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

1.1 Product identifier

Trade name	:	Crude C4
REACH Registration Number	:	01-2119485494-27-0010, 01-2119485494-27-XXXX
Substance name	:	gases (petroleum, light steam-cracked, butadiene conc.
EC-No.	:	273-265-5

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, Use in fuel, Use in polymer production

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

+1 760 476 3962 (3E), Access code: 336296

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Classification (REGULATION (EC) No 1272/2008)

Flammable gases, Category 1	H220: Extremely flammable gas.

Gases under pressure, Refrigerated liquefied gas	H281: Contains refrigerated gas; may cause cryogenic burns or injury.
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.
H281 Contains refrigerated gas; may cause cryogenic burns or injury.
H340 May cause genetic defects.
H350 May cause cancer.

Precautionary statements :

Prevention:

P202 Do not handle until all safety precautions have been read and understood.
P210 Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P243 Take action to prevent static discharges.
P282 Wear cold insulating gloves and either face shield or eye protection.

Response:

P381 In case of leakage, eliminate all ignition sources.
P377 Leaking gas fire: Do not extinguish, unless leak can be stopped safely.

Storage:

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

Additional Labelling

Restricted to professional users.

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

The product is a complex combination of hydrocarbons produced by the distillation of products from a thermal cracking process. It consists of hydrocarbons having a carbon number predominantly of C4.

3.1 Substances

Substance name : gases (petroleum, light steam-cracked, butadiene conc.

EC-No. : 273-265-5

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) :			
Gases (petroleum, light steam-cracked, butadiene conc.; Petroleum gas	68955-28-2 273-265-5	100	
Main constituents :			
1,3-butadiene	106-99-0 203-450-8	>= 50 - < 70	
butane	106-97-8 203-448-7	>= 30 - < 50	
but-1-ene	106-98-9 203-449-2	>= 10 - < 20	
2-methylpropene	115-11-7 204-066-3	>= 10 - < 20	
(Z)-but-2-ene	590-18-1 209-673-7	>= 1 - < 10	
(E)-but-2-ene	624-64-6 210-855-3	>= 1 - < 10	

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 : Remove/ Take off immediately all contaminated clothing.
If clothing already frozen and stuck to the skin:
Do not remove contaminated clothing.
Wash frost-bitten areas with plenty of lukewarm water.
Do not rub affected area.
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.
Contact with liquid or refrigerated gas can cause cold burns and frostbite.

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	:	Do NOT use 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 containers/tanks with water spray.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Use personal protective equipment.
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.
Keep people away from and upwind of spill/leak.
Attempt to stop leakage without personal risk.
Keep away from sources of ignition - No smoking.

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. Smoking, eating and drinking should be prohibited in the application area.

Ensure adequate ventilation, especially in confined areas.
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.
Keep away from incompatible materials.

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.

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. No smoking. 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			

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

Substance name	End Use	Exposure routes	Potential health effects	Value
Crude C4	Workers	Inhalation	Long-term systemic effects	2,21 mg/m3
	Consumers	Inhalation	Long-term systemic effects	0,265 mg/m3

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.
(EN 166)

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.
Safety shoes

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 : Refrigerated liquefied gas

Colour	:	clear
Odour	:	characteristic
Melting range	:	-185 - -106 °C
Boiling point	:	< 0 °C
Flammability	:	Extremely flammable gas.
Upper explosion limit / Upper flammability limit	:	12 %(V)
		16,3 %(V) 1,3-butadiene
Lower explosion limit / Lower flammability limit	:	1,6 %(V)
		ca. 1,1 %(V) 1,3-butadiene
Flash point	:	-60 °C
Auto-ignition temperature	:	364 - 413 °C
pH	:	No data available
Solubility(ies)		
Water solubility	:	135,6 - 792,3 mg/l 0,735 g/l 1,3-butadiene (20 °C)
Partition coefficient: n-octanol/water	:	log Pow: 2,09 - 2,31
Vapour pressure	:	Not applicable
Relative density	:	0,6
Relative vapour density	:	2
Particle size	:	Not applicable

9.2 Other information

Explosives	:	Not applicable
Oxidizing properties	:	Not applicable
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 : Polymerises with risk of fire and explosion.

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 Method: OECD Test Guideline 403
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:

Species	:	Rabbit
Exposure time	:	72 h
Result	:	No skin irritation

Serious eye damage/eye irritation

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

Product:

Species	:	Rabbit
Result	:	No eye irritation

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: In vitro gene mutation study in mammalian cells Result: positive Test substance: Read-across (Analogy)

Genotoxicity in vivo	:	Test Type: In vivo micronucleus test Species: Mouse Method: OPPTS 870.5395 Result: positive

Carcinogenicity

May cause cancer.

Product:

Species	:	Rat
Application Route	:	inhalation (gas)
NOAEC	:	1.000 ppm
Method	:	OECD Test Guideline 453
Test substance	:	Read-across (Analogy)

Reproductive toxicity

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

Product:

Effects on fertility	:	Application Route: inhalation (vapour) General Toxicity - Parent: No observed adverse effect concentration: 20 mg/l General Toxicity F1: No observed adverse effect concentration: 20 mg/l Method: OECD Test Guideline 422 Result: No effects on fertility and early embryonic development were detected.
Effects on foetal development	:	Species: Rat Application Route: Inhalation General Toxicity Maternal: NOAEC: 20.000 mg/m³ Teratogenicity: NOAEC F1: 20.000 mg/m³ Method: OECD Test Guideline 422 Result: No adverse effects

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	:	148,6 mg/kg
Application Route	:	Oral

Exposure time	:	28 d
Method	:	OECD Test Guideline 407

Species	:	Rat
Application Route	:	Inhalation
Method	:	OECD Test Guideline 422
Remarks	:	No adverse effect has been observed in chronic toxicity tests.

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.

SECTION 12: Ecological information

12.1 Toxicity

Product:

Toxicity to fish	:	LC50 : 45,7 mg/l Method: QSAR
Toxicity to daphnia and other aquatic invertebrates	:	LC50 : 79,51 mg/l Method: QSAR
Toxicity to algae/aquatic plants	:	EC50 : 33,6 mg/l Method: QSAR

Ecotoxicology Assessment

Short-term (acute) aquatic hazard	:	This product has no known ecotoxicological effects.
Long-term (chronic) aquatic hazard	:	This product has no known ecotoxicological effects.

12.2 Persistence and degradability

Product:

Biodegradability	:	Remarks: Not readily biodegradable.

Photodegradation	:	Half-life (direct photolysis): 2,12 d Remarks: Prone to photochemical degradation, reacting with OH radicals and ozone.

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.

SECTION 14: Transport information

14.1 UN number or ID number

ADR	:	UN 1010
IMDG	:	UN 1010
IATA (Cargo)	:	UN 1010

14.2 UN proper shipping name

ADR	:	BUTADIENES AND HYDROCARBON MIXTURE, STABILIZED
IMDG	:	BUTADIENES AND HYDROCARBON MIXTURE, STABILIZED
IATA (Cargo)	:	Butadienes and hydrocarbon mixture, stabilized

14.3 Transport hazard class(es)

ADR	:	2
IMDG	:	2.1
IATA (Cargo)	:	2.1

14.4 Packing group

ADR

Packing group	:	Not assigned by regulation
Classification Code	:	2F
Hazard Identification Number	:	239
Labels	:	2.1
Tunnel restriction code	:	(B/D)

IMDG

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

IATA (Cargo)

Packing instruction (cargo aircraft)	:	200
Packing group	:	Not assigned by regulation

Labels : Flammable Gas

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

Ship type : NA
Pollution category : NA

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, mixtures and articles (Annex XVII) : Conditions of restriction for the following entries should be considered:
Number on list 75, 40
Gases (petroleum, light steam-cracked, butadiene conc.; Petroleum gas (Number on list 29, 28)
1,3-butadiene (Number on list 29, 28)
butane (Number on list 29, 28)
isobutane

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:

Comply with below indicated regulations, relevant updatings and amendments, as applicable:
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

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
Sources of key data used to compile the Safety Data Sheet	:	Chemical Safety Report, Gases (petroleum), light steam-cracked, butadiene conc., 2019

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

1.1. Title section

Structured Short Title	:	Use at industrial sites, Manufacture

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 substances (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

No other specific measures identified.		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Inhalation - minimum efficiency of 30 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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 No other specific measures identified.		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 40 °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)		
Duration	:	Covers use up to 4 h

Technical and organisational conditions and measures		
Handle substance within a predominantly closed system provided with extract ventilation. Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Handle substance within a predominantly closed system provided with extract ventilation. Occupational Health and Safety Management System: Advanced		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Inhalation - minimum efficiency of 30 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced Provide extract ventilation to points where emissions occur.		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with ‘basic’ employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		

Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 10 Inhalation - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 20 Inhalation - minimum efficiency of 95 %		
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)

Duration	:	Covers use up to 0,25 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced Ensure samples are obtained under containment or extract ventilation. or Sample via a closed loop or other system to avoid exposure.		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 0,25 h
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). Inhalation - minimum efficiency of 70 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 10 Inhalation - minimum efficiency of 90 %		

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)		
Duration	:	Covers use up to 0,25 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 20 Inhalation - minimum efficiency of 95 %		
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)		
Duration	:	Covers use up to 4 h
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).		

Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Ensure material transfers are under containment or extract ventilation. Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
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

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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Ensure material transfers are under containment or extract ventilation. Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
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

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)		
Duration	:	Covers use up to 0,25 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
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 20 Inhalation - minimum efficiency of 95 %		
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)		
Duration	:	Covers use up to 4 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Drain down and flush system prior to equipment break-in or maintenance. Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
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 Inhalation - minimum efficiency of 90 %		
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.

Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
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). Inhalation - minimum efficiency of 30 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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 substances (ERC1)

Release route	Release rate	Release estimation method
Water	122,6 kg/day	
Air	0,014 kg/day	

Compartment	Exposure level	RCR
Freshwater	0,083 mg/L (EUSES v2.1)	
Freshwater sediment	1,242 mg/kg dry weight (EUSES v2.1)	
Marine water	0,032 mg/L (EUSES v2.1)	
Marine sediment	0,485 mg/kg dry weight (EUSES v2.1)	
Sewage treatment plant	3,191 mg/L (EUSES v2.1)	
Air	0,028 mg/m³ (EUSES v2.1)	
Agricultural soil	0,042 mg/kg dry weight (EUSES v2.1)	
Predator's prey (freshwater)	0,354 mg/kg wet weight (EUSES v2.1)	
Predator's prey (marine water)	0,134 mg/kg wet weight (EUSES v2.1)	
Top predator's prey (marine water)	0,031 mg/kg wet weight (EUSES v2.1)	
Predator's prey (terrestrial)	0,016 mg/kg wet weight (EUSES v2.1)	
Man via environment - Inhalation	0,028 mg/m³ (EUSES v2.1)	0,105

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	0,016 mg/m³ (ECETOC TRA worker v3)	0,007	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	0,016 mg/m³ (ECETOC TRA worker v3)	0,007	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	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	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	1,578 mg/m³ (ECETOC TRA worker v3)	0,714	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	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	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	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	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	1,578 mg/m³ (ECETOC TRA worker v3)	0,714	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	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	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	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	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	1,578 mg/m³ (ECETOC TRA worker v3)	0,714	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	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	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	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	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	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	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	1,183 mg/m³ (ECETOC TRA worker v3)	0,535	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	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	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	0,016 mg/m³ (ECETOC TRA worker v3)	0,007	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	0,789 mg/m³ (ECETOC TRA worker v3)	0,357	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	**Environment**	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	:	220000 tonnes/year
Daily amount per site	:	734 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. Wet scrubber – gas removal		
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		
No other specific measures identified.		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Inhalation - minimum efficiency of 30 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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 No other specific measures identified.		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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.		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 4 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced Handle substance within a predominantly closed system provided with extract ventilation.		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		

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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced Provide extract ventilation to points where emissions occur.		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with ‘basic’ employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		

Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 10 Inhalation - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 20 Inhalation - minimum efficiency of 95 %		
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)		
Duration	:	Covers use up to 0,25 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced Ensure samples are obtained under containment or extract ventilation. or Sample via a closed loop or other system to avoid exposure.		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 0,25 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 10		

Inhalation - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 0,25 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 20 Inhalation - minimum efficiency of 95 %		
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)		
Duration	:	Covers use up to 4 h
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). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Ensure material transfers are under containment or extract ventilation. Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Ensure material transfers are under containment or extract ventilation. Local exhaust ventilation Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
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 Inhalation - minimum efficiency of 90 %		

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)		
Duration	:	Covers use up to 0,25 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Drain down and flush system prior to equipment break-in or maintenance. Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
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.

Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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)		
Duration	:	Covers use up to 1 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Store substance within a closed system.		
Provide a good standard of controlled ventilation (10 to 15 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
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	1.100 kg/day	
Air	256,9 kg/day	

Compartment	Exposure level	RCR
Freshwater	0,719 mg/L (EUSES v2.1)	
Freshwater sediment	10,74 mg/kg dry weight (EUSES v2.1)	
Marine water	0,287 mg/L (EUSES v2.1)	
Marine sediment	4,287 mg/kg dry weight (EUSES v2.1)	
Sewage treatment plant	28,64 mg/L (EUSES v2.1)	
Air	0,237 mg/m³ (EUSES v2.1)	
Agricultural soil	0,463 mg/kg dry weight (EUSES v2.1)	
Predator's prey (freshwater)	2,918 mg/kg wet weight (EUSES v2.1)	
Predator's prey (marine water)	1,159 mg/kg wet weight (EUSES v2.1)	
Top predator's prey (marine water)	0,236 mg/kg wet weight (EUSES v2.1)	
Predator's prey (terrestrial)	0,157 mg/kg wet weight (EUSES v2.1)	
Man via environment - Inhalation	0,237 mg/m³ (EUSES v2.1)	0,895

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	0,016 mg/m³ (ECETOC TRA worker v3)	0,007	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	0,016 mg/m³ (ECETOC TRA worker v3)	0,007	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	1,691 mg/m³ (ECETOC TRA worker v3)	0,765	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	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	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	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	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	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	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	1,578 mg/m³ (ECETOC TRA worker v3)	0,714	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	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	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	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	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	1,578 mg/m³ (ECETOC TRA worker v3)	0,714	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	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	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	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	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	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	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	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	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	1,691 mg/m³ (ECETOC TRA worker v3)	0,765	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	0,016 mg/m³ (ECETOC TRA worker v3)	0,007	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	0,338 mg/m³ (ECETOC TRA worker v3)	0,153	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).

ES3: Use in polymer production

3.1. Title section

Structured Short Title	:	Use at industrial sites, Use in polymer production

Environment		
CS1	**Environment**	ERC6c
Worker		
CS2	**General measures (eye irritants), General measures (carcinogens), General measures applicable to all activities**	PROC1, PROC2, PROC3, PROC4, PROC5, PROC6, PROC8a, PROC8b, PROC14, PROC15, PROC21, PROC28
CS3	**General exposures (closed systems), Continuous process, no sampling**	PROC1
CS4	**Bulk transfers, transport, With sample collection**	PROC8b
CS5	**Polymerisation, Continuous process, With sample collection**	PROC2
CS6	**Polymerisation, Batch process, With sample collection**	PROC3
CS7	**Polymerisation, Batch process, With sample collection, Elevated temperature**	PROC3
CS8	**Finishing operations, Batch process, With sample collection**	PROC3
CS9	**Intermediate polymer storage**	PROC4
CS10	**Additivation and stabilisation**	PROC3
CS11	**Mixing in containers, Batch process**	PROC5
CS12	**Pelletizing, Extrusion and masterbatching**	PROC6
CS13	**Pelletizing**	PROC14
CS14	**Pelletisation and pellet screening, Open systems, Rework of articles**	PROC8b, PROC21
CS15	**Bulk transfers, Continuous process, With sample collection**	PROC3

CS16	**transport, With sample collection**	PROC8b
CS17	**Equipment maintenance**	PROC8a, PROC28
CS18	**Storage, With occasional controlled exposure**	PROC2, PROC1

3.2. Conditions of use affecting exposure

3.2.1. Control of environmental exposure: Use of monomer in polymerisation processes at industrial site (inclusion or not into/onto article) (ERC6c)

Amount used, frequency and duration of use (or from service life)		
Annual amount per site	:	210000 tonnes/year
Daily amount per site	:	700 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.		
Process optimized for highly efficient use of raw materials (very minimal environmental release)		
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	:	Municipal sewage treatment plant
STP effluent	:	2.000 m³/d
Conditions and measures related to treatment of waste (including article waste)		
Waste treatment	:	No waste from process

3.2.2. Control of worker exposure: General measures (eye 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) / Mixing or blending in batch processes (PROC5) / Calendering operations (PROC6) / Transfer of substance or mixture (charging/discharging) at non dedicated-facilities (PROC8a) / Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b) / Tabletting, compression, extrusion, pelettisation, granulation (PROC14) / Use as laboratory reagent (PROC15) / Low energy manipulation and handling of substances bound in/on materials and/or articles (PROC21) / 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.		
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.		

3.2.3. Control of worker exposure: General exposures (closed systems), Continuous process, no sampling
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

No other specific measures identified.		
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. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.4. Control of worker exposure: Bulk transfers, transport, With sample collection
Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers use up to 1 h
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). Inhalation - minimum efficiency of 70 %		
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. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.5. Control of worker exposure: Polymerisation, Continuous process, With sample collection

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)		
Duration	:	Covers use up to 4 h
Technical and organisational conditions and measures		
Use in closed, continuous process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.6. Control of worker exposure: Polymerisation, Batch process, With sample collection 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)		
Duration	:	Covers use up to 4 h
Technical and organisational conditions and measures		
Closed batch process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		

Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.7. Control of worker exposure: Polymerisation, Batch process, With sample collection, Elevated temperature
Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Technical and organisational conditions and measures		
Closed batch process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.8. Control of worker exposure: Finishing operations, Batch process, With sample collection
Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Product (article) characteristics
Covers percentage substance in the product up to 5%.

Technical and organisational conditions and measures		
Closed batch process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.9. Control of worker exposure: Intermediate polymer storage
Chemical production where opportunity for exposure arises (PROC4)

Product (article) characteristics		
Covers percentage substance in the product up to 5%.		
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). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use

Temperature	:	Assumes process temperature up to 20 °C

3.2.10. Control of worker exposure: Additivation and stabilisation
Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Product (article) characteristics		
Covers percentage substance in the product up to 5%.		
Technical and organisational conditions and measures		
Closed batch process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.11. Control of worker exposure: Mixing in containers, Batch process
Mixing or blending in batch processes (PROC5)

Product (article) characteristics		
Covers percentage substance in the product up to 5%.		
Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers use up to 4 h
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). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.12. Control of worker exposure: Pelletizing, Extrusion and masterbatching Calendering operations (PROC6)

Product (article) characteristics		
Covers percentage substance in the product up to 5%.		
Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers use up to 4 h
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). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use

Temperature	:	Assumes process temperature up to 20 °C

3.2.13. Control of worker exposure: Pelletizing
Tabletting, compression, extrusion, pelettisation, granulation (PROC14)

Product (article) characteristics		
Covers percentage substance in the product up to 5%.		
Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers use up to 4 h
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). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.14. Control of worker exposure: Pelletisation and pellet screening, Open systems, Rework of articles
Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b) / Low energy manipulation and handling of substances bound in/on materials and/or articles (PROC21)

Product (article) characteristics
Covers percentage substance in the product up to 5%.
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). Inhalation - minimum efficiency of 70 %
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. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %
Other conditions affecting workers exposure

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

3.2.15. Control of worker exposure: Bulk transfers, Continuous process, With sample collection Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Product (article) characteristics
Covers percentage substance in the product up to 5%.
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). Inhalation - minimum efficiency of 70 %
Local exhaust ventilation Inhalation - minimum efficiency of 90 %
Conditions and measures related to personal protection, hygiene and health evaluation
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %
Other conditions affecting workers exposure

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

3.2.16. Control of worker exposure: transport, With sample collection

Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Product (article) characteristics		
Covers percentage substance in the product up to 5%.		
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). Inhalation - minimum efficiency of 70 %		
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. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

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

Product (article) characteristics		
Covers percentage substance in the product up to 5%.		
Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers use up to 4 h
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). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		

Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.2.18. Control of worker exposure: Storage, With occasional controlled exposure Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2) / 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, continuous process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear suitable gloves tested to EN374. Wear suitable coveralls to prevent exposure to the skin. Dermal - minimum efficiency of 80 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

3.3. Exposure estimation and reference to its source

3.3.1. Environmental release and exposure: Use of monomer in polymerisation processes at industrial site (inclusion or not into/onto article) (ERC6c)

Release route	Release rate	Release estimation method
Water	7 kg/day	
Air	490 kg/day	

Compartment	Exposure level	RCR
Freshwater	0,022 mg/L (EUSES v2.1)	
Freshwater sediment	0,322 mg/kg dry weight (EUSES v2.1)	
Marine water	0,00237 mg/L (EUSES v2.1)	
Marine sediment	0,035 mg/kg dry weight (EUSES v2.1)	
Sewage treatment plant	0,182 mg/L (EUSES v2.1)	
Air	0,113 mg/m³ (EUSES v2.1)	
Agricultural soil	0,435 mg/kg dry weight (EUSES v2.1)	
Predator's prey (freshwater)	0,106 mg/kg wet weight (EUSES v2.1)	
Predator's prey (marine water)	0,013 mg/kg wet weight (EUSES v2.1)	
Top predator's prey (marine water)	0,00688 mg/kg wet weight (EUSES v2.1)	
Predator's prey (terrestrial)	0,134 mg/kg wet weight (EUSES v2.1)	
Man via environment - Inhalation	0,113 mg/m³ (EUSES v2.1)	0,428

3.3.3. 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	0,023 mg/m³ (ECETOC TRA worker v3)	0,01	1,3-butadiene

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

Exposure route	Health effect	Exposure	Exposure level	RCR	Remarks

		indicator			
inhalative	systemic	long-term	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	1,3-butadiene

3.3.5. 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	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	1,3-butadiene

3.3.6. 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	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	1,3-butadiene

3.3.7. 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	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	1,3-butadiene

3.3.8. 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	0,676 mg/m³ (ECETOC TRA worker v3)	0,306	1,3-butadiene

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

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	1,353 mg/m³ (ECETOC TRA worker v3)	0,612	1,3-butadiene

3.3.10. 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	0,676 mg/m³ (ECETOC TRA worker v3)	0,306	1,3-butadiene

3.3.11. Worker exposure: Mixing or blending in batch processes (PROC5)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	1,3-butadiene

3.3.12. Worker exposure: Calendering operations (PROC6)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	1,3-butadiene

3.3.13. Worker exposure: Tabletting, compression, extrusion, pelettisation, granulation (PROC14)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	1,3-butadiene

3.3.14. Worker exposure: Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b) / Low energy manipulation and handling of substances bound in/on materials and/or articles (PROC21)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	1,3-butadiene

3.3.15. 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	0,676 mg/m³ (ECETOC TRA worker v3)	0,306	1,3-butadiene

3.3.16. 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	1,014 mg/m³ (ECETOC TRA worker v3)	0,459	1,3-butadiene

3.3.17. 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	2,029 mg/m³ (ECETOC TRA worker v3)	0,918	1,3-butadiene

3.3.18. Worker exposure: Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2) / 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	1,691 mg/m³ (ECETOC TRA worker v3)	0,765	1,3-butadiene

3.4. 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).

ES4: Use in fuel

4.1. Title section

Structured Short Title	:	Use at industrial sites, Use in fuel

Environment		
CS1	**Environment**	ERC7
Worker		
CS2	**General measures (eye irritants), General measures (skin irritants), General measures (carcinogens), General measures applicable to all activities**	PROC1, PROC2, PROC3, PROC8a, PROC8b, PROC16, PROC28
CS3	**Bulk transfers, Dedicated facility, Local exhaust ventilation, Indoor**	PROC8b
CS4	**Drum/batch transfers, Local exhaust ventilation, Indoor**	PROC8b
CS5	**General exposures (closed systems)**	PROC1
CS6	**General exposures (closed systems), With occasional controlled exposure**	PROC2
CS7	**General exposures (closed systems), With occasional controlled exposure, Indoor**	PROC2
CS8	**General exposures (closed systems), With occasional controlled exposure, Outdoor**	PROC2
CS9	**Use in fuel, Closed systems, Indoor**	PROC16
CS10	**Use in fuel, Closed systems, Indoor**	PROC3
CS11	**Equipment maintenance, Local exhaust ventilation, Indoor**	PROC8a, PROC28
CS12	**Storage, Outdoor**	PROC1, PROC2
CS13	**Storage, Indoor**	PROC2, PROC1

4.2. Conditions of use affecting exposure

4.2.1. Control of environmental exposure: Use of functional fluid at industrial site (ERC7)

Amount used, frequency and duration of use (or from service life)		
Annual amount per site	:	44000 tonnes/year
Daily amount per site	:	147 tonnes/day
Technical and organisational conditions and measures		
Process optimized for highly efficient use of raw materials (very minimal environmental release)		
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	:	Municipal sewage treatment plant
STP effluent	:	2.000 m³/d
Conditions and measures related to treatment of waste (including article waste)		
Waste treatment	:	This substance is consumed during use and no waste of the substance is generated.

4.2.2. 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) / Transfer of substance or mixture (charging/discharging) at non dedicated-facilities (PROC8a) / Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b) / Use of fuels (PROC16) / 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.

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

Product (article) characteristics
Covers percentage substance in the product up to 1 %.
Technical and organisational conditions and measures
Occupational Health and Safety Management System: Advanced
Local exhaust ventilation Inhalation - minimum efficiency of 95 %
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %
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

4.2.4. Control of worker exposure: Drum/batch transfers, Local exhaust ventilation, Indoor Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)

Product (article) characteristics		
Covers percentage substance in the product up to 1 %.		
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Local exhaust ventilation Use drum pumps. Inhalation - minimum efficiency of 95 %		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
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

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

Product (article) characteristics
Covers percentage substance in the product up to 1 %.
Technical and organisational conditions and measures

Use in closed process No other specific measures identified.		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Inhalation - minimum efficiency of 30 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

4.2.6. Control of worker exposure: General exposures (closed systems), With occasional controlled exposure
Use in closed, continuous process with occasional controlled exposure (PROC2)

Product (article) characteristics		
Covers percentage substance in the product up to 1 %.		
Technical and organisational conditions and measures		
Use in closed process No other specific measures identified.		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

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

Product (article) characteristics		
Covers percentage substance in the product up to 1 %.		
Technical and organisational conditions and measures		
Use in closed, continuous process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Inhalation - minimum efficiency of 30 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

4.2.8. Control of worker exposure: General exposures (closed systems), With occasional controlled exposure, Outdoor
Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)

Product (article) characteristics		
Covers percentage substance in the product up to 1 %.		
Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers use up to 4 h
Technical and organisational conditions and measures		
Use in closed, continuous process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training.		

Dermal - minimum efficiency of 90 %		
Wear suitable respiratory protection. Efficiency: APF 10 Inhalation - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

4.2.9. Control of worker exposure: Use in fuel, Closed systems, Indoor
Use of fuels (PROC16)

Product (article) characteristics		
Covers percentage substance in the product up to 1 %.		
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Inhalation - minimum efficiency of 30 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with ‘basic’ employee training. Dermal - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

4.2.10. Control of worker exposure: Use in fuel, Closed systems, Indoor
Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)

Product (article) characteristics		
Covers percentage substance in the product up to 1 %.		

Technical and organisational conditions and measures		
Closed batch process with occasional controlled exposure		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of controlled ventilation (5 to 10 air changes per hour). Inhalation - minimum efficiency of 70 %		
Local exhaust ventilation Inhalation - minimum efficiency of 90 %		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

4.2.11. Control of worker exposure: Equipment 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)

Product (article) characteristics		
Covers percentage substance in the product up to 1 %.		
Amount used, frequency and duration of use (or from service life)		
Duration	:	Covers use up to 4 h
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Inhalation - minimum efficiency of 30 %		
Local exhaust ventilation Drain down and flush system prior to equipment break-in or maintenance. Inhalation - minimum efficiency of 90 %		
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 Inhalation - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Indoor use
Temperature	:	Assumes process temperature up to 20 °C

4.2.12. 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)

Product (article) characteristics		
Covers percentage substance in the product up to 1 %.		
Technical and organisational conditions and measures		
Occupational Health and Safety Management System: Advanced		
Conditions and measures related to personal protection, hygiene and health evaluation		
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %		
Other conditions affecting workers exposure		
Indoor or outdoor use	:	Outdoor use
Temperature	:	Assumes process temperature up to 20 °C

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

Product (article) characteristics
Covers percentage substance in the product up to 1 %.
Technical and organisational conditions and measures

Use in closed, continuous process with occasional controlled exposure
Occupational Health and Safety Management System: Advanced
Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). Inhalation - minimum efficiency of 30 %
Local exhaust ventilation Inhalation - minimum efficiency of 90 %
Conditions and measures related to personal protection, hygiene and health evaluation
Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training. Dermal - minimum efficiency of 90 %
Other conditions affecting workers exposure

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

4.3. Exposure estimation and reference to its source

4.3.1. Environmental release and exposure: Use of functional fluid at industrial site (ERC7)

Release route	Release rate	Release estimation method
Water	1,47 kg/day	
Air	735 kg/day	

Compartment	Exposure level	RCR
Freshwater	0,00714 mg/L (EUSES v2.1)	
Freshwater sediment	0,107 mg/kg dry weight (EUSES v2.1)	
Marine water	0,000934 mg/L (EUSES v2.1)	
Marine sediment	0,014 mg/kg dry weight (EUSES v2.1)	
Sewage treatment plant	0,038 mg/L (EUSES v2.1)	
Air	0,169 mg/m³ (EUSES v2.1)	
Agricultural soil	0,319 mg/kg dry weight (EUSES v2.1)	
Predator's prey (freshwater)	0,048 mg/kg wet weight (EUSES v2.1)	

Predator's prey (marine water)	0,00695 mg/kg wet weight (EUSES v2.1)	
Top predator's prey (marine water)	0,00572 mg/kg wet weight (EUSES v2.1)	
Predator's prey (terrestrial)	0,106 mg/kg wet weight (EUSES v2.1)	
Man via environment - Inhalation	0,169 mg/m³ (EUSES v2.1)	0,639

4.3.3. 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	0,507 mg/m³ (ECETOC TRA worker v3)	0,229	1,3-butadiene

4.3.4. 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	0,507 mg/m³ (ECETOC TRA worker v3)	0,229	1,3-butadiene

4.3.5. 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	0,00158 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

4.3.6. Worker exposure: Use in closed, continuous process with occasional controlled exposure (PROC2)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,00158 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

4.3.7. 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	0,394 mg/m³ (ECETOC TRA worker v3)	0,178	1,3-butadiene

4.3.8. 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	0,237 mg/m³ (ECETOC TRA worker v3)	0,107	1,3-butadiene

4.3.9. Worker exposure: Use of fuels (PROC16)

Exposure route	Health effect	Exposure indicator	Exposure level	RCR	Remarks
inhalative	systemic	long-term	0,394 mg/m³ (ECETOC TRA worker v3)	0,178	1,3-butadiene

4.3.10. 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	0,338 mg/m³ (ECETOC TRA worker v3)	0,153	1,3-butadiene

4.3.11. 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	0,237 mg/m³ (ECETOC TRA worker v3)	0,107	1,3-butadiene

4.3.12. 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	0,00158 mg/m³ (ECETOC TRA worker v3)	< 0,01	1,3-butadiene

4.3.13. Worker exposure: Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2) / 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	0,394 mg/m³ (ECETOC TRA worker v3)	0,178	1,3-butadiene

4.4. 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).