SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier

Trade name	:	Raffinate 1
REACH Registration Number	:	01-2119474204-43-0013, 01-2119474204-43-XXXX
Substance name	:	hydrocarbons, C4, steam-cracker distillate
EC-No.	:	295-405-4

1.2 Relevant identified uses of the substance or mixture and uses advised against

Use of the Substance/Mixture	:	Raw material in chemical industry, Manufacture, Use as an intermediate

1.3 Details of the supplier of the safety data sheet

Manufacturer	:	Borealis Polymers Oy P.O.Box 330, FI-06101 Porvoo, Finland Telephone: +358 9 394900 Borealis AB S-444 86 Stenungsund, Sweden Telephone: +46 303 86000
Supplier	:	Borealis AG Trabrennstrasse 6-8, 1020 Vienna, Austria Telephone: +43 1 22400 0
E-mail address	:	sds@borealisgroup.com

1.4 Emergency telephone number

+44 (0) 1235 239 670 (NCEC Carechem 24)

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Classification (REGULATION (EC) No 1272/2008)

Flammable gases, Category 1A	H220: Extremely flammable gas.

Gases under pressure, Liquefied gas	H280: Contains gas under pressure; may explode if heated.
Germ cell mutagenicity, Category 1B	H340: May cause genetic defects.
Carcinogenicity, Category 1A	H350: May cause cancer.

2.2 Label elements

Labelling (REGULATION (EC) No 1272/2008)

Hazard pictograms :

Signal word : Danger

Hazard statements :
H220 Extremely flammable gas.
H280 Contains gas under pressure; may explode if heated.
H340 May cause genetic defects.
H350 May cause cancer.

Precautionary statements :

Prevention:

P201 Obtain special instructions before use.
P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P280 Wear protective gloves/ protective clothing/ eye protection/ face protection/ hearing protection.

Response:

P308 + P313 IF exposed or concerned: Get medical advice/ attention.
P377 Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381 In case of leakage, eliminate all ignition sources.

Storage:

P410 + P403 Protect from sunlight. Store in a well-ventilated place.

Additional Labelling

Restricted to professional users.

2.3 Other hazards

This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.

Ecological information: The substance/mixture does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or Commission Delegated regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

Toxicological information: The substance/mixture does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or Commission Delegated regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

SECTION 3: Composition/information on ingredients

3.1 Substances

Substance name : hydrocarbons, C4, steam-cracker distillate

EC-No. : 295-405-4

Components

Chemical name	CAS-No. EC-No.	Concentration (% w/w)	M-Factor, SCL, ATE
Substance of unknown or variable composition, complex reaction products or biological material (UVCB) :			
Hydrocarbons, C4, steam-cracker distillate; Petroleum gas	92045-23-3 295-405-4	<= 100	
Main constituents :			
butene	25167-67-3 246-689-3	>= 30 - < 50	
2-methylpropene	115-11-7 204-066-3	>= 30 - < 50	
butane	106-97-8 203-448-7	>= 30 - < 50	
butene, mixed-1-and-2-isomers	107-01-7 203-452-9	>= 10 - < 20	
1,3-butadiene	106-99-0 203-450-8	>= 0,1 - < 1	

SECTION 4: First aid measures

4.1 Description of first aid measures

General advice : 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.
Avoid and prevent all contact and exposure.
Move the victim to fresh air.
In the case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

If inhaled : Move to fresh air.
Do not leave the victim unattended.
Causes asphyxiation in high concentrations. The victim will not realize that he/she is suffocating.
Keep patient warm and at rest.
Seek medical advice immediately.
If breathing is irregular or stopped, administer artificial respiration.
If unconscious place in recovery position.

In case of skin contact : Wash frost-bitten areas with plenty of water. Do not remove clothing.
Seek medical advice.

In case of eye contact : Remove contact lenses.
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.
Keep eye wide open while rinsing.

If swallowed : Not probable:
The product evaporates readily.

4.2 Most important symptoms and effects, both acute and delayed

Symptoms : Shortness of breath
Unconsciousness
Frostbite

Risks : May cause effects on the central nervous system, resulting in lowering of consciousness.
May cause genetic defects.
May cause cancer.

4.3 Indication of any immediate medical attention and special treatment needed

Treatment : Artificial respiration and/or oxygen may be necessary.
There is no specific antidote available.
Treat frost-bitten areas as needed.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media : Dry powder
Carbon dioxide (CO2)
Foam
Water mist

Unsuitable extinguishing media : High volume water jet

5.2 Special hazards arising from the substance or mixture

Specific hazards during firefighting : Vapours are heavier than air and may spread along floors.
Flash back possible over considerable distance.
Cool closed containers exposed to fire with water spray.
Do not allow run-off from fire fighting to enter drains or water courses.
Hazardous decomposition products formed under fire conditions.
See chapter 10.

5.3 Advice for firefighters

Special protective equipment for firefighters : Wear self-contained breathing apparatus and protective suit.

Further information : Attempt to stop leakage without personal risk.
If conditions permit, let fire burn itself out.
Cool tanks with water spray.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Personal protection through wearing a tightly closed chemical protection suit and a self-contained breathing apparatus.
Do not breathe vapours.
Ensure adequate ventilation, especially in confined areas.
Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.

To avoid ignition of vapours by static electricity discharge, all metal parts of the equipment must be grounded.
Avoid all contact with the product.
Keep people away from and upwind of spill/leak.
Attempt to stop leakage without personal risk.

6.2 Environmental precautions

Prevent further leakage or spillage if safe to do so.
Prevent product from entering environment and drains.
If major spillage occurs, contact the proper local authorities.

6.3 Methods and material for containment and cleaning up

Attempt to stop leakage without personal risk.
Ventilate the area.
Allow to evaporate.

6.4 Reference to other sections

For personal protection see section 8.
For disposal considerations see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Advice on safe handling	:	To be handled by trained personnel only. 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 and flush system prior to equipment opening or maintenance. Clean / flush equipment, where possible, prior to maintenance. Consider the need for risk based health surveillance. Ensure safe systems of work or equivalent arrangements are in place to manage risks. Regularly inspect, test and maintain all control measures. Wear respiratory protection when its use is identified for certain contributing scenarios. Prevent leaks by checking valves, pipelines and joints regularly. Handle and open container with care. Dispose of rinse water in accordance with local and national regulations. Vapours are heavier than air and may spread along floors.

Advice on protection against fire and explosion	:	Vapours may form explosive mixtures with air. Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapours). To avoid ignition of vapours by static electricity discharge, all metal parts of the equipment must be grounded. Ensure adequate ventilation. Keep product and empty container away from heat and sources of ignition.
Hygiene measures	:	Ensure adequate ventilation, especially in confined areas. Smoking, eating and drinking should be prohibited in the application area.

7.2 Conditions for safe storage, including any incompatibilities

Requirements for storage areas and containers	:	Keep only in the original container in a cool, well-ventilated place. Keep product and empty container away from heat and sources of ignition. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Bund storage facilities to prevent soil and water pollution in the event of spillage. Store in accordance with the particular national regulations.
Further information on storage conditions	:	Keep locked up or in an area accessible only to qualified or authorised persons. Ensure adequate ventilation.
Advice on common storage	:	Keep away from incompatible materials. See chapter 10.

7.3 Specific end use(s)

Specific use(s) : Not applicable

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Occupational Exposure Limits

Components	CAS-No.	Value type (Form of exposure)	Control parameters	Basis
1,3-butadiene	106-99-0	TWA	1 ppm 2,2 mg/m3	2004/37/EC
Further information	Carcinogens or mutagens			

Substances for which there are Community workplace exposure limits.

Derived No Effect Level (DNEL) according to Regulation (EC) No. 1907/2006:

Substance name	End Use	Exposure routes	Potential health effects	Value
Raffinate 1	Consumers	Inhalation	Long-term systemic	0,265 mg/m3

			effects	
	Workers	Inhalation	Long-term systemic effects	2,21 mg/m3

Predicted No Effect Concentration (PNEC) according to Regulation (EC) No. 1907/2006:

Substance name	Environmental Compartment	Value
Raffinate 1		
Remarks:	No data available	

8.2 Exposure controls

Engineering measures

Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation.
Ensure safe systems of work or equivalent arrangements are in place to manage risks.
Regularly inspect, test and maintain all control measures.

Personal protective equipment

Eye protection : Safety goggles or face-shield.

Hand protection
Material : Cold-insulating gloves (e.g. nitrile rubber).

Remarks : Please observe the instructions regarding permeability and breakthrough time which are provided by the supplier of the gloves. Also take into consideration the specific local conditions under which the product is used, such as the danger of cuts, abrasion, and the contact time. The selected protective gloves have to satisfy the specifications of Regulation (EU) 2016/425 and the standard EN 374 derived from it. This recommendation is only valid for the product mentioned in the safety data sheet and provided by us and for the application specified by us.

Skin and body protection : Wear suitable protective clothing and rubber boots.

Respiratory protection : In case of insufficient ventilation: Self-contained breathing apparatus.
Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.

Environmental exposure controls

General advice : Prevent further leakage or spillage if safe to do so. Prevent product from entering environment and drains. If major spillage occurs, contact the proper local authorities.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

Physical state	:	Liquefied gas
Colour	:	colourless
Odour	:	characteristic
Melting range	:	-185 - -106 °C
Boiling point	:	-11,73 - 10,9 °C
Upper explosion limit / Upper flammability limit	:	12 %(V)
Lower explosion limit / Lower flammability limit	:	1,6 %(V)
Flash point	:	< -18 °C
pH	:	Not applicable (gaseous)
Viscosity		
Viscosity, kinematic	:	Not applicable (gaseous)
Solubility(ies)		
Water solubility	:	135,6 - 792,3 mg/l
Partition coefficient: n-octanol/water	:	log Pow: 1,40 - 2,89
Vapour pressure	:	Not applicable
Density	:	630 g/cm³
Relative vapour density	:	1,9
Particle size	:	Not applicable

9.2 Other information

Explosives	:	Not applicable
Oxidizing properties	:	Not applicable

Self-ignition	:	324 - 465 °C
Surface tension	:	Not applicable
Molecular weight	:	Not applicable

SECTION 10: Stability and reactivity

10.1 Reactivity

Stable under recommended storage conditions.
Vapours may form explosive mixture with air.
Risk of violent reaction.

10.2 Chemical stability

No decomposition if stored and applied as directed.

10.3 Possibility of hazardous reactions

Hazardous reactions : Vapours may form explosive mixtures with air.

10.4 Conditions to avoid

Conditions to avoid : Keep away from heat and sources of ignition.

10.5 Incompatible materials

Materials to avoid :
Air
Ozone
Oxidizing agents
Chlorine
Hydrogen chloride
Hydrogen fluoride
chlorine dioxide
Nitrogen oxides (NOx)
Copper
Copper alloys
phenol
crotonaldehyde
hydroquinone

10.6 Hazardous decomposition products

Under fire conditions:
Carbon monoxide, carbon dioxide and unburned hydrocarbons (smoke).

SECTION 11: Toxicological information

11.1 Information on hazard classes as defined in Regulation (EC) No 1272/2008

Acute toxicity

Based on available data, the classification criteria are not met.

Product:

Acute oral toxicity	:	Remarks: study technically not feasible (gaseous)
Acute inhalation toxicity	:	LC50 (Rat, male and female): > 5,3 mg/l Exposure time: 4 h Test atmosphere: gas Method: OECD Test Guideline 403 Remarks: Read-across (Analogy)
Acute dermal toxicity	:	Remarks: study technically not feasible (gaseous)
Acute toxicity (other routes of administration)	:	Remarks: No data available

Skin corrosion/irritation

Based on available data, the classification criteria are not met.

Product:

Result	:	No skin irritation
Remarks	:	Read-across (Analogy)

Serious eye damage/eye irritation

Based on available data, the classification criteria are not met.

Product:

Result	:	No eye irritation
Remarks	:	Read-across (Analogy)

Respiratory or skin sensitisation

Skin sensitisation

Based on available data, the classification criteria are not met.

Respiratory sensitisation

Based on available data, the classification criteria are not met.

Product:

Remarks	:	study technically not feasible

Germ cell mutagenicity

May cause genetic defects.

Product:

Genotoxicity in vitro	:	Test Type: Chromosome aberration test in vitro Method: OECD Test Guideline 473 Result: positive Test substance: 1,3-butadiene
Genotoxicity in vivo	:	Test Type: Cytogenetic assay Species: Mouse Application Route: Inhalation Method: OECD Test Guideline 478 Result: positive

Carcinogenicity

May cause cancer.

Product:

Application Route	:	Inhalation
LOAEL	:	2,21 mg/l
Remarks	:	Positive evidence from human epidemiological studies (inhalation)

Reproductive toxicity

Based on available data, the classification criteria are not met.

Product:

Effects on fertility	:	Test Type: Fertility/early embryonic development Species: Rat Application Route: Inhalation General Toxicity - Parent: No observed adverse effect concentration: 7.131 mg/m³ Method: OECD Test Guideline 422
Effects on foetal development	:	Test Type: Fertility/early embryonic development Developmental Toxicity: NOAEC Parent: 88 mg/m³

STOT - single exposure

Based on available data, the classification criteria are not met.

STOT - repeated exposure

Based on available data, the classification criteria are not met.

Repeated dose toxicity

Product:

Species	:	Rat
NOAEL	:	mg/m³, 2212
Application Route	:	inhalation (vapour)
Method	:	OECD Test Guideline 453

Aspiration toxicity

Based on available data, the classification criteria are not met.

11.2 Information on other hazards

Endocrine disrupting properties

Product:

Assessment	:	The substance/mixture does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or Commission Delegated regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

Further information

Product:

Remarks	:	Rapid evaporation of the liquid may cause frostbite. Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing. May cause effects on the central nervous system, resulting in lowering of consciousness. Absorbs into the body by inhalation.

SECTION 12: Ecological information

12.1 Toxicity

Product:

Toxicity to fish	:	LC50 : 25,37 mg/l Exposure time: 96 h Method: QSAR
Toxicity to daphnia and other aquatic invertebrates	:	LC50 : 14,818 mg/l Exposure time: 48 h Method: QSAR
Toxicity to algae/aquatic	:	EC50 (Pseudokirchneriella subcapitata (green algae)): 12,405

plants		mg/l Method: QSAR
Toxicity to fish (Chronic toxicity)	:	Chronic Toxicity Value: 2,564 mg/l Method: QSAR
Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity)	:	Chronic Toxicity Value: 1,563 mg/l Method: QSAR

12.2 Persistence and degradability

Product:

Biodegradability	:	Remarks: Not readily biodegradable.

12.3 Bioaccumulative potential

Product:

Bioaccumulation	:	Remarks: Bioaccumulation not expected: Partition coefficient (n-octanol/water) log Pow < 3.

12.4 Mobility in soil

Product:

Mobility	:	Remarks: The product evaporates readily.

12.5 Results of PBT and vPvB assessment

Product:

Assessment	:	This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher..

12.6 Endocrine disrupting properties

Product:

Assessment	:	The substance/mixture does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or Commission Delegated regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

12.7 Other adverse effects

Product:

Additional ecological information	:	The product should not be allowed to enter drains, water courses or the soil.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product	:	Dispose of as hazardous waste in compliance with local and national regulations. European waste code: 07 01 99 (wastes not otherwise specified (basic organic chemicals)) Where possible recycling is preferred to disposal or incineration.
Contaminated packaging	:	Dispose of as hazardous waste in compliance with local and national regulations.

SECTION 14: Transport information

14.1 UN number or ID number

ADR	:	UN 1012
IMDG	:	UN 1012

14.2 UN proper shipping name

ADR	:	BUTYLENES MIXTURE
IMDG	:	BUTYLENE

14.3 Transport hazard class(es)

ADR	:	2
IMDG	:	2.1

14.4 Packing group

ADR

Packing group	:	Not assigned by regulation
Classification Code	:	2F
Hazard Identification Number	:	23
Labels	:	2.1
Tunnel restriction code	:	(B/D)

IMDG

Packing group	:	Not assigned by regulation
Labels	:	2.1
EmS Code	:	F-D, S-U

14.5 Environmental hazards

ADR

Environmentally hazardous	:	no

IMDG

Marine pollutant	:	no

14.6 Special precautions for user

Remarks	:	SDS: No specific instructions needed.

The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

14.7 Maritime transport in bulk according to IMO instruments

Remarks	:	Not applicable

SECTION 15: Regulatory information

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

REACH - Restrictions on the manufacture, placing on the market and use of certain dangerous substances, preparations and articles (Annex XVII) :

Seveso III: Directive 2012/18/EU of the European Parliament and of the Council on the control of major-accident hazards involving dangerous substances.

Category		Quantity 1	Quantity 2
P2	FLAMMABLE GASES	10 t	50 t

Other regulations:

Europe. Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work

15.2 Chemical safety assessment

A Chemical Safety Assessment has been carried out for this substance.

SECTION 16: Other information

H220	:	Extremely flammable gas.
H280	:	Contains gas under pressure; may explode if heated.

Full text of other abbreviations

2004/37/EC	:	Europe. Directive 2004/37/EC on the protection of workers from the risks related to exposure to carcinogens or mutagens at work
2004/37/EC / TWA	:	Long term exposure limit

Further information

Other information	:	Changes since the last version are highlighted in the margin. This version replaces all previous versions.
Issuer	:	Borealis, Group Product Stewardship / Mikaela Eriksson.
Sources of key data used to compile the Safety Data Sheet	:	Chemical Safety Report, Hydrocarbons, C4, steam-cracker distillate, Lower Olefins and Aromatics REACH Consortium, 2021 ECHA - Information on Registered Substances (http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances) International Chemical Safety Card, 1,3-Butadiene, April 2000 (http://www.inchem.org/documents/icsc/icsc/eics0017.htm)

Disclaimer

To the best of our knowledge, the information contained herein is accurate and reliable as of the date of publication; however we do not assume any liability whatsoever for the accuracy and completeness of such information.

Borealis makes no warranties which extend beyond the description contained herein. Nothing herein shall constitute any warranty of merchantability or fitness for a particular purpose.

It is the customer's responsibility to inspect and test our products in order to satisfy itself as to the suitability of the products for the customer's particular purpose. The customer is responsible for the appropriate, safe and legal use, processing and handling of our products.

No liability can be accepted in respect of the use of Borealis' products in conjunction with other materials. The information contained herein relates exclusively to our products when not used in conjunction with any third party materials.

Annex: Exposure Scenarios

Table of Contents

ES1: Manufacture of substance

1.1. Title section

Structured Short Title	:	Use at industrial sites, Manufacture of substance

Environment		
CS1	**Manufacture of substance**	ERC1
Worker		
CS2	**General measures (eye irritants), General measures (skin irritants), General measures (carcinogens), General measures applicable to all activities**	PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15, PROC28
CS3	**General exposures (closed systems), Indoor**	PROC1
CS4	**General exposures (closed systems), Outdoor**	PROC1
CS5	**General exposures (closed systems), Local exhaust ventilation, Indoor**	PROC2
CS6	**General exposures (closed systems), Local exhaust ventilation, Indoor**	PROC3
CS7	**General exposures (open systems), Local exhaust ventilation, Indoor**	PROC4
CS8	**General exposures (open systems), Respiratory protection, Indoor**	PROC4
CS9	**General exposures (open systems), Respiratory protection, Outdoor**	PROC4
CS10	**Process sampling, Local exhaust ventilation, Indoor**	PROC9
CS11	**Process sampling, Respiratory protection, Indoor**	PROC9
CS12	**Process sampling, Respiratory protection, Outdoor**	PROC9
CS13	**Laboratory activities, Local exhaust ventilation, Indoor**	PROC15
CS14	**Bulk transfers, Closed systems, Local exhaust ventilation, Indoor**	PROC8b
CS15	**Bulk transfers, Open systems, Local exhaust ventilation, Indoor**	PROC8b
CS16	**Bulk transfers, Open systems, Respiratory protection, Outdoor**	PROC8b
CS17	**Equipment cleaning and maintenance, Local exhaust ventilation, Indoor**	PROC8a, PROC28

CS18	**Storage, Outdoor**	PROC1, PROC2
CS19	**Storage, Indoor**	PROC1, PROC2

1.2. Conditions of use affecting exposure

1.2.1. Control of environmental exposure: Manufacture of the substance (ERC1)

Amount used, frequency and duration of use (or from service life)		
Annual amount per site	:	261000 tonnes/year
Daily amount per site	:	870 tonnes/day
Technical and organisational conditions and measures		
Vapour recovery (e.g. adsorption) or other technique for reducing volatiles emissions (incineration, thermal oxidation) Air - minimum efficiency of 90 %		
Acclimated biological treatment Water - minimum efficiency of 70 %		
No release to wastewater from process as such, wastewater emissions limited to release generated from final equipment cleaning step using water		
Conditions and measures related to sewage treatment plant		
STP type	:	Onsite Sewage Treatment Plant
STP effluent	:	2.000 m³/d
Other conditions affecting environmental exposure		
Local freshwater dilution factor	:	40

1.2.2. Control of worker exposure: General measures (eye irritants), General measures (skin irritants), General measures (carcinogens), General measures applicable to all activities Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2) / Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3) / Chemical production where opportunity for exposure arises (PROC4) / Transfer of substance or mixture (charging/discharging) at non dedicated-facilities (PROC8a) /

Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b) / Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9) / Use as laboratory reagent (PROC15) / Manual maintenance (cleaning and repair) of machinery (PROC28)

Product (article) characteristics		
Covers percentage substance in the product up to 100 %.		
Physical form of product	:	Liquefied gas
Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers daily exposures up to 8 hours (unless stated differently).
Conditions and measures related to personal protection, hygiene and health evaluation		
General measures (eye irritants) Use suitable eye protection. Avoid direct eye contact with product, also via contamination on hands.		
General measures (skin irritants) Avoid direct skin contact with product. Identify potential areas for indirect skin contact. Wear gloves (tested to EN374) if hand contact with substance likely. Clean up contamination/spills as soon as they occur. Wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop.		
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply		
General measures (carcinogens) 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. Handle in accordance with good industrial hygiene and safety practice.		

1.2.3. Control of worker exposure: General exposures (closed systems), Indoor
Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)

Technical and organisational conditions and measures

Occupational Health and Safety Management System: Advanced Use in closed process		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.4. Control of worker exposure: General exposures (closed systems), Outdoor
Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)

Technical and organisational conditions and measures		
Use in closed process		
Occupational Health and Safety Management System: Advanced		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.5. Control of worker exposure: General exposures (closed systems), Local exhaust ventilation, Indoor
Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 4 h/day

Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Use in closed, continuous process with occasional controlled exposure		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Handle substance within a predominantly closed system provided with extract ventilation. Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor
Temperature	:	Assumes process temperature up to 20 °C

1.2.6. Control of worker exposure: General exposures (closed systems), Local exhaust ventilation, Indoor
Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced Closed batch process with occasional controlled exposure		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).		
Handle substance within a predominantly closed system provided with extract ventilation. Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor

Temperature	:	Assumes process temperature up to 20 °C

1.2.7. Control of worker exposure: General exposures (open systems), Local exhaust ventilation, Indoor
Chemical production where opportunity for exposure arises (PROC4)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Local exhaust ventilation Provide extract ventilation to points where emissions occur. Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.8. Control of worker exposure: General exposures (open systems), Respiratory protection, Indoor
Chemical production where opportunity for exposure arises (PROC4)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374.		

Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 10		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.9. Control of worker exposure: General exposures (open systems), Respiratory protection, Outdoor
Chemical production where opportunity for exposure arises (PROC4)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 20		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.10. Control of worker exposure: Process sampling, Local exhaust ventilation, Indoor
Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 0,25 h/day
Technical and organisational conditions and measures		

Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Ensure samples are obtained under containment or extract ventilation. or Sample via a closed loop or other system to avoid exposure. Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.11. Control of worker exposure: Process sampling, Respiratory protection, Indoor
Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 0,25 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 10		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.12. Control of worker exposure: Process sampling, Respiratory protection, Outdoor

Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 0,25 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 20		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.13. Control of worker exposure: Laboratory activities, Local exhaust ventilation, Indoor Use as laboratory reagent (PROC15)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 4 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Handle in a fume cupboard or under extract ventilation. Inhalation - minimum efficiency of 90 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		

Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.14. Control of worker exposure: Bulk transfers, Closed systems, Local exhaust ventilation, Indoor
Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Ensure material transfers are under containment or extract ventilation. Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.15. Control of worker exposure: Bulk transfers, Open systems, Local exhaust ventilation, Indoor
Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Ensure material transfers are under containment or extract ventilation.		

Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.16. Control of worker exposure: Bulk transfers, Open systems, Respiratory protection, Outdoor
Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 0,25 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 20		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.17. Control of worker exposure: Equipment cleaning and maintenance, Local exhaust ventilation, Indoor
Transfer of substance or mixture (charging/discharging) at non dedicated-facilities (PROC8a) / Manual maintenance (cleaning and repair) of machinery (PROC28)

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

Use frequency	:	Covers use up to 4 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Local exhaust ventilation Drain down and flush system prior to equipment break-in or maintenance. Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Respiratory protection Efficiency: APF 10		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.18. Control of worker exposure: Storage, Outdoor
Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Store substance within a closed system.		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

1.2.19. Control of worker exposure: Storage, Indoor
Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Store substance within a closed system.		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).		
Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

1.3. Exposure estimation and reference to its source

1.3.1. Environmental release and exposure: Manufacture of the substance (ERC1)

Release route	Release rate	Release estimation method
Water	783 kg/day	
Air	217,5 kg/day	

Compartment	Exposure level	RCR
Man via environment - Inhalation	0,169 mg/m³ (EUSES v2.1)	0,638

1.3.3. Worker exposure: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,00321 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

1.3.4. Worker exposure: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,00321 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

1.3.5. Worker exposure: Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,207 mg/m³ (ECETOC TRA worker v3)	0,093	1,3-butadiene

1.3.6. Worker exposure: Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,321 mg/m³ (ECETOC TRA worker v3)	0,145	1,3-butadiene

1.3.7. Worker exposure: Chemical production where opportunity for exposure arises (PROC4)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,276 mg/m³ (ECETOC TRA worker v3)	0,125	1,3-butadiene

1.3.8. Worker exposure: Chemical production where opportunity for exposure arises (PROC4)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,276 mg/m³ (ECETOC TRA worker v3)	0,125	1,3-butadiene

1.3.9. Worker exposure: Chemical production where opportunity for exposure arises (PROC4)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,321 mg/m³ (ECETOC TRA worker v3)	0,145	1,3-butadiene

1.3.10. Worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,276 mg/m³ (ECETOC TRA worker v3)	0,125	1,3-butadiene

1.3.11. Worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,276 mg/m³ (ECETOC TRA worker v3)	0,125	1,3-butadiene

1.3.12. Worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,321 mg/m³ (ECETOC TRA worker v3)	0,145	1,3-butadiene

1.3.13. Worker exposure: Use as laboratory reagent (PROC15)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,413 mg/m³ (ECETOC TRA worker v3)	0,187	1,3-butadiene

1.3.14. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,207 mg/m³ (ECETOC TRA worker v3)	0,093	1,3-butadiene

1.3.15. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,207 mg/m³ (ECETOC TRA worker v3)	0,093	1,3-butadiene

1.3.16. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,241 mg/m³ (ECETOC TRA worker v3)	0,109	1,3-butadiene

1.3.17. Worker exposure: Transfer of substance or mixture (charging/discharging) at non dedicated-facilities (PROC8a) / Manual maintenance (cleaning and repair) of machinery (PROC28)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,207 mg/m³ (ECETOC TRA worker v3)	0,093	1,3-butadiene

1.3.18. Worker exposure: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or

refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,00321 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

1.3.19. Worker exposure: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,161 mg/m³ (ECETOC TRA worker v3)	0,073	1,3-butadiene

1.4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

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.
Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination.
Required removal efficiency for air can be achieved using on-site technologies, either alone or in combination.
Further details on scaling and control technologies are provided in SpERC factsheet (http://cefic.org/en/reach-for-industries-libraries.html).

ES2: Use as an intermediate

2.1. Title section

Structured Short Title	:	Use at industrial sites, Use as an intermediate

Environment		
CS1	**Use as an intermediate**	ERC6a
Worker		
CS2	**General measures (eye irritants), General measures (skin irritants), General measures (carcinogens), General measures applicable to all activities**	PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15, PROC28
CS3	**General exposures (closed systems), Indoor**	PROC1
CS4	**General exposures (closed systems), Outdoor**	PROC1
CS5	**General exposures (closed systems), Local exhaust ventilation, Indoor**	PROC2
CS6	**General exposures (closed systems), Local exhaust ventilation, Indoor**	PROC3
CS7	**General exposures (open systems), Local exhaust ventilation, Indoor**	PROC4
CS8	**General exposures (open systems), Respiratory protection, Indoor**	PROC4
CS9	**General exposures (open systems), Respiratory protection, Outdoor**	PROC4
CS10	**Process sampling, Local exhaust ventilation, Indoor**	PROC9
CS11	**Process sampling, Respiratory protection, Indoor**	PROC9
CS12	**Process sampling, Respiratory protection, Outdoor**	PROC9
CS13	**Laboratory activities, Local exhaust ventilation, Indoor**	PROC15
CS14	**Bulk transfers, Closed systems, Local exhaust ventilation, Indoor**	PROC8b
CS15	**Bulk transfers, Open systems, Local exhaust ventilation, Indoor**	PROC8b
CS16	**Bulk transfers, Open systems, Respiratory protection, Indoor**	PROC8b
CS17	**Equipment cleaning and maintenance, Local exhaust ventilation, Indoor**	PROC8a, PROC28

CS18	**Storage, Outdoor**	PROC1, PROC2
CS19	**Storage, Indoor**	PROC1, PROC2

2.2. Conditions of use affecting exposure

2.2.1. Control of environmental exposure: Use of intermediate (ERC6a)

Amount used, frequency and duration of use (or from service life)		
Annual amount per site	:	60000 tonnes/year
Daily amount per site	:	200 tonnes/day
Technical and organisational conditions and measures		
Typical measures to maintain workplace concentrations of airborne VOCs and particulates below respective OELs: e.g. thermal wet scrubber – gas removal and/or air filtration – particle removal and/or thermal oxidation and/or vapour recovery – adsorption. Upgrade of the system in place or additional air treatment measures, such as wet scrubber and/or air filtration and/or thermal oxidation and/or vapour recovery systems, in order to achieve a reduction of the air emissions. Air - minimum efficiency of 50 %		
Process optimized for highly efficient use of raw materials (very minimal environmental release)		
Acclimated biological treatment Water - minimum efficiency of 70 %		
No release to wastewater from process as such, wastewater emissions limited to release generated from final equipment cleaning step using water		
Conditions and measures related to sewage treatment plant		
STP type	:	Onsite Sewage Treatment Plant
STP effluent	:	2.000 m³/d
Other conditions affecting environmental exposure		
Local freshwater dilution factor	:	40

2.2.2. Control of worker exposure: General measures (eye irritants), General measures (skin irritants), General measures (carcinogens), General measures applicable to all activities

Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2) / Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3) / Chemical production where opportunity for exposure arises (PROC4) / Transfer of substance or mixture (charging/discharging) at non dedicated-facilities (PROC8a) / Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b) / Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9) / Use as laboratory reagent (PROC15) / Manual maintenance (cleaning and repair) of machinery (PROC28)

Product (article) characteristics		
Covers percentage substance in the product up to 100 %.		
Physical form of product	:	Liquefied gas
Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers daily exposures up to 8 hours (unless stated differently).
Conditions and measures related to personal protection, hygiene and health evaluation		
General measures (eye irritants) Use suitable eye protection. Avoid direct eye contact with product, also via contamination on hands.		
General measures (skin irritants) Avoid direct skin contact with product. Identify potential areas for indirect skin contact. Wear gloves (tested to EN374) if hand contact with substance likely. Clean up contamination/spills as soon as they occur. Wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop.		
Additional good practice advice. Obligations according to Article 37(4) of REACH do not apply		
General measures (carcinogens) 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. Handle in accordance with good industrial hygiene and safety practice.		

2.2.3. Control of worker exposure: General exposures (closed systems), Indoor
Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)

Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced Use in closed process		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.4. Control of worker exposure: General exposures (closed systems), Outdoor
Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)

Technical and organisational conditions and measures		
Use in closed process		
Occupational Health and Safety Management System: Advanced		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 40 °C

2.2.5. Control of worker exposure: General exposures (closed systems), Local exhaust ventilation, Indoor

Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Handle substance within a predominantly closed system provided with extract ventilation. Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor
Temperature	:	Assumes process temperature up to 20 °C

2.2.6. Control of worker exposure: General exposures (closed systems), Local exhaust ventilation, Indoor
Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 4 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced Closed batch process with occasional controlled exposure		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Handle substance within a predominantly closed system provided with extract ventilation. Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		

Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor
Temperature	:	Assumes process temperature up to 20 °C

2.2.7. Control of worker exposure: General exposures (open systems), Local exhaust ventilation, Indoor
Chemical production where opportunity for exposure arises (PROC4)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Local exhaust ventilation Provide extract ventilation to points where emissions occur. Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.8. Control of worker exposure: General exposures (open systems), Respiratory protection, Indoor
Chemical production where opportunity for exposure arises (PROC4)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		

Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 10		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.9. Control of worker exposure: General exposures (open systems), Respiratory protection, Outdoor
Chemical production where opportunity for exposure arises (PROC4)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 20		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.10. Control of worker exposure: Process sampling, Local exhaust ventilation, Indoor
Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

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

Use frequency	:	Covers use up to 0,25 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Local exhaust ventilation Ensure samples are obtained under containment or extract ventilation. or Sample via a closed loop or other system to avoid exposure. Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.11. Control of worker exposure: Process sampling, Respiratory protection, Indoor Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 0,25 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 10		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use

Temperature	:	Assumes process temperature up to 20 °C

2.2.12. Control of worker exposure: Process sampling, Respiratory protection, Outdoor Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 0,25 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Wear suitable respiratory protection. Efficiency: APF 20		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.13. Control of worker exposure: Laboratory activities, Local exhaust ventilation, Indoor Use as laboratory reagent (PROC15)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 4 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374.		

Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.14. Control of worker exposure: Bulk transfers, Closed systems, Local exhaust ventilation, Indoor
Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Local exhaust ventilation Ensure material transfers are under containment or extract ventilation. Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with specific activity training. Dermal - minimum efficiency of 95 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.15. Control of worker exposure: Bulk transfers, Open systems, Local exhaust ventilation, Indoor
Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		

Local exhaust ventilation Ensure material transfers are under containment or extract ventilation. Inhalation - minimum efficiency of 95 %
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).
Conditions and measures related to personal protection, hygiene and health evaluation
Wear chemically resistant gloves (tested to EN374) in combination with specific activity training. Dermal - minimum efficiency of 95 %
Other conditions affecting workers exposure

Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.16. Control of worker exposure: Bulk transfers, Open systems, Respiratory protection, Indoor
Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

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

Use frequency	:	Covers use up to 1 h/day

Technical and organisational conditions and measures
Occupational Health and Safety Management System: Advanced
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).
Conditions and measures related to personal protection, hygiene and health evaluation
Wear chemically resistant gloves (tested to EN374) in combination with specific activity training. Dermal - minimum efficiency of 95 %
Wear suitable respiratory protection. Efficiency: APF 10
Other conditions affecting workers exposure

Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.17. Control of worker exposure: Equipment cleaning and maintenance, Local exhaust ventilation, Indoor
Transfer of substance or mixture (charging/discharging) at non dedicated-facilities (PROC8a) / Manual maintenance (cleaning and repair) of machinery (PROC28)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 0,25 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Local exhaust ventilation Drain down and flush system prior to equipment break-in or maintenance. Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with specific activity training. Dermal - minimum efficiency of 95 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.18. Control of worker exposure: Storage, Outdoor
Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Store substance within a closed system.		
Provide a basic standard of general ventilation (1 to 3 air changes per hour).		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

2.2.19. Control of worker exposure: Storage, Indoor
Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Amount used, frequency and duration of use (or from service life)		
Use frequency	:	Covers use up to 1 h/day
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Use in closed, continuous process with occasional controlled exposure Store substance within a closed system.		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour).		
Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

2.3. Exposure estimation and reference to its source

2.3.1. Environmental release and exposure: Use of intermediate (ERC6a)

Release route	**Release rate**	**Release estimation method**
Water	60 kg/day	
Air	250 kg/day	

Compartment	**Exposure level**	**RCR**
Man via environment - Inhalation	0,059 mg/m³ (EUSES v2.1)	0,221

2.3.3. Worker exposure: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,00321 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

2.3.4. Worker exposure: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,00321 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

2.3.5. Worker exposure: Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,344 mg/m³ (ECETOC TRA worker v3)	0,156	1,3-butadiene

2.3.6. Worker exposure: Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,413 mg/m³ (ECETOC TRA worker v3)	0,187	1,3-butadiene

2.3.7. Worker exposure: Chemical production where opportunity for exposure arises (PROC4)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,276 mg/m³ (ECETOC TRA worker v3)	0,125	1,3-butadiene

2.3.8. Worker exposure: Chemical production where opportunity for exposure arises (PROC4)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,276 mg/m³ (ECETOC TRA worker v3)	0,125	1,3-butadiene

2.3.9. Worker exposure: Chemical production where opportunity for exposure arises (PROC4)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,321 mg/m³ (ECETOC TRA worker v3)	0,145	1,3-butadiene

2.3.10. Worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,276 mg/m³ (ECETOC TRA worker v3)	0,125	1,3-butadiene

2.3.11. Worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,276 mg/m³ (ECETOC TRA worker v3)	0,125	1,3-butadiene

2.3.12. Worker exposure: Transfer of substance or mixture into small containers (dedicated filling line, including weighing) (PROC9)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,321 mg/m³ (ECETOC TRA worker v3)	0,145	1,3-butadiene

2.3.13. Worker exposure: Use as laboratory reagent (PROC15)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,413 mg/m³ (ECETOC TRA worker v3)	0,187	1,3-butadiene

2.3.14. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,207 mg/m³ (ECETOC TRA worker v3)	0,093	1,3-butadiene

2.3.15. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,207 mg/m³ (ECETOC TRA worker v3)	0,093	1,3-butadiene

2.3.16. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,413 mg/m³ (ECETOC TRA worker v3)	0,187	1,3-butadiene

2.3.17. Worker exposure: Transfer of substance or mixture (charging/discharging) at non dedicated-facilities (PROC8a) / Manual maintenance (cleaning and repair) of machinery (PROC28)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,344 mg/m³ (ECETOC TRA worker v3)	0,156	1,3-butadiene

2.3.18. Worker exposure: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or

refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,00321 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

2.3.19. Worker exposure: Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1) / Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,069 mg/m³ (ECETOC TRA worker v3)	0,031	1,3-butadiene

2.4. Guidance to DU to evaluate whether he works inside the boundaries set by the ES

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.
Required removal efficiency for wastewater can be achieved using onsite/offsite technologies, either alone or in combination.
Required removal efficiency for air can be achieved using on-site technologies, either alone or in combination.
Further details on scaling and control technologies are provided in SpERC factsheet (http://cefic.org/en/reach-for-industries-libraries.html).