Extruder overview screen
 - Line 1&2 winders Winder overview screen :
 - Line 7&8 extruders Extruder overview screen Line 7&8 winders Winder overview screen •

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ANNEX 7 – SAFE WORKING PRACTICE FOR TRICHLOROETHYLENE DELIVERY AT ENTEK NEWCASTLE FACILITY

	STAND	Line Number / Position:	Vara		
Revision Date	Revised B	/ SOP #	SOP NAME	Initial Release Date:	15/10/14
07/09/18 M. Campbell-F		on 10-003	TCE DELIVERIES Originator:	Originator:	G. Ackroyd
Purpose	T	identify the steps for cor	mpleting a TCE delivery		
Scope	ppe Completed in the North Yard				
Responsibilities VARA technicians, Environmental Manager					

PPE REQUIREMENTS 1.0

1.1 The following PPE is mandatory whilst completing this task:

	Hi Visibility Clothing mandatory when working in the yard	Safety Footwear mandatory when working in the yard
	Safety eyewear to be worn when working in the North Yard	Caution when handling heavy items e.g. polymer bags Know you capabilities Adopt appropriate manual handling techniques
	Nitrile gloves to be wom as a minimum during this procedure	Work coveralls to be worn as a minimum during this procedure
0	Ear defenders must be worn when in and around the Vara/ancillary equipment in the North Yard	

KEY POINTS & NO 26

2.1 Health & Safety Key Points
 • H&S: Before TCE is transferred, the Diphoterine portable shower must be positioned in close proximity to the tanker bund as a
 health and safety precaution. It is located outside of the compressor room. The below photo is the shower (Photo 1)



2.2 Environmental Key Points

- .
- International spills are to be containing TCE should be placed in the oily rag bin (hi-pods) after TCE has evaporated. Larger spills are to be contained with the use of the site spill kits and inform supervisory team immediately Drain covers must be placed and secured on drains near solvent bund 2. The spill house containing spill materials is located in the north yard. In the event of a TCE spill, use these materials as fast as possible on the spill in line with the spill instruction located in the Vara control room and spill house. The water interceptor tank discharge valve must be shut off during TCE deliveries. The long pole used to close the interceptor is located on a t-rack adjacent to the interceptor (red arrow). To close it, place the pole in the hole and turn right to open it, turn left (Photo 2). .



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	STANDAR	Line Number / Position:	Vara		
Revision Date	Revised By	SOP #	SOP NAME	Initial Release Date:	15/10/14
07/09/18	M. Campbell-Robson	10-003	TCE DELIVERIES	Originator:	G. Ackroyd
Qualit	y Key Points QUAL: TCE must	be tested by the qua	lity control lab. Step 3.2 in the procedure	details the requirements.	

2.3 Notes .

Notes can be used within the procedure to aid understanding.

PROCEDUR 3.0

3.1 Tanker Bund

- H&S: Hi vis vest/jacket, safety glasses & safety footwear must be worn at all times in the North Yard
 H&S: Ear defenders must be worn when in and around the ancillary/Vara equipment
 H&S: Adopt appropriate manual handling techniques and use manual handling lifting aids where appropriate when assembling the tanker
- . The purpose of the tanker bund is to provide temporary secondary containment of the tanker during delivery.
- The tanker bund must be deployed before the TCE tanker arrives in the north yard. This is so there is sufficient space to set up the bund. The bund must be set up perpendicular to the solvent tank bund pointing towards the east of the site. .
- The tanker bund is located in the warehouse racking across from the production office. The environmental manager can locate it if needed. The below photo shows the tanker bund set up in the north yard (Photo 3)



- Tanker bund set up: The tanker bund consists of 4 parts
- Fabric liner Plastic bund
- Tyre tracks (2)
- · All 4 parts are neatly stored in the tanker bund box. Ensure that once the delivery is complete that all parts are neatly folded and stored in the same manner to prevent damage
- Before setting up the bund, ensure that no foreign object or debris is located on the yard that might rip the bund. Sweep the area with a brush before setting .
- before setting up the bund, ensure that no loneign object or debris is located on the yard that might hip the bund. The fabric liner must be placed on the ground first. Position the fabric liner perpendicular to solvent bund as shown below (red arrow). During windy conditions use heavy objects (e.g. bags of absorbent granules) to keep the fabric liner in place (Photo 4) The plastic bund must be placed entirely on top of the fabric liner (green arrow) (Photo 4) In order to stand up the tanker bund wall. Velcro the supports against the wall. The blue arrow points to the supports. Ensure supports at the end of the bund are flat until the tanker drives into the bund. The above photo shows the end of the bund (Photo 4)
- The last two parts, the tyre tracks, must be placed inside the tanker bund. The yellow arrow points to one of the tyre tracks placed in the bund. The second
 one must be placed in the same manner. They may have to be adjusted to ensure the tanker drives on the tyre track only and not the plastic bund (Photo 4)



Tanker bund entry:

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Revision Date	Revised By	SOP #	SOP NAME	Initial Release Date:	15/10/14
07/09/18	M. Campbell-Robson	10-003	TCE DELIVERIES	Originator:	G. Ackroyd

- Once the tanker bund is set up, walk to the south yard and tell the driver that he will be backing the tanker up into a tanker bund. The tanker shou positioned in the same manner as the bund. Ensure that there are no bends in the transfer pipe. H&S: Oversee the positioning of the tanker to ensure it does not come into contact with any equipment or any personnel enter the area .
- Ensure the outlet valve is located inside the tanker bund (Photo 5 red arrow)

Ensure the tanker drives on the tyre tracks only in the bund.

If the outlet valve cannot be positioned within the tanker bund, use the stainless steel tray and bucket stored outside the bund as a protection measure. Place the stainless steel tray and bucket directly underneath the discharge point of the TCE tanker (Photo 6)

(Photo 5)



· Once the tanker is in position, the remaining Veloro supports can be set up to finish the final tanker bund wall. Photo 7 below shows the supports set up to create the bund



3.2 Obtain a sample of TCE to test the specific gravity:

- H&S: Disposable nitrile gloves must be worn as a minimum when taking a TCE sample
- H&S: If any TCE comes into contact with the glove they must be removed and disposed of Collect a clean sample bottle from the Vara control room

- If needed, use the sample valve/adaptor which is stored on the bund wall (Photo 8) Fit the Valve/Adaptor to the tanker outlet pipe and secure with thread tape to ensure no TCE leaks through the threads. Slightly open the outlet valve and fill the sample bottle with TCE

(Photo 8)



- Take the sample to the laboratory where the Quality Technician will check the specific gravity of the sample. The specific gravity must be 1.46
 If the sample is rejected make sure the next sample bottle is clean and have another sample taken
- If the sample is still rejected then the tanker cannot transfer the TCE
- The Quality Technician will retain the accepted sample of TCE in the bottle Only three retained samples are held at any one time therefore the oldest sample should be retrieved from the lab cupboard and pour the TCE contents down the drain in the lab fume cupboard
- Store the empty and clean bottle in the Vara Control Room :
- Store the empty and clean bottle in the Varia Control Hoom
 While the sample of TCE is being checked, the driver can couple up the discharge pipe to the unloading point ready for transfer
 The unloading point is at the top of the steps into solvent bund 2. There is a tank identification plate attached to the pipes. Ensure the TCE unloading point is used (see Photo 9 below with red arrow).
 The driver MUST NOT OPEN the discharge valve or start unloading until the TCE sample has been accepted

(Photo 9)

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TANDAR	D OPERATII	NG PROCEDURE	Line Number / Position:	Vara
Revised By	SOP #	SOP NAME	Initial Release Date:	15/10/14
Campbell-Robson	10-003	TCE DELIVERIES	Originator:	G. Ackroyd
	TANDAR Revised By Campbell-Robson	TANDARD OPERATII Revised By SOP # Campbell-Robson 10-003	SOP # SOP NAME Campbell-Robeon 10-003 TCE DELIVERIES	TANDARD OPERATING PROCEDURE Line Number / Position: Revised By SOP # SOP NAME Initial Release Date: Campbell-Robeon 10-003 TCE DELIVERIES Originator:



3.3 Identifying bulk tanks to transfer TCE:

The 3 bulk tanks that accept TCE are TCE tanks 1,2&3 located in solvent bund 2. Tank 3 should be used first to accept TCE during tanker transfer. Tank 2 should only be used when Tank 1 is at capacity

- Tank 1 has a capacity of 4,000 litres It must only be filled to 90% capacity which is 3,000 litres
 Tank 2 has a capacity of 4,000 litres It must only be filled to 75% capacity which is 3,000 litres
 Tank 3 has a capacity of 20,000 litres. It must only be filled to 90% capacity which is 18,000 litres.

3.4 Determine if there is enough capacity in TCE tanks to accept the tanker load

- The Vara smart HMI screen (photo 10 below) measures TCE in litres and in kilograms present in Tanks 1,2&3
- .
- If needed, convert killingrams into itres by performing the following calculation:
 Kilograms/specific gravity (S G) = litres in the tanker: Example: 5 840 tonnes = 5840 kilos = 4000 litres approximately when S G is 1.46

(Photo 10)

		SOLVENT SYSTEM			
AT TRADE OF	1.00	BOLV TRANSFER PUMP			
CONVERSE.	MINUN	DISTILLATION FEED PUMP			
11:DAMENTS	MANUAL	DISTREATION BOTTOM PUMP			
STATES.	and the second	SOLV STORAGE PUMP 1			
DIGHTER		SOLV STORAGE PUMP 2			
91	603	204 HE SOLV HEAD TK (PROCESS)			
79	3160	4014 HE SOLV STORE TK 1 (PURE)			
78	3040	4438 HE BOLV STORE TH 2 PROCEED			
11	11 1291 1291 1184 KE SULV STORE TK S PURE				
	6904	10082 THE SOLVENT TOTAL			

3.5 Prevention of Vara system over pressurization After delivery, the tanker must vent into the VARA system. This may cause the VARA system to over pressurise. Therefore, prior to the tanker discharging, drain down the TCE Transfer Tank and isolate it.

- Check that the production lines are not going to call for TCE in the next few minutes. If so, let them obtain the TCE needed. When complete, refill the TCE Header Tank and complete the below steps.
- Turn off the TCE Production Header Tank Pumps via the selector switches on the VARA Ancillary panel (Photo 11)

(Photo 11)



· Place the TCE transfer Tank Pump into 'Manual' mode via the selector switch on the VARA control panel (Photo 12 - red arrow). Then, 'Start' the pump via the selector switch on the VARA control panel (Photo 13 - yellow arrow).



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· Walk out to the TCE Transfer Tank next to the layer tank (Photo 14 - red arrow). The tank will start to drain. Watch the sight glass and drain the tank of TCE until it reaches a minimum level of 2"-3". (Photo 15 - yellow arrow)



- · Once the TCE Transfer Tank is at the minimum level, walk back into the VARA control room and 'stop' the pump via the selector switch on the VARA control
- panel. Walk back to the TCE Transfer Tank and isolate it via the isolation valve underneath the tank. There are two TCE Transfer Pumps, one duty (Photo 16 red arrow) & one standby (Photo 17 yellow arrow). Isolate the duty pump. There should only be one valve open .





- Once the sample is accepted, discharging may proceed The driver must pressurise his tanker to 1 Bar :
- The driver should slightly open the discharge valve Check for leaks. Any leaks must be repaired before unloading. If there are no leaks, instruct the driver to discharge at 1 bar pressure

3.5 Transferring into TCE Tanks

· Identify / familiarise yourself with TCE Tanks No's 1, 2 &3 Fill Valves.



- Open TCE Tank No.3 fill valve.
- . Instruct the tanker driver to commence discharging.
- . Using the VARA HMI, observe the filling.
- Should the tanker driver discharge too quickly the system will pressurise and the VARA instrumentation be affected. Once the rate of filling has been established, return to the Vara bund and observe the delivery for any risk of TCE escaping (e.g. leak or spiil)

When Tank No 3. reaches 90% capacity • Open TCE Tank No.3 fill valve

- Close TCE Tank No.1 fill valve
- Transfer the remaining amount of TCE into tank 1. You must follow this step, if you do it the wrong way this could burst a tanker discharge pipe and cause a spill Tank 2 should not be used to accept TCE from bulk deliveries. . .

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3.6 Completing the TCE Delivery

- Once the TCE transfer is complete, restrict the tanker outlet valve
 Close the TCE tank fill valve (tank 3 or 1).
- Allow the tanker to vent the pressurised air slowly through the Vara System. Assist the driver to drain his discharge pipes into the stainless steel bucket Make sure that absolutely NO TCE leaks onto the ground .
- Hold one end of the pipe in the container while the driver disconnects the pipe, fits the end cap & drains it towards you. Once the pipe is drained fit the . other end cap
- •
- .
- other end cap Sign the driver's delivery note and retain one copy. The delivery note must be passed to a quality lab technician. Enter the amount of TCE delivered into the "TCE /Oil Stocks" document, under the "Delivery" column The electronic log must also be completed it can be found at: <u>I:\Process Oil and TCE Logs</u> At the end of the TCE delivery, transfer any TCE collected in the stainless steel tray and bucket to the waste water tank in the vacuum plant Make sure the tanker driver does not leave the site with Entek's stainless steel bucket **H&S: Oversee tanker turning in yard H&S: Return the Diphoterine shower to outside the compressor room.** .
- .
- :

3.7 Reinstate the TCE transfer tank that was isolated in Step 3.5

- Open the 'closed' TCE Transfer Tank isolation valve
- Drain the tank down in manual to check there are no airlocks in the pumps.
- Place TCE Transfer Pump No.1 pump back into 'Auto' mode via the selector switch on the VARA control panel.
- Place TCE Transfer Pump No.1 pump boos new constraints
 Refer to step 3.5 for selector switches and pump photos.

3.8 Reinstate the TCE production header tank that was isolated in Step 3.5

- Place TCE Header Tank pump (that was on Duty) back into 'Auto' mode via the selector switch on the VARA Ancillary panel.
 Ask for one of the lines to call for TCE to ensure the tank transfer is working correctly.

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ANNEX 8 – STATIC MONITORING

Trichloroethylene concentrations within the plant are continuously monitored every 15 minutes using static monitors located in different areas within the plant. Static monitoring in some areas within the plant, such as the oven exit, is performed to comply with pollution prevention and control permitting (regulated by the Environment Agency of England and Wales). No worker exposure occurs within the oven exits, therefore, static monitoring data for this area are not considered for the purpose of worker exposure assessment.

The table below shows a summary of static monitoring data collected between 25/09/2019 to 31/12/2019]. Monitoring data for these periods were selected for analyses to align them with period during which the badge monitoring was conducted in 2019.

As shown in Table, the 90th percentile of data over the period selected has been reported. As would be expected, exposure concentrations within the enclosure are high compared to outside the enclosure. Workers however only typically spend <10 mins within the enclosure during normal operating conditions activities with use of appropriate respiratory protective equipment. Hence, during normal operating conditions, workers experience peak exposure within the enclosure and are therefore required to use RPE. The height of the static monitors could be considered, on average, to be within the breathing zone of the worker (defined as the zone within a 0.3 m radius of a worker's nose and mouth (EN1540 (workplace atmospheres –terminology)), apart from static monitors in Line 1 and 2 enclosure; and in the pelletiser area.

Table A8.1	Summary	of statio	monitoring	results
------------	---------	-----------	------------	---------

Workers' positions/work Areas	Within/outside the enclosure	Worker's activity/functions	Height of static monitor from the floor (cm)	Exposure concentration (mg/m ³) – 90 th percentile	Exposure with use of RPE (90% efficiency) (mg/m ³)
Line 1&2 Enclosure	Within the enclosure	Make checks, investigate faults (generally working from platform 1.25 m high)	86	268.73	26.87
Line 7&8 Enclosure	Within the enclosure	Make checks, investigate faults (generally working from platform 2.5 m high)	30.5	402	40.2
Winder Line 1	Outside the enclosure	Winding of finished product rolls, boxes rolls.	254	4.2	N/A
Winder Line 2	Outside the enclosure	Winding of finished product rolls, boxes rolls.	254	4.11	N/A
Winder Line 7	Outside the enclosure	Winding of finished product rolls, boxes rolls.	198	5.06	N/A
Winder Line8	Outside the enclosure	Winding of finished product rolls, boxes rolls.	200	4.64	N/A

Winder Laminator	Outside the enclosure	Winding of finished product rolls, boxes rolls.	160	0.99*	N/A
Pelletiser Grey Silo	Outside the enclosure	Not applicable - This is an enclosed vessel which is vented to line 7&8 enclosure. No operator involvement.	668	No Data	N/A
Laboratory	Outside the enclosure	Quality technician testing product.	1701	0.38*	N/A

*Single measurement taken12/12/2019

The location of workers position for badge monitoring and in relation to static monitoring can be seen at Annex 5 of this document.

ANNEX 9 - BADGE MONITORING PROTOCOL

		Line Number / Position:	SharePoint		
Revision Date	Revised B	/ Wi#	SOP NAME	Initial Release Date:	11/10/19
11/10/19 J McManus		s 140-034	140-034 Exposure Monitoring Protocol		J McManus
Purpose	Т	define the way in which	n employee exposure to trichloroethylene (TCE) is r	nonitored and measured	
Scope	S	Site			
Responsibilities Health & Safety Manager and Operators					

PPE REQUIREMENTS

1.1 The following PPE is mandatory whilst completing this task:

0	Ear defenders must be worn at all times in Production Area	Safety footwear must be worn at all times in Production Area
	Safety eyewear must be worn at all times in Production Area	

2. KEY POINTS & NOTES

- 2.1. Health & Safety Key Points
 - H&S: Ensure you use PPE as detailed in this SOP as appropriate. H&S: Ensure that all H&S Control measures are followed. 1
- 2.2. **Environmental Key Points**
 - ENV: Small spills should be dealt with immediately using appropriate PPE and rags. Used rags containing oil should be placed in the oily rag bin. Other used rags should be placed in a general waste skip.
 - ENV: Larger spills are to be contained with the use of the site spill kits and inform supervisory team immediately

2.3. **Quality Key Points**

.

. QUAL: Quality Control is the responsibility of ALL Entek employees and as such removes risk to our customers.

2.4. Notes

Notes can be used within the procedure to aid understanding. .

3. PROCEDURE

.

FREQUENCY & TIMING 1.1.

- Monitoring campaigns will be conducted 6 times a calendar year (bi monthly)
- Where feasible monitoring campaigns will be conducted on the second day of 2 consecutive day shifts for a particular day shift e.g. . Wednesdays & Fridays.
- This will allow time on the first of the 2 shifts for the Operators to be briefed on what is expected/required to ensure the monitoring protocol is . followed correctly and the importance of such.

METHODOLOGY 1.2.

- During each monitoring campaign 9 different "similar exposure groups" (SEG) will be evaluated;
 - Line 1/2 Extruders
 Line 1/2 Winders

 - Line 7/8 Extruders Line 7/8 Winders
 - Pelletiser
 - . Laminator
 - Laboratory
 - Supervisory Team
 - Maintenance
- Requirements of employees chosen to represent each SEG;

 Maintain a log of the tasks they complete during the time monitoring period, including areas in which the task were performed
 - Remove themselves from Winder Enclosures;
 O During line start ups

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	V	VORK INST	RUCTION	Line Number / Position:	SharePoint
Revision Date	Revised By	WI#	SOP NAME	Initial Release Date:	11/10/19
11/10/19	J McManus	140-034	Exposure Monitoring Protocol	Originator:	J McManus
 Up to 2 1 	When Winder When Winder i.e. when then asamplers will be x Passive Diffusior Procedure to method using x Extractive Sorber o Procedure to	r Enclosure 'high lew re is a requirement to placed on each SEG bebased on Health g diffusive samplers, so the Samplers bebased on Health	el" alarm sounds o don a respirator & Safety Executive methodology MDHS 88 "Volatil solvent desorption and gas chromatography" & Safety Executive methodology MDHS 96 "Volatil	e Organic Compounds in Air. Li e Organic Compounds In Air, la	aboratory
 Monit A T E A 6 A Any c monit 	using pumpe toring criteria; Ill sampling devices the sampling period xtractive Sorbent T o Flow rates of determined fi should be cle ir temperatures in a blank samples will o 4 passive diff o 2 extractives Il laboratories used deviations from the toring of any particu	for each individual S for each SEG samplube Sampler air-sam a sampling pump to ow rates are outside any highlighted in the accessed areas will b be taken during each usion badge samples for the analysis of th above methods will i lar SEG during a car	, sovent desorption and gas chromatography. EG will be started and ended at the same time during le will be a minimum of 4hours upling rates to be 50 to 200 mL/min be determined with a calibrated flowmeter at least ±5% of the nominal value the measurement point services a report e taken, recorded & included in resultant reports i monitoring campaign; s (2 by Entek International Limited e samples will be conducted by laboratories with the be documented and included in the resultant report paign. Information resulting from a deviation in pr	ing a specific campaign before and after the measurem should be discarded or, as a mi ne relevant UKAS accreditations ts. This includes reasons for no ocess may be omitted from the	ent. If the nimum, this fac s t completing to report.
1.3. RESUL	TS & REPORTING	3			20
All inf	formation in the rep	orts are to be clear a	nd legible. This includes any analytical certificates	supplied by third parties used.	
Resu	Its will be reported I	by all parties as 8hr 1	Time Weight Average (8-hr TWA)		
 Repo U D 	rts will compare res IK Work Exposure L lerived Minimum Ef	sults; Limit (WEL) – 550mg, fect Level (DMEL) – :	/m3 (100ppm) 8-hr TWA 33mg/m3 (6ppm)		
 Repo 	rts <mark>will d</mark> isplay resu	lts with a clear indica	tion of which SEG each result relates to		
	e applicable, report Il raw data inc. tem	ts will include; peratures, flow rates to achieve the 8hr T	WA including (inc. reference to non-exposure time	used)	

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ANNEX 10 – SITE MONITORING SYSTEM

Trichloroethylene site monitoring system – guidance document:

	ST	Line Number / Position:	Supervisors Office			
Revision Date	Revised 8	By SOP #	SOP NAME	Initial Release Date:	12/04/18	
07/09/18	MCR	140-018	TCE Monitoring System – Guidance Document	Originator:	MCR	
Purpose To give guidance on using		To give guidance on using	the TCE monitoring system.			
Scope		This guidance includes GEMS TCE dashboard use and Smart Extruder HMI software customised for TCE emission monitoring.				
Responsibilities As defined in the procedure.		re.				

1.0 PPE REQUIREMENTS

No PPE is required for this procedure as it is describing and providing guidance on TCE monitoring software.

2.0 KEY POINTS & NOTES

- 2.1 Health & Safety Key Points
 - H&S: Ensure you use PPE as detailed in this SOP as appropriate. H&S: Ensure that all H&S Control measures are followed.
- 2.2 Environmental Key Points
 - ENV: Small spills should be dealt with immediately using appropriate PPE and rags. Used rags containing oil should be placed in the oily rag bin. Other used rags should be placed in a general waste skip. ENV: Larger spills are to be contained with the use of the site spill kits and inform supervisory team immediately .
 - .
- 2.3 Quality Key Points
 - . QUAL: Quality Control is the responsibility of ALL Entek employees and as such removes risk to our customers.

2.4 Notes

٠ Notes can be used within the procedure to aid understanding.

3.0 PROCEDURE

- 3.1 H&S: General Best Practice for working with computers:

 Break up long spells of computer work
 Routinely look away from screen to focus on more distant objects
 Set up work station so:

 forearms are horizontal and wrists not excessively bent
 lower back is supported by chair
 eyes are level with top of screen
 feet flat on the floor (or footrest)

3.2 GEMS TCE Dashboard: Access . 0

The TCE dashboard is accessed via GEMS, the screenshot below shows the menu from which it is accessed:

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Pancham Line Provide	urra Stedul og Vap				
Desire	e 10 t				
Nationals	 TeitmMata 				
Understand	• Independent +	South feet actives then any Row			
Rel in and an		Soul in places the cyline's periode totable ways			
Ric Contrain		Sanda Terrandana, Der y Tatlefa			
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Revision Date	Revised By	SOP #	SOP NAME	Initial Release Date:	12/04/18
07/09/18	MCR	140-018	TCE Monitoring System – Guidance Document	Originator:	MCR

TCE Monitor Dashboard: Access to the Live Monitor Panels

Once accessed the below screen is visible. The two blocks called 'Monitor 1 and Monitor 2' are the only blocks to be used. Clicking on either Monitor 1 or Monitor 2 will display a live monitor panel. Each live monitor panel displays 6 dashboards. Each dashboard displays live solvent laden air concentrations in parts per million (ppm) in various parts of the factory. It is recommended two computer monitors are used so all dashboards can be on display.



TCE Dashboard: Live Monitor Panels

0



The live monitor panels display a twelve panel configurable 'dashboard' in 2 6-panel screens with line charts showing live data trends, refreshing every 60 seconds.

• Using the Dashboard:

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07/09/18	MCR	140-018	TCE Monitoring System – Guidance Document	Originator:	MCR

The aim of the dashboard is to quickly display TCE emission data collected by the Smart Extruder HMI software (section 3.2 below).

• The TCE dashboard will display:

0

Data of key sampling points within the factory that aid in determining line/process control

- The main stack that emits TCE to atmosphere outside of the factory
- Key sampling points within the factory located in critical areas for worker exposure.

Sampling points within the factory for process/line control:

- Solvent laden air (SLA) pre carbon bed. 8hr' display TCE emission data (in parts per a million or ppm) from the following sampling points:
 After Fans—positioned after the SLA fans and before the carbon beds.
 - Before Fans- positioned the main SLA duct after all specific line SLA ducts connect to form the main SLA duct
 - After Vacuum—positioned in the central vacuum unit

o 'Line SLA Ducts: 8 hr' display TCE emission data (in parts per a million or ppm) from the following sampling points:

- Line 1 SLA—positioned in the duct dedicated to Line 1 ovens near enclosure 1&2 bay door adjacent to Line 1
 - Line 2 SLA—positioned in the duct dedicated to Line 2 ovens above Line 2
 - Line 7 SLA positioned in the duct dedicated to Line 7 ovens (in enclosure 7&8 in between the ovens for each line)
- Line 8 SLA—positioned in the duct dedicated to Line 8 ovens (in enclosure 7&8 in between the ovens for each line)

Using this data for process control:

- o The process owners will set SLA targets for each Line duct (Line 1, SLA, Line 2 SLA etc.) based on the sheet profile being made at the time.
- o The environmental manager will set 'action limits' for the following sample points:
 - Main stack
 - Before fans
- All limits will be displayed on the TCE dashboard in the form of a red line on each dashboard. The Line ducts will also have the target displayed above the dashboard. A screenshot of the dashboards displaying Line ducts and their targets is below:

The second second processing of average and other 1(19) (19) (19)	14 s	
Ling 15LA Duct Shr	Im 2 GLA Dept Str Im Im Im Im	Line 78LA Gues 12hr 66
	Nor-Line Directs: 24/or	Man Stask 24m

 If these limits are breached, action must be taken by production (Supervisors, Lead Hands, Process Owners) to reduce the TCE emissions below the limit.

• Each TCE emission problem could be unique, however the following actions are the first points of intervention:

- Review the SLA targets for the profile currently running on each line. These are located in the shift report. If the TCE ppms from a line
 specific duct is above the set target, this is probably contributing to the above sample points breaching the 'action limits.'
- Adjust dryer settings to reduce SLA ppms in line specific ducts
- Adjust oven settings to reduce SLA ppms in line specific ducts
- Reducing line speed of the line could reduce SLA ppms
- Sampling points within the factory for worker exposure:
 - 'Enclosures: 8 hr' display TCE emission data (in parts per a million or ppm) from the following sampling points:
 - Enclosure 1&2—positioned in the middle of the enclosure room for lines 1&2
 - Enclosure 7&8—positioned on the mezzanine of enclosure 7&8, on the line 7 side.

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3	STANDARD OPERATING PROCEDURE				Supervisors Office
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o 'Winders: 8 hr' display TCE emission data (in parts per a million or ppm) from the following sampling points:

- Winder 1—positioned above the winder station on L1
- Winder 2—positioned above the winder station on L2
- Winder 7-positioned above the winder station on L7
 Winder 8-positioned above the winder station on L8
- winder o positioned above the winder station on to

Using this data to manage worker exposure:

- o Winders:
- The H&S manager will set limits for the winder sampling points and inform key employees. Production (Supervisors, Lead Hands, Process Owners) must take action if the limits are breached. Actions can include:
 - Natural/mechanical ventilation
 - Reduce line speed
 - Adjust oven/dryer settings
 - Require workers to wear respirators

o Enclosures:

- o Enclosure ppm limits are static. All employees must wear PPE identified in section 1.0 of this procedure.
 - If an enclosure is over 500ppm powered air respirator is required
 - If an enclosure is over 1000ppm, no one should enter the enclosure, inform management and engineering

ENTEK Smart HMI Software

- o The ENTEK Smart HMI software specifically designed to:
 - Monitor TCE Emissions in various locations in/out of the plant
 - Provide standard averages and reports of TCE emissions resulting from running the lines and make decisions on line speed, throughput
 etc.
 - Provide live data on emissions in worker's areas so we can instantly determine if respirators are needed
 - Provide live data on the main stack to ensure Entek stays under the Emission Limit Value of 17ppm
 - Access trends in TCE emissions in a particular area over time (current and historical)

• From this point on it will be called the TCE monitoring system.

Locations of where you can access the TCE Monitoring System:

- The TCE monitoring system can be viewed on 3 PCs in the plant:
 - Production Office
 - Supervisors Office
 Vara Control Room
 - o The production office is the main PC of the system. It holds all historical data. The other 2 PCs will hold 2 weeks' worth of TCE emission data.

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• TCE monitoring system hardware:

o It is important to have a basic understanding of the hardware of the TCE monitoring system in order to better use the software.

• The hardware consists of equipment called: • PTFE tubing

- · Sequencer-consists of a series of pumps. The pumps are controlled by the software to pump air from the sample point. This air called, 'sample gas' is delivered to the analyser. Each sample point is allocated to a pump. On the software it is called 'channel.'
- Analyser-contains the optical bench which measures the amount of TCE in a 'sample gas' received from the pump

o Ancillary hardware including PLCs, Ethernet connections and I/Os are used.

There are two locations in the factory where the hardware is located, the VARA control room and the quality records cupboard:

TCE monitoring system software:
 MAIN MENU:

CPERATOR	11-	10		ANAL	YZER C MO	NITORING (/	ADC 7000)	5/ 14:2	7 / 2017	€ ENTE
ollepse Menu		CU	RRENT		CHANNEL	C	ANNELCON	TROL			
SYSTEM	SAMPLE	SAMPLE CH 5 SELECT CH SAMPLE 1002 PPM				SAMPLING	NENCE				
NALYZER A ARA ROCM	TIME REN	CAUNING	104	SEC	our our and			ACC NOL			
NALYZER B					CHANNE	L SAMPLE MONITO	RING (EACH	SCAN)			
ARA ROOM	CHANNEL LOCATION				STATUS	AVERAGE	LOW	HIGH	LAST TIME	TREND	
NALVZED C	01	SLA LIN	E1			IDLE	3490	3167	3974	14 : 8 : 1	TREND
ARA ROOM	02	3LA LINE 2			IDLE	837	860	932	14.11.1	TREND	
	03	AIR ST	RIPPER			IDLE	6196	6023	6302	14:14:1	TREND
ARA ROOM	04	SLALIN	ES 7/8			IDLE	755	729	822	14 : 17 : 1	TREND
New York Contract of the second s	05	SLA AF	TER FA	NS		IDLE	1416	1230	1870	14:20:1	TREND
NALYZER E	06	SLA BE	FOREF	ANS		SAMPLING	991	974	1011	13:63:1	TREND
and a state of the	-07	SLA AF	TER VA	CUUMPL	ANT	PRIMING	1225	1197	1265	13 : 56 : 1	TREND
NALYZER F	08	ALLOC.	ATED FO	OR FUTU	REUSE	DLE	D	0	10	13:69:1	TREND
	09	SLALIN	E7			IDLE	2732	2702	2702 2767	14:2:1	TREND
- 1	10	SLALIN	E 8			DLE	1403	1367	1430	14 : 5 : 1	TREND
	- 11	CHANNEL 11 NOT USED									
	12	CHANNEL 12 NOT USED									
	13	CHANNEL 15 NOT USED							_	_	
	14					CHANNEL	14 NOT USE	D			
						and the first of					
	Primite	Time	Col.	Aları	Norve		Alam	Desuiștia			

o The menu on the left is the main menu to navigate the between analysers. To find the main menu you will have to click 'expand menu'

o There is access to all analysers, but for the purpose of this procedure to explain how to use analyser C and D.

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	STAN	DARD OPERAT	TING PROCEDU	JRE			Line Number ,	/ Position:	Supe
Revision Date	Revised By	SOP #	SOP # SOP NAME					Date:	12/
07/09/18	MCR	140-018	TCE Monitoring Syst	em – Guidance	e Document		Originator:		N
 ANALYSER I Eac of t The 	MENU: th analyser has its (the screen; so in th e analyser menu co 1. Monitoring 2. Averaging 3. Map 4. Settings – this n	own menu. All the menu e above Screen shot, you onsists of nenu exists but is not need	us are the same except I are viewing the 'monitori ded currently.) (explained l ng' screen for	ater). To kn analyser C.	ow <mark>w</mark> hat s	screen you ar	e on, the titl	le is at
N LComet HM System	- MONTIORING							water in	-
						67	7 / 2017	PENTER	
OPERATOR	JU JU	ANALYZEI	RCMONITORING	ADC 7000	0	14 : 4	0:6	ENIER	-
Expand Menu		HERENT SAMPLE CHANN	51	NAMMEL COM	TROP				
	3 SAMPLE CH	7 SELEC	ТСН		TRUE				
ANALYZER C	SAMPLE	1259 PPM		SAMPLIN	3				
	TIME REMAINING	17 SEC GO	TO CHANNEL	HOLD	QUENCE				
MAP	3								
			2		4				
MONITORING	1		CHANNEL SAMPLE MONI	TORING (EACH	SCAN	10000			
AVERACING	CHANNEL LOCA		STATUS	AVERAGE	2240	9545	LAST TIME	TREND	
AVENAGING	COL SLA		DLE	1016	000	1032	14.30.1	TREND	
SETTINGS			DLE	6106	5033	6300	44.44.4	TREND	
- 25/2010/19/2013			DLE	768	700	8/19	14.14.1	TREND	
	OF SLA		DLE	100	129	1970	14.17.1	TREND	
	06 SLA		DLE	064	12:30	1011	14:20:1	TOCHO	
	05 SLA	AFTER MACHUNINE ANT	DLE	301	1000	1011	14:20:1	TREND	
	OP ALL		PORGING	1010	1023	1025	14.20.1	TREND	
	00 ALL.	INE 7	DIE	0740	2495	3775	14.20.1	TREND	
	TO SLA		DLE	1410	4174	4464	44 - 25 - 4	TREND	
	10 354		CHANNE	T ALL NOT USE	1374	1401	14 - 33 - 1	TREND	
	40		CHANNE	L 11 NOT USE	9 5	_	_		
	12	_	CHANNE	AT NOT USE		_	_		
	14		CHANNE			_			
			CONTINUE						4
	Privaily Time	Alarm Name	1	Alarm	Description				1
									1
11								Marms	
hannels: Display	r list of shannels and	I comple points allocated	on this pophase						
names, pispiay.		sumple points unceated	Sin this unaryset.						
tatus: Displavs w	here the analyser is	in the sampline cycle. Prin	ning = preparing sample p	oint for sampli	ne. Pureine :	= sampling	has complete	d and being c	ourged
nple gas. There is	s also a status called	'sampling' in green.			а			- o P	
Current sample d	hannel: Displays cur	rent PPM and sampling tir	ne of sample point being	nalysed. Use '	goto channe	l' to jump t	to a sample no	oint.	
he box adjacent	called 'channel cont	rol' allows the sampling of	one channel only, this is	bassword prot	ected.			1075	
werage, low, high	h: Displays 'average	, low and high' of sample p	point currently being sam	led.					
rend menu: Disc	ussed below								

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6 Trend: allows you to choose data from a particular analyser/sample point and display it on the graph. Choose the data and click 'show trend' Also ensure 'historical data' is ticked if you are displaying older than the current day.

7 This box allows you to remove data if you need to. Clicking on one of the titles will turn the data on/off. To see them all again, click on 'show all'

8 Zoom in on data using the arrow keys. The Y-axis can be altered and the chart can be reset with these buttons.

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Averaging Men

PERATOR			ANALYZER C A	VERAGES (ADC 7000)		14:47	: 51	ENI
and Menu		CURRENT SA	MPLE CHANNEL		CHANNEL CON	ITROL		AVE	RAGES
ALYZER C	SAMPLE C	H 9 2741 F	9 3ELECT CH 0 2741 PPM			G		CLE	AR ALL RAGES
	TIME REM	AINING 32 S	GOTO CHAN	NNEL	HOLD	QUENCE	10	CL	.ear
MAP									
ITORING			CHANNEL AN	HANNEL AVERAGING					
	CHANNEL	LOCATION		SAMPLE	15-MIN	6-HR-	8-HR	12-HR	24.HF
RAGING	01	SLA LINE 1		2418	3490	703	978	1043	1147
	02	SLA LINE 2		1016	887	929	1039	1088	1040
TTINGS	03	AIR STRIPPER	6196	6196	56 0 8	6670	6684	6742	
	04	SLA LINES 7/8	766	766	763	768	764	821	
	05	SLA AFTER FANS	1416	1416	1235	1266	1256	1276	
	05	SLA BEFORE FAN	961	961	864	919	893	948	
	07	SLA AFTER VACU	1228	1222	1149	1191	1170	1207	
	0B	ALLOCATED FOR	1	0	3	4	3	11	
	09	SLALINE 7		2722	2728	2682	2791	2698	3324
	10	SLA LINE B		1416	1403	1555	1695	1636	1820
	11	CHANNEL 11 NOT USED							
	12	CHANNEL 12 NOT USED							
	13	CHANNEL 13 NOT USED							
	14	-	-	CHANN	EL 14 NOT USE	D			
-	La constante de		State Protocol Inc.						

• This screen shows 'rolling averages' of each sample point.

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o The Maps screen displays location and names of each sample point. It also displays which analyser and channel the sample point is located on.

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ALARMS- As you've noticed there is an alarm section at the bottom of the menu. Besides the limit of the main stack, 14, alarms for TCE emissions have not been
established. When they are established the guide will be updated.

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Appendix 1: Sample Point Analyser and Channel vs. Sample Point Name.

Please note that some names have been changed from the old system.
 Oven Exit = Slitter Racks
 Factory SLA = SLA before fans
 Oil mist 1&2 = PAQ 1&2
 Oil mist 7&8 = PAQ 7&8

Analysers	Analyser A (ADC 7000)	Analyser B (Fresenius)	Analyser C (ADC 7000)	Analyser D (SAM)	Analyser E (Fresenius)	Analyser F (Fresenius)
Sample Channels	1					
1	Line 1 Slitter Rack	Pelletiser grey silo	SLA Line 1	Main Stack A12	ALLOCATED FOR FUTURE	Line 1 Winder
2	Line 2 Slitter Rack	ALLOCATED FOR FUTURE USE	SLA Line 2	Not applicable	ALLOCATED FOR FUTURE	Line 2 Winder
3	Line 7 Slitter Rack	ALLOCATED FOR FUTURE USE	Air stripper	Not applicable	ALLOCATED FOR FUTURE	Lab
4	Line 8 Slitter Rack	SPARE	SLA Line 7 & 8	Not applicable	ALLOCATED FOR FUTURE	Laminator Winder
5	Lines 1 & 2 Enclosure	Lines 1 & 2 extruder	SLA after fans	Not applicable	ALLOCATED FOR FUTURE	Line 7 Winder
6	Lines 7 & 8 Enclosure	Lines 7 & 8 extruder	SLA before fans	Not applicable	SPARE	Line 8 Winder
7	Enclosure 1&2 SLA duct	DCE 1 (A10)	SLA After Vacuum Plant	Not applicable	SPARE	SPARE
B	Glenro Oven	DCE 2 (A9)	ALLOCATED FOR FUTURE	Not applicable	SPARE	SPARE
9	ALLOCATED FOR FUTURE USE	1 & 2 (A6) PAQ	SLA line 7	Not applicable	Not applicable	Not applicable
10	ALLOCATED FOR FUTURE USE	7 & 8 (A5) PAQ	SLA line 8	Not applicable	Not applicable	Not applicable
11	SPARE	Laminator Unwind	ALLOCATED FOR FUTURE	Not applicable	Not applicable	Not applicable
12	SPARE	SPARE	ALLOCATED FOR FUTURE	Not applicable	Not applicable	Not applicable
13	Not applicable	Not applicable	ALLOCATED FOR FUTURE	Not applicable	Not applicable	Not applicable
14	Not applicable	Not applicable	ALLOCATED FOR FUTURE	Not applicable	Not applicable	Not applicable

• Example: Analyser A, Sample Channel 1 is the slitter rack for line 1.

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ANNEX 11 - SITE IMPROVEMENT LOG

Log of improvements to reduce emissions of trichloroethylene (TCE). The areas indicate health and safety (H&E) and ambient (ENV) (or BOTH) improvements logs:

					Planned /	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
		MCR to complete				
		OMA actions				
Main Stack		regarding	The OMA actions are complete	this will benefit TCE		
	ENV	Environment Agency	except for a correction in the	management as it	31.01.2016	environment
LIIISSIOIIS		Compliance	'drift procedure.'	ensures data quality.		
		Assessment visit on				
		08.08.2014				
			There are differences in			
			readings on lines 7&8. Bob	Identifying even small		
Data			Stobbs checked the flow meter	discrepancies in data		Environment/
management	ENV	Line 7&8 TCE Usage	and there are differences. John	management will aid in	Oct-18	Engineering
management			Buckle should change the flow	reducing TCE		Linginieering
			meter readings. Bob Stobbs is	consumption.		
			now working on it.			

					Planned /	
Focus Area	Area	Action	Summary	Benefit to TCE management	Completed Date	Owner
Fugitive Emissions	BOTH	FLIR Camera	Utilise the FLEAR camera once major fugitives are identified and stopped. Found a UK supplier in Aberdeen that can come down with a few days' notice. Prices are: £1200 a day+£400 for report+£450 technician in transit and training+10% expenses.	The FLIR camera will identify any fugitive emissions.	Sep-17	environment
Data management	вотн	Installation of new sequencers and software for TCE data	The new software is customisable and the new sequencers are more robust.	More accurate data and more data on TCE emissions will aid in reducing exposure even more.	31.05.2017	Environment/ Engineering
Fugitive Emissions	BOTH	secondary condensing box (2017) for lines 7&8	This process converts Trichloroethylene into a liquid thus reduces the SLA being sent to the carbon beds	Capturing TCE in a liquid form provides more control on fugitive emission and reduces main stack emissions.	Q4 2016-Q1 2017	Engineering

				Benefit to TCF	Planned /	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational exposure	BOTH	comprehensive tracking charts for each work area and stack, example end of each winder station, with traffic light system	Charts accessible to both Extruder Ops and Supervisors so they can see any trends i.e. rising emissions and address where needed	the traffic light system will increase awareness to operatives working in the area the current ppm level of TCE in their working area	May-17	H&S
Fugitive Emissions	BOTH	Survey of mechanical seals was implemented in 2015. Need to re- instate.	SOP and risk assessment is completed. We need to start monitoring them again for line 1 and 2. Question was asked if this also needs to happen for lines 7&8.	mechanical seals prevent TCE emissions from the extractors.	17.02.2015 -current	Process Owners
Data management	ENV	Investigate more accurate air flow measurements from more ducts to understand fugitive loss from a mass standpoint.	We've installed a sample point in this duct to more accurately monitor TCE	this will benefit the plant to better understand TCE consumption and recovery amounts.	17.02.2015	process owners/ environment

				Benefit to TCE	Planned / Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Main Stack Emissions	ENV	Plumb second line into the Fresenius analyser into the VARA	This was completed.	this will benefit TCE management to compare TCE emissions on different analysers.	28.02.2015	Environment/ Engineering
Data management	BOTH	Target TCE consumption and Target oven exit and target SLA per profile and profile roll.	Standard Runs have been completed for all profile rolls.	Creating control charts of TCE consumption per a profile roll adds significant control to the process.	31.12.2014 -ongoing.	process owners/ environment
Carbon Beds	ENV	Oil mist contaminating the carbon beds; Review oil mist report	In order to prevent oil mist reaching the beds, the HPT decided on the following actions: clean SLA grids. Now part of the PM schedule.	Protecting the carbon beds from oil will increase the lifespan and reduce TCE loss via the stack.	31.12.2014	Environment/ Engineering

				Benefit to TCE	Planned / Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Fugitives, process control	вотн	daily review of TCE for prior 24 hours, actions recoded for anomalies, high levels	Production meetings' key performance indicator now includes TCE consumption per a line and profile. This allows easier identification of anomalies.	Identifying and responding to anomalies within 24 hours of their occurrence aids in TCE consumption and emission troubleshoot	01.01.2016	TCE HPT
Main Stack Emissions	ENV	Increased carbon in the beds	Carbon amounts were increased in each carbon bed	More carbon in each bed reduces main stack TCE emission	23.02.2015	Engineering
Main Stack Emissions	ENV	Monitor carbon efficiency	Regular monitoring of carbon activity efficiency will help to determine when carbon is degrading and needs replacing	Reduces TCE loss	30.06.2015	environment

					Planned /	
Focus Area	Area	Action	Summary	Benefit to TCE management	Completed Date	Owner
Fugitive Emissions	ENV	Check Vara for leaks including: carbon beds and vapour lines	Found leak on carbon bed 3 inspection hatch on 03.08.2016. Gasket failed. Fixed on 05.08.2016. Leak was moderate. Rupture discs on all beds are slightly weeping. All are being replaced.	Reduces TCE loss	03.08.2016 - 10.08.2016	Environment/ Engineering
Fugitive Emissions	ENV	Check non- condensable line	Hooked the non-condensable pipe up to our analyser with the highest range (10,000ppm). Readings were off the scale of the analyser. Investigate installing sample point.	Data for this line will allow quicker identification of process/Vara issues.	installed after vacuum sample point.	environment, engineering, process owner
Carbon beds	ENV	Vara condensers: Open up condensers, check condition and take photos	Photos were taken of the condensers. Nigel summarised with the group on 31.08.2016	Ensuring the condensers are in good condition to recover vapour TCE.	24.08.2016	Engineering

					Planned /	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Data Management	ENV	Install a sample point to read ppms from the Glenro only	By monitoring the ppm from the Glenro oven we can determine the efficiency of the cryo ovens. If these are efficient then the TCE recovery can be monitored	Reduces TCE loss	18.08.2016	Environment
Carbon beds	ENV	Check the vapour line valves/SLA inlets outlets.	Leaks found on SLA valves on all 4 beds. Bed 4 is the worst. Nigel to speak with Joe Gird on how to rebuild. Locking was also found on the valve, this was removed and it has improved the stack. (see picture below of locking valve) PM has been set up to check these valves yearly	Reduces TCE loss	01.09.2016	Engineering

Focus Area	Area	Action	Summary	Benefit to TCE management	Planned / Completed Date	Owner
Carbon beds	ENV	Check the water side of the condenser (VARA)	Nigel discussed the condenser clean during this year's May shutdown. The contractors described the state of the condenser before and after when it was cleaned. PM has been set up to carry this out yearly	Improve TCE recovery from the carbon beds	01.09.2016	Engineering

					Planned /	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Process control	ENV	Tank Plates on lines 7&8	There are two types of tank plates in all dryers in 7&8. The tank plates are steam heated. Each dryer has a tank plate on the top and the bottom. The purpose of the top tank plate is to stop water from touching the sheet. The purpose of the bottom plate is to maintain temperature in the dryers. During discussions with the USA, pressure/temperature on the tank plates were adjusted to a lower temperature/pressure. This increased the SLA. The tank plates were adjusted back to the original position. See Fen's email from 31.10.2016 that explains this.	Reduces TCE loss	Oct-16	Process Owner, Engineering
					Planned /	
----------------------------------	------	--	---	------------------------------------	----------------------	-------------
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Fugitives, process control	ENV	Line 8 water Seal	Higher line usage due to the water seal on dryer 2 of Line 8 was empty and the sensor was in the incorrect place, hence the seal was not filling up all the way. This has been corrected and the stack has decreased	Reduces TCE loss	07.11.2016	Engineering
Carbon beds	ENV	Changed out vapour line valve seals and ensured seals were closing properly	Since this change, the stack has decreased from 10ppm monthly average to 7.2ppm average	Improve carbon bed efficiencies	May 2017 shutdown	Engineering
Fugitives, process control	ENV	Reduce SLA from the central vacuum system by improving the TCE condensing by reducing the SLA suction	The SLA from the central vacuum system is a significant percentage of the total SLA being sent to the carbon beds. By reducing this the stack ppm will reduce This reduced the SLA to the beds by 5%	Reduces TCE loss	Jun-17	Engineering

				Bonofit to TCE	Planned /	
Focus Area	Area	Action	Summary	management	Date	Owner
Carbon Beds	ENV	Reduce SLA from the central vacuum system by improving the TCE condensing by putting the heat exchanger onto chilled water	The SLA from the central vacuum system is a significant percentage of the total SLA being sent to the carbon beds. By reducing this the stack ppm will reduce This reduced the SLA to the beds by 10%	Reduces TCE loss	Mar-18	Engineering
Carbon beds	ENV	Partially changed out carbon media in each bed.	Since this change, the stack has decreased from 7.2ppm average to below 1.5 ppm.	Reduces TCE Loss	Jan-18	Engineering
Carbon beds	ENV	Partially changed out carbon media in each bed.	Since this change, the stack has decreased from 11.4ppm average to below 2.5 ppm.	Reduces TCE Loss	May-20	Engineering

					Planned /	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Date Management	BOTH	Reporting 6 hrly winder, stack and ambient emissions	Supervisors/Lead Hands must communicate 6 hrly figures. Tables automatically change colour to indicate if actions needed. Comments and actions to be added in these scenarios	Drive management of issues	Jun-19	Production
Carbon beds	ENV	New equipment	PAQ installed to Line 1 LR system to prevent oil mist being taken back to the carbon beds and reducing its efficiency	Improve carbon bed efficiencies	May-18	Engineering
Carbon Beds	ENV	Reduce SLA from the central vacuum system by improving the TCE condensing by reducing the SLA suction	Introduction of new heat exchanger to condense from the TCE and reduce the quantity being sent to the carbon beds. The filter is also designed to reduce any liquid entering the vacuum pumps and prolong their life	Improve carbon bed efficiencies	Sep-20	Engineering

					Planned /	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Fugitive Emissions	ENV	FLIR Camera	Repeat FLIR camera survey	The FLIR camera will identify any fugitive emissions.	Apr-18	Environment
Fugitive Emissions	ENV	FLIR Camera	Repeat FLIR camera survey	The FLIR camera will identify any fugitive emissions.	Apr-19	Environment
Fugitive Emissions	ENV	FLIR Camera	Repeat FLIR camera survey	The FLIR camera will identify any fugitive emissions.	Oct-20	Environment
Fugitive Emissions	ENV	L1&2 Winder Enclosures	Installation of an enclosure with extraction of fugitive TCE to the Carbon beds. Enclosure covers the winder area	Reduces loss	Feb-19	Engineering
Fugitive Emissions	ENV	L7&8 Winder Enclosures	Installation of an enclosure with extraction of fugitive TCE to the Carbon beds. Enclosure covers the winder area	Reduces loss	Sep-19	Engineering

Focus Area	Area	Action	Summary	Benefit to TCE management	Planned / Completed Date	Owner
Fugitive Emissions	ENV	Zerma Grinder Enclosure	Installation of an enclosure with extraction of fugitive TCE to the Carbon beds. This will capture any TCE associated with grinding of scrap sheet	Reduces loss	Oct-19	Engineering
Main Stack Emissions	ENV	Installation of new equipment	Large knock out pot / tank installed on central vacuum to capture solvent May 2020	Captures solvent before it gets to twisters and boosters - reducing TCE leaving via the stack	May-20	Engineering

Log of improvements to reduce worker exposure to trichloroethylene (TCE). The areas indicate health and safety (H&E) and ambient (ENV) (or BOTH) improvements logs:

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Fugitive Emissions	BOTH	FLIR Camera	Utilise the FLIR camera once major fugitives are identified and stopped. Found a UK supplier in Aberdeen that can come down with a few days' notice. Prices are: £1200 a day+£400 for report+£450 technician in transit and training+10% expenses.	The FLIR camera will identify any fugitive emissions.	Sep-17	environment
Data management	BOTH	Installation of new sequencers and software for TCE data	The new software is customisable, and the new sequencers are more robust.	More accurate data and more data on TCE emissions will aid in reducing exposure even more.	31.05.2017	Environment/ Engineering

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Fugitive Emissions	BOTH	secondary condensing box (2017) for lines 7&8	This process converts TCE into a liquid thus reduces the SLA being sent to the carbon beds	Capturing TCE in a liquid form provides more control on fugitive emission and reduces main stack emissions.	Q4 2016- Q12017	Engineering
Occupational exposure	BOTH	comprehensive tracking charts for each work area and stack, example end of each winder station, with traffic light system	Charts accessible to both Extruder Ops and Supervisors so they can see any trends i.e. rising emissions and address where needed	the traffic light system will increase awareness to operatives working in the area the current ppm level of TCE in their working area	Aug-19	H&S

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational exposure			Training on PPE use for all employees	Increased awareness of	Sep-18	H&S
				PPE use, maintenance		
				and understanding		
	H&S	PPE training		when the PPE is at the		
				end of its' life will aid in		
				reducing TCE exposure		
				amounts workers.		
			SOP and risk assessment is		17.02.2015-	Process Owners
			completed. We need to start		current	
		Survey of	monitoring them again for			
Fusitive		mechanical seals	line 1 and 2. Question was	mechanical seals		
Fugitive	BOTH	was implemented	asked if this also needs to	prevent TCE emissions		
ETHISSIONS		in 2015. Need to	happen for lines 7&8. NS is	from the extractors.		
		re-instate.	going to investigate the			
			feasibility of monitoring the			
			seals.			

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Data management	BOTH	Target TCE consumption and Target oven exit and target SLA per profile and profile roll.	Standard Runs have been completed for all profile rolls.	Creating control charts of TCE consumption per a profile roll adds significant control to the process.	31.12.2014- ongoing.	process owners/environment
Fugitive Emissions	H&S	grey waste inside enclosures for 72 hours to evacuate TCE	Procedure to ensure all grey waste is stored inside the enclosures to collect any TCE fugitives	The benefit to this improvement is to capture TCE emissions at source and thus reduce occupational exposure.	in progress	Production
Occupational exposure	H&S	air fed hoods required for higher concentrations	Implemented for operatives working in areas with potential higher concentrations.	provides extra protection against TCE exposure to workers.	31.10.2014	H&S

					Planned/	
Focus Area	Area	Action	Summary	Benefit to TCE management	Completed Date	Owner
Occupational exposure	H&S	long sleeve tops in the enclosure, plus gloves to cover skin that may potentially be splashed by TCE	Implemented for operatives working in areas with potential higher concentrations.	provides extra protection against TCE exposure to workers.	31.10.2014	H&S
Occupational exposure	H&S	Lift button was moved further away from extractor lids	As the extractor releases steam with trace amounts of TCE, relocating this extractor button eliminates exposure of operatives to the steam	provides extra protection against TCE exposure to workers.	2017	Engineering
Occupational exposure	H&S	New 3M masks that have an indicator level	Implemented for operatives working in areas with potential higher concentrations.	provides extra protection against TCE exposure to workers.	31.12.2017	Production

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational exposure	H&S	new quantitative face fit testing, company invested £5K	Implemented for operatives working in areas with potential higher concentrations.	provides extra protection against TCE exposure to workers.	Face Fit is in progress	Production
Occupational exposure	H&S	clean shaven policy for perfect fit of masks	Implemented following suggestions from the UK HSE inspectorate.	provides extra protection against TCE exposure to workers.	31.10.2015	Production
Occupational exposure	H&S	regular testing for TCE of fit for PPE (3M and mask unit)	Regular testing	Provides most accurate data available for occupational exposure for TCE	31.12.2017	H&S
Occupational exposure	H&S	PPE cleaning station	Installation of PPE cleaning stations for shop floor workers	Ensuring PPE is clean will ensure it effectiveness is maximised.	31.12.2017	H&S

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Fugitives, process control	вотн	daily review of tce for prior 24 hours, actions recoded for anomalies, high levels	Production meetings' key performance indicator now includes TCE consumption per a line and profile. This allows easier identification of anomalies.	Identifying and responding to anomalies within 24 hours of their occurrence aids in TCE consumption and emission troubleshoot	01.01.2016	TCE HPT
Fugitives, process control	H&S	Disciplinary action taken if TCE bearing sheet not placed inside enclosures	Aids in employees understanding of importance of TCE management	Aids in employees understanding of importance of TCE management	in progress	SMT
Occupational exposure	H&S	Routine Exposure Monitoring	Conduct routnine TCE exposure monitoring of selected job functions	Gives actual exposure data for employees	29.04.2016	H&S

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational exposure	H&S	ST1 Oven Flow Alarm	If flow drops below 5 m3/min we lose negativity through the line. The solvent vapours come back through extractor 1 and push the ppm level to approx. 2000 ppm in that particular area. Value to flash at the operator if it drops below 5 so they can react and open the ST1 air flow control valve.	Reduces exposure in enclosure	09/06/2017	Process Owners
Occupational exposure	H&S	Upgrade Enclosure doors	Doors do not self close/shut properly	Upgrading the doors will reduce risk of fugitive emissions escaping the enclosure	30/06/2017	Engineering
Fugitive Emissions	H&S	Cryo-oven door seals	New door seals fitted, this has reduced ppms in the enclosure near the Z-section from 195-30 ppm		08.08.2016	Process Owners

				Benefit to TCF	Planned/	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational Exposure	H&S	Bleed valve	Bleed valve has been opened more to see a drop in PPMs near the extractor entrance box. (ST1)	Reduces TCE loss	08.08.2016	Engineering
Occupational Exposure	H&S	Oven exits	Ensured that oven exits indicated 'clean sheet' all were ok	Reduces TCE loss	Fen can confirm when he did this	Process Owner, Lean
Process control	H&S	DB5	DB5 was removed from line 7. DB5 has a tendency to consume larger amounts of TCE than usual.	Reduces TCE loss	09.08.2016	Production
Fugitive Emissions	H&S	Improving Central Vacuum Skid	Central Vacuum skid TCE/water storage tank was emitting fugitive emissions. Extraction to carbon beds fitted	Reduces TCE loss	Still in planning phase Q2 2018	Engineering

				Benefit to TCE	Planned/ Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Fugitives, process control	H&S	Line 1 oven temperatures	oven temperatures and air flow adjustments were made to improve TCE recovery from 161-0.9-0.15 GE_LR	Reduces TCE loss	Mar-18	Process Owners
Hydrometer Reading - L1 & L2	H&S	Readout outside of enclosure	Currently L1/2 Ext Ops have to enter enclosure every hour to take a hydrometer reading and more frequently during start ups/profile change. Using redundant equip from L7/8 readouts can be displayed outside of the enclosure	Reduce Employee Exposure	Jun-18	Engineering
Fugitive Emissions	H&S	Improved Communication of Winder Emissions	Shift Supervisors are now required to record 12-hour shift averages as part of the entire shift report, reveiwed every morning	Improves TCE awareness	Feb-18	H&S

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational Exposure	H&S	FLIR (forward looking infrared) camera survey	FLIR camera survey conducted in September 2017 and April 2018 to detect solvent fugitive emissions	Improves occupational expsoure	ongoing since 2017 (annually)	Environment
Occupational Exposure	H&S	Extraction for dryer waste water containers	Dryer waste water will contain certain degree of TCE. Vapours now extracted and recovered	Reduce TCE levels in general production environment	Sep-18	Engineering
Occupational Exposure	H&S	L7/8 Winder Enclosure	Winder area where finished product is packaged is enclosed under negative pressure. Air is directed through VARA and TCE recovered	Reduce TCE levels in general production environment	Oct-18	Engineering

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational Exposure	H&S	L1/2 Winder Enclosure	Winder area where finished product is packaged is enclosed under negative pressure. Air is directed through VARA and TCE recovered	Reduce TCE levels in general production environment	Nov-18	Engineering
Occupational Exposure	H&S	Zerma Enclosure	Zerma area where out of spec finished product is granulated to be enclosed under negative pressure. Air is directed through VARA and TCE recovered	Reduce TCE levels in general production environment	Jun-19	Engineering
Occupational Exposure	H&S	RPE Inspection Regime	Implement formalised documented monthly inspection of personal RPE	Ensure effective abatement of TCE emissions	Oct-19	H&S

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational Exposure	H&S	SLA Alarm	If the main enclosure extraction fans speed drops below a threshold SLA alarms sound.	Gives early warning of potential build up of TCE in main enclosures Notifies staff to don RPE even if not in main enclosures	Oct-19	H&S
Occupational Exposure	H&S	Cutting Bombers (scrap rolls)	SOP & training - only to cut bombers in main enclosures	Reduces cut solvent laden sheet being transferred in main plant	Oct-19	H&S
Occupational Exposure	BOTH	Reporting 6hrly winder, stack and ambient emissions	Supervisors/Lead Hands must communicate 6hrly figures. Tables automatically change colour to indicate if actions needed. Comments and actions to be added in these scenarios	Drive management of issues	Jun-19	Production

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
			Issues with creasing on line		Sep-20	Process Owners
			7 resulted in having to run at			
			a reduced steam throughput			
Operational		Improvements to	setting. Investigated issue	Reduced TCE being		
Exposure	H&S	L7 dryer	and found a lid had became	carried through with		
Exposure		alignments	out of alignment. This	sheet		
			removed the creasing and			
			allowed the steam to be			
			increased by almost 20%			

				Planned/	
			Benefit to TCE	Completed	
Area	Action	Summary	management	Date	Owner
		There were issues with		Sep-20	Process Owners
		automatic water level			
		controllers on the lids of lines			
		7&8 extractor dryers. This			
		meant the driers and	Reduce TCE escaping		
ц <u>о</u> .с	L7/8 Water Seals automatic fill	extractors were not sealed	into main enclosures		
Πασ		and solvent / steam would	reducing potential		
		escape reducing the	operator exposure		
		effectiveness of the system			
		and sending solvent vapours			
		back to system via the			
		enclosure extraction			
		The oven temps on both		Jul-20	Process Owners
		lines were increased to aid	Reduced TCE being		
H&S	L//8 Oven temps	solvent removal by adjusting	carried through with		
	increase	steam flow and condensate	sheet		
		return pipework.			
	Area H&S H&S	AreaActionH&SL7/8 Water Seals automatic fillH&SL7/8 Oven temps increase	AreaActionSummaryH&SL7/8 Water Seals automatic fillThere were issues with automatic water level controllers on the lids of lines 	AreaActionSummaryBenefit to TCE managementH&SL7/8 Water Seals automatic fillThere were issues with automatic water level controllers on the lids of lines 7&8 extractor dryers. This meant the driers and extractors were not sealed and solvent / steam would escape reducing the effectiveness of the system and sending solvent vapours back to system via the enclosure extractionReduce TCE escaping into main enclosures reducing potential operator exposureH&SL7/8 Oven temps increaseThe oven temps on both lines were increased to aid solvent removal by adjusting steam flow and condensate return pipework.Reduced TCE being carried through with sheet	AreaActionSummaryBenefit to TCE managementPlanned/ Completed DateH&SActionSummaryBenefit to TCE managementCompleted DateH&SL7/8 Water Seals automatic fill automatic fillThere were issues with automatic water level controllers on the lids of lines 7&8 extractor dryers. This meant the driers and extractors were not sealed and solvent / steam would escape reducing the effectiveness of the system and sending solvent vapours back to system via the enclosure extractionReduce TCE escaping into main enclosures reducing potential operator exposureJul-20H&SL7/8 Oven temps increaseThe oven temps on both lines were increased to aid solvent removal by adjusting steam flow and condensate return pipework.Reduced TCE being carried through with sheetJul-20

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Operational Exposure	H&S	Line audits to identify leaks	Audits are carried out in enclosure prior to a line down pm and identified solvent leaks which were fixed when down	Reduce TCE escaping into main enclosures reducing potential operator exposure	Apr-16	Engineering
Operational Exposure	H&S	Improved controls and equipment	Line 7 dryer 1, controls and super – heated steam spargers were installed to increase the efficiency of the dryer	Reduced TCE being carried through with sheet	May-17	Engineering
Operational Exposure	H&S	Improved controls and equipment	Line 7 dryer 2, 4 rib steam lances were installed to reduce solvent use and emissions	Reduced TCE being carried through with sheet	Apr-18	Engineering

				Benefit to TCE	Planned/	
Focus Area	Area	Action	Summary	management	Date	Owner
Operational Exposure	H&S	Upgrade to equipment	Line 7 & 8 ovens, extra bank installed on each from 2 to 3 to reduce moistures but will also help with solvent recovery and emissions at winder	Reduced TCE being carried through with sheet	Jun-18	Engineering
Operational Exposure	H&S	Upgrade to equipment	Line 7 & 8 ovens, extra bank installed on each from 3 to 4 to reduce moistures but will also help with solvent recovery and emissions at winder	Reduced TCE being carried through with sheet	Jun-18	Engineering
Operational Exposure	H&S	Improved detection	Sheet width sensors installed Lines 1 & 2 to make operators more aware of issues at the winder. Quicker responses to width issues and potential solvent laden fold overs reaching the winders.	Reduced TCE being carried through with sheet	Oct-18	Engineering

					Planned/	
				Benefit to TCE	Completed	
Focus Area	Area	Action	Summary	management	Date	Owner
Occupational Exposure	H&S	L7/8 Winder Enclosure	Beacon system in enclosures and on entry to the enclosure to warn operators of elevated levels and to wear RPE.	Reduce employee exposure	Nov-18	Engineering
Occupational Exposure	H&S	L1/2 Winder Enclosure	Beacon system in enclosures and on entry to the enclosure to warn operators of elevated levels and to wear RPE.	Reduce employee exposure	Nov-18	Engineering
Occupational Exposure	H&S	Zerma Grinder Enclosure	Beacon system in enclosures and on entry to the enclosure to warn operators of elevated levels and to wear RPE.	Reduce employee exposure	Nov-18	Engineering
Occupational Exposure	H&S	L1 Cryo Oven - L1/2 Main Enclosure	Seal on cryo oven doors tightened	Reduce possible employee exposure (although RPE used in the main enclosures)	Sep-17	environment