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

### 1.1 Product identifier

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

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

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

### 1.3 Details of the supplier of the safety data sheet

| | | |
|---|---|---|
| Manufacturer | : | Borealis Polymers Oy<br>P.O.Box 330, FI-06101 Porvoo, Finland<br>Telephone: +358 9 394900 |
| Supplier | : | Borealis AG<br>Trabrennstrasse 6-8, 1020 Vienna, Austria<br>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 1A | H220: Extremely flammable gas. |
| Gases under pressure, Liquefied gas | H280: Contains gas under pressure; may explode if heated. |
| Germ cell mutagenicity, Category 1B | H340: May cause genetic defects. |
| Carcinogenicity, Category 1A | H350: May cause cancer. |

## 2.2 Label elements

**Labelling (REGULATION (EC) No 1272/2008)**

Hazard pictograms :

Signal word : Danger

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

Precautionary statements :

**Prevention:**

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

**Response:**

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

**Storage:**

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

**Additional Labelling**

Restricted to professional users.

## 2.3 Other hazards

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

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

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

## SECTION 3: Composition/information on ingredients

### 3.1 Substances

Substance name : hydrocarbons, C4, steam-cracker distillate

EC-No. : 295-405-4

**Components**

| Chemical name | CAS-No.<br>EC-No. | Concentration (% w/w) | M-Factor, SCL, ATE |
|---|---|---|---|
| Substance of unknown or variable composition, complex reaction products or biological material (UVCB) : | | | |
| Hydrocarbons, C4, steam-cracker distillate; Petroleum gas | 92045-23-3<br>295-405-4 | <= 100 | |
| Main constituents : | | | |
| 2-methylpropene | 115-11-7<br>204-066-3 | > 10 - < 40 | |
| butane | 106-97-8<br>203-448-7 | > 10 - < 40 | |
| but-1-ene | 106-98-9<br>203-449-2 | > 5 - < 50 | |
| butene, mixed-1-and-2-isomers | 107-01-7<br>203-452-9 | > 0,1 - < 60 | |
| isobutane | 75-28-5<br>200-857-2 | > 1 - < 10 | |
| 1,3-butadiene | 106-99-0<br>203-450-8 | >= 0 - < 1 | |

## SECTION 4: First aid measures

### 4.1 Description of first aid measures

General advice : Where there is potential for exposure:
Restrict access to authorised persons.
Provide specific activity training to operators to minimise exposures.
Wear suitable gloves and coveralls to prevent skin contamination.

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

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

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

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

If swallowed : Not probable:
The product evaporates readily.

### 4.2 Most important symptoms and effects, both acute and delayed

Symptoms : Shortness of breath
Unconsciousness
Frostbite

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

### 4.3 Indication of any immediate medical attention and special treatment needed

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

## SECTION 5: Firefighting measures

### 5.1 Extinguishing media

Suitable extinguishing media : Dry powder

Carbon dioxide (CO2)
Foam
Water mist

| | | |
|---|---|---|
| Unsuitable extinguishing media | : | High volume water jet |

### 5.2 Special hazards arising from the substance or mixture

| | | |
|---|---|---|
| Specific hazards during firefighting | : | Vapours are heavier than air and may spread along floors.<br>Flash back possible over considerable distance.<br>Cool closed containers exposed to fire with water spray.<br>Do not allow run-off from fire fighting to enter drains or water courses.<br>Hazardous decomposition products formed under fire conditions.<br>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.<br>If conditions permit, let fire burn itself out.<br>Cool tanks with water spray. |

## SECTION 6: Accidental release measures

### 6.1 Personal precautions, protective equipment and emergency procedures

Personal protection through wearing a tightly closed chemical protection suit and a self-contained breathing apparatus.
Do not breathe vapours.
Ensure adequate ventilation, especially in confined areas.
Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
To avoid ignition of vapours by static electricity discharge, all metal parts of the equipment must be grounded.
Avoid all contact with the product.
Keep people away from and upwind of spill/leak.
Attempt to stop leakage without personal risk.

### 6.2 Environmental precautions

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

### 6.3 Methods and material for containment and cleaning up

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

### 6.4 Reference to other sections

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

## SECTION 7: Handling and storage

### 7.1 Precautions for safe handling

| | | |
|---|---|---|
| Advice on safe handling | : | To be handled by trained personnel only.<br>Consider technical advances and process upgrades (including automation) for the elimination of releases.<br>Minimise exposure using measures such as closed systems, dedicated facilities and suitable general / local exhaust ventilation.<br>Drain down and flush system prior to equipment opening or maintenance.<br>Clean / flush equipment, where possible, prior to maintenance.<br>Consider the need for risk based health surveillance.<br>Ensure safe systems of work or equivalent arrangements are in place to manage risks.<br>Regularly inspect, test and maintain all control measures.<br>Wear respiratory protection when its use is identified for certain contributing scenarios.<br>Prevent leaks by checking valves, pipelines and joints regularly.<br>Handle and open container with care.<br>Dispose of rinse water in accordance with local and national regulations.<br>Vapours are heavier than air and may spread along floors. |
| Advice on protection against fire and explosion | : | Vapours may form explosive mixtures with air. Take necessary action to avoid static electricity discharge (which might cause ignition of organic vapours). To avoid ignition of vapours by static electricity discharge, all metal parts of the equipment must be grounded. Ensure adequate ventilation. Keep product and empty container away from heat and sources of ignition. |
| Hygiene measures | : | Ensure adequate ventilation, especially in confined areas. Smoking, eating and drinking should be prohibited in the application area. |

### 7.2 Conditions for safe storage, including any incompatibilities

Requirements for storage areas and containers : Keep only in the original container in a cool, well-ventilated place. Keep product and empty container away from heat and sources of ignition. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Bund storage facilities to prevent soil and water pollution in the event of spillage. Store in accordance with the particular national regulations.

Further information on storage conditions : Keep locked up or in an area accessible only to qualified or authorised persons. Ensure adequate ventilation.

Advice on common storage : Keep away from incompatible materials.
See chapter 10.

### 7.3 Specific end use(s)

Specific use(s) : Not applicable

## SECTION 8: Exposure controls/personal protection

### 8.1 Control parameters

**Occupational Exposure Limits**

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

Substances for which there are Community workplace exposure limits.

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

| Substance name | End Use | Exposure routes | Potential health effects | Value |
|---|---|---|---|---|
| Raffinate 1 | Consumers | Inhalation | Long-term systemic effects | 0,265 mg/m3 |
| | Workers | Inhalation | Long-term systemic effects | 2,21 mg/m3 |

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

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

### 8.2 Exposure controls

**Engineering measures**

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

**Personal protective equipment**

| | | |
|---|---|---|
| Eye protection | : | Safety goggles or face-shield. |
| Hand protection | | |
| Material | : | Cold-insulating gloves (e.g. nitrile rubber). |
| Remarks | : | Please observe the instructions regarding permeability and breakthrough time which are provided by the supplier of the gloves. Also take into consideration the specific local conditions under which the product is used, such as the danger of cuts, abrasion, and the contact time. The selected protective gloves have to satisfy the specifications of Regulation (EU) 2016/425 and the standard EN 374 derived from it. This recommendation is only valid for the product mentioned in the safety data sheet and provided by us and for the application specified by us. |
| Skin and body protection | : | Wear suitable protective clothing and rubber boots. |
| Respiratory protection | : | In case of insufficient ventilation: Self-contained breathing apparatus.<br>Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing. |

**Environmental exposure controls**

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

## SECTION 9: Physical and chemical properties

### 9.1 Information on basic physical and chemical properties

| | | |
|---|---|---|
| Physical state | : | Liquefied gas |
| Colour | : | colourless |
| Odour | : | characteristic |
| Melting range | : | -185 - -106 °C |
| Boiling point | : | -11,73 - 10,9 °C |
| Upper explosion limit / Upper flammability limit | : | 12 %(V) |
| Lower explosion limit / Lower flammability limit | : | 1,6 %(V) |

| | | |
|---|---|---|
| Flash point | : | < -30 °C |
| pH | : | Not applicable (gaseous) |
| Viscosity | | |
| Viscosity, kinematic | : | Not applicable (gaseous) |
| Solubility(ies) | | |
| Water solubility | : | 53,5 - 2.837,9 mg/l |
| Partition coefficient: n-octanol/water | : | log Pow: 1,40 - 2,89 |
| Vapour pressure | : | 168 - 1.750 kPa |
| Density | : | 630 g/cm³ |
| Relative vapour density | : | No data available |
| Particle size | : | Not applicable |

### 9.2 Other information

| | | |
|---|---|---|
| Explosives | : | Not applicable |
| Oxidizing properties | : | Not applicable |
| Self-ignition | : | 324 - 465 °C |
| Surface tension | : | Not applicable |
| Molecular weight | : | Not applicable |

## SECTION 10: Stability and reactivity

### 10.1 Reactivity

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

### 10.2 Chemical stability

No decomposition if stored and applied as directed.

### 10.3 Possibility of hazardous reactions

Hazardous reactions : Vapours may form explosive mixtures with air.

### 10.4 Conditions to avoid

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

### 10.5 Incompatible materials

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

### 10.6 Hazardous decomposition products

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

## SECTION 11: Toxicological information

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

**Acute toxicity**

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

**Product:**

Acute oral toxicity : Remarks: study technically not feasible (gaseous)

Acute inhalation toxicity : LC50 (Rat, male and female): > 5,3 mg/l
Exposure time: 4 h
Test atmosphere: gas
Method: OECD Test Guideline 403
Remarks: Read-across (Analogy)

Acute dermal toxicity : Remarks: study technically not feasible (gaseous)

Acute toxicity (other routes of administration) : Remarks: No data available

**Skin corrosion/irritation**

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

**Product:**

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

**Serious eye damage/eye irritation**

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

**Product:**

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

**Respiratory or skin sensitisation**

**Skin sensitisation**

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

**Respiratory sensitisation**

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

**Product:**

| | | |
|---|---|---|
| Remarks | : | study technically not feasible |

**Germ cell mutagenicity**

May cause genetic defects.

**Product:**

| | | |
|---|---|---|
| Genotoxicity in vitro | : | Test Type: Chromosome aberration test in vitro<br>Method: OECD Test Guideline 473<br>Result: positive<br>Test substance: 1,3-butadiene |

**Carcinogenicity**

May cause cancer.

**Product:**

| | | |
|---|---|---|
| Remarks | : | Information given is based on data on the components and the toxicology of similar products. |

**Reproductive toxicity**

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

**STOT - single exposure**

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

**STOT - repeated exposure**

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

**Repeated dose toxicity**

**Product:**

| | | |
|---|---|---|
| Species | : | Rat |
| NOAEL | : | mg/m³, > 2765 |
| Application Route | : | inhalation (vapour) |
| Method | : | OECD Test Guideline 453 |
| Test substance | : | 1,3-butadiene |

**Aspiration toxicity**

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

### 11.2 Information on other hazards

**Endocrine disrupting properties**

**Product:**

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

**Further information**

**Product:**

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

## SECTION 12: Ecological information

### 12.1 Toxicity

**Product:**

Toxicity to fish : LC50 : 25,37 mg/l
Exposure time: 96 h

Method: QSAR

| | | |
|---|---|---|
| Toxicity to daphnia and other aquatic invertebrates | : | LC50 : 14,818 mg/l<br>Exposure time: 48 h<br>Method: QSAR |
| Toxicity to algae/aquatic plants | : | EC50 (Pseudokirchneriella subcapitata (green algae)): 12,405 mg/l<br>Method: QSAR |
| Toxicity to fish (Chronic toxicity) | : | Chronic Toxicity Value: 2,564 mg/l<br>Method: QSAR |
| Toxicity to daphnia and other aquatic invertebrates (Chronic toxicity) | : | Chronic Toxicity Value: 1,563 mg/l<br>Method: QSAR |

### 12.2 Persistence and degradability

**Product:**

| | | |
|---|---|---|
| Biodegradability | : | Remarks: Not readily biodegradable. |

### 12.3 Bioaccumulative potential

**Product:**

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

### 12.4 Mobility in soil

**Product:**

| | | |
|---|---|---|
| Mobility | : | Remarks: The product evaporates readily. |

### 12.5 Results of PBT and vPvB assessment

**Product:**

| | | |
|---|---|---|
| Assessment | : | This substance/mixture contains no components considered to be either persistent, bioaccumulative and toxic (PBT), or very persistent and very bioaccumulative (vPvB) at levels of 0.1% or higher.. |
| | : | 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.<br>European waste code:<br>07 01 99 (wastes not otherwise specified (basic organic chemicals))<br>Where possible recycling is preferred to disposal or incineration. |
| Contaminated packaging | : | Dispose of as hazardous waste in compliance with local and national regulations. |

## SECTION 14: Transport information

### 14.1 UN number or ID number

| | | |
|---|---|---|
| **ADR** | : | UN 1012 |
| **IMDG** | : | UN 1012 |

### 14.2 UN proper shipping name

| | | |
|---|---|---|
| **ADR** | : | BUTYLENES MIXTURE |
| **IMDG** | : | BUTYLENE |

### 14.3 Transport hazard class(es)

| | | |
|---|---|---|
| **ADR** | : | 2 |
| **IMDG** | : | 2.1 |

### 14.4 Packing group

**ADR**

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

**IMDG**

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

### 14.5 Environmental hazards

**ADR**

| | | |
|---|---|---|
| Environmentally hazardous | : | no |

**IMDG**

| | | |
|---|---|---|
| Marine pollutant | : | no |

### 14.6 Special precautions for user

Remarks : SDS: No specific instructions needed.
The transport classification(s) provided herein are for informational purposes only, and solely based upon the properties of the unpackaged material as it is described within this Safety Data Sheet. Transportation classifications may vary by mode of transportation, package sizes, and variations in regional or country regulations.

### 14.7 Maritime transport in bulk according to IMO instruments

Remarks : Not applicable

## SECTION 15: Regulatory information

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

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

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

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

**Other regulations:**

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

### 15.2 Chemical safety assessment

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

## SECTION 16: Other information

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

**Full text of other abbreviations**

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

**Further information**

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

**Disclaimer**

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

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

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

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

# Annex: Exposure Scenarios

## Table of Contents

## ES1: Manufacture of substance

### 1.1. Title section

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

| | | |
|---|---|---|
| **Environment** | | |
| **CS1** | **Manufacture of substance** | ERC1 |
| **Worker** | | |
| **CS2** | **General measures applicable to all activities, General measures (carcinogens)** | PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15, PROC28 |
| **CS3** | **General exposures (closed systems)** | PROC1 |
| **CS4** | **General exposures (closed systems), With sample collection** | PROC2 |
| **CS5** | **General exposures (closed systems), Use in contained batch processes** | PROC3 |
| **CS6** | **General exposures** | PROC4 |
| **CS7** | **Process sampling** | PROC9 |
| **CS8** | **Laboratory activities** | PROC15 |
| **CS9** | **Bulk transfers, Closed systems** | PROC8b |
| **CS10** | **Bulk transfers** | PROC8b |
| **CS11** | **Bulk transfers** | PROC8b |
| **CS12** | **Equipment cleaning and maintenance** | PROC8a, PROC28 |
| **CS13** | **Storage** | PROC1 |
| **CS14** | **Storage** | PROC2 |

## 1.2. Conditions of use affecting exposure

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

| | | |
|---|---|---|
| **Amount used, frequency and duration of use (or from service life)** | | |
| Annual amount per site | : | 3600000 tonnes/year |
| Daily amount per site | : | 12000 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) | | |
| Vapour recovery (e.g. adsorption) or other technique for reducing volatiles emissions (incineration, thermal oxidation)<br>Air - minimum efficiency of 90 % | | |
| Acclimated biological treatment<br>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 applicable to all activities, General measures (carcinogens)

**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). |
| **Technical and organisational conditions and measures** | | |
| Occupational Health and Safety Management System: Advanced | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| General measures (carcinogens)<br>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. | | |
| **Other conditions affecting workers exposure** | | |
| Indoor or outdoor use | : | Indoor use |
| Temperature | : | Assumes use at not more than 20°C above ambient temperature. |

**1.2.3. 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)**

| |
|---|
| **Technical and organisational conditions and measures** |
| Closed systems |
| Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). |

| **Conditions and measures related to personal protection, hygiene and health evaluation** |
|---|
| Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training.<br>Dermal - minimum efficiency of 90 % |
| Use suitable eye protection. |

**1.2.4. Control of worker exposure: General exposures (closed systems), 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)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** | | |
| Use in closed, continuous process with occasional controlled exposure | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

**1.2.5. Control of worker exposure: General exposures (closed systems), Use in contained batch processes**
**Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 1 h/day |
| **Technical and organisational conditions and measures** | | |
| Closed batch process with occasional controlled exposure | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). | | |

| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
|---|---|---|
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |
| **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**
**Chemical production where opportunity for exposure arises (PROC4)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 1 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

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

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 0,25 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |

| **Conditions and measures related to personal protection, hygiene and health evaluation** |
|---|
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % |
| Use suitable eye protection. |

**1.2.8. Control of worker exposure: Laboratory activities**
**Use as laboratory reagent (PROC15)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

**1.2.9. Control of worker exposure: Bulk transfers, Closed systems**
**Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 1 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Ensure material transfers are under containment or extract ventilation.<br>Inhalation - minimum efficiency of > 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

**1.2.10. Control of worker exposure: Bulk transfers**
**Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)**

| **Product (article) characteristics** |
|---|
| Covers percentage substance in the product up to 25 %. |
| **Amount used, frequency and duration of use (or from service life)** |
| Use frequency : Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** |
| Local exhaust ventilation<br>Ensure material transfers are under containment or extract ventilation.<br>Inhalation - minimum efficiency of 95 % |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). |
| **Conditions and measures related to personal protection, hygiene and health evaluation** |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % |
| Use suitable eye protection. |

**1.2.11. Control of worker exposure: Bulk transfers**
**Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)**

| **Amount used, frequency and duration of use (or from service life)** |
|---|
| Use frequency : Covers use up to 1 h/day |
| **Technical and organisational conditions and measures** |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). |
| **Conditions and measures related to personal protection, hygiene and health evaluation** |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % |
| Wear suitable respiratory protection.<br>Efficiency: APF 10 |
| Use suitable eye protection. |

**1.2.12. Control of worker exposure: Equipment cleaning and 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)** |
| Use frequency : Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** |
| Local exhaust ventilation<br>Drain down and flush system prior to equipment break-in or maintenance.<br>Inhalation - minimum efficiency of 95 % |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). |
| **Conditions and measures related to personal protection, hygiene and health evaluation** |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 80 % |
| Use suitable eye protection. |

**1.2.13. Control of worker exposure: Storage**
**Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)**

| **Amount used, frequency and duration of use (or from service life)** |
|---|
| Use frequency : Covers use up to 8 h/day |
| **Technical and organisational conditions and measures** |
| Store substance within a closed system. |
| Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). |
| **Conditions and measures related to personal protection, hygiene and health evaluation** |
| Wear chemically resistant gloves (tested to EN374) in combination with ‘basic’ employee training.<br>Dermal - minimum efficiency of 90 % |
| Use suitable eye protection. |

**1.2.14. Control of worker exposure: Storage**

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

| **Amount used, frequency and duration of use (or from service life)** |
|---|
| Use frequency : Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** |
| Store substance within a closed system. |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). |
| **Conditions and measures related to personal protection, hygiene and health evaluation** |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % |
| Use suitable eye protection. |

## 1.3. Exposure estimation and reference to its source

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

| Release route | Release rate | Release estimation method |
|---|---|---|
| Water | 21,6 kg/day | |
| Air | 0,115 kg/day | |

| Compartment | Exposure level | RCR |
|---|---|---|
| Man via environment - Inhalation | 0,064 mg/m³ | 0,241 |

### 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 | < 0,01 | 1,3-butadiene |

**1.3.4. 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 | 0,459 | 1,3-butadiene |

**1.3.5. 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 |

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

| Exposure route | Health effect | Exposure indicator | Exposure level | RCR | Remarks |
|---|---|---|---|---|---|
| inhalative | systemic | long-term | 1,352 mg/m³ | 0,612 | 1,3-butadiene |

**1.3.7. 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 | 1,352 mg/m³ | 0,612 | 1,3-butadiene |

**1.3.8. Worker exposure: Use as laboratory reagent (PROC15)**

| Exposure route | Health effect | Exposure indicator | Exposure level | RCR | Remarks |
|---|---|---|---|---|---|
| inhalative | systemic | long-term | 2,028 mg/m³ | 0,918 | 1,3-butadiene |

**1.3.9. 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 | 0,459 | 1,3-butadiene |

**1.3.10. 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 | 1,826 mg/m³ | 0,826 | 1,3-butadiene |

**1.3.11. 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 | 2,028 mg/m³ | 0,918 | 1,3-butadiene |

**1.3.12. 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 | 2,028 mg/m³ | 0,918 | 1,3-butadiene |

**1.3.13. 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 | < 0,01 | 1,3-butadiene |

**1.3.14. 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 | 0,459 | 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.

## ES2: Use as an intermediate

### 2.1. Title section

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

| | | |
|---|---|---|
| **Environment** | | |
| **CS1** | **Use as an intermediate, Environment** | ERC6a |
| **Worker** | | |
| **CS2** | **General measures applicable to all activities, General measures (carcinogens)** | PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15, PROC28 |
| **CS3** | **General exposures (closed systems)** | PROC1 |
| **CS4** | **General exposures (closed systems), With sample collection** | PROC2 |
| **CS5** | **General exposures (closed systems), Batch process** | PROC3 |
| **CS6** | **General exposures (open systems)** | PROC4 |
| **CS7** | **Process sampling** | PROC9 |
| **CS8** | **Laboratory activities** | PROC15 |
| **CS9** | **Bulk transfers, Closed systems** | PROC8b |
| **CS10** | **Bulk transfers** | PROC8b |
| **CS11** | **Bulk transfers** | PROC8b |
| **CS12** | **Equipment cleaning and maintenance** | PROC8a, PROC28 |
| **CS13** | **Storage** | PROC1 |
| **CS14** | **Storage** | 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 | : | 488000 tonnes/year |
| Daily amount per site | : | 1630 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.<br>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.<br>Air - minimum efficiency of 50 % | | |
| Process optimized for highly efficient use of raw materials (very minimal environmental release) | | |
| Acclimated biological treatment<br>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 applicable to all activities, General measures (carcinogens)**
**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). |
| **Technical and organisational conditions and measures** | | |
| Occupational Health and Safety Management System: Advanced | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| General measures (carcinogens)<br>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. | | |
| **Other conditions affecting workers exposure** | | |
| Indoor or outdoor use | : | Indoor use |
| Temperature | : | Assumes use at not more than 20°C above ambient temperature. |

**2.2.3. 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)**

| |
|---|
| **Technical and organisational conditions and measures** |
| Closed systems |
| Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). |

| **Conditions and measures related to personal protection, hygiene and health evaluation** |
|---|
| Wear chemically resistant gloves (tested to EN374) in combination with 'basic' employee training.<br>Dermal - minimum efficiency of 90 % |
| Use suitable eye protection. |

**2.2.4. Control of worker exposure: General exposures (closed systems), 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)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** | | |
| Use in closed, continuous process with occasional controlled exposure<br>Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

**2.2.5. Control of worker exposure: General exposures (closed systems), Batch process Manufacture or formulation in the chemical industry in closed batch processes with occasional controlled exposure or processes with equivalent containment condition (PROC3)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 1 h/day |
| **Technical and organisational conditions and measures** | | |
| Closed batch process with occasional controlled exposure | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |

| |
|---|
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % |
| Use suitable eye protection. |

**2.2.6. Control of worker exposure: General exposures (open systems)**
**Chemical production where opportunity for exposure arises (PROC4)**

| | | |
|---|---|---|
| **Amount used, frequency and duration of use (or from service life)** | | |
| Use frequency | : | Covers use up to 1 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

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

| | | |
|---|---|---|
| **Amount used, frequency and duration of use (or from service life)** | | |
| Use frequency | : | Covers use up to 0,25 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with ‘basic’ employee training.<br>Dermal - minimum efficiency of 90 % | | |
| Use suitable eye protection. | | |

**2.2.8. Control of worker exposure: Laboratory activities**

**Use as laboratory reagent (PROC15)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

**2.2.9. Control of worker exposure: Bulk transfers, Closed systems**
**Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 1 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Ensure material transfers are under containment or extract ventilation.<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

**2.2.10. Control of worker exposure: Bulk transfers**
**Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)**

| **Product (article) characteristics** |
|---|
| Covers percentage substance in the product up to 25 %. |

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Ensure material transfers are under containment or extract ventilation.<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

**2.2.11. Control of worker exposure: Bulk transfers**
**Transfer of substance or mixture (charging/discharging) at dedicated facilities (PROC8b)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 1 h/day |
| **Technical and organisational conditions and measures** | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Wear suitable respiratory protection.<br>Efficiency: APF 10 | | |
| Use suitable eye protection. | | |

**2.2.12. Control of worker exposure: Equipment cleaning and 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)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** | | |
| Local exhaust ventilation<br>Drain down and flush system prior to equipment break-in or maintenance.<br>Inhalation - minimum efficiency of 95 % | | |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). | | |
| **Conditions and measures related to personal protection, hygiene and health evaluation** | | |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % | | |
| Use suitable eye protection. | | |

**2.2.13. Control of worker exposure: Storage**
**Chemical production or refinery in closed process without likelihood of exposure or processes with equivalent containment conditions (PROC1)**

| **Technical and organisational conditions and measures** |
|---|
| Store substance within a closed system. |
| Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour). |
| **Conditions and measures related to personal protection, hygiene and health evaluation** |
| Wear chemically resistant gloves (tested to EN374) in combination with ‘basic’ employee training.<br>Dermal - minimum efficiency of 90 % |
| Use suitable eye protection. |

**2.2.14. Control of worker exposure: Storage**
**Chemical production or refinery in closed continuous process with occasional controlled exposure or processes with equivalent containment conditions (PROC2)**

| **Amount used, frequency and duration of use (or from service life)** | | |
|---|---|---|
| Use frequency | : | Covers use up to 4 h/day |
| **Technical and organisational conditions and measures** | | |
| Use in closed, continuous process with occasional controlled exposure<br>Store substance within a closed system. | | |

| |
|---|
| Local exhaust ventilation<br>Inhalation - minimum efficiency of 95 % |
| Provide a good standard of controlled ventilation (5 to 10 air changes per hour). |
| **Conditions and measures related to personal protection, hygiene and health evaluation** |
| Wear chemically resistant gloves (tested to EN374) in combination with specific activity training.<br>Dermal - minimum efficiency of 95 % |
| Use suitable eye protection. |

## 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 | 29,28 kg/day | |
| Air | 48,81 kg/day | |

| Compartment | Exposure level | RCR |
|---|---|---|
| Man via environment - Inhalation | 0,07 mg/m³ | 0,265 |

### 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 | < 0,01 | 1,3-butadiene |

### 2.3.4. 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 | 0,459 | 1,3-butadiene |

### 2.3.5. 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 | Exposure level | RCR | Remarks |
|---|---|---|---|---|---|

| | | indicator | | | |
|---|---|---|---|---|---|
| inhalative | systemic | long-term | 1,578 mg/m³ | 0,714 | 1,3-butadiene |

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

| Exposure route | Health effect | Exposure indicator | Exposure level | RCR | Remarks |
|---|---|---|---|---|---|
| inhalative | systemic | long-term | 1,352 mg/m³ | 0,612 | 1,3-butadiene |

**2.3.7. 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 | 1,352 mg/m³ | 0,612 | 1,3-butadiene |

**2.3.8. Worker exposure: Use as laboratory reagent (PROC15)**

| Exposure route | Health effect | Exposure indicator | Exposure level | RCR | Remarks |
|---|---|---|---|---|---|
| inhalative | systemic | long-term | 2,028 mg/m³ | 0,918 | 1,3-butadiene |

**2.3.9. 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 | 0,459 | 1,3-butadiene |

**2.3.10. 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 | 1,826 mg/m³ | 0,826 | 1,3-butadiene |

**2.3.11. 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 | 2,028 mg/m³ | 0,918 | 1,3-butadiene |

**2.3.12. 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 | 2,028 mg/m³ | 0,918 | 1,3-butadiene |

**2.3.13. 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 | 0,01 | 1,3-butadiene |

**2.3.14. 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 | 0,459 | 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.