

SAFETY DATA SHEET

in accordance with the Regulation EU 453/2010 and Rule book on the content of safety data sheet ("Sl. glasnik RS", 100/11)

C-4 FRACTION

Version: 4 – this version replaces all previous
Revision: 1

Date: 01.06.2015.



PETROHEMIJA

1. IDENTIFICATION OF CHEMICAL AND INFORMATION ABOUT THE PERSON WHO PUTS THE CHEMICAL ON THE MARKET

1.1 IDENTIFICATION OF THE CHEMICAL

Chemical name	Hydrocarbons, C-4
CAS number	68476-52-8
EC number	270-691-3
Trade name	C-4 fraction
REACH registration No.	01-2119473796-21-0020

1.2 IDENTIFIED WAYS OF USAGE OF CHEMICALS AND WAYS OF USAGE THAT ARE NOT RECOMMENDED

Ways of usage of chemicals	The raw material for the chemical and petrochemical production, extraction of 1,3 butadiene and production of SBR and MTBE (R30990)
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1.3 INFORMATION ON SUPPLIER

Producer name	"HIP-Petrohemija" a.d. Pančevo
Address and telephone number	Spoljnostarčevačka 82 26000 Pančevo The Republic of Serbia +381 13 30 70 00

E-mail of the person responsible for safety data sheet iboja.rasa@hip-petrohemija.rs

Only Representative REACHLaw, Finland; info@reachlaw.fi

1.4 TELEPHONE NUMBER FOR EMERGENCIES

Emergency Contact (24h) See Section 16. for the list of telephone numbers of poison centers in the European Economic Area

2. HAZARD IDENTIFICATION


2.1 CHEMICAL CLASSIFICATION

Rule book on classification, packaging, signing and advertising of the chemical and certain product in accordance with Global harmonized system for classification and signing of UN („Sl.glasnik RS“ No. 105/13)	Flam. gas 1; H220 Gas under pres.; H280 (liquid gas) Carc. 1A; H350 Mut. germ. 1B; H340
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For the total name of the hazard classes and notification on hazard, see Chapter 16

Adverse effect on the environment	Not classified as dangerous. Product immediately evaporates.
Adverse physical-chemical effects	At outlets or locations of fire flames in storage tanks vapor can form polymers and lead to clogging of the openings. The product can, under certain conditions (exposure to air) to form explosive peroxides and initiate polymerization. Product may polymerize due to fire or explosion. The substance decomposes explosively on rapid increase in temperature under pressure.

2.2 LABEL ELEMENTS

Hazard pictogram	
Word of warning	Danger!
Information on hazards	H220, H280, H350, H340
Information on precautionous measures	P210, P281, P243, P377, P381, P410+P403, P501

For the total name of information on precautionous measurements see Chapter 16

2.3 OTHER HAZARDS

C-4 fraction does not meet the criteria for identification as persistent - bioaccumulative - toxic (PBT) or very persistent - very bioaccumulative (vPvB).

3. CONTENT / INFORMATION ON COMPONENTS

3.1 INFORMATION ON SUPSTANCE COMPONENTS

Name of chemical	Index number	Concentration (%(m/m))
1,3-butadiene	601-013-00-X	43 – 60
1-butene	601-012-00-4	
iso-butene	601-012-00-4	25 – 45
2-butene	601-012-00-4	

4. FIRST AID MEASURES

4.1 DESCRIPTION OF FIRST AID MEASURES

General advice	<p>The product is highly flammable. When leaks there is a high risk of developing fire. Gas is heavier than air and may spread and cause ignition. As a result of flow, it can occur electrostatic charge, the change of current. May form explosive mixtures with air. Contact with the gas which is in a liquid state may cause frostbite.</p> <p>The product is toxic. Inhalation of moderate concentration can cause cough, sore throat, dizziness, headache, drowsiness, worsened vision, nausea, loss of balance and dizziness and in extreme cases, coma and possible death. Can cause cancer.</p> <p>Take the necessary precautions to protect their own health before rescue and providing first aid.</p>
Inhalation	Fresh air, rest. Seek medical assistance.
Contact with skin	Frostbite: Rinse with plenty of water. Do not remove clothing or taped stuff. Seek medical assistance. Do not use hot water.
Contact with eyes	First, rinse a few minutes with plenty of water (remove contact lenses carefully). Do not use hot water.
Ingestion	It is not possible.

4.2 MOST IMPORTANT SYMPTOMS AND EFFECTS, BOTH ACUTE AND DELAYED

Inhalation	This product is a mild narcotic suffocating gas that can cause unconsciousness or even death if the extremely low levels of oxygen. Inhalation of moderate concentrations causes coughing, sore throat, dizziness, headache, drowsiness, blurred vision, nausea, loss of sense of balance and in extreme cases, coma and possibly death. High concentrations can cause improper operation and possible sensitization of the heart.
Contact with skin	CONTACT WITH LIQUEFIED GAS: COLD BURNS. The product does not penetrate the skin.
Contact with eyes	Gas is a mild irritant and can cause redness, pain and blurred vision. CONTACT WITH LIQUEFIED GAS: COLD BURNS.
Ingestion	Ingestion of the product is impossible. The product evaporates easily.

4.3 IMMEDIATE MEDICAL ATTENTION AND SPECIAL TREATMENT

With the standard methods to treat sleepiness, frostbite, nausea, decreased blood pressure and cardiac arrhythmias. Sympathomimetic and catecholamines should be avoided or used with caution (even small doses can have an impact) because it can cause cardiac sensitization. Provide oxygen mask if there is a disruption in breathing. Treatment of consequences from exposure should be directed at establishing control of symptoms and the clinical picture of the patient. After initial assistance there is no need for further treatment if symptoms do not happen again.

5. FIREFIGHTING MEASURES

5.1 EXTINGUISHING MEDIA

Suitable extinguishing media	Do not extinguish fire caused by a gas leak, except when the source can be isolated if it can repair the leak. Use: Dry powder or carbon dioxide (CO ₂) extinguisher, foam fire extinguisher.
Unsuitable extinguishing media:	Do not use direct water stream as it may scatter and spread fire.

5.2 SPECIAL HAZARDS ARISING FROM THE SUBSTANCE OR MIXTURE

Hazardous combustion products: Carbon monoxide, carbon dioxide and unburnt hydrocarbons (smoke).

5.3 ADVICE FOR FIREFIGHTERS

Special measures of protection during fire fighting:	Use large amounts of water for cooling the fire affected tank. Fight fire from protected location of the maximum possible distance. Avoid breathing smoke or burnt material. Keep away in the event of fire while opening the vessels or colour change caused by heat reservoir.
Special protective equipment for firefighters:	A set of protective equipment for firefighters by ref. Standard SRPS EN 469 Protective gloves for firefighters (ref. Standard SRPS EN 659) and boots in combination with the appropriate respiratory protection (ref. standard EN 137).

6. MEASURES IN CASE OF ACCIDENT

6.1 PERSONAL PRECAUTIONS, PROTECTIVE EQUIPMENT AND EMERGENCY PROCEDURES

Complete personal protective equipment including breathing apparatus. Avoid inhalation of vapors. Ensure adequate ventilation, and the absence of ignition sources.

6.2 PRECAUTIONS RELATED TO THE ENVIRONMENT

Spills on land: Prevent further leakage or spillage if possible. Prevent entry into sewers or confined. Spills into waterways: Prevent further leakage or spillage if possible. If there is contamination of watercourses inform the relevant authorities.

6.3 MEASURES TO BE TAKEN AND MATERIALS FOR CONTAINMENT AND CLEANING UP

Prevent material spillage. Evacuate and isolate hazard area. Remove all sources of ignition. Call a rescue team and firefighters. The product evaporates easily. In case of cold weather (low temperature) to cover the substance of combustible material to absorb (sand, universal binders) placed in sealed canisters (barrel). Dispose of contaminated material in accordance with Chapter 13 Use water spray to reduce the concentration in the air.

6.4 REFERENCE TO OTHER SECTIONS

See chapters 8. and 13.

7. HANDLING AND STORAGE

7.1 PRECAUTIONS FOR SAFETY HANDLING

Avoid any release into the environment. Avoid breathing. Avoid contact with skin and eyes. Do not handle and store near an open flame, sources of heat or ignition. No smoking occasion of use. Prohibited from consuming food and drink when handling. Get changed all his clothes when finished working with this product and dispose of it. Handle products in accordance with instructions for hygienic and safe operation.

7.2 CONDITIONS FOR SAFE STORAGE, INCLUDING INCOMPATIBILITY

Store in a cool place fireproof. All electrical equipment must be secured so that it does not spark and does not explode. Pipelines, containers or materials storage must not contain more than 63% copper.

7.3 SPECIAL WAY OF USAGE

No information.

8. EXPOSURE CONTROL

8.1 PARAMETERS OF EXPOSURE CONTROL

The maximum allowable concentration

1,3-butadiene	ACGIH	TLV: 2 ppm as TWA
	OSHA	TLV: 1 ppm as TWA
1-butene	ACGIH	TLV: 250 ppm as TWA

8.2 EXPOSURE CONTROL AND PERSONAL PROTECTIVE EQUIPMENT

Protection of eyes/face	Face masks, goggles or in combination with breathing apparatus (ref.standard SRPS EN 166).
Protection of skin (hands/other body parts)	Chemical resistant gloves. Protective clothing that substantially prevents contact with the skin. Chemical resistant protective boots (ref.standard SRPS EN 374)
Respiratory protection	Wear protective mask in case there is a possibility of exposure to steam. If there is a low level of oxygen in the air use breathing apparatus (ref.standard SRPS EN 137).
Control of environmental exposure	Exposure control of the environment conducted in accordance with applicable regulations

9. PHYSICAL AND CHEMICAL PROPERTIES ⁽¹⁾

9.1 INFORMATION ON BASIC PHYSICAL AND CHEMICAL PROPERTIES

Aggregate state	Gas on the standard conditions (20°C and 1013 hPa)
Colour	Colourless
Odour	Characteristic of hydrocarbons
Odour threshold	Detected on 0,45 ppm/ 1,0 mg/m ³ - 1,3-butadiene.
pH	Not applicable

Melting point / freezing point	-138.88 to -105.52°C
Initial boiling point (boiling range)	-12°C to -4°C
Flash point	< -30°C
Evaporation rate	Immediately on 20°C
Flammability	Very easily flammable
The lower limit of flammability (explosive)	1,8%
The upper limit of flammability (explosive)	9,6%
Vapour pressure	No information
Vapour density (air=1)	1,9-1,3 (1,3-butadiene)
The relative density	0,6-0,62
Solubility	135,6 mg/l
Coef.of partition n-oktanol/water (Log Pow)	2,34
Autoignition temperature	413°C
Decomposition temperature	No information
Viscosity	No information
Explosive properties	The mixture of gas and air is explosive
Oxidising properties	Exposure to air, peroxide is formed, causing explosive polymerization

9.2 OTHER INFORMATION

No other information

10. STABILITY AND REACTIVITY

10.1 REACTIVITY

Reacts violently with oxidants, phenol, ethanol, nitric acid, oxygen, causing fire and explosion.

10.2 CHEMICAL STABILITY

The product is unstable. The substance may, under certain conditions (exposure to air) form a peroxide and initiate explosive polymerization. The product can polymerize during a fire or explosion. Product disintegrate explosively by rapid rise in temperature and pressure.

10.3 POSSIBILITY OF HAZARDOUS REACTIONS

Thermal decomposition may produce oxides of carbon and other toxic gases by which it is released the heat and pressure. The polymerization can be carried out at elevated temperatures or in the presence of oxidizers. The formation of polymers can build sufficient mechanical force to break the process equipment. Polymers can also clog safety ventilation devices.

10.4 CONDITIONS WHICH SHOULD BE AVOID

Heat, sparks, open flames and other ignition sources.

10.5 INCOMPATIBLE MATERIAL

Oxidizing agents, organic materials, some plastics and rubber, acid. The materials from which the piping are made must not contain more than 63% copper.

10.6 HAZARDOUS DECOMPOSITION PRODUCTS

Carbon monoxide, carbon dioxide and other toxic gases.

11. TOXICOLOGICAL INFORMATION ⁽¹⁾

11.1 INFORMATION ON TOXICOLOGICAL EFFECTS OF A SUBSTANCE

Acute toxicity	LC ₅₀ inhaling, rat, for gases and vapours	> 5,3 mg/l (4h)
Skin corrosion / irritation	It does not cause skin corrosion / irritation	
Serious eye damage / eye irritation	It does not cause serious eye damage / eye irritation.	
Respiratory sensitization or skin	No information.	
Germ cell mutagenicity	Mutagenicity of germ cell, category 1B <i>The positive results of in vivo tests in mice bone marrow.</i>	
Carcinogenicity	Carcinogenicity, category 1A It has been proved that it causes carcinogenicity at mice that have been exposed (by inhalation) of 1,3-butadiene in a concentration from 6.25 to 625 ppm in a period of 2 years.	
Reproductive toxicity	It does not cause toxicity for reproduction. NOAEC: 20 mg / l (inhalation, rat, female / male, exposed 36 days, 6 h / day)	
Specific toxicity for target organ - JI	It does not cause specific toxicity for target organ - JI	
Specific toxicity for target organ - VI	It does not cause specific toxicity for target organ – VI NOAEC: 20 mg/l (inhalation, rat, female / male, 6 h/day)	
Risk of aspiration	No information.	

12. ECOTOXICAL INFORMATION ⁽¹⁾

12.1 TOXICITY

Acute toxicity	96 h LC ₅₀ (for fish)	19 mg/l
	48 h LC ₅₀ (for crabs)	11 mg/l
	96 h EC ₅₀ (for algae)	11 mg/l
	M - factor	/
Chronic toxicity	96 h LC ₅₀ (for fish)	Information not available
	48 h LC ₅₀ (for crabs)	Information not available
	96 h EC ₅₀ (for algae)	Information not available
	M - factor	/

12.2 PERSISTENCE AND DEGRADABILITY

Biodegradation	It is expected that there will be biodegradation, and the speed depends on the type of component and the environmental conditions.
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12.3 BIOACCUMULATION POTENTIAL

Bioaccumulation	The ability to bioaccumulate was determined by the octanol / water log Kow is 2.34, which means that the substance has no potential to bioconcentrate.
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12.4 MOBILITY IN SOIL

The mixture is spread 99.9% of the air and almost no penetration into the soil, sediment, etc..

12.5 RESULTS PBT I vPvB ASSESSMENT

PBT I vPvB	The substance does not meet the criteria for identification as persistent-bioaccumulative - toxic or very persistent - very bioaccumulative.
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12.6 OTHER ADVERSE EFFECTS

Effects on the environment	Information not available
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Photochemical ozone creation	Information not available
Disorders of the endocrine system	Information not available


13. DISPOSAL

13.1 WASTE TREATMENT METHODS


Disposal of unused product and packaging	Disposal of unused product is made in accordance with the regulations on waste management - the rest of the unused product shall be delivered to the authorized operator or at the place designated for hazardous waste. This product is not packaged in a package.
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14. INFORMATION ON TRANSPORT


Road(ADR) / Rail (RID)/ Water (ADN) transport

Proper shipping name	BUTADIENES AND HYDROCARBON MIXTURE, STABILISED	Signing
UN number	1010	
Class of danger in transport	2.1 (Flammable gas)	
Classification code	2F	
Hazard identification number	239	
Packing group	/	

International maritime transport (IMDG)

Proper shipping name	BUTADIENES AND HYDROCARBON MIXTURE, STABILISED	Signing
UN number	1010	
IMDG class	2.1 (Flammable gas)	
EmS classification	F-D, S-U	
Packing group	/	

International airline transport (IATA/ICAO)

Proper shipping name	BUTADIENES AND HYDROCARBON MIXTURE, STABILISED	Signing
UN number	1010	
ICAO/IATA class	2.1 (Flammable gas)	
Packing group	/	

14.1 UN NUMBER

UN 1010

14.2 UN NAME OF BURDEN IN TRANSPORT

BUTADIENES AND HYDROCARBON MIXTURE, STABILISED

14.3 HAZARD CLASS IN TRANSPORT

2.1 (Flammable gas)

14.4 PACKAGE GROUP

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14.5 HAZARD FOR THE ENVIRONMENT

ADR	Yes
RID	Yes
ADN	Yes

IMDG	Yes
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14.6 SPECIAL PRECAUTIONS FOR USER

Code for labeling for tunnels: B/D

14.7 TRANSPORT IN BULK

Not applicable.

15. REGULATORY INFORMATION

15.1 REGULATIONS RELATED TO SECURITY, HEALTH AND ENVIRONMENT

Rule book on the List of hazardous substances and their amounts and the criteria for determining the types of documents drawn up by the operator Seveso facility i.e. complex. („Sl.gl. RS“, No. 89/10, 71/11 and 90/11):

Number of limits and restrictions 28 and 29 1,3-butadiene CAS NO. 106-99-0 EC NO. 270-691-3

"1. It shall not be placed on the market or use:

- as substance;*
- as a component of other substances or in mixtures intended for general use, and their individual concentrations equal to or greater than:*
- specific limit concentration given in the List of Classified Substances*
- relevant concentrations given in the Regulation on the classification, packaging, labeling and marketing of chemicals and certain products („Službeni glasnik RS“, number 59/10).*

The supplier shall ensure that the packaging of such substance or mixture, in addition to labeling in accordance with the regulations on the classification, packaging and labeling of chemicals, shall be visible and indelibly marked as follows: "It is intended for professional use."

2 The prohibition from Section 1 shall not apply to:

- a) medical or veterinary products as defined by special regulations;*
- b) cosmetic products that are regulated by specific regulations;*
- v) motor fuels which are regulated by special regulations, and to:*
 - mineral oils used as fuel in engines or power plants;*
 - mineral fuels sold in closed systems (eg, bottles with liquid gas);*

g) painting color.“

Rule book on the List of Hazardous Substances and their amounts and the criteria for determining the types of documents drawn up by the operator Seveso facility or complex. („Sl.gl. RS.“ No.41/10)

Table II:

A list of the hazard classes and limit the amount of hazardous substances Rb. 8 threshold quantity in tons: 10-50

15.2 CHEMICAL SAFETY ASSESSMENT

It is undertaken an assessment of chemical safety. Exposure scenario is given in Annex Safety Data Sheet

16. OTHER INFORMATION

Advice on training	Personnel who are handling the product must be familiar with its hazardous properties, the principles of health and environmental protection related to the product and the principles of first aid.	
Recommendation for use	The product is intended exclusively for professional use. Used only in industry.	
Full name of the hazard class, information on risk and precautionary measures	Flam. gas 1	Flammable gases, category 1
	Gas under pres.	Gases under pressure
	Carc. 1A	Carcinogenicity, category 1A
	Mut. germ. 1B	Germ cell mutagenicity, category 1B
	H220	Very flammable gas
	H280	Contains gas under pressure, may explode if heated
	H340	May cause genetic defects

	H350	May cause cancer
	P210	Keep away from heat / sparks / open flames / hot surfaces. - No smoking
	P281	Use personal protective equipment
	P243	Take precautions to avoid creating static electricity
	P377	Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
	P381	Remove all sources of ignition, if it can be done safely.
	P410+P403	Protect from sunlight. Store in a well-ventilated
	P501	Dispose of contents / package in accordance with local / regional / national / international regulations
Changes and additions to the SDS	Changes were made in subsection 2.1 and section 16 for the purpose of classification and labeling only with the "Regulation on classification, packaging, labeling and advertising chemicals and certain products in accordance with the Globally Harmonized System for classification and labeling UN" („Sl.glasnik RS“ No. 105/13)	
The sources used for critical information in making safety data sheet	⁽¹⁾ ECHA – European Agency for chemicals (http://echa.europa.eu/) ESIS - European chemical Substances Information System (http://esis.jrc.ec.europa.eu/)	

List of abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
CAS	Chemical Abstract Service
ErC ₅₀	Half maximal effective concentration
EU	European Union
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IMDG	International Maritime Dangerous Goods
LC ₅₀	Lethal Concentration
LD ₅₀	Lethal Dose
M-factor	M-factor is a coefficient which is multiplied by the concentration of substances classified as hazardous to the aquatic environment, acute, category 1 or chronic, category 1, which is used in a method of summarizing the classification of a mixture containing that substance
NOAEC	No Observed Adverse Effect Concentration
OSHA	Occupational Safety and Health Administration
RID	International Rule for Transport of Dangerous Substances by Railway
TLV	Threshold Limit Value
TWA	Time Weighted Averages

LIST OF TELEPHONE NUMBERS OF POISON CENTRES IN THE EUROPEAN ECONOMIC AREA

AUSTRIA (Vienna Wien)	+43 1 40 400 2222
BELGIUM (Brussels Bruxelles)	+32 70 245 245
BULGARIA (Sofia)	+359 2 9154 409 / +359 887 435 325
CZECH REPUBLIC (Prague Praha)	+42 2 2491 9293 or +42 2 2491 5402
DENMARK (Copenhagen)	+45 35 31 54 04
FINLAND (Helsinki)	+358 9 471 977
FRANCE (Paris)	+33 1 40 05 48 48
GERMANY (Berlin)	+49 30 450 653565
GREECE (Athens Athinai)	+30 10 779 3777
HUNGARY (Budapest)	+36 80 20 11 99
ICELAND (Reykjavik)	+354 525 111, +354 543 2222
IRELAND (Dublin)	+353 1 8379964
ITALY (Rome)	+39 06 305 4343
LATVIA (Riga)	+371 704 2468
LITHUANIA (Vilnius)	+370 2 36 20 52, +370 2 36 20 92
NETHERLANDS (Bilthoven)	+31 30 274 88 88
NORWAY (Oslo)	+47 22 591300
POLAND (Gdansk)	+48 58 301 65 16 or +48 58 349 2831
PORTUGAL (Lisbon Lisboa)	808 250 143 (for use only in Portugal), +351 21 330 3284
ROMANIA (Bucharest)	+40 21 230 8000;
SLOVAKIA (Bratislava)	+421 2 54 77 4 166
SLOVENIA (Ljubljana)	+ 386 41 650 500
SPAIN (Barcelona)	+34 93 227 98 33 or +34 93 227 54 00 bleep 190
SWEDEN (Stockholm)	+46 8 33 12 31 (International) 112 (National)
UNITED KINGDOM (London)	0870 243 2241

ANEX OF SAFETY DATA SHEET

EXPOSURE SCENARIO

Exposure scenario is entirely taken from Chapter 9. EXPOSURE ASSESSMENT, „CHEMICAL SAFETY REPORT, Part B“ for hydrocarbon, C-4.

9. EXPOSURE ASSESSMENT

The following generic uses were evaluated in the exposure assessment of C4, high 1,3-butadiene ($\geq 0.1\%$) category streams. The ‘C4, high 1,3-butadiene ($>0.1\%$)’ category covers hydrocarbon streams containing high purity hydrocarbons, hydrocarbon substances with impurities and complex hydrocarbon reaction products. These hydrocarbon streams have a carbon number distribution that is predominantly C4 but with a range of C3-C5 and more than 0.1% 1,3-butadiene. Category members are typically produced from the steam-cracking of naphtha as a C4-rich stream.

ES	Identified use	Process category (PROC)	Product Category (PC)	Sector of Use (SU)	Article category (AC)	Environmental Release Category (ERC)	EU tonnage (tonnes/yr)	Regional fraction
1	Manufacture (Industrial)	PROC 1, PROC 2, PROC 3, PROC 4, PROC 8a, PROC 8b, PROC 15	NA	3, 8, 9,	NA	1, 4	5.00E+05	0.1
2	Distribution (Industrial)	PROC 1, PROC 2, PROC 3, PROC 4, PROC 8a, PROC 8b, PROC 9, PROC 15	NA	3, 8, 9	NA	1-7	5.00E+05	0.1
3	Intermediate (Industrial)	PROC 1, PROC 2, PROC 3, PROC 4, PROC 8a, PROC 8b, PROC 15	NA	3, 8, 9	NA	6a	2.50E+05	0.1
4	Formulation	PROC 1, PROC 2, PROC 3, PROC 4, PROC 5, PROC 8a, PROC 8b, PROC 9, PROC 14, PROC 15	NA	3, 10	NA	2	2.50E+05	0.1

5	Use in coatings (industrial)	PROC1, PROC2, PROC3, PROC4, PROC5, PROC7, PROC8a, PROC8b, PROC10, PROC13, PROC15	NA	3	NA	4	1.00E+03	0.1
6	Uses in Fuels (Industrial)	PROC 1, PROC 2, PROC 3, PROC 8a, PROC 8b, PROC 16	NA	3	NA	7	1.00E+05	0.1
7	Use in Fuels (Professional)	PROC1, PROC2, PROC3, PROC8a, PROC8b, PROC16	NA	22	NA	9a, 9b	7.50E+04	0.1
8	Use in polymer production (Industrial)	PROC 1, PROC 2, PROC 3, PROC 4, PROC 5, PROC 6, PROC 8a, PROC 8b, PROC 14, PROC 21	NA	3, 10	NA	4, 6c	5.00E+04	0.1
9	Use in polymer processing (Industrial)	PROC 1, PROC 2, PROC 3, PROC 4, PROC 5, PROC 6, PROC 8a, PROC 8b, PROC 9, PROC 13, PROC 14, PROC 21	NA	3, 10	NA	4	1.00E+03	0.
10	Use in polymer processing (Professional)	PROC 1, PROC 2, PROC 6, PROC 8a, PROC 8b, PROC 14, PROC 21	NA	22	NA	8a, 8d	1.00E+03	0.1

The primary marker substance for this category is 1,3-butadiene. The worker exposure estimates for the activities associated with the above uses of streams in the C4,high 1,3-butadiene content category were assessed using ECETOC TRAv2. The maximum content of the marker substance used in the modelling was <80% based on information available for the streams.

For human health, the CSA has been undertaken by reference to marker components for the substance (as described in section 5.11 of the CSR). Within the worker CSA, where the phrase "Limit the substance content in the product to 1%, OC16" or "Limit the substance content in the product to 5%, OC17" routinely appears, this refers to the upper bound of the key marker component and not to any limitation applied to the UVCB substance. As such it is not intended to be communicated as part of any ES for the substance but is included in the CSA for the purposes of transparency.

PETRORISK: The combined role of partitioning and degradation properties of constituent hydrocarbons on environmental fate and resulting exposure of complex petroleum substances at both local and regional scales has been predicted using the PETRORISK mode 1 (Redman, A. (2010). PETRORISK Users Guide, HydroQual, Inc., for Conservation of Clean Air and Water in Europe (CONCAWE), based on the principles of the hydrocarbon block method and using fate factors derived from EUSES v2. This model also incorporates the relevant PNECs for these constituent hydrocarbons.

The Petrorisk model was used for the environmental assessment. The model assigns individual structures from the library to the hydrocarbon blocks that the user enters. The input parameters are provided in Appendix B. Details of the library structure mapping, some relevant physico-chemical properties and the mass fraction that is assigned to each chemical are also found in this appendix. Compounds assigned to hydrocarbon blocks without appreciable mass are assigned a vanishingly small value of "1E-40" in order to carry out subsequent calculations.

9a Carcinogenicity (R45) and Mutagenicity (R46) Hazard Qualitative Risk Assessment

A qualitative risk characterisation is required for the human health assessment (See Section 5).

The purpose of the qualitative risk characterisation is to assess:

"...the likelihood that effects are avoided when implementing the exposure scenario..." (REACH Annex 1, Section 6.5).

The general approach aims to reduce/avoid contact or incidents with the substance. However, implementation of risk management measures (RMMs) and operational conditions (OCs) needs to be proportional to the degree of concern for the health hazard presented by the substance. Exposures should be controlled to at least the levels that represent an acceptable level of risk, i.e. implementation of the chosen RMMs will ensure that the likelihood of an event occurring due to the hazard of the substance is negligible, and the risk is considered to be controlled to a level of no concern.

For carcinogenic and mutagenic hazards a qualitative risk assessment was conducted and handling and storage risk management measures that are generally identified to control potential risks are outlined in Appendix C. A review of these RMMs indicates that if the user complies with the following generic statement, risks due to carcinogenic and mutagenic hazards are considered to be controlled:

- Consider technical advances and process upgrades (including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general/local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean/flush equipment, where possible, prior to maintenance.
- Where there is potential for exposure: restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely.
- Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures.
- Consider the need for risk based health surveillance. [G20]

9.1. Exposure scenario 1: Manufacture of C4, high 1.3-butadiene ($\geq 0.1\%$) streams

9.1.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Manufacture of C4, high 1.3-butadiene ($\geq 0.1\%$) streams
Use Descriptor	Sector of Use: Industrial (SU3, SU8, SU9) Process Categories: PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15 Environmental Release Categories: ERC1, ERC4
Processes, tasks, activities covered	Manufacture of the Substance or use as an intermediate or process chemical or extraction agent. Includes recycling/recovery, material transfers, storage, sampling, associated laboratory activities, maintenance and loading (including marine vessel/barge, road/rail car and bulk container).
Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	Risk Management Measures <i>Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures, 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS.
General measures (carcinogens) [G18]	Consider technical advances and process upgrades (including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean / flush equipment, where possible, prior to maintenance. Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing

	<p>scenarios; clear up spills immediately and dispose of wastes safely.</p> <p>Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures.</p> <p>Consider the need for risk based health surveillance. [G20].</p>
General exposures (closed systems) [CS15].	Handle substance within a closed system [E47].
General exposures (closed systems) [CS15]. With sample collection [CS56]. With occasional controlled exposure [CS137]	Handle substance within a predominantly closed system provided with extract ventilation [E49].; Sample via a closed loop or other system to avoid exposure [E8] Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
General exposures (closed systems) [CS15]. Use in contained batch processes [CS37].	Handle substance within a predominantly closed system provided with extract ventilation [E49].; Sample via a closed loop or other system to avoid exposure [E8] Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Avoid carrying out activities involving exposure for more than 15 minutes [OC26].
General exposures (open systems) [CS16]. Batch process [CS55]. With sample collection [CS56].	Handle substance within a predominantly closed system provided with extract ventilation [E49].; Sample via a closed loop or other system to avoid exposure [E8] Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Avoid carrying out activities involving exposure for more than 15 minutes [OC26].
Process sampling [CS2].	Sample via a closed loop or other system to avoid exposure [E8] Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Avoid carrying out activities involving exposure for more than 15 minutes [OC26].
Laboratory activities [CS36].	Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. [E12]. Avoid carrying out activities involving exposure for more than 15 minutes [OC26].
Bulk transfers [CS14]. (open systems) [CS108] With potential for aerosol generation [CS138].	Use dry break couplings for material transfer [E75]. Ensure material transfers are under containment or extract ventilation [E66]. ; Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Bulk transfers [CS14]. (closed systems) [CS107];	Use dry break couplings for material transfer [E75]. Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Equipment cleaning and maintenance [CS39].	Drain down and flush system prior to equipment break-in or maintenance [E55]. Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Clear spills immediately [C&H13]. Wear a respirator conforming to EN140 with Type A filter or better. [PPE22] Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].
Storage [CS67] With occasional	Sample via a closed loop or other system to avoid exposure

controlled exposure [CS137]	[E8]Provide extract ventilation to material transfer points and other openings [E82].; Store substance within a closed system [E84].
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Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	5e4
Fraction of Regional tonnage used locally	1
Annual site tonnage (tonnes/year)	5e4
Maximum daily site tonnage (kg/day)	1.7e5

Frequency and duration of use

Continuous release [FD2].	
Emission days (days/year)	300

Environmental factors not influenced by risk management

Local freshwater dilution factor	40
Local marine water dilution factor	100

Other given operational conditions affecting environmental exposure

Conditions given in SPERC fact sheet (ESVOC SpERC 1.1.v1) give rise to following releases fractions

Release fraction to air from process (initial release prior to RMM)	2.0e-6
Release fraction to wastewater from process (initial release prior to RMM)	1.0e-5
Release fraction to soil from process (initial release prior to RMM)	1.0e-4

Technical conditions and measures at process level (source) to prevent release

Common practices vary across sites thus conservative process release estimates used [TCS1].

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation). [TCR1k]. On-site wastewater treatment required [TCR13]. Prevent discharge of undissolved substance to or recover from wastewater [TCR14].

Treat air emission to provide a typical removal efficiency of (%)	90
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	0

Organisation measures to prevent/limit release from site

Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].

Conditions and measures related to municipal sewage treatment plant

Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7
Maximum allowable site tonnage (M_{safe}) based on domestic sewage treatment release (kg/d)	9.0e7
Assumed domestic sewage treatment plant flow (m^3/d)	10000

Conditions and measures related to external treatment of waste for disposal

During manufacturing no waste of the substance is generated. [ETW 4].

Conditions and measures related to external recovery of waste

During manufacturing no waste of the substance is generated. [EWR 2].

Section 3

Exposure Estimation

3.1. Health

When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed,

	<i>exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC.</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
	<i>The SpERC emissions to air, and/or water, in this scenario have been amended to reflect those reported in the EU risk assessment report on 1,3-butadiene. The usual scaling factors can be amended to avoid the use of these emissions. Consult the SpERC to assess what factors need to be addressed.</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.	
Control of Worker Exposure	
<i>Selection of relevant Contributing Scenario phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>

9.1.2. Exposure estimation

9.1.2.1. Workers exposure

The worker exposure estimates for the activities associated with the manufacturing of C4, high 1,3-butadiene (>=0.1%) streams were reassessed using ECETOC TRAv2 (See Appendix A). Appendix A

contains Tables 1 and 2 used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.1.2.2. Consumer exposure

Not applicable.

9.1.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B.

9.1.2.4. Environmental exposure

See Appendix B.

9.2. Exposure scenario 2: Distribution of C4, high 1.3-butadiene ($\geq 0.1\%$) streams

9.2.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Distribution of C4, high 1.3-butadiene ($\geq 0.1\%$) streams
Use Descriptor	Sector of Use: Industrial (SU3, SU8, SU9) Process Categories: PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15 Environmental Release Categories: ERC1 - 7
Processes, tasks, activities covered	Loading (including marine vessel/barge, rail/road car and IBC loading) and repacking (including drums and small packs) of substance, including its distribution and associated laboratory activities
Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1]. Risk Management Measures
Contributing Scenarios	<i>Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical</i>

	<p><i>measures to prevent dispersion, 3. Organisational measures , 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS.</p>
General measures (carcinogens) [G18]	<p>Consider technical advances and process upgrades (including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean / flush equipment, where possible, prior to maintenance. Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely. Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures. Consider the need for risk based health surveillance. [G20].</p>
General exposures (closed systems) [CS15].	Handle substance within a closed system [E47].
General exposures (closed systems) [CS15]. ; With sample collection [CS56]. With occasional controlled exposure [CS137]	<p>Handle substance within a closed system [E47]. Ensure material transfers are under containment or extract ventilation [E66]. ; Sample via a closed loop or other system to avoid exposure [E8] Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
General exposures (closed systems) [CS15]. Use in contained batch processes [CS37].	<p>Handle substance within a closed system [E47]. Ensure material transfers are under containment or extract ventilation [E66]. ; Sample via a closed loop or other system to avoid exposure [E8] Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
General exposures (open systems) [CS16]. Batch process [CS55]. ; With sample collection [CS56].	<p>Ensure material transfers are under containment or extract ventilation [E66]. ; Sample via a closed loop or other system to avoid exposure [E8] Avoid carrying out activities involving exposure for more than 1 hour [OC27]. Clear transfer lines prior to de-coupling [E39].; Transfer via enclosed lines [E52].</p>
Process sampling [CS2].	<p>Handle substance within a closed system [E47]. Sample via a closed loop or other system to avoid exposure [E8]</p>
Laboratory activities [CS36].	<p>Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11].; Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. [E12].</p>
Bulk transfers [CS14]. ; (closed systems) [CS107]	<p>Clear transfer lines prior to de-coupling [E39].; Transfer via enclosed lines [E52]. Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure</p>

	for more than 1 hour [OC27].
Bulk transfers [CS14]. ; (open systems) [CS108]	Clear transfer lines prior to de-coupling [E39].; Transfer via enclosed lines [E52].Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Drum and small package filling [CS6].	Transfer via enclosed lines [E52].Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]
Equipment cleaning and maintenance [CS39].	Drain down and flush system prior to equipment break-in or maintenance [E55].Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11].Clear spills immediately [C&H13]. Wear a respirator conforming to EN140 with Type A filter or better. [PPE22] Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].
Storage [CS67]With occasional controlled exposure [CS137]	Transfer via enclosed lines [E52].Provide extract ventilation to points where emissions occur [E54]. ; Store substance within a closed system [E84].Avoid carrying out activities involving exposure for more than 4 hours [OC28]

Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	5.0e4
Fraction of Regional tonnage used locally	2.0e-3
Annual site tonnage (tonnes/year)	1.0e2
Maximum daily site tonnage (kg/day)	5.0e3

Frequency and duration of use

Continuous release [FD2].	
Emission days (days/year)	20

Environmental factors not influenced by risk management

Local freshwater dilution factor	10
Local marine water dilution factor	100

Other given operational conditions affecting environmental exposure

Conditions given in SPERC fact sheet (ESVOC SpERC 1.1b.v1) give rise to following releases fractions

Release fraction to air from process (initial release prior to RMM)	1.0e-4
Release fraction to wastewater from process (initial release prior to RMM)	1.0e-5
Release fraction to soil from process (initial release prior to RMM)	1.0e-5

Technical conditions and measures at process level (source) to prevent release

Common practices vary across sites thus conservative process release estimates used [TCS1].

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation). [TCR1k]. If discharging to domestic sewage treatment plant, no on-site wastewater treatment required [TCR9]. Prevent discharge of undissolved substance to or recover from wastewater [TCR14].

Treat air emission to provide a typical removal efficiency of (%)	90
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	0

Organisation measures to prevent/limit release from site

Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].

Conditions and measures related to municipal sewage treatment plant

Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7
Maximum allowable site tonnage (M_{Safe}) based on domestic sewage treatment release (kg/d)	1.1e7
Assumed domestic sewage treatment plant flow (m^3/d)	2000

Conditions and measures related to external treatment of waste for disposal

During manufacturing no waste of the substance is generated. [ETW 4]

Conditions and measures related to external recovery of waste

During manufacturing no waste of the substance is generated. [EWR 2]

Section 3	Exposure Estimation
3.1. Health	<i>When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC.</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOG (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.	
Control of Worker Exposure	

<i>Selection of relevant Contributing Scenario phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system</i>

9.2.2. Exposure estimation

9.2.2.1. Workers exposure

The worker exposure estimates for the activities associated with the manufacturing of C4, high 1.3 butadiene ($\geq 0.1\%$) streams were assessed using ECETOC TRAv2 (See Appendix A). Appendix A contains Tables 1 and 2 used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.2.2.2. Consumer exposure

Not applicable.

9.2.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B

9.2.2.4. Environmental exposure

See Appendix B

9.3. Exposure scenario 3: Intermediate use of C4, high 1.3-butadiene ($\geq 0.1\%$) streams

The worker exposure is considered as part of the manufacturing exposure. See 9.1 Exposure scenario 1: Manufacture of C4, high 1.3-butadiene ($\geq 0.1\%$) streams

9.3.1. Exposure scenario

Section 1	Exposure Scenario Title
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Title	Intermediate use of C4, high 1.3-butadiene ($\geq 0.1\%$) streams
Use Descriptor	Sector of Use: Industrial (SU3, SU8, SU9)
	Process Categories: PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15
	Environmental Release Categories: ERC 6a
Processes, tasks, activities covered	Use as a isolated intermediate not under strictly controlled conditions
Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
See Exposure 1: Manufacture of Fuel Oil Streams	
Section 2.2 Control of environmental exposure	
Product characteristics	
Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.	
Amounts used	
Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	2.5e4
Fraction of Regional tonnage used locally	6.0e-1
Annual site tonnage (tonnes/year)	1.5e4
Maximum daily site tonnage (kg/day)	5.0e4
Frequency and duration of use	
Continuous release [FD2].	
Emission days (days/year)	300
Environmental factors not influenced by risk management	
Local freshwater dilution factor	10
Local marine water dilution factor	100
Other given operational conditions affecting environmental exposure	
Conditions given in SPERC fact sheet (ESVOC SpERC 6.1a.v1) give rise to following releases fractions	
Release fraction to air from process (initial release prior to RMM)	5.0e-3
Release fraction to wastewater from process (initial release prior to RMM)	3.0e-4
Release fraction to soil from process (initial release prior to RMM)	1.0e-3
Common practices vary across sites thus conservative process release estimates used [TCS1].	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Risk from environmental exposure is driven by freshwater sediment. [TCR1b].	
If discharging to domestic sewage treatment plant, no on-site wastewater treatment required [TCR9]. Prevent discharge of undissolved substance to or recover from wastewater [TCR14].	
Treat air emission to provide a typical removal efficiency of (%)	80
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	
Organisation measures to prevent/limit release from site	
Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].	
Conditions and measures related to municipal sewage treatment plant	
Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7

Maximum allowable site tonnage (M_{safe}) based on domestic sewage treatment release (kg/d)	1.1e7
Assumed domestic sewage treatment plant flow (m ³ /d)	2000
Conditions and measures related to external recovery of waste	
This substance is consumed during use and no waste of the substance is generated. [ETW 5]	
Conditions and measures related to external treatment of waste for disposal	
This substance is consumed during use and no waste of the substance is generated. [EWR 3]	
Section 3	Exposure Estimation
3.1. Health	<i>See ES 1 Manufacture</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>See ES 1 Manufacture</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.	
Control of Worker Exposure	
<i>Selection of relevant Contributing Scenario phrases</i>	<i>See ES 1 Manufacture</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>

9.3.2. Exposure estimation

9.3.2.1. Workers exposure

Not applicable

9.3.2.2. Consumer exposure

Not applicable.

9.3.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B

9.3.2.4. Environmental exposure

See Appendix B

9.4. Exposure scenario 4: Formulation of C4, high 1.3-butadiene ($\geq 0.1\%$) streams

9.4.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Formulation & (re)packaging of C4, high 1.3-butadiene ($\geq 0.1\%$) streams
Use Descriptor	Sector of Use: Industrial (SU3, SU10) Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC8a, PROC8b, PROC9, PROC14, PROC15 Environmental Release Categories: ERC2
Processes, tasks, activities covered	Formulation, packing and re-packing of the substance and its mixtures in batch or continuous operations, including storage, materials transfers, mixing, large and small scale packing, maintenance and associated laboratory activities
Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1]. Risk Management Measures <i>Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures, 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS.
Contributing Scenarios	
General measures (carcinogens) [G18]	Consider technical advances and process upgrades

	<p>(including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean / flush equipment, where possible, prior to maintenance. Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely. Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures. Consider the need for risk based health surveillance. [G20].</p>
General exposures (closed systems) [CS15].	Handle substance within a closed system [E47].
General exposures (closed systems) [CS15]. ; With sample collection [CS56]. With occasional controlled exposure [CS137]	<p>Handle substance within a closed system [E47]. Provide extract ventilation to points where emissions occur [E54].;</p> <p>Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11].;</p> <p>Sample via a closed loop or other system to avoid exposure [E8] Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
General exposures (closed systems) [CS15]. Use in contained batch processes [CS37].	<p>Handle substance within a closed system [E47]. Provide extract ventilation to points where emissions occur [E54].;</p> <p>Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11].;</p> <p>Sample via a closed loop or other system to avoid exposure [E8] Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
General exposures (open systems) [CS16]. Batch process [CS55]. ; With sample collection [CS56]. ; With potential for aerosol generation [CS138].	<p>Formulate in enclosed or ventilated mixing vessels [E46]. Provide extract ventilation to points where emissions occur [E54]. ;</p> <p>Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11].;</p> <p>Sample via a closed loop or other system to avoid exposure [E8] Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
Batch processes at elevated temperatures [CS136].	<p>Handle substance within a closed system [E47]. Provide extract ventilation to points where emissions occur [E54].; Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11].;</p> <p>Sample via a closed loop or other system to avoid exposure [E8] Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
Process sampling [CS2].	<p>Handle substance within a closed system [E47]. Provide extract ventilation to points where emissions occur [E54].; Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).</p>

	[E11].; Sample via a closed loop or other system to avoid exposure [E8] Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Laboratory activities [CS36].	Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. [E12].; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].
Bulk transfers [CS14].	Clear transfer lines prior to de-coupling [E39].; Transfer via enclosed lines [E52].Ensure material transfers are under containment or extract ventilation [E66].
Mixing operations (open systems) [CS30]. With potential for aerosol generation [CS138].	Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Manual [CS34]. ; Transfer from/pouring from containers [CS22].	Use drum pumps or carefully pour from container [E64].Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].Avoid spillage when withdrawing pump [C&H16]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]
Drum/batch transfers [CS8].	Use drum pumps or carefully pour from container [E64].Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66].
Production or preparation or articles by tableting, compression, extrusion or pelletisation [CS100]	Limit the substance content in the product to 1% [OC16]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Drum and small package filling [CS6].	Clear transfer lines prior to de-coupling [E39].; Transfer via enclosed lines [E52].Ensure material transfers are under containment or extract ventilation [E66]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].
Equipment cleaning and maintenance [CS39].	Drain down and flush system prior to equipment break-in or maintenance [E55].Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Apply vessel entry procedures including use of forced supplied air [AP15]. ; Clear spills immediately [C&H13]. Wear a respirator conforming to EN140 with Type A filter or better. [PPE22] Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].
Storage [CS67] With occasional controlled exposure [CS137]	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66]. ; Store substance within a closed system [E84]. Avoid carrying out activities involving

exposure for more than 4 hours [OC28]

Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	2.5e4
Fraction of Regional tonnage used locally	1
Annual site tonnage (tonnes/year)	2.5e4
Maximum daily site tonnage (kg/day)	8.3e4

Frequency and duration of use

Continuous release [FD2].	
Emission days (days/year)	300

Environmental factors not influenced by risk management

Local freshwater dilution factor	10
Local marine water dilution factor	100

Other given operational conditions affecting environmental exposure

Conditions given in SPERC fact sheet (ESVOC SpERC 2.2.v1) (give rise to following releases fractions

Release fraction to air from process (initial release prior to RMM)	1.0e-4
Release fraction to wastewater from process (initial release prior to RMM)	1.0e-5
Release fraction to soil from process (initial release prior to RMM)	1.0e-4

Technical conditions and measures at process level (source) to prevent release

Common practices vary across sites thus conservative process release estimates used [TCS1].

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation). [TCR1k]. If discharging to domestic sewage treatment plant, no on site wastewater treatment required [TCR9]. Prevent discharge of undissolved substance to or recover from wastewater [TCR14]. Release fraction to air from process (after typical onsite RMMs consistent with EU Solvent Emissions Directive requirements): [OOC11]

Treat air emission to provide a typical removal efficiency of (%)	0
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	0

Organisation measures to prevent/limit release from site

Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].

Conditions and measures related to municipal sewage treatment plant

Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7
Maximum allowable site tonnage (M_{safe}) based on domestic sewage treatment release (kg/d)	2.7e6
Assumed domestic sewage treatment plant flow (m^3/d)	2000

Conditions and measures related to external treatment of waste for disposal

During manufacturing no waste of the substance is generated. [ETW 4]

Conditions and measures related to external recovery of waste

During manufacturing no waste of the substance is generated. [EWR 2]

Section 3

Exposure Estimation

3.1. Health

When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed,

	<i>exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
	<i>The SpERC emissions to air, and/or water, in this scenario have been amended to reflect those used for distribution. The justification being that as 1,3-butadiene is a hazardous gas, the conditions for formulation are extremely unlikely to be more lax than those for distribution. The usual scaling factors can be amended to avoid the use of these emissions. Consult the SpERC to assess what factors need to be addressed.</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.	
Control of Worker Exposure	
<i>Selection of relevant Contributing Scenario phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>

9.4.2. Exposure estimation

9.4.2.1. Workers exposure

The worker exposure estimates for the activities associated with the use in formulation using C4, high 1,3-butadiene ($\geq 0.1\%$) streams were assessed using ECETOC TRAv2. See Appendix A). Appendix

A contains Tables 1 and 2, used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.4.2.2. Consumer exposure

9.4.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B

9.4.2.4. Environmental exposure

See Appendix B

9.5. Exposure scenario 5: Use of C4, high 1.3-butadiene ($\geq 0.1\%$) streams in coatings-Industrial

9.5.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Use in coatings of C4, high 1.3-butadiene ($\geq 0.1\%$) streams CAS RN
Use Descriptor	Sector of Use: Industrial (SU3) Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC7, PROC8a, PROC8b, PROC10, PROC13, PROC15 Environmental Release Categories: ERC 4
Processes, tasks, activities covered	Covers the use in coatings (paints, inks, adhesives, etc) including exposures during use (including materials receipt, storage, preparation and transfer from bulk and semi-bulk, application by spray, roller, spreader, dip, flow, fluidised bed on production lines and film formation) and equipment cleaning, maintenance and associated laboratory activities.
Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	Risk Management Measures
	<i>Note: list RMM standard phrases according to the</i>

	<p><i>control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures, 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS.</p>
General measures (carcinogens) [G18]	<p>Consider technical advances and process upgrades (including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean / flush equipment, where possible, prior to maintenance. Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely. Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures. Consider the need for risk based health surveillance. [G20].</p>
General exposures (closed systems) [CS15].	<p>Handle substance within a closed system [E47].</p>
General exposures (closed systems) [CS15]. With sample collection [CS56]. ; Use in contained systems [CS38].	<p>Handle substance within a closed system [E47]. Ensure material transfers are under containment or extract ventilation [E66]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]</p>
Film formation - force drying (50-100°C). Stoving (>100°C). UV/EB radiation curing [CS94]	<p>Ensure material transfers are under containment or extract ventilation [E66]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]</p>
Mixing operations (closed systems) [CS29]. General exposures (closed systems) [CS15].	<p>Formulate in enclosed or ventilated mixing vessels [E46]. Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
Film formation - air drying [CS95]	<p>Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
Preparation of material for application [CS96] Mixing operations (open systems) [CS30].	<p>Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Wear a respirator conforming to EN140 with Type</p>

	A filter or better. [PPE22]
Spraying (automatic/robotic) [CS97]	Carry out in a vented booth provided with laminar airflow [E59]. Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Manual [CS34]. Spraying [CS10].	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Minimise exposure by extracted full enclosure for the operation or equipment [E61]. Wear a full face respirator conforming to EN140 with Type A filter or better. [PPE24]
Material transfers [CS3]. Non-dedicated facility [CS82]	Clear transfer lines prior to de-coupling [E39]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]
Material transfers [CS3]. Dedicated facility [CS81]	Clear transfer lines prior to de-coupling [E39]. Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Roller, spreader, flow application [CS98]	Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Dipping, immersion and pouring [CS4].	Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Laboratory activities [CS36].	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11].; Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure. [E12]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Material transfers [CS3]. Drum/batch transfers [CS8]. ; Transfer from/pouring from containers [CS22].	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Production or preparation of articles by tableting, compression, extrusion or pelletisation [CS100]	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Use ventilation to extract vapours from freshly coated articles/objects [E56]. Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Equipment cleaning and maintenance [CS39].	Drain down system prior to equipment break-in or maintenance [E65]. Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Clear spills immediately [C&H13]. Avoid carrying out activities involving exposure for more than 1 hour [OC27]. Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENV4].

Storage [CS67]With occasional controlled exposure [CS137]

Handle substance within a closed system [E47].Provide extract ventilation to points where emissions occur [E54].; Store substance within a closed system [E84].

Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	1.0e2
Fraction of Regional tonnage used locally	1
Annual site tonnage (tonnes/year)	1.0e2
Maximum daily site tonnage (kg/day)	5.0e3

Frequency and duration of use

Continuous release [FD2].	
Emission days (days/year)	20

Environmental factors not influenced by risk management

Local freshwater dilution factor	10
Local marine water dilution factor	100

Other given operational conditions affecting environmental exposure

Conditions given in SPERC fact sheet (ESVOC SpERC 7.12a.v1) give rise to following releases fractions

Release fraction to air from process (initial release prior to RMM)	9.8e-2
Release fraction to wastewater from process (initial release prior to RMM)	7.0e-4
Release fraction to soil from process (initial release prior to RMM)	0.0e0

Technical conditions and measures at process level (source) to prevent release

Common practices vary across sites thus conservative process release estimates used [TCS1].

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation). [TCR1k].

If discharging to domestic sewage treatment plant, no on-site wastewater treatment required [TCR9]. Prevent discharge of undissolved substance to or recover from wastewater [TCR14].

Treat air emission to provide a typical removal efficiency of (%)	90
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	0

Organisation measures to prevent/limit release from site

Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].

Conditions and measures related to municipal sewage treatment plant

Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7
Maximum allowable site tonnage (M_{safe}) based on domestic sewage treatment release (kg/d)	4.4e4
Assumed domestic sewage treatment plant flow (m^3/d)	2000

Conditions and measures related to external treatment of waste for disposal

This substance is consumed during use and no waste of the substance is generated.[ETW 5]

Conditions and measures related to external recovery of waste

This substance is consumed during use and no waste of the substance is generated.[ERW 3]

Section 3

Exposure Estimation

3.1. Health

When the recommended risk management measures

	<i>(RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorsk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC.</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.	
Control of Worker Exposure	
<i>Selection of relevant Contributing Scenario phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>

9.5.2. Exposure estimation

9.5.2.1. Workers exposure

The worker exposure estimates for the activities associated with the industrial use in coatings of C4, high 1,3-butadiene ($\geq 0.1\%$) streams were assessed using ECETOC TRAv2. See Appendix A). Appendix A contains Tables 1 and 2, used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.5.2.2. Consumer exposure

Not applicable.

9.5.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B

9.5.2.4. Environmental exposure

See Appendix B

9.6. Exposure scenario 6: Use of C4, high 1.3-butadiene ($\geq 0.1\%$) streams in fuels - Industrial

9.6.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Use in Fuels of C4, high 1.3-butadiene ($\geq 0.1\%$) streams
Use Descriptor	Sector of Use: Industrial (SU3) Process Categories: PROC1, PROC2, PROC3, PROC8a, PROC8b, PROC16 Environmental Release Categories: ERC7
Processes, tasks, activities covered	Covers the use as a fuel (or fuel additive) and includes activities associated with its transfer, use, equipment maintenance and handling of waste.
Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	Risk Management Measures <i>Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures, 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS.
General measures (carcinogens) [G18]	Consider technical advances and process upgrades

	<p>(including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean / flush equipment, where possible, prior to maintenance. Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely. Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures. Consider the need for risk based health surveillance. [G20]</p>
Bulk transfers [CS14].	Transfer via enclosed lines [E52]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66].
Drum/batch transfers [CS8].	Use drum pumps [E53]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66].
General exposures (closed systems) [CS15].	Handle substance within a closed system [E47].
General exposures (closed systems) [CS15]. With occasional controlled exposure [CS137]	Handle substance within a closed system [E47]. Provide extract ventilation to points where emissions occur [E54].; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]
General exposures (closed systems) [CS15]. Batch process [CS55].	Handle substance within a closed system [E47]. Provide extract ventilation to points where emissions occur [E54].; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
General exposures (open systems) [CS16]. ; (closed systems) [CS107]	Handle substance within a predominantly closed system provided with extract ventilation [E49]. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
General exposures (open systems) [CS16]. ; (closed systems) [CS107] Batch process [CS55].	Handle substance within a predominantly closed system provided with extract ventilation [E49]. Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Equipment maintenance [CS5].	Drain down and flush system prior to equipment break-in or maintenance [E55]. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). [E11]. Clear spills immediately [C&H13]. Wear a full

	face respirator conforming to EN140 with Type A filter or better. [PPE24] Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].
Storage [CS67]	Handle substance within a closed system [E47]. Store substance within a closed system [E84].
Storage [CS67] With occasional controlled exposure [CS137]	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Provide extract ventilation to points where emissions occur [E54]. ; Store substance within a closed system [E84]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]
Disposal of wastes [CS28].	Transfer via enclosed lines [E52]. Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Clear spills immediately [C&H13].

Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	1e4
Fraction of Regional tonnage used locally	1
Annual site tonnage (tonnes/year)	1e4
Maximum daily site tonnage (kg/day)	3.3e4

Frequency and duration of use

Continuous release [FD2].	
Emission days (days/year)	300

Environmental factors not influenced by risk management

Local freshwater dilution factor	10
Local marine water dilution factor	100

Other given operational conditions affecting environmental exposure

Conditions given in SPERC fact sheet (ESVOC SpERC 7.12a.v1) give rise to following releases fractions

Release fraction to air from process (initial release prior to RMM)	2.5e-3
Release fraction to wastewater from process (initial release prior to RMM)	1e-5
Release fraction to soil from process (initial release prior to RMM)	0

Technical conditions and measures at process level (source) to prevent release

Common practices vary across sites thus conservative process release estimates used [TCS1].

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation). [TCR1k]. If discharging to domestic sewage treatment plant, no on-site wastewater treatment required [TCR9]. Prevent discharge of undissolved substance to or recover from wastewater [TCR14].

Treat air emission to provide a typical removal efficiency of (%)	95.0
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	0

Organisation measures to prevent/limit release from site

Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].

Conditions and measures related to municipal sewage treatment plant

Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7
Maximum allowable site tonnage (M _{Safe}) based on domestic sewage treatment release (kg/d)	1.2e5
Assumed domestic sewage treatment plant flow (m ³ /d)	2000
Conditions and measures related to external treatment of waste for disposal	
This substance is consumed during use and no waste of the substance is generated.[ETW 5]	
Conditions and measures related to external recovery of waste	
This substance is consumed during use and no waste of the substance is generated.[ERW 3]	
Section 3	Exposure Estimation
3.1. Health	<i>When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC.</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.	
Control of Worker Exposure	
<i>Selection of relevant Contributing Scenario phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>

9.6.2. Exposure estimation

9.6.2.1. Workers exposure

The worker exposure estimates for the activities associated with the industrial use in fuels of C4, high 1,3-butadiene ($\geq 0.1\%$) streams were assessed using ECETOC TRAv2 (See Appendix A). Appendix A contains Tables 1 and 2 used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.6.2.2. Consumer exposure

Not applicable

9.6.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B

9.6.2.4. Environmental exposure

See Appendix B

9.7. Exposure scenario 7: Use of C4, high 1.3-butadiene ($\geq 0.1\%$) streams as a fuel - Professional

9.7.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Use in Fuels of C4, high 1.3-butadiene ($\geq 0.1\%$) streams ;CAS RN
Use Descriptor	Sector of Use: Professional (SU22) Process Categories: PROC1, PROC2, PROC3, PROC8a, PROC8b, PROC16 Environmental Release Categories: ERC 9A, ERC 9B
Processes, tasks, activities covered	Covers the use as a fuel (or fuel additive) and includes activities associated with its transfer, use, equipment maintenance and handling of waste.
Section 2	Operational conditions and risk management measures
Field for additional statements to explain scenario if required.	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20 °C above ambient [G15]; Assumes a good basic standard of occupational hygiene is

<p>Contributing Scenarios</p>	<p>implemented [G1]. Risk Management Measures <i>Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures, 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS</p>
<p>General measures (carcinogens)</p>	<p>Consider technical advances and process upgrades (including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean / flush equipment, where possible, prior to maintenance. Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely. Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures. Consider the need for risk based health surveillance. [G20].</p>
<p>Bulk transfers [CS14].</p>	<p>Clear transfer lines prior to de-coupling [E39].; Transfer via enclosed lines [E52].Ensure material transfers are under containment or extract ventilation [E66]. ; Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) [E11]. Or Ensure operation is undertaken outdoors [E69]. Avoid carrying out activities involving exposure for more than 1 hour [OC 27].</p>
<p>Drum/batch transfers [CS8].</p>	<p>Use drum pumps [E53].; Transfer via enclosed lines [E52].Ensure material transfers are under containment or extract ventilation [E66]. ; Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) [E11]. Or Ensure operation is undertaken outdoors [E69]. Avoid carrying out activities involving exposure for more than 1 hour [OC 27].</p>
<p>Dipping, immersion and pouring [CS4].</p>	<p>Transfer via enclosed lines [E52].Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC 27].</p>
<p>General exposures (closed systems) [CS15].</p>	<p>Handle substance within a closed system [E47].</p>
<p>General exposures (closed systems) [CS15]. With occasional controlled exposure [CS137]</p>	<p>Handle substance within a closed system [E47].Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) [E11]. Or Ensure operation is undertaken outdoors [E69]. ; Provide extract ventilation</p>

<p>General exposures (open systems) [CS16]. ; (closed systems) [CS107]Batch process [CS55].</p>	<p>to points where emissions occur [E54]. Formulate in enclosed or ventilated mixing vessels [E46]. Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) [E11]. Or Ensure operation is undertaken outdoors [E69]. ; Provide extract ventilation to points where emissions occur [E54]. Avoid carrying out activities involving exposure for more than 4 hours [OC 28]</p>
<p>General exposures (open systems) [CS16]. ; (closed systems) [CS107]</p>	<p>Handle substance within a predominantly closed system provided with extract ventilation [E49].Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) [E11]. Or Ensure operation is undertaken outdoors [E69]. ; Provide extract ventilation to points where emissions occur [E54].</p>
<p>Equipment cleaning and maintenance [CS39].</p>	<p>Drain down and flush system prior to equipment break-in or maintenance [E55]. Ensure material transfers are under containment or extract ventilation [E66]. Clear spills immediately [C&H13]. Avoid carrying out activities involving exposure for more than 4 hours [OC 28].Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].</p>
<p>Vessel and container cleaning [CS103]</p>	<p>Drain down and flush system prior to equipment break-in or maintenance [E55]. Provide extract ventilation to points where emissions occur [E54]. Clear spills immediately [C&H13]. Avoid carrying out activities involving exposure for more than 4 hours [OC 28].Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].</p>
<p>Storage [CS67]</p>	<p>Store substance within a closed system [E84].; Sample via a closed loop or other system to avoid exposure [E8].</p>

Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	7.5e3
Fraction of Regional tonnage used locally	0.0005
Annual site tonnage (tonnes/year)	3.75
Maximum daily site tonnage (kg/day)	10

Frequency and duration of use

Continuous release [FD2].

Emission days (days/year)	365
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Environmental factors not influenced by risk management

Local freshwater dilution factor	10
Local marine water dilution factor	100

Other given operational conditions affecting environmental exposure

Conditions given in SPERC fact sheet (ESVOC SpERC 9.12b.v1) give rise to following releases fractions

Release fraction to air from process (initial release prior to RMM)	1e-2
Release fraction to wastewater from process (initial release prior to RMM)	1e-5

Release fraction to soil from process (initial release prior to RMM) 1e-5

Technical conditions and measures at process level (source) to prevent release

Common practices vary across sites thus conservative process release estimates used [TCS1].

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation). [TCR1k]. Soil emission controls are not applicable as there is no direct release to soil. [TCLR 4] Negligible air emissions as process operates in a contained system.

Treat air emission to provide a typical removal efficiency of (%) 0

Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8]. 0

Organisation measures to prevent/limit release from site

Prevent environmental discharge consistent with regulatory requirements. [OMS 4]

Conditions and measures related to municipal sewage treatment plant

Estimated substance removal from wastewater via domestic sewage treatment (%) 96.7

Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%) 96.7

Maximum allowable site tonnage (M_{safe}) based on domestic sewage treatment release (kg/d) 3.0e4

Assumed domestic sewage treatment plant flow (m^3/d) 2000

Conditions and measures related to external treatment of waste for disposal

This substance is consumed during use and no waste of the substance is generated.[ETW 5]

Conditions and measures related to external recovery of waste

This substance is consumed during use and no waste of the substance is generated.[ERW 3]

Section 3	Exposure Estimation
3.1. Health	<i>When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrорisk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC.</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure	

estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.

Control of Worker Exposure

Selection of relevant Contributing Scenario phrases

Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.

Control of environmental exposure

Selection of relevant RMM Core Phrases

Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.

9.7.2. Exposure estimation

9.7.2.1. Workers exposure

The worker exposure estimates for activities associated with the professional use of C4, high 1,3-butadiene ($\geq 0.1\%$) streams as fuels were assessed using ECETOC TRAv2 (See Appendix A). Appendix A contains Tables 1 and 2 used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.7.2.2. Consumer exposure

Not applicable

9.7.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B

9.7.2.4. Environmental exposure

See Appendix B

9.8. Exposure scenario 8: Use of C4, high 1.3-butadiene ($\geq 0.1\%$) streams in polymer production – Industrial

9.8.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Use in polymer production of C4, high 1.3-butadiene ($\geq 0.1\%$) streams; CAS RN
	Sector of Use: Industrial (SU3, SU10)
Use Descriptor	Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC6, PROC8a, PROC8b, PROC14, PROC21
	Environmental Release Categories: ERC4, ERC6C
Processes, tasks, activities covered	Manufacture of polymers from monomers in continuous and batch processes, include sparging, discharging, and reactor maintenance and immediate polymer product formation (i.e. compounding, pelletisation, product off-gassing).

Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	<p>Risk Management Measures <i>Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures, 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS.</p> <p>Consider technical advances and process upgrades (including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean/flush equipment, where possible, prior to maintenance.</p> <p>Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely.</p> <p>Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures.</p> <p>Consider the need for risk based health surveillance. [G20].</p>
General measures (carcinogens) [G18]	
General exposures (closed systems) [CS15]. Continuous process [CS54]. ; No sampling [CS57].	Handle substance within a closed system [E47].
Bulk transfers [CS14]. Transport [CS58]. ; With sample collection [CS56].	Ensure material transfers are under containment or extract ventilation [E66]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]
Polymerisation (bulk and batch) [CS65] Continuous process [CS54]. ; With sample collection [CS56].	Ensure material transfers are under containment or extract ventilation [E66]. ; Ensure operation is undertaken outdoors [E69]. Avoid carrying out activities involving

Polymerisation (bulk and batch) [CS65]Batch process [CS55]. ; With sample collection [CS56]. Elevated Temperature	exposure for more than 1 hour [OC27]. Formulate in enclosed or ventilated mixing vessels [E46].Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60].
Finishing operations [CS102]Batch process [CS55]. ; With sample collection [CS56].	Formulate in enclosed or ventilated mixing vessels [E46].Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60].
Intermediate polymer storage [CS66]	Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Store substance within a closed system [E84].
Additivition and stabilisation [CS69]	Formulate in enclosed or ventilated mixing vessels [E46]. Provide extract ventilation to points where emissions occur [E54].; Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60].
Mixing in containers [CS23].Batch process [CS55].	Formulate in enclosed or ventilated mixing vessels [E46]. Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].Wear suitable gloves tested to EN374 [PPE15].
Pelletizing [CS53]. Extrusion and masterbatching [CS88]	Handle substance within a closed system [E47]. Provide extract ventilation to points where emissions occur [E54].; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].Wear suitable gloves tested to EN374 [PPE15].
Pelletizing [CS53]. Production or preparation or articles by tableting, compression, extrusion or pelletisation [CS100].	Limit the substance content in the product to 1% [OC16]. Provide extract ventilation to points where emissions occur [E54]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].
Pelletisation and pellet screening [CS68](open systems) [CS108]	Limit the substance content in the product to 5% [OC17]. Ensure material transfers are under containment or extract ventilation [E66].
Bulk transfers [CS14]. Continuous process [CS54]. ; With sample collection [CS56].	Formulate in enclosed or ventilated mixing vessels [E46].Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60]. ; Ensure material transfers are under containment or extract ventilation [E66].
Transport [CS58]. With sample collection [CS56].	Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Equipment maintenance [CS5].	Drain down system prior to equipment break-in or maintenance [E65]. Provide extract ventilation to points where emissions occur [E54]. Clear spills immediately [C&H13]. Avoid carrying out activities involving exposure for more than 1 hour [OC27]. Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].
Storage [CS67]With occasional controlled exposure [CS137]	Provide extract ventilation to points where emissions occur [E54]. ; Store substance within a closed system [E84]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].

Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	5.0e3
Fraction of Regional tonnage used locally	1
Annual site tonnage (tonnes/year)	5.0e3
Maximum daily site tonnage (kg/day)	5.0e4

Frequency and duration of use

Continuous release [FD2].	
Emission days (days/year)	100

Environmental factors not influenced by risk management

Local freshwater dilution factor	10
Local marine water dilution factor	100

Other given operational conditions affecting environmental exposure

Conditions given in SPERC fact sheet (SpERC 4.20. v1) give rise to following releases fractions

Release fraction to air from process (initial release prior to RMM)	2.0e-3
Release fraction to wastewater from process (initial release prior to RMM)	3.0e-4
Release fraction to soil from process (initial release prior to RMM)	1.0e-4

Technical conditions and measures at process level (source) to prevent release

Common practices vary across sites thus conservative process release estimates used [TCS1].

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk from environmental exposure is driven by freshwater sediment [TCR1b].
If discharging to domestic sewage treatment plant, no on-site wastewater treatment required [TCR9].
Prevent discharge of undissolved substance to or recover from wastewater [TCR14].

Treat air emission to provide a typical removal efficiency of (%)	80
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	0

Organisation measures to prevent/limit release from site

Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].

Conditions and measures related to municipal sewage treatment plant

Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7
Maximum allowable site tonnage (M_{safe}) based on domestic sewage treatment release (kg/d)	4.0e5
Assumed domestic sewage treatment plant flow (m^3/d)	2000

Conditions and measures related to external treatment of waste for disposal

This substance is consumed during use and no waste of the substance is generated.. [ETW 5]

Conditions and measures related to external recovery of waste

This substance is consumed during use and no waste of the substance is generated. [EWR 3]

Section 3**Exposure Estimation**

3.1. Health
When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.

3.2. Environment
The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model [EE2].

Section 4**Guidance to check compliance with the Exposure**

	Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC.</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.	
Control of Worker Exposure	
<i>Selection of relevant Contributing Scenario phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>

9.8.2. Exposure estimation

9.8.2.1. Workers exposure

The worker exposure estimates for the activities associated with the polymer production using C4, high 1,3-butadiene ($\geq 0.1\%$) streams were assessed using ECETOC TRAv2 (See Appendix A). Appendix A contains Tables 1 and 2 used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.8.2.2. Consumer exposure

Not applicable.

9.8.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B.

9.8.2.4. Environmental exposure

See Appendix B.

9.9. Exposure scenario 9: Use of C4, high 1.3-butadiene ($\geq 0.1\%$) streams in polymer processing – Industrial

9.9.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Use in polymer processing of C4, high 1.3-butadiene ($\geq 0.1\%$) streams
Use Descriptor	Sector of Use: Industrial (SU3, SU10)
	Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC6, PROC8a, PROC8b, PROC9, PROC13, PROC14, PROC21
	Environmental Release Categories: ERC 4
Processes, tasks, activities covered	Processing of formulated polymers including material transfers, additives handling (e.g. pigments, stabilisers, fillers, plasticisers, etc.), moulding, curing and forming activities, material re-works, storage and associated maintenance.
Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	Risk Management Measures <i>Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures, 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS
	Consider technical advances and process upgrades (including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean / flush equipment, where possible, prior to maintenance. Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to
General measures (carcinogens) [G18]	

	<p>operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely.</p> <p>Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures.</p> <p>Consider the need for risk based health surveillance. [G20].</p>
Bulk transfers [CS14]. ; (closed systems) [CS107]	<p>Ensure material transfers are under containment or extract ventilation [E66].</p>
Bulk transfers [CS14]. ; (closed systems) [CS107] With occasional controlled exposure [CS137]	<p>Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].;</p> <p>Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
Bulk transfers [CS14]. Dedicated facility [CS81]. Bulk weighing [CS91](closed systems) [CS107].	<p>Use drum pumps [E53]. Ensure material transfers are under containment or extract ventilation [E66].</p> <p>No specific measures identified [EI18]. {Wear suitable gloves tested to EN374 [PPE15]}.</p>
Bulk weighing [CS91] With occasional controlled exposure [CS137]	<p>Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].;</p> <p>Provide extract ventilation to points where emissions occur [E54]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]</p>
Small scale weighing [CS90]	<p>Use drum pumps [E53]. Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
Additive premixing [CS92](closed systems) [CS107]	<p>Formulate in enclosed or ventilated mixing vessels [E46]. Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60]. ; Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]</p>
Additive premixing [CS92](open systems) [CS108]; With sample collection [CS56].	<p>Ensure material transfers are under containment or extract ventilation [E66]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].</p>
Additive premixing [CS92] General exposures (open systems) [CS16].	<p>Ensure material transfers are under containment or extract ventilation [E66]. ;</p> <p>Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].;</p> <p>Minimise exposure by extracted full enclosure for the operation or equipment [E61].</p>
Bulk transfers [CS14]. Drum/batch transfers [CS8].	<p>Provide enhanced mechanical ventilation by mechanical means [E48].;</p> <p>Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27]</p>
Bulk transfers [CS14]. Small package filling [CS7].	<p>Transfer via enclosed lines [E52]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].;</p>

	Ensure material transfers are under containment or extract ventilation [E66].
Calendering (including Banburys) [CS64] Elevated temperature [CS111]	Restrict area of openings to equipment [E68]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60].
Production of articles by dipping and pouring [CS113].	Limit the substance content in the product to 1% [OC16]. Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].
Extrusion and masterbatching [CS88]	Limit the substance content in the product to 1% [OC16]. Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60]. ; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].
Injection moulding of articles [CS89]	Restrict area of openings to equipment [E68]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Provide extract ventilation to material transfer points and other openings [E82].
Finishing operations [CS102]	No specific measures identified [EI18].
Equipment maintenance [CS5].	Drain down system prior to equipment break-in or maintenance [E65]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Provide extract ventilation to points where emissions occur [E54]. Clear spills immediately [C&H13]. Avoid carrying out activities involving exposure for more than 1 hour [OC27]. Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].
Storage [CS67] With occasional controlled exposure [CS137]	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Provide extract ventilation to points where emissions occur [E54]. ; Store substance within a closed system [E84]. Avoid carrying out activities involving exposure for more than 4 hours [OC28]

Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	1e2
Fraction of Regional tonnage used locally	1
Annual site tonnage (tonnes/year)	1e2
Maximum daily site tonnage (kg/day)	5e3

Frequency and duration of use

Continuous release [FD2].	
Emission days (days/year)	20

Environmental factors not influenced by risk management

Local freshwater dilution factor	10
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Local marine water dilution factor	100
Other given operational conditions affecting environmental exposure	
Conditions given in SPERC fact sheet (ESVOC SpERC 4.21a.v1) give rise to following releases fractions	
Release fraction to air from process (initial release prior to RMM)	1.5e-1
Release fraction to wastewater from process (initial release prior to RMM)	0
Release fraction to soil from process (initial release prior to RMM)	1.0e-5
Technical conditions and measures at process level (source) to prevent release	
Common practices vary across sites thus conservative process release estimates used [TCS1].	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation). [TCR1k]. If discharging to domestic sewage treatment plant, no on-site wastewater treatment required [TCR9]. Prevent discharge of undissolved substance to or recover from wastewater [TCR14].	
Treat air emission to provide a typical removal efficiency of (%)	80
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	0
Organisation measures to prevent/limit release from site	
Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].	
Conditions and measures related to municipal sewage treatment plant	
Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7
Maximum allowable site tonnage (M_{safe}) based on domestic sewage treatment release (kg/d)	2.9e4
Assumed domestic sewage treatment plant flow (m^3/d)	2000
Conditions and measures related to external treatment of waste for disposal	
This substance is consumed during use and no waste of the substance is generated. [ETW 5]	
Conditions and measures related to external recovery of waste	
This substance is consumed during use and no waste of the substance is generated. [EWR 3]	
Section 3	Exposure Estimation
3.1. Health	<i>When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrорisk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC.</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using</i>

	<i>onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH. Control of Worker Exposure	
<i>Selection of relevant Contributing Scenario phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>

9.9.2. Exposure estimation

9.9.2.1. Workers exposure

The worker exposure estimates for the activities associated with the industrial use in polymer processing of C4, high 1,3-butadiene ($\geq 0.1\%$) streams were assessed using ECETOC TRAv2 (See Appendix A). Appendix A contains Tables 1 and 2 used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.9.2.2. Consumer exposure

Not applicable.

9.9.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B

9.9.2.4. Environmental exposure

See Appendix B

9.10. Exposure scenario 10: Use of Use of C4, high 1.3-butadiene ($\geq 0.1\%$) in polymer processing – Professional

9.10.1. Exposure scenario

Section 1	Exposure Scenario Title
Title	Use in polymer processing of C4, high 1.3-butadiene (>=0.1%) ;CAS RN
Use Descriptor	Sector of Use: Professional (SU22) Process Categories: PROC1, PROC2, PROC6, PROC8a, PROC8b, PROC14, PROC21 Environmental Release Categories: ERC 8A, ERC 8D
Processes, tasks, activities covered	Processing of formulated polymers including material transfers, moulding and forming activities, material re-works and associated maintenance.
Section 2	Operational conditions and risk management measures
<i>Field for additional statements to explain scenario if required.</i>	
Section 2.1	Control of worker exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	<i>Not applicable</i>
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	<i>Not applicable</i>
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	<p>Risk Management Measures</p> <p><i>Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures , 4. Personal protection.</i> Phrases between brackets are good practice advice only, beyond REACH Chemical Safety Assessment and may be communicated in Section 5 of the ES or within the main sections of the SDS</p> <p>Consider technical advances and process upgrades (including automation) for the elimination of releases. Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation. Drain down systems and clear transfer lines prior to breaking containment. Clean / flush equipment, where possible, prior to maintenance.</p> <p>Where there is potential for exposure: Restrict access to authorised persons; provide specific activity training to operators to minimise exposures; wear suitable gloves and coveralls to prevent skin contamination; wear respiratory protection when its use is identified for certain contributing scenarios; clear up spills immediately and dispose of wastes safely.</p> <p>Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and</p>
General measures (carcinogens) [G18]	

	maintain all control measures. Consider the need for risk based health surveillance. [G20].
Bulk transfers [CS14]. ; (closed systems) [CS107]	Ensure material transfers are under containment or extract ventilation [E66].
Bulk transfers [CS14].; (closed systems) [CS107] With occasional controlled exposure [CS137]	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Material transfers [CS3].	Use drum pumps [E53]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Injection moulding of articles [CS89]	Restrict area of openings to equipment [E68]. Provide extract ventilation to points where emissions occur [E54].; Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40]. Avoid carrying out activities involving exposure for more than 1 hour [OC27].
Rework of articles [CS86]	No specific measures identified [E118].
Equipment maintenance [CS5].	Drain down and flush system prior to equipment break-in or maintenance [E55]. Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Ensure material transfers are under containment or extract ventilation [E66]. Clear spills immediately [C&H13]. Avoid carrying out activities involving exposure for more than 1 hour [OC27]. Retain drain downs in sealed storage pending disposal or for subsequent recycle [ENVT4].
Storage [CS67]	Store substance within a closed system [E84].
Storage [CS67] With occasional controlled exposure [CS137]	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour) [E40].; Provide extract ventilation to points where emissions occur [E54].; Store substance within a closed system [E84].

Section 2.2 Control of environmental exposure

Product characteristics

Substance is complex UVCB [PrC3]. Predominantly hydrophobic [PrC4a]. Not readily biodegradable.

Amounts used

Fraction of EU tonnage used in region	0.1
Regional use tonnage (tonnes/year)	1e2
Fraction of Regional tonnage used locally	5.0e-04
Annual site tonnage (tonnes/year)	5.0e-02
Maximum daily site tonnage (kg/day)	1.4e-01

Frequency and duration of use

Continuous release [FD2].	
Emission days (days/year)	365

Environmental factors not influenced by risk management

Local freshwater dilution factor	10
Local marine water dilution factor	100

Other given operational conditions affecting environmental exposure

Conditions given in SPERC fact sheet (ESVOC SpERC 4.21a.v1) give rise to following releases fractions

Release fraction to air from process (initial release prior to RMM)	9.8e-1
Release fraction to wastewater from process (initial release prior to RMM)	1.0e-2
Release fraction to soil from process (initial release prior to RMM)	1.0e-2

Technical conditions and measures at process level (source) to prevent release

Common practices vary across sites thus conservative process release estimates used [TCS1].

Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil

Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation). [TCR1k]. If discharging to domestic sewage treatment plant, no on-site wastewater treatment required [TCR9]. Prevent discharge of undissolved substance to or recover from wastewater [TCR14].

Treat air emission to provide a typical removal efficiency of (%)	0
Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of \geq (%) [TCR8].	0

Organisation measures to prevent/limit release from site

Do not apply industrial sludge to natural soils [OMS2]. Sludge should be incinerated, contained or reclaimed [OMS3].

Conditions and measures related to municipal sewage treatment plant

Estimated substance removal from wastewater via domestic sewage treatment (%)	96.7
Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%)	96.7
Maximum allowable site tonnage (M_{Safe}) based on domestic sewage treatment release (kg/d)	4.0e2
Assumed domestic sewage treatment plant flow (m^3/d)	2000

Conditions and measures related to external treatment of waste for disposal

This substance is consumed during use and no waste of the substance is generated. [ETW 5]

Conditions and measures related to external recovery of waste

This substance is consumed during use and no waste of the substance is generated. [EWR 3]

Section 3	Exposure Estimation
3.1. Health	<i>When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1 as indicated in Appendix A.</i>
3.2. Environment	<i>The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model [EE2].</i>
Section 4	Guidance to check compliance with the Exposure Scenario
4.1. Health	<i>Confirm that RMMs and OCs are as described or of equivalent efficiency. See Appendix A for details of efficiencies and OC.</i>
4.2. Environment	<i>Guidance is based on assumed operating conditions which may not be applicable to all sites; thus, scaling may be necessary to define appropriate site-specific risk management measures [DSU1]. Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination [DSU2]. Required removal efficiency for air can be achieved using onsite technologies, either alone or in</i>

	<i>combination [DSU3]. Further details on scaling and control technologies are provided in factsheet for ESVOC (http://cefic.org/en/reach-for-industries-libraries.html) [DSU4]</i>
Section 5	Additional good practice advice beyond the REACH Chemical Safety Assessment - (Section Optional)
Note: The measures reported in this section have not been taken into account in the exposure estimates related to the exposure scenario above. They are not subject to obligation laid down in Article 37 (4) of REACH.	
Control of Worker Exposure	
<i>Selection of relevant Contributing Scenario phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>
Control of environmental exposure	
<i>Selection of relevant RMM Core Phrases</i>	<i>Good practice RMM phrases may be incorporated in this section or consolidated into the main sections of the SDS, depending on the preference of the Registrant and functionality of the available e-SDS system.</i>

9.10.2. Exposure estimation

9.10.2.1. Workers exposure

The worker exposure estimates for the activities associated with the professional use in polymer processing of C4, high 1,3-butadiene ($\geq 0.1\%$) streams were assessed using ECETOC TRAv2 (See Appendix A). Appendix A contains Tables 1 and 2 used to model the worker exposures. These tables contain all the operating conditions, and the efficiencies of the exposure modifiers including RPE, PPE and LEV. A separate table (also in Appendix A) contains the associated RMMs.

9.10.2.2. Consumer exposure

Not applicable.

9.10.2.3. Indirect exposure of humans via the environment (oral)

See Appendix B

9.10.2.4. Environmental exposure

See Appendix B