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

1.1. Product identifier

Product form : Substance

Trade name : Crude C4

EC no/ CAS no : 270-691-3 / 68476-52-8

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

1.2.1. Relevant identified uses

Use of the substance/mixture : Manufacture
Distribution
Use as an intermediate
Formulation
Uses in coatings
Use as a fuel
Polymer production
Polymer processing

Title	Use descriptors
Manufacture of C4, high 1.3-butadiene (>=0.1%) streams[x] (ES Ref.: ES 1)	SU3, SU8, SU9, PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15, ERC1, ERC4, ESVOC SPERC 1.1.v1
Distribution of C4, high 1.3-butadiene (>=0.1%) streams[x] (ES Ref.: ES 2)	SU3, SU8, SU9, PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15, ERC1, ERC2, ERC3, ERC4, ERC5, ERC6a, ERC6b, ERC6c, ERC6d, ERC7, ESVOC SPERC 1.1b.v1
Intermediate use of C4, high 1.3-butadiene (>=0.1%) streams[x] (ES Ref.: ES 3)	SU3, SU8, SU9, PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15, ERC6a, ESVOC SPERC 6.1a.v1
Formulation of C4, high 1.3-butadiene (>=0.1%) streams[x] (ES Ref.: ES 4)	SU3, SU10, PROC1, PROC2, PROC3, PROC4, PROC5, PROC8a, PROC8b, PROC9, PROC14, PROC15, ERC2, ESVOC SPERC 2.2.v1
Use of C4, high 1.3-butadiene (>=0.1%) streams in coatings - Industrial[x] (ES Ref.: ES 5)	SU3, PROC1, PROC2, PROC3, PROC4, PROC5, PROC7, PROC8a, PROC8b, PROC9, PROC10, PROC13, PROC14, PROC15, ERC4, ESVOC SPERC 4.3a.v1
Use of C4, high 1.3-butadiene (>=0.1%) streams in fuels - Industrial[x] (ES Ref.: ES 6)	SU3, PROC1, PROC2, PROC3, PROC8a, PROC8b, PROC16, ERC7, ESVOC SPERC 7.12a.v1
Use of C4, high 1.3-butadiene (>=0.1%) streams as a fuel - Professional[x] (ES Ref.: ES 7)	SU22, PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC16, ERC9a, ERC9b, ESVOC SPERC 9.12b.v1
Use of C4, high 1.3-butadiene (>=0.1%) streams in polymer production – Industrial[x] (ES Ref.: ES 8)	SU3, SU10, PROC1, PROC2, PROC3, PROC4, PROC5, PROC6, PROC8a, PROC8b, PROC14, PROC21, ERC4, ERC6c, ESVOC SPERC 4.20.v1
Use of C4, high 1.3-butadiene (>=0.1%) streams in polymer processing – Industrial[x] (ES Ref.: ES 9)	SU3, SU10, PROC1, PROC2, PROC3, PROC4, PROC5, PROC6, PROC8a, PROC8b, PROC9, PROC13, PROC14, PROC21, ERC4, ESVOC SPERC 4.21a.v1
Use of Use of C4, high 1.3-butadiene (>=0.1%) in polymer processing – Professional[x] (ES Ref.: ES 10)	SU22, PROC1, PROC2, PROC6, PROC8a, PROC8b, PROC14, PROC21, ERC8a, ERC8d, ESVOC SPERC 8.21b.v1

Full text of use descriptors: see section 16

1.2.2. Uses advised against

No additional information available

1.3. Details of the supplier of the safety data sheet

Supplier (Only Representative):
Braskem Netherland BV
Weena 238-240, 9th Floor, Tower C

NL - 3012 NJ – Rotterdam

Manufacturer:
Braskem S.A.
Rua Eteno, 1561
Polo Petroquímico de Camaçari
42810-000 – Camaçari – BA – Brasil

Braskem S.A.
Rua Marumbi, 1001
25221-000 – Duque de Caxias – RJ – Brasil

Braskem S.A.
Avenida Presidente Costa e Silva , 1178 , Capuava
09270-901 - Santo André - SP

Email: productsafety@braskem.com

1.4. Emergency telephone number

Emergency number : +31 10 205 2945

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

Classification according to Regulation (EC) No. 1272/2008 [CLP]

Flam. Gas 1 H220
Liquefied gas H280
Muta. 1B H340
Carc. 1A H350

Full text of hazard classes and H-statements : see section 16

Adverse physicochemical, human health and environmental effects

Fatigue, euforia, headache, excitation, desorientation, drowsiness, anestesia, insomnia, mental confusion and convulsions.
. This product contains no hazardous components for the aquatic environment. Extremely flammable gas.

2.2. Label elements

Labelling according to Regulation (EC) No. 1272/2008 [CLP]

Hazard pictograms (CLP) :

GHS02 GHS08

Signal word (CLP) : Danger

Hazard statements (CLP) : H220 - Extremely flammable gas
H280 - Contains gas under pressure; may explode if heated
H340 - May cause genetic defects (if inhaled)
H350 - May cause cancer (if inhaled)

Precautionary statements (CLP) : P201 - Obtain special instructions before use
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
P280 - Wear eye protection, protective gloves
P308+P313 - IF exposed or concerned: Get medical advice/attention
P377 - Leaking gas fire: Do not extinguish, unless leak can be stopped safely

2.3. Other hazards

other hazards which do not result in classification : Gas/vapour heavier than air. May accumulate in confined spaces, particularly at or below ground level. Gas/air mixtures are explosive. High concentrations may cause asphyxiation. Contact with the liquid may cause frostbite and serious damage to eyes.

SECTION 3: Composition/information on ingredients

3.1. Substance

Substance type : Multi-constituent

Name : Hydrocarbons, C4, ethylene-manufacture-by-product

EC no : 270-691-3

CAS no 68476-52-8

Name	Product identifier	%
1,3-butadiene, buta-1,3-diene	(CAS No) 106-99-0 (EC no) 203-450-8 (EC index no) 601-013-00-X	40 - 68
2-methylpropene	(CAS No) 115-11-7 (EC no) 204-066-3 (EC index no) 601-012-00-4	2 - 30

Name	Product identifier	%
but-1-ene	(CAS No) 106-98-9 (EC no) 203-449-2 (EC index no) 601-012-00-4	8 - 16
butane	(CAS No) 106-97-8 (EC no) 203-448-7 (EC index no) 601-004-00-0 (REACH-no) not available	2 - 10
Isobutane	(CAS No) 75-28-5 (EC no) 200-857-2 (EC index no) 601-004-00-0 (REACH-no) not available	0 - 7
(Z)-but-2-ene	(CAS No) 590-18-1 (EC no) 209-673-7 (EC index no) 601-012-00-4	2 - 6
(E)-but-2-ene	(CAS No) 624-64-6 (EC no) 210-855-3 (EC index no) 601-012-00-4	3 - 5
Vinyl-acethylene	(CAS No) Not applicable	0 - 5
1,2-Butadiene	(CAS No) 590-19-2 (EC no) 209-674-2	0.1 - 3.5
C3	(CAS No) Not applicable	0 - 3
1-Butyne	(CAS No) 107-00-6 (EC no) 203-451-3	0 - 2

Full text of R- and H-statements: see section 16

3.2. Mixture

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures after inhalation : Remove casualty to fresh air and keep warm and at rest. In case of irregular breathing or respiratory arrest provide artificial respiration. In case of breathing difficulties administer oxygen. Seek medical advice (show the label where possible).

First-aid measures after skin contact : After contact with skin, take off immediately all contaminated clothing, and wash immediately with plenty of water and soap. Contact with the liquefied gas may cause frostbite. Thaw frosted parts with lukewarm water. Do not rub affected area. Seek medical advice (show the label where possible).

First-aid measures after eye contact : Rinse immediately and plentifully with water, also under the eyelids, for at least 20 minutes. Contact with the product may cause cold burns or frostbite. Seek medical advice (show the label where possible).

First-aid measures after ingestion : not applicable.

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

Symptoms/injuries : May cause genetic defects. May cause cancer.

Symptoms/injuries after inhalation : Asphyxiant in high concentrations.

Symptoms/injuries after skin contact : Non-toxic in contact with skin. Slightly irritating to skin. Contact with the product may cause cold burns or frostbite.

Symptoms/injuries after eye contact : May cause slight irritation. Contact with the liquid may cause frostbite and serious damage to eyes.

Symptoms/injuries after ingestion : Not applicable.

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

Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Dry powder. Carbon dioxide (CO_2). Water mist.

Unsuitable extinguishing media : Do not use a water jet since it may cause the fire to spread.

5.2. Special hazards arising from the substance or mixture

Fire hazard : Extremely flammable gas. Risk of ignition at all temperatures. Risk of rapid formation of explosive mixtures when combined with air. Heavier than air, vapours may travel long distances along ground, ignite and flash back to source. Incomplete combustion releases dangerous carbon monoxide, carbon dioxide and other toxic gases.

Explosion hazard : Contains gas under pressure; may explode if heated. Cylinders may rupture under fire conditions.

5.3. Advice for firefighters

Firefighting instructions : Cut off the gas flow and then apply extinguishing agents. Do not approach fire except upwind and only with proper skin and respiratory protection (supplied air only). Cool closed containers exposed to fire with water spray.

Protective equipment for firefighters : Wear a self contained breathing apparatus. Full protective flameproof clothing.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Do not allow the product to be released into the environment. Reduce vapour with fog or fine water spray. Gas or vapour heavier than air. Mechanically ventilate the spillage area.

6.1.1. For non-emergency personnel

Protective equipment : Personal protective equipment. Wear closed safety glasses. Boots. Gloves. Self contained breathing apparatus.

Emergency procedures : Evacuate unnecessary personnel. Inform the public about the hazard and give advice to keep upwind. Eliminate all sources of ignition, avoid sparks, flames and do not smoke in risk area . Do not transfer under air or oxygen pressure. Containers must be properly grounded before beginning transfer. Use explosion-proof electrical equipment. Do not breathe fumes from fires or vapours from decomposition. Self contained breathing apparatus. Wear suitable protective clothing. Gloves. Prevent the product from entering drains or confined areas. Risk of suffocation due to oxygen deficiency in confined areas.

6.1.2. For emergency responders

Protective equipment : Personal protection equipment. Wear closed safety glasses. Boots. Gloves. Self contained breathing apparatus.

Emergency procedures : Evacuate unnecessary personnel. Inform the public about the hazard and give advice to keep upwind. Eliminate all sources of ignition, avoid sparks, flames and do not smoke in risk area . Do not transfer under air or oxygen pressure. Containers must be properly grounded before beginning transfer. Do not breathe fumes from fires or vapours from decomposition. Wear suitable protective clothing. Gloves. Prevent the product from entering drains or confined areas. Risk of suffocation due to oxygen deficiency in confined areas. Use explosion-proof ventilating equipment.

6.2. Environmental precautions

Stop leak if safe to do so. Avoid contact with skin. Avoid release to the environment.

6.3. Methods and material for containment and cleaning up

For containment : Prevent the product from reaching inhabited areas. Control the vapours with a fine water spray. Vapours are heavier than air and may spread along floors. Mechanically ventilate the spillage area.

Methods for cleaning up : Prevent the product from reaching inhabited areas. Use water spray to disperse the vapours. Vapours are heavier than air and may spread along floors. Mechanically ventilate the spillage area.

6.4. Reference to other sections

For further information refer to section 8: "Exposure controls/personal protection". For disposal of residues refer to section 13: Disposal considerations.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Avoid ignition sources. No smoking. Do not use compressed air to transfer, discharge or transport the product. Keep away from open flames, hot surfaces and sources of ignition.

Hygiene measures : Handle in accordance with good industrial hygiene and safety practices.

7.2. Conditions for safe storage, including any incompatibilities

Technical measures : Provide local exhaust or general room ventilation. Use grounded electrical/mechanical equipment. Use explosion-proof lighting equipment. Use explosion-proof ventilating equipment. Use only non-sparking tools. Ventilation along the floor.

Storage conditions : Store, if possible, in a cool, well ventilated place away from incompatible materials. Store in dry, cool, well-ventilated area. Keep container tightly closed. Keep away from open flames, hot surfaces and sources of ignition.

Incompatible materials : Oxidizing agent.

Storage area : Keep away from open flames, hot surfaces and sources of ignition. Keep container tightly closed. Store in dry, cool, well-ventilated area. Do not store near oxidizing agents. Use explosion-proof lighting equipment. Use explosion-proof ventilating equipment.

Packaging materials : stainless steel.

7.3. Specific end use(s)

Refer to section 1.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

1,3-butadiene, buta-1,3-diene (106-99-0)		
Austria	MAK (mg/m³)	11 mg/m³
Austria	MAK (ppm)	5 ppm
Austria	MAK Short time value (mg/m³)	44 mg/m³
Austria	MAK Short time value (ppm)	20 ppm
Belgium	Limit value (mg/m³)	4.5 mg/m³
Belgium	Limit value (ppm)	2 ppm
Belgium	Remark (BE)	c
Denmark	Grænseværdie (langvarig) (mg/m³)	22 mg/m³
Denmark	Grænseværdie (langvarig) (ppm)	10 ppm
Denmark	Grænseværdie (kortvarig) (mg/m³)	44 mg/m³
Denmark	Grænseværdie (kortvarig) (ppm)	20 ppm
Finland	HTP-arvo (8h) (mg/m³)	2.2 mg/m³
Finland	HTP-arvo (8h) (ppm)	1 ppm
Hungary	CK-érték	1 mg/m³
Ireland	OEL (8 hours ref) (mg/m³)	2.2 mg/m³
Ireland	OEL (8 hours ref) (ppm)	1 ppm
Ireland	Notes (IE)	C1, Mut2
Lithuania	IPRV (mg/m³)	1 mg/m³
Lithuania	IPRV (ppm)	0.5 ppm
Lithuania	TPRV (mg/m³)	10 mg/m³
Lithuania	TPRV (ppm)	5 ppm
Lithuania	Remark (LT)	K
Netherlands	Grenswaarde TGG 8H (mg/m³)	46.2 mg/m³
Poland	NDS (mg/m³)	10 mg/m³
Poland	NDSCh (mg/m³)	40 mg/m³
Spain	VLA-ED (mg/m³)	4.5 mg/m³
Spain	VLA-ED (ppm)	2 ppm
Sweden	nivågränsvärde (NVG) (mg/m³)	1 mg/m³ 0.5 mg/m³ C
Sweden	nivågränsvärde (NVG) (ppm)	0.5 ppm 1 ppm C
Sweden	kortidsvärde (KTV) (mg/m³)	10 mg/m³ 5 mg/m³ C
Sweden	kortidsvärde (KTV) (ppm)	5 ppm 10 ppm C
United Kingdom	Local name	Buta-1,3-diene
United Kingdom	WEL TWA (mg/m³)	22 mg/m³
United Kingdom	WEL TWA (ppm)	10 ppm
United Kingdom	Remark (WEL)	Carc (Capable of causing cancer and/or heritable genetic damage. See paragraphs 49–51)
Norway	Grenseverdier (AN) (mg/m³)	2.2 mg/m³
Norway	Grenseverdier (AN) (ppm)	1 ppm
Norway	Merknader (NO)	K
Switzerland	VME (mg/m³)	11 mg/m³
Switzerland	VME (ppm)	5 ppm
Canada (Quebec)	VEMP (mg/m³)	4.4 mg/m³
Canada (Quebec)	VEMP (ppm)	2 ppm
USA - ACGIH	Local name	1,3-Butadiene
USA - ACGIH	ACGIH TWA (mg/m³)	4.4 mg/m³
USA - ACGIH	ACGIH TWA (ppm)	2 ppm
USA - ACGIH	Remark (ACGIH)	Cancer

1,3-butadiene, buta-1,3-diene (106-99-0)		
USA - OSHA	Local name	Butadiene (1,3-Butadiene); See 29 CFR 1910.1051; 29 CFR 1910.19(1)
USA - OSHA	OSHA PEL (TWA) (ppm)	1 ppm
USA - OSHA	OSHA PEL (STEL) (ppm)	5 ppm

2-methylpropene (115-11-7)		
Lithuania	IPRV (mg/m³)	100 mg/m³
USA - ACGIH	Local name	Isobutene
USA - ACGIH	ACGIH TWA (ppm)	250 ppm
USA - ACGIH	Remark (ACGIH)	URT irr; body weight eff

but-1-ene (106-98-9)		
USA - ACGIH	Local name	Butenes, all isomers
USA - ACGIH	ACGIH TWA (ppm)	250 ppm

(E)-but-2-ene (624-64-6)		
USA - ACGIH	Local name	Butenes, all isomers
USA - ACGIH	ACGIH TWA (ppm)	250 ppm

Isobutane (75-28-5)		
Austria	MAK (mg/m³)	1900 mg/m³
Austria	MAK (ppm)	800 ppm
Austria	MAK Short time value (mg/m³)	3800 mg/m³
Austria	MAK Short time value (ppm)	1600 ppm
Belgium	Limit value (ppm)	1000 ppm (gas)
Estonia	OEL TWA (mg/m³)	1900 mg/m³
Estonia	OEL TWA (ppm)	800 ppm
Finland	HTP-arvo (8h) (ppm)	800 ppm
Finland	HTP-arvo (15 min)	2400 mg/m³
Finland	HTP-arvo (15 min) (ppm)	1000 ppm
Germany	TRGS 900 Occupational exposure limit value (mg/m³)	2400 mg/m³
Germany	TRGS 900 Occupational exposure limit value (ppm)	1000 ppm
Slovenia	OEL TWA (mg/m³)	2400 mg/m³
Slovenia	OEL TWA (ppm)	1000 ppm
Slovenia	OEL STEL (mg/m³)	9600 mg/m³
Slovenia	OEL STEL (ppm)	4000 ppm
Switzerland	VME (mg/m³)	1900 mg/m³
Switzerland	VME (ppm)	800 ppm
Switzerland	VLE (mg/m³)	7200 mg/m³
Switzerland	VLE (ppm)	3200 ppm
USA - ACGIH	Local name	Butane, all isomers
USA - ACGIH	ACGIH STEL (ppm)	1000 ppm
USA - NIOSH	NIOSH REL (TWA) (mg/m³)	1900 mg/m³
USA - NIOSH	NIOSH REL (TWA) (ppm)	800 ppm

butane (106-97-8)		
Austria	MAK (mg/m³)	1900 mg/m³
Austria	MAK (ppm)	800 ppm
Austria	MAK Short time value (mg/m³)	3800 mg/m³
Austria	MAK Short time value (ppm)	1600 ppm
France	Local name	n-Butane
France	VME (mg/m³)	1900 mg/m³
France	VME (ppm)	800 ppm
Germany	TRGS 900 Occupational exposure limit value (mg/m³)	2400 mg/m³
Germany	TRGS 900 Occupational exposure limit value (ppm)	1000 ppm
Spain	VLA-ED (mg/m³)	1935 mg/m³
Spain	VLA-ED (ppm)	800 ppm
United Kingdom	Local name	Butane
United Kingdom	WEL TWA (mg/m³)	1450 mg/m³

butane (106-97-8)		
United Kingdom	WEL TWA (ppm)	600 ppm
United Kingdom	WEL STEL (mg/m³)	1810 mg/m³
United Kingdom	WEL STEL (ppm)	750 ppm
United Kingdom	Remark (WEL)	Carc (Capable of causing cancer and/or heritable genetic damage. See paragraphs 49–51), (only applies if Butane contains more than 0.1% of buta-1,3-diene)
Switzerland	VME (mg/m³)	1900 mg/m³
Switzerland	VME (ppm)	800 ppm
Australia	TWA (mg/m³)	1450 mg/m³
Australia	TWA (ppm)	600 ppm
Australia	STEL (mg/m³)	1810 mg/m³
Australia	STEL (ppm)	750 ppm
Canada (Quebec)	VEMP (mg/m³)	1900 mg/m³
Canada (Quebec)	VEMP (ppm)	800 ppm
USA - ACGIH	Local name	Butane, all isomers
USA - ACGIH	ACGIH TWA (ppm)	1000 ppm
USA - ACGIH	ACGIH STEL (ppm)	1000 ppm
(Z)-but-2-ene (590-18-1)		
USA - ACGIH	Local name	Butenes, all isomers
USA - ACGIH	ACGIH TWA (ppm)	250 ppm

Crude C4 (68476-52-8)	
DNEL/DMEL (Workers)	
Long-term - systemic effects, inhalation	2.21 mg/m³/day
Long-term - local effects, inhalation	1530 mg/m³/day
DNEL/DMEL (General population)	
Long-term - systemic effects, inhalation	0.0664 mg/m³/day
Long-term - local effects, inhalation	918 mg/m³/day

DNEL : 2.21 Long-term - systemic effects, inhalation

8.2. Exposure controls

Appropriate engineering controls : Provide local exhaust or general room ventilation. Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure. Handle in accordance with good industrial hygiene and safety procedures. Use explosion-proof lighting equipment. Use explosion-proof ventilating equipment. When using do not eat, drink or smoke.

Materials for protective clothing : PVC (Polyvinyl chloride)

Hand protection : Protective gloves made of PVC

Eye protection : Safety glasses with side shields

Skin and body protection : PVC (Polyvinyl chloride). Wear suitable protective clothing, gloves and eye/face protection. Boots

Respiratory protection : An approved organic vapour respirator/supplied air or self-contained breathing apparatus must be used when vapour concentration exceeds applicable exposure limits. Self contained breathing apparatus

Environmental exposure controls : Avoid release to the environment.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state : Gas

Appearance : Liquefied gas.

Molecular mass : 54.09 g/mol

Colour : colourless.

Odour : Mildly aromatic.

Odour threshold : No data available

pH : Not applicable

Relative evaporation rate (butyl acetate=1) : Not applicable

Melting point : No data available

Freezing point : -185.53 °C

Boiling point : -4.41 °C (101.3 kPa)

Flash point	:	-76 °C
Critical temperature	:	146 °C
Auto-ignition temperature	:	415 - 420 °C
Decomposition temperature	:	Not available
Flammability (solid, gas)	:	Extremely flammable
Vapour pressure	:	248.9 kPa (2.46 atm; 21°C)
Critical pressure	:	4022.6 kPa (39.7 atm)
Relative vapour density at 20 °C	:	1.87 (15°C)
Relative density	:	0.6452; 0°C 0.621; 20°C
Solubility	:	Soluble in alcohols. Soluble in benzene. Soluble in ether. Water: 735 mg/l
Log Pow	:	Not available
Viscosity, kinematic	:	Not applicable
Viscosity, dynamic	:	Not applicable
Explosive properties	:	No data available
Oxidising properties	:	No data available
Explosive limits	:	2 - 11.5 vol %

9.2. Other information

Gas group : Liquefied gas

SECTION 10: Stability and reactivity

10.1. Reactivity

The product is non-reactive under normal conditions of use, storage and transport.

10.2. Chemical stability

Stable at ambient temperature and under normal conditions of use.

10.3. Possibility of hazardous reactions

None known.

10.4. Conditions to avoid

Avoid ignition sources. Avoid static electricity discharges. Incompatible materials.

10.5. Incompatible materials

oxidizing agents.

10.6. Hazardous decomposition products

Incomplete combustion releases dangerous carbon monoxide, carbon dioxide and other toxic gases.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Not classified

Isobutane (75-28-5)	
LC50 inhalation rat (mg/l)	658 mg/l/4h

Skin corrosion/irritation	:	Not classified pH: Not applicable
Serious eye damage/irritation	:	Not classified pH: Not applicable
Respiratory or skin sensitisation	:	Not classified
Germ cell mutagenicity	:	May cause genetic defects (if inhaled).
Carcinogenicity	:	May cause cancer (if inhaled).
Reproductive toxicity	:	Not classified
Specific target organ toxicity (single exposure)	:	Not classified
Specific target organ toxicity (repeated exposure)	:	Not classified
Aspiration hazard	:	Not classified

SECTION 12: Ecological information

12.1. Toxicity

No additional information available

12.2. Persistence and degradability

No additional information available

12.3. Bioaccumulative potential

Crude C4 (68476-52-8)	
Log Pow	Not available

Isobutane (75-28-5)	
BCF fish 1	1.57 - 1.97
Log Pow	2.88 (at 20 °C)

12.4. Mobility in soil

Crude C4 (68476-52-8)	
Ecology - soil	Not applicable.

12.5. Results of PBT and vPvB assessment

Crude C4 (68476-52-8)	
Results of PBT assessment	Potentially Not P or vP, Not B or vB, Not T

12.6. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Regional legislation (waste) : Dispose of at authorized waste collection point.

Waste treatment methods : Avoid release to the environment.

Additional information : Dispose in a safe manner in accordance with local/national regulations. Non-recyclable empty containers must be destroyed and forwarded to re-melting in authorized installations.

SECTION 14: Transport information

Classification for ROAD and RAIL transport: ADR/RID

14.1 UN Number : UN1010

14.2 Proper Shipping Name : BUTADIENES AND HYDROCARBON MIXTURE, STABILIZED

14.3 Class / Division : 2.1

14.4 Packing group : Not applicable

14.5 Environmental hazards : Product considered not environmentally hazardous based on available data

14.6 Special precautions for user : Hazard identification number: 239

Classification for SEA transport: IMO - IMDG

14.1 UN Number : UN1010

14.2 Proper Shipping Name : BUTADIENES AND HYDROCARBON MIXTURE, STABILIZED

14.3 Class / Division : 2.1

14.4 Packing group : Not applicable

14.5 Environmental hazards : Product considered not marine pollutant based on available data

14.6 Special precautions for user : No additional information available

14.7 Transport in bulk according to IGC Code

Product name : Butadiene

Classification for AIR transport: IATA - ICAO

14.1 UN Number : UN1010

14.2 Proper Shipping Name : Butadienes and hydrocarbon mixture, stabilized

14.3 Class / Division : 2.1

14.4 Packing group : Not applicable

14.5 Environmental hazards : Product considered not environmentally hazardous based on available data

14.6 Special precautions for user : No additional information available

This information does not intend to convey all specific regulatory or operational requirements/information relating to the product, therefore it cannot be considered exhaustive. Consult ADR, RID, IMO and ICAO regulations before transporting the product. It is responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.

SECTION 15: Regulatory information

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

15.1.1. EU-Regulations

No REACH Annex XVII restrictions

Crude C4 is not on the REACH Candidate List

Crude C4 is not on the REACH Annex XIV List

15.1.2. National regulations

Listed on the AICS (Australian Inventory of Chemical Substances)
Listed on the Canadian DSL (Domestic Substances List)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)
Listed on the Korean ECL (Existing Chemicals List)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

Germany

Water hazard class (WGK) : 3 - severe hazard to waters

15.2. Chemical safety assessment

No additional information available

SECTION 16: Other information

Indication of changes:
Physical and chemical properties.

Abbreviations and acronyms:

	ACGIH (American Conference of Government Industrial Hygienists)
	GHS - Globally Harmonised System
	IARC (International Agency for Research on Cancer)
DNEL	Derived-No Effect Level
	TWA- Time Weighted Average
	OSHA - Occupational Safety and Health Administration
	PEL- Permissible Exposure Level
	STEL- Short-Term Exposure Limit
	URT irr (upper respiratory tract irritation)

Sources of Key data : Data arise from reference works and literature.

Full text of R-, H- and EUH-statements:	
Carc. 1A	Carcinogenicity, Category 1A
Dissolved gas	Gases under pressure : Dissolved gas
Flam. Gas 1	Flammable gases, Category 1
Liquefied gas	Gases under pressure : Liquefied gas
Muta. 1B	Germ cell mutagenicity, Category 1B
Press. Gas	Gases under pressure
H220	Extremely flammable gas
H280	Contains gas under pressure; may explode if heated
H340	May cause genetic defects
H350	May cause cancer
ERC1	Manufacture of substances
ERC2	Formulation of preparations
ERC3	Formulation in materials
ERC4	Industrial use of processing aids in processes and products, not becoming part of articles
ERC5	Industrial use resulting in inclusion into or onto a matrix
ERC6a	Industrial use resulting in manufacture of another substance (use of intermediates)
ERC6b	Industrial use of reactive processing aids
ERC6c	Industrial use of monomers for manufacture of thermo-plastics

ERC6d	Industrial use of process regulators for polymerisation processes in production of resins, rubbers, polymers
ERC7	Industrial use of substances in closed systems
ERC8a	Wide dispersive indoor use of processing aids in open systems
ERC8d	Wide dispersive outdoor use of processing aids in open systems
ERC9a	Wide dispersive indoor use of substances in closed systems
ERC9b	Wide dispersive outdoor use of substances in closed systems
ESVOC SPERC 1.1.v1	Manufacture of substances: Industrial (SU8, SU9)
ESVOC SPERC 1.1b.v1	Distribution: Industrial (SU3)
ESVOC SPERC 2.2.v1	Formulation & packing of preparations and mixtures: Industrial (SU10)
ESVOC SPERC 4.20.v1	Polymer production: Industrial (SU10)
ESVOC SPERC 4.21a.v1	Polymer production: Industrial (SU10)
ESVOC SPERC 4.3a.v1	Uses in Coatings: Industrial (SU3)
ESVOC SPERC 6.1a.v1	Manufacture of substances: Industrial (SU8, SU9)
ESVOC SPERC 7.12a.v1	Use as a fuel: Industrial (SU3)
ESVOC SPERC 8.21b.v1	Polymer production: Professional (SU22)
ESVOC SPERC 9.12b.v1	Use as a fuel: Professional (SU22)
PROC1	Use in closed process, no likelihood of exposure
PROC10	Roller application or brushing
PROC13	Treatment of articles by dipping and pouring
PROC14	Production of preparations or articles by tabletting, compression, extrusion, pelletisation
PROC15	Use as laboratory reagent
PROC16	Using material as fuel sources, limited exposure to unburned product to be expected
PROC2	Use in closed, continuous process with occasional controlled exposure
PROC21	Low energy manipulation of substances bound in materials and/or articles
PROC3	Use in closed batch process (synthesis or formulation)
PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises
PROC5	Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact)
PROC6	Calendering operations
PROC7	Industrial spraying
PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities
PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities
PROC9	Transfer of substance or preparation into small containers (dedicated filling line, including weighing)
SU10	Formulation [mixing] of preparations and/or re-packaging (excluding alloys)
SU22	Professional uses: Public domain (administration, education, entertainment, services, craftsmen)
SU3	Industrial uses: Uses of substances as such or in preparations* at industrial sites
SU8	Manufacture of bulk, large scale chemicals (including petroleum products)
SU9	Manufacture of fine chemicals

Braskem - SDS EU

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product. It warns that the handling of any chemical substance requires the previous knowledge of its hazards for the user. It is up to the user of the product company providing this SDS to and promote the training of its employees about possible risks come upon of the product. The information contained herein is not absolute, but only general information on the use of the chemical and indication of safety and security measures.

Annex to the Safety Data Sheet

Product exposure scenario(s)	
ES Type	**ES title**
Worker	Manufacture of C4, high 1.3-butadiene (>=0.1%) streams
Worker	Distribution of C4, high 1.3-butadiene (>=0.1%) streams
Worker	Intermediate use of C4, high 1.3-butadiene (>=0.1%) streams
Worker	Formulation of C4, high 1.3-butadiene (>=0.1%) streams
Worker	Use of C4, high 1.3-butadiene (>=0.1%) streams in coatings - Industrial
Consumer	Use of C4, high 1.3-butadiene (>=0.1%) streams in fuels - Industrial
Worker	Use of C4, high 1.3-butadiene (>=0.1%) streams as a fuel - Professional
Worker	Use of C4, high 1.3-butadiene (>=0.1%) streams in polymer production – Industrial
Worker	Use of C4, high 1.3-butadiene (>=0.1%) streams in polymer processing – Industrial
Worker	Use of Use of C4, high 1.3-butadiene (>=0.1%) in polymer processing – Professional

1. Exposure scenario ES 1

Manufacture of C4, high 1.3-butadiene (>=0.1%) streams

ES Ref.: ES 1 ES Type: Worker	

Use descriptors	SU3, SU8, SU9 PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15 ERC1, ERC4 ESVOC SPERC 1.1.v1
Processes, tasks, activities covered	Manufacture of substance or use as an intermediate, process chemical or extracting agent. Includes recycling/ recovery, material transfers, storage, maintenance and loading (ncluding marine vessel/barge, road/rail car and bulk container) Industrial use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC1) (General exposures (closed systems))

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills	

	immediately and dispose of waste 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 substance within a closed system	

2.1.2 Contributing scenario controlling worker exposure (PROC2) (General exposures (closed systems))

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a predominantly closed system provided with extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Sample via a closed loop or other system to avoid exposure	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.3 Contributing scenario controlling worker exposure (PROC3) (General exposures (closed systems))

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a predominantly closed system provided with extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Sample via a closed loop or other system to avoid exposure	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 15 minutes	

2.1.4 Contributing scenario controlling worker exposure (PROC4) (General exposures (open systems))

PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a predominantly closed system provided with extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Sample via a closed loop or other system to avoid exposure	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 15 minutes	

2.1.5 Contributing scenario controlling worker exposure (PROC8a) (Process sampling)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Sample via a closed loop or other system to avoid exposure	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 15 minutes	

2.1.6 Contributing scenario controlling worker exposure (PROC15) (Laboratory activities)

PROC15	Use as laboratory reagent

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 within a fume cupboard or implement suitable equivalent methods to minimise exposure	
Technical conditions and measures to control dispersion from source towards the worker	Avoid carrying out activities involving exposure for more than 15 minutes	

2.1.7 Contributing scenario controlling worker exposure (PROC8b) (Bulk transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Use dry break couplings for material transfer	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.8 Contributing scenario controlling worker exposure (PROC8b) (Bulk transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level	Consider technical advances and process upgrades (including automation) for the elimination of	

(source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Use dry break couplings for material transfer	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.9 Contributing scenario controlling worker exposure (PROC8a) (Equipment cleaning and maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down and flush system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Clear spills immediately	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.10 Contributing scenario controlling worker exposure (PROC2) (Storage)

PROC2	Use in closed, continuous process with occasional controlled exposure	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Sample via a closed loop or other system to avoid exposure	
	Provide extract ventilation to material transfer points and other openings	
	Store substance within a closed system	

2.2 Contributing scenario controlling environmental exposure (ERC1, ERC4, ESVOC SPERC 1.1.v1)

ERC1	Manufacture of substances
ERC4	Industrial use of processing aids in processes and products, not becoming part of articles
ESVOC SPERC 1.1.v1	Manufacture of substances: Industrial (SU8, SU9)

Product characteristics		
Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable	
Operational conditions		
Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	50000
	Fraction of Regional tonnage used locally:	1
	Annual site tonnage (tons/year):	50000
	Maximum daily site tonnage (kg/day):	170000
Frequency and duration of use	Continuous release	
	Emission days (days/year):	300
Environmental factors not influenced by risk management	Local freshwater dilution factor:	40
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.000002
	Release fraction to wastewater from process (initial release prior to RMM):	0.00001
	Release fraction to soil from process (initial release prior to RMM):	0.0001
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or	Risk from environmental exposure is driven by	

limit discharges, air emissions and releases to soil	humans via indirect exposure (primarily inhalation)	
	Onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Treat air emission to provide a typical removal efficiency of (%):	90
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils	
	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	9000000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	10000
Conditions and measures related to external treatment of waste for disposal	During manufacturing no waste of the substance is generated	
Conditions and measures related to external recovery of waste	During manufacturing no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects						
DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 (General exposures (closed systems))	0.01	0.01	0.34	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (General exposures (closed systems))	0.7	0.7	0.14	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (General exposures (closed systems))	0.7	0.7	0.03	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC4 (General exposures (open systems))	0.7	0.7	0.69	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Process sampling)	0.53	0.53	0.69	0	0.53	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC15 (Laboratory activities)	0.5	0.5	0.03	0	0.5	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Bulk transfers)	0.63	0.63	0.69	0	0.63	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Bulk transfers)	0.63	0.63	0.69	0	0.63	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

PROC8a (Equipment cleaning and maintenance)	0.18	0.18	1.37	0	0.18	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Storage)	0.7	0.7	0.14	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 2

Distribution of C4, high 1.3-butadiene (>=0.1%) streams

ES Ref.: ES 2 ES Type: Worker	

Use descriptors	SU3, SU8, SU9 PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15 ERC1, ERC2, ERC3, ERC4, ERC5, ERC6a, ERC6b, ERC6c, ERC6d, ERC7 ESVOC SPERC 1.1b.v1
Processes, tasks, activities covered	Loading (including marine vessel/barge, rail/road car and IBC loading) and repacking (including drums and small packs) of substance, including its sampling, storage, unloading, distribution and associated laboratory activities Industrial use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC1) (General exposures (closed systems))

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	

2.1.2 Contributing scenario controlling worker exposure (PROC2) (General exposures (closed systems))

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers	Assumes use at not more than 20°C above ambient temperature, unless stated differently	

exposure	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Sample via a closed loop or other system to avoid exposure	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.3 Contributing scenario controlling worker exposure (PROC3) (General exposures (closed systems))

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Sample via a closed loop or other system to avoid exposure	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.4 Contributing scenario controlling worker exposure (PROC4) (General exposures (open systems))

PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Sample via a closed loop or other system to avoid exposure	
	Avoid carrying out activities involving exposure for more than 1 hour	
	Clear transfer lines prior to de-coupling	
	Transfer via enclosed lines	

2.1.5 Contributing scenario controlling worker exposure (PROC3) (Process sampling)

PROC3	Use in closed batch process (synthesis or formulation)	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Sample via a closed loop or other system to avoid exposure	

2.1.6 Contributing scenario controlling worker exposure (PROC15) (Laboratory activities)

PROC15	Use as laboratory reagent

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 within a fume cupboard or implement suitable equivalent methods to minimise exposure	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	

2.1.7 Contributing scenario controlling worker exposure (PROC8b) (Bulk transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	

Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Clear transfer lines prior to de-coupling	
	Transfer via enclosed lines	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.8 Contributing scenario controlling worker exposure (PROC8b) (Bulk transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	

Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Clear transfer lines prior to de-coupling	
	Transfer via enclosed lines	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.9 Contributing scenario controlling worker exposure (PROC9) (Drum and small package filling)

PROC9	Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Transfer via enclosed lines	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.10 Contributing scenario controlling worker exposure (PROC8a) (Equipment cleaning and maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down and flush system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Clear spills immediately	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.11 Contributing scenario controlling worker exposure (PROC2) (Storage)

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Transfer via enclosed lines	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Store substance within a closed system	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.2 Contributing scenario controlling environmental exposure (ERC1, ERC2, ERC3, ERC4, ERC5, ERC6a, ERC6b, ERC6c, ERC6d, ERC7, ESVOC SPERC 1.1b.v1)

ERC1	Manufacture of substances
ERC2	Formulation of preparations
ERC3	Formulation in materials

ERC4	Industrial use of processing aids in processes and products, not becoming part of articles
ERC5	Industrial use resulting in inclusion into or onto a matrix
ERC6a	Industrial use resulting in manufacture of another substance (use of intermediates)
ERC6b	Industrial use of reactive processing aids
ERC6c	Industrial use of monomers for manufacture of thermo-plastics
ERC6d	Industrial use of process regulators for polymerisation processes in production of resins, rubbers, polymers
ERC7	Industrial use of substances in closed systems
ESVOC SPERC 1.1b.v1	Distribution: Industrial (SU3)

Product characteristics

Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable

Operational conditions

Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	50000
	Fraction of Regional tonnage used locally:	0.002
	Annual site tonnage (tons/year):	100
	Maximum daily site tonnage (kg/day):	5000
Frequency and duration of use	Continuous release	
	Emission days (days/year):	20
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.0001
	Release fraction to wastewater from process (initial release prior to RMM):	0.00001
	Release fraction to soil from process (initial release prior to RMM):	0.00001

Risk management measures

Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation)	
	If discharging to domestic sewage treatment plant, no onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Treat air emission to provide a typical removal efficiency of (%):	90
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils	
	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	11000000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	2000
Conditions and measures related to external treatment of waste for disposal	During manufacturing no waste of the substance is generated	
Conditions and measures related to external recovery of waste	During manufacturing no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects						
DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 (General exposures (closed systems))	0.01	0.01	0.34	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (General exposures (closed systems))	0.35	0.35	0.14	0	0.35	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (General exposures (closed systems))	0.7	0.7	0.03	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC4 (General exposures (open systems))	0.6	0.6	0.69	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (Process sampling)	0.7	0.7	0.03	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC15 (Laboratory activities)	0.35	0.35	0.03	0	0.35	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Bulk transfers)	0.63	0.63	0.69	0	0.63	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Bulk transfers)	0.63	0.63	0.69	0	0.63	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC9 (Drum and small package filling)	0.72	0.72	0.69	0	0.72	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Equipment cleaning and maintenance)	0.18	0.18	13.71	0.04	0.22	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Storage)	0.9	0.9	1.37	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 3

Intermediate use of C4, high 1.3-butadiene (>=0.1%) streams

ES Ref.: ES 3 ES Type: Worker	

Use descriptors	SU3, SU8, SU9 PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15 ERC6a ESVOC SPERC 6.1a.v1
Processes, tasks, activities covered	Manufacture of substance or use as an intermediate, process chemical or extracting agent. Includes recycling/ recovery, material transfers, storage, maintenance and loading (ncluding marine vessel/barge, road/rail car and bulk container) Industrial use
Assessment method	Human health assessment is not required for this use, use as an intermediate is included in the manufacture of the substance

2. Operational conditions and risk management measures

2.2 Contributing scenario controlling environmental exposure (ERC6a, ESVOC SPERC 6.1a.v1)

ERC6a	Industrial use resulting in manufacture of another substance (use of intermediates)
ESVOC SPERC 6.1a.v1	Manufacture of substances: Industrial (SU8, SU9)

Product characteristics

Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable

Operational conditions

Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	25000
	Fraction of Regional tonnage used locally:	0.6
	Annual site tonnage (tons/year):	15000
	Maximum daily site tonnage (kg/day):	50000
Frequency and duration of use	Continuous release	
	Emission days (days/year):	300
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.005
	Release fraction to wastewater from process (initial release prior to RMM):	0.0003
	Release fraction to soil from process (initial release prior to RMM):	0.001

Risk management measures

Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by freshwater sediment.	
	If discharging to domestic sewage treatment plant, no onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Treat air emission to provide a typical removal efficiency of (%):	80
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils	
	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	11000000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow	2000

	(m3/d):	
Conditions and measures related to external treatment of waste for disposal	This substance is consumed during use and no waste of the substance is generated	
Conditions and measures related to external recovery of waste	This substance is consumed during use and no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Human health assessment is not required for this use, use as an intermediate is included in the manufacture of the substance

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Human health assessment is not required for this use, use as an intermediate is included in the manufacture of the substance

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 4

Formulation of C4, high 1.3-butadiene (>=0.1%) streams

ES Ref.: ES 4 ES Type: Worker	

Use descriptors	SU3, SU10 PROC1, PROC2, PROC3, PROC4, PROC5, PROC8a, PROC8b, PROC9, PROC14, PROC15 ERC2 ESVOC SPERC 2.2.v1
Processes, tasks, activities covered	Formulation of the substance and its mixtures in batch or continuous operations within closed or contained systems, including incidental exposures during storage, materials transfers, mixing, maintenance, sampling and associated laboratory activities Industrial use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC1) (General exposures (closed systems))

PROC1	Use in closed process, no likelihood of exposure	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	

2.1.2 Contributing scenario controlling worker exposure (PROC2) (General exposures (closed systems))

PROC2	Use in closed, continuous process with occasional controlled exposure	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers	Assumes use at not more than 20°C above ambient temperature, unless stated differently	

exposure	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Sample via a closed loop or other system to avoid exposure	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.3 Contributing scenario controlling worker exposure (PROC3) (General exposures (closed systems))

PROC3	Use in closed batch process (synthesis or formulation)
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	

	Sample via a closed loop or other system to avoid exposure	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.4 Contributing scenario controlling worker exposure (PROC4) (General exposures (open systems))

PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Sample via a closed loop or other system to avoid exposure	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.5 Contributing scenario controlling worker exposure (PROC3) (Batch processes at elevated temperatures)

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Sample via a closed loop or other system to avoid exposure	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.6 Contributing scenario controlling worker exposure (PROC3) (Process sampling)

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Sample via a closed loop or other system to avoid exposure	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.7 Contributing scenario controlling worker exposure (PROC15) (Laboratory activities)

PROC15	Use as laboratory reagent

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 within a fume cupboard or implement suitable equivalent methods to minimise exposure	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

2.1.8 Contributing scenario controlling worker exposure (PROC8b) (Bulk transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Clear transfer lines prior to de-coupling	
	Transfer via enclosed lines	
	Ensure material transfers are under containment or extract ventilation	

2.1.9 Contributing scenario controlling worker exposure (PROC5) (Mixing operations (open systems))

PROC5	Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.10 Contributing scenario controlling worker exposure (PROC8a) (Manual;Transfer from/pouring from containers)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level	Consider technical advances and process upgrades	

(source) to prevent release	(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 scenario; clear up spills immediately and dispose of waste 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	
	Use drum pumps or carefully pour from container	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 4 hours	
Organisational measures to prevent /limit releases, dispersion and exposure	Avoid spillage when withdrawing pump	

2.1.11 Contributing scenario controlling worker exposure (PROC8b) (Drum/batch transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Use drum pumps or carefully pour from container	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

2.1.12 Contributing scenario controlling worker exposure (PROC14) (Production of preparations or articles by tabletting, compression, extrusion, pelettisation)

PROC14	Production of preparations or articles by tabletting, compression, extrusion, pelletisation	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Limit the substance content in the mixture to 1 %	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.13 Contributing scenario controlling worker exposure (PROC9) (Drum and small package filling)

PROC9	Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Clear transfer lines prior to de-coupling	
	Transfer via enclosed lines	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

2.1.14 Contributing scenario controlling worker exposure (PROC8a) (Equipment cleaning and maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down and flush system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Apply vessel entry procedures including use of supplied compressed air	
	Clear spills immediately	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.15 Contributing scenario controlling worker exposure (PROC2) (Storage)

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)
Operational conditions	

Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Ensure material transfers are under containment or extract ventilation	
	Store substance within a closed system	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.2 Contributing scenario controlling environmental exposure (ERC2, ESVOC SPERC 2.2.v1)

ERC2	Formulation of preparations
ESVOC SPERC 2.2.v1	Formulation & packing of preparations and mixtures: Industrial (SU10)

Product characteristics		
Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable	
Operational conditions		
Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	25000
	Fraction of Regional tonnage used locally:	1
	Annual site tonnage (tons/year):	25000
	Maximum daily site tonnage (kg/day):	83000
Frequency and duration of use	Continuous release	
	Emission days (days/year):	300
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.0001
	Release fraction to wastewater from process (initial release prior to RMM):	0.00001
	Release fraction to soil from process (initial release prior to RMM):	0.0001
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation)	
	If discharging to domestic sewage treatment plant, no onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Release fraction to air from process (after typical onsite RMMs consistent with EU Solvent Emissions Directive requirements):	

	Treat air emission to provide a typical removal efficiency of (%):	0
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils	
	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	2700000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	2000
Conditions and measures related to external treatment of waste for disposal	During manufacturing no waste of the substance is generated	
Conditions and measures related to external recovery of waste	During manufacturing no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects						
DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 (General exposures (closed systems))	0.01	0.01	0.34	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (General exposures (closed systems))	0.7	0.7	0.14	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (General exposures (closed systems))	0.7	0.7	0.03	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC4 (General exposures (open systems))	0.7	0.7	0.69	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (Batch processes at elevated temperatures)	0.7	0.7	0.03	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (Process sampling)	0.7	0.7	0.03	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC15 (Laboratory activities)	0.15	0.15	0.03	0	0.15	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Bulk transfers)	0.45	0.45	0.69	0	0.45	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC5 (Mixing operations (open systems))	0.75	0.75	0.07	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

PROC8a (Manual,Transfer from/pouring from containers)	0.9	0.9	0.14	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Drum/batch transfers)	0.9	0.9	0.69	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC14 (Production of preparations or articles by tabletting, compression, extrusion, pelettisation)	0.75	0.75	0.34	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC9 (Drum and small package filling)	0.3	0.3	0.69	0	0.3	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Equipment cleaning and maintenance)	0.75	0.75	1.37	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Storage)	0.9	0.9	1.37	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 5

Use of C4, high 1.3-butadiene (>=0.1%) streams in coatings - Industrial

ES Ref.: ES 5 ES Type: Worker	

Use descriptors	SU3 PROC1, PROC2, PROC3, PROC4, PROC5, PROC7, PROC8a, PROC8b, PROC9, PROC10, PROC13, PROC14, PROC15 ERC4 ESVOC SPERC 4.3a.v1
Processes, tasks, activities covered	Covers the use in coatings (paints, inks, adhesives, etc) within closed or contained systems including incidental exposures during use (including materials receipt, storage, preparation and transfer from bulk and semi-bulk, application activities and film formation) and equipment cleaning, maintenance and associated laboratory activities Industrial use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC1) (General exposures (closed systems))

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	

2.1.2 Contributing scenario controlling worker exposure (PROC2) (General exposures (closed systems))

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	

Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.3 Contributing scenario controlling worker exposure (PROC2) (Film formation - force drying (50-100°C). stoving (>100°C). UV/EB radiation curing)

PROC2	Use in closed, continuous process with occasional controlled exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.4 Contributing scenario controlling worker exposure (PROC3) (Mixing operations (closed systems))

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.5 Contributing scenario controlling worker exposure (PROC4) (Film formation - air drying)

PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.6 Contributing scenario controlling worker exposure (PROC5) (Preparation of material for application)

PROC5	Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.7 Contributing scenario controlling worker exposure (PROC7) (Spraying (automatic/robotic))

PROC7	Industrial spraying

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	

Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Carry out in a vented booth provided with laminar airflow	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.8 Contributing scenario controlling worker exposure (PROC7) (Manual)

PROC7	Industrial spraying
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Minimise exposure by extracted full enclosure for the operation or equipment	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a full face respirator conforming to EN140 with Type A filter or better	

2.1.9 Contributing scenario controlling worker exposure (PROC8a) (Material transfers)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Clear transfer lines prior to de-coupling	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Ensure material transfers are under containment or extract ventilation	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.10 Contributing scenario controlling worker exposure (PROC8b) (Material transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Clear transfer lines prior to de-coupling	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.11 Contributing scenario controlling worker exposure (PROC10) (Roller, spreader, flow application)

PROC10	Roller application or brushing

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.12 Contributing scenario controlling worker exposure (PROC13) (Dipping, immersion and pouring)

PROC13	Treatment of articles by dipping and pouring

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers	Assumes use at not more than 20°C above ambient	

exposure	temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.13 Contributing scenario controlling worker exposure (PROC15) (Laboratory activities)

PROC15	Use as laboratory reagent
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 within a fume cupboard or implement suitable equivalent methods to minimise exposure	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.14 Contributing scenario controlling worker exposure (PROC9) (Material transfers)

PROC9	Transfer of substance or preparation into small containers (dedicated filling line, including weighing)	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Ensure material transfers are under containment or extract ventilation	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.15 Contributing scenario controlling worker exposure (PROC14) (Production of preparations or articles by tabletting, compression, extrusion, pelettisation)

PROC14	Production of preparations or articles by tabletting, compression, extrusion, pelletisation	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Use ventilation to extract vapours from freshly coated articles/objects and surfaces	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.16 Contributing scenario controlling worker exposure (PROC8a) (Equipment cleaning and maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Clear spills immediately	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.17 Contributing scenario controlling worker exposure (PROC2) (Storage)

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	

Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Store substance within a closed system	

2.2 Contributing scenario controlling environmental exposure (ERC4, ESVOC SPERC 4.3a.v1)

ERC4	Industrial use of processing aids in processes and products, not becoming part of articles
ESVOC SPERC 4.3a.v1	Uses in Coatings: Industrial (SU3)

Product characteristics		
Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable	
Operational conditions		
Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	100
	Fraction of Regional tonnage used locally:	1
	Annual site tonnage (tons/year):	100
	Maximum daily site tonnage (kg/day):	5000
Frequency and duration of use	Continuous release	
	Emission days (days/year):	20
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.098
	Release fraction to wastewater from process (initial release prior to RMM):	0.0007
	Release fraction to soil from process (initial release prior to RMM):	0
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation)	
	If discharging to domestic sewage treatment plant, no onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Treat air emission to provide a typical removal efficiency of (%):	90
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from	Do not apply industrial sludge to natural soils	

site	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	44000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	2000
Conditions and measures related to external treatment of waste for disposal	This substance is consumed during use and no waste of the substance is generated	
Conditions and measures related to external recovery of waste	This substance is consumed during use and no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects						
DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 (General exposures (closed systems))	0.01	0.01	0.34	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (General exposures (closed systems))	0.9	0.9	0.14	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Film formation - force drying (50-100°C). stoving (>100°C). UV/EB radiation curing)	0.9	0.9	0.14	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (Mixing operations (closed systems))	0.6	0.6	0.03	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC4 (Film formation - air drying)	0.6	0.6	0.69	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC5 (Preparation of material for application)	0.75	0.75	0.07	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC7 (Spraying (automatic/robotic))	0.5	0.5	2.14	0.01	0.51	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC7 (Manual)	0.75	0.75	2.14	0.01	0.76	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Material transfers)	0.9	0.9	0.14	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Material transfers)	0.9	0.9	0.69	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

PROC10 (Roller, spreader, flow application)	0.75	0.75	1.37	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC13 (Dipping, immersion and pouring)	0.75	0.75	0.69	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC15 (Laboratory activities)	0.7	0.7	0.03	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC9 (Material transfers)	0.6	0.6	0.69	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC14 (Production of preparations or articles by tabletting, compression, extrusion, pelettisation)	0.75	0.75	0.34	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Equipment cleaning and maintenance)	0.7	0.7	0.69	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Storage)	0.5	0.5	1.37	0	0.5	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 6

Use of C4, high 1.3-butadiene (>=0.1%) streams in fuels - Industrial

ES Ref.: ES 6 ES Type: Consumer	

Use descriptors	SU3 PROC1, PROC2, PROC3, PROC8a, PROC8b, PROC16 ERC7 ESVOC SPERC 7.12a.v1
Processes, tasks, activities covered	Covers the use as a fuel (or fuel additive), and includes activities associated with its transfer, use, equipment maintenance and handling of waste Industrial use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC4) (Bulk transfers)

PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Transfer via enclosed lines	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Ensure material transfers are under containment or extract ventilation	

2.1.2 Contributing scenario controlling worker exposure (PROC8b) (Drum/batch transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	

Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Use drum pumps	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

2.1.3 Contributing scenario controlling worker exposure (PROC1) (General exposures (closed systems))

PROC1	Use in closed process, no likelihood of exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	

2.1.4 Contributing scenario controlling worker exposure (PROC2) (General exposures (closed systems))

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.5 Contributing scenario controlling worker exposure (PROC3) (General exposures (closed systems))

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.6 Contributing scenario controlling worker exposure (PROC16) (General exposures (open systems);(closed systems))

PROC16	Using material as fuel sources, limited exposure to unburned product to be expected

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a predominantly closed system provided with extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.7 Contributing scenario controlling worker exposure (PROC3) (General exposures (open systems);(closed systems))

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers	Assumes use at not more than 20°C above ambient	

exposure	temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a predominantly closed system provided with extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of general or controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.8 Contributing scenario controlling worker exposure (PROC8a) (Equipment maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down and flush system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	

Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour)	
	Clear spills immediately	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a full face respirator conforming to EN140 with Type A filter or better	

2.1.9 Contributing scenario controlling worker exposure (PROC1) (Storage)

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Store substance within a closed system	

2.1.10 Contributing scenario controlling worker exposure (PROC2) (Storage)

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Provide extract ventilation to points where emissions occur	
	Store substance within a closed system	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.11 Contributing scenario controlling worker exposure (PROC8a) (Disposal of wastes)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Transfer via enclosed lines	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Clear spills immediately	

2.2 Contributing scenario controlling environmental exposure (ERC7, ESVOC SPERC 7.12a.v1)

ERC7	Industrial use of substances in closed systems
ESVOC SPERC 7.12a.v1	Use as a fuel: Industrial (SU3)

Product characteristics		
Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable	
Operational conditions		
Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	10000

	Fraction of Regional tonnage used locally:	1
	Annual site tonnage (tons/year):	10000
	Maximum daily site tonnage (kg/day):	33000
Frequency and duration of use	Continuous release	
	Emission days (days/year):	300
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.0025
	Release fraction to wastewater from process (initial release prior to RMM):	0.00001
	Release fraction to soil from process (initial release prior to RMM):	0
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation)	
	If discharging to domestic sewage treatment plant, no onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Treat air emission to provide a typical removal efficiency of (%):	95
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils	
	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	120000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	2000
Conditions and measures related to external treatment of waste for disposal	This substance is consumed during use and no waste of the substance is generated	
Conditions and measures related to external recovery of waste	This substance is consumed during use and no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects						
DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC4 (Bulk transfers)	0.6	0.6	0.69	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Drum/batch transfers)	0.9	0.9	0.69	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC1 (General exposures (closed systems))	0.01	0.01	0.03	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

PROC2 (General exposures (closed systems))	0.9	0.9	1.37	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (General exposures (closed systems))	0.6	0.6	0.34	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC16 (General exposures (open systems),(closed systems))	0.35	0.35	0.34	0	0.35	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (General exposures (open systems),(closed systems))	0.6	0.6	0.34	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Equipment maintenance)	0.88	0.88	2.74	0.01	0.89	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC1 (Storage)	0.01	0.01	0.03	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Storage)	0.9	0.9	1.37	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Disposal of wastes)	0.7	0.7	1.37	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 7

Use of C4, high 1.3-butadiene (>=0.1%) streams as a fuel - Professional

ES Ref.: ES 7 ES Type: Worker	

Use descriptors	SU22 PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC16 ERC9a, ERC9b ESVOC SPERC 9.12b.v1
Processes, tasks, activities covered	Covers the use as a fuel (or fuel additive), and includes activities associated with its transfer, use, equipment maintenance and handling of waste Professional use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC4) (Bulk transfers)

PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Clear transfer lines prior to de-coupling	
	Transfer via enclosed lines	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) OR	
	Ensure operation is undertaken outdoors	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.2 Contributing scenario controlling worker exposure (PROC8b) (Drum/batch transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)
Operational conditions	

Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Use drum pumps	
	Transfer via enclosed lines	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) OR	
	Ensure operation is undertaken outdoors	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.3 Contributing scenario controlling worker exposure (PROC8b) (Dipping, immersion and pouring)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Transfer via enclosed lines	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.4 Contributing scenario controlling worker exposure (PROC1) (General exposures (closed systems))

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	

2.1.5 Contributing scenario controlling worker exposure (PROC2) (General exposures (closed systems))

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) OR	
	Ensure operation is undertaken outdoors	
	Provide extract ventilation to points where emissions occur	

2.1.6 Contributing scenario controlling worker exposure (PROC3) (General exposures (closed systems);(open systems))

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) OR	
	Ensure operation is undertaken outdoors	
	Provide extract ventilation to points where emissions occur	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.7 Contributing scenario controlling worker exposure (PROC16) (General exposures (open systems);(closed systems))

PROC16	Using material as fuel sources, limited exposure to unburned product to be expected

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	

Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a predominantly closed system provided with extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour) OR	
	Ensure operation is undertaken outdoors	
	Provide extract ventilation to points where emissions occur	

2.1.8 Contributing scenario controlling worker exposure (PROC8a) (Equipment cleaning and maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	

	Drain down and flush system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Clear spills immediately	
	Avoid carrying out activities involving exposure for more than 4 hours	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.9 Contributing scenario controlling worker exposure (PROC8a) (Vessel and container cleaning)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down and flush system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Clear spills immediately	
	Avoid carrying out activities involving exposure for more than 4 hours	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better	

2.1.10 Contributing scenario controlling worker exposure (PROC1) (Storage)

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	

Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Store substance within a closed system	
	Sample via a closed loop or other system to avoid exposure	

2.2 Contributing scenario controlling environmental exposure (ERC9a, ERC9b, ESVOC SPERC 9.12b.v1)

ERC9a	Wide dispersive indoor use of substances in closed systems
ERC9b	Wide dispersive outdoor use of substances in closed systems
ESVOC SPERC 9.12b.v1	Use as a fuel: Professional (SU22)

Product characteristics	
Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable

Operational conditions		
Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	7500
	Fraction of Regional tonnage used locally:	0.0005
	Annual site tonnage (tons/year):	3.75
	Maximum daily site tonnage (kg/day):	10
Frequency and duration of use	Continuous release	
	Emission days (days/year):	365
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.01
	Release fraction to wastewater from process (initial release prior to RMM):	0.00001
	Release fraction to soil from process (initial release prior to RMM):	0.00001
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation)	
	Soil emission controls are not applicable as there is no direct release to soil	
	Negligible air emissions as process operates in a contained system	
	Treat air emission to provide a typical removal efficiency of (%):	0
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Prevent environmental discharge consistent with regulatory requirements	
Conditions and measures related to municipal sewage	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7

treatment plant	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	30000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	2000
Conditions and measures related to external treatment of waste for disposal	This substance is consumed during use and no waste of the substance is generated	
Conditions and measures related to external recovery of waste	This substance is consumed during use and no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects						
DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC4 (Bulk transfers)	0.7	0.7	0.69	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Drum/batch transfers)	0.7	0.7	0.34	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Dipping, immersion and pouring)	0.35	0.35	0.34	0	0.35	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC1 (General exposures (closed systems))	0.1	0.1	0.34	0	0.1	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (General exposures (closed systems))	0.7	0.7	0.14	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (General exposures (closed systems),(open systems))	0.84	0.84	0.03	0	0.84	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC16 (General exposures (open systems),(closed systems))	0.7	0.7	0.34	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Equipment cleaning and maintenance)	0.7	0.7	13.71	0.04	0.74	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Vessel and container cleaning)	0.7	0.7	13.71	0.04	0.74	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC1 (Storage)	0.1	0.1	0.34	0	0.1	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 8

Use of C4, high 1.3-butadiene (>=0.1%) streams in polymer production – Industrial

ES Ref.: ES 8 ES Type: Worker	

Use descriptors	SU3, SU10 PROC1, PROC2, PROC3, PROC4, PROC5, PROC6, PROC8a, PROC8b, PROC14, PROC21 ERC4, ERC6c ESVOC SPERC 4.20.v1
Processes, tasks, activities covered	Manufacture of polymers from monomers in continuous and batch processes. Including production, re-cycling and recovery, degassing, discharging, reactor maintenance and immediate polymer product formation (i.e. compounding, pelletisation, product off-gassing) Industrial use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC1) (General exposures (closed systems))

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	

2.1.2 Contributing scenario controlling worker exposure (PROC8b) (Bulk transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers	Assumes use at not more than 20°C above ambient temperature, unless stated differently	

exposure	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.3 Contributing scenario controlling worker exposure (PROC2) (polymerization (Bulk and batch))

PROC2	Use in closed, continuous process with occasional controlled exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Ensure operation is undertaken outdoors	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.4 Contributing scenario controlling worker exposure (PROC3) (polymerization (Bulk and batch))

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
Technical conditions and measures to control dispersion from source towards the worker	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	

2.1.5 Contributing scenario controlling worker exposure (PROC3) (Finishing operations)

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
Technical conditions and measures to control dispersion from source towards the worker	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	

2.1.6 Contributing scenario controlling worker exposure (PROC4) (Intermediate polymer storage)

PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Store substance within a closed system	

2.1.7 Contributing scenario controlling worker exposure (PROC3) (Additivation and stabilisation)

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	

2.1.8 Contributing scenario controlling worker exposure (PROC5) (Mixing operations (closed systems))

PROC5	Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear suitable gloves tested to EN374	

2.1.9 Contributing scenario controlling worker exposure (PROC6) (Pelletising)

PROC6	Calendering operations

Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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 substance within a closed system	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
Conditions and measures related to personal protection, hygiene and health evaluation	Wear suitable gloves tested to EN374	

2.1.10 Contributing scenario controlling worker exposure (PROC14) (Pelletising)

PROC14	Production of preparations or articles by tabletting, compression, extrusion, pelletisation
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Limit the substance content in the mixture to 1 %	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

2.1.11 Contributing scenario controlling worker exposure (PROC8b) (Pelletisation and pellet screening)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Limit the substance content in the product to 5 %	
	Ensure material transfers are under containment or extract ventilation	

2.1.12 Contributing scenario controlling worker exposure (PROC3) (Bulk transfers)

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	

2.1.13 Contributing scenario controlling worker exposure (PROC8b) (Transport)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.14 Contributing scenario controlling worker exposure (PROC8a) (Equipment maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	

Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Clear spills immediately	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.15 Contributing scenario controlling worker exposure (PROC2) (Storage)

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control	Provide extract ventilation to points where emissions occur	

dispersion from source towards the worker	Store substance within a closed system	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.2 Contributing scenario controlling environmental exposure (ERC4, ERC6c, ESVOC SPERC 4.20.v1)

ERC4	Industrial use of processing aids in processes and products, not becoming part of articles
ERC6c	Industrial use of monomers for manufacture of thermo-plastics
ESVOC SPERC 4.20.v1	Polymer production: Industrial (SU10)

Product characteristics

Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable

Operational conditions

Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	5000
	Fraction of Regional tonnage used locally:	1
	Annual site tonnage (tons/year):	5000
	Maximum daily site tonnage (kg/day):	50000
Frequency and duration of use	Continuous release	
	Emission days (days/year):	100
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.002
	Release fraction to wastewater from process (initial release prior to RMM):	0.0003
	Release fraction to soil from process (initial release prior to RMM):	0.0001

Risk management measures

Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by freshwater sediment	
	If discharging to domestic sewage treatment plant, no onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Treat air emission to provide a typical removal efficiency of (%):	80
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils	
	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	400000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	2000
Conditions and measures related to external treatment of waste for disposal	This substance is consumed during use and no waste of the substance is generated	
Conditions and measures related to external recovery of waste	This substance is consumed during use and no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects

DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 (General exposures (closed systems))	0.01	0.01	0.34	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Bulk transfers)	0.81	0.81	0.69	0	0.81	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (polymerization (Bulk and batch))	0.7	0.7	0.14	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (polymerization (Bulk and batch))	0.5	0.5	0.34	0	0.5	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (Finishing operations)	0.5	0.5	0.03	0	0.5	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC4 (Intermediate polymer storage)	0.3	0.3	0.69	0	0.3	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (Additivation and stabilisation)	0.5	0.5	0.03	0	0.5	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC5 (Mixing operations (closed systems))	0.75	0.75	1.37	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC6 (Pelletising)	0.75	0.75	1.37	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC14 (Pelletising)	0.75	0.75	0.34	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Pelletisation and pellet screening)	0.9	0.9	0.69	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (Bulk transfers)	0.5	0.5	0.34	0	0.5	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Transport)	0.9	0.9	0.69	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Equipment maintenance)	0.5	0.5	1.37	0	0.5	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Storage)	0.7	0.7	1.37	0	0.7	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 9

Use of C4, high 1.3-butadiene (>=0.1%) streams in polymer processing – Industrial

ES Ref.: ES 9 ES Type: Worker	

Use descriptors	SU3, SU10 PROC1, PROC2, PROC3, PROC4, PROC5, PROC6, PROC8a, PROC8b, PROC9, PROC13, PROC14, PROC21 ERC4 ESVOC SPERC 4.21a.v1
Processes, tasks, activities covered	Processing of formulated polymers within closed or contained systems, ncluding incidental exposures during material transfers, additives handling (e.g. pigments, stabilisers, fillers, plasticisers, etc.), moulding, curing and forming activities, material re-works, storage and associated maintenance Industrial use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC1) (Bulk transfers;(closed systems))

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Ensure material transfers are under containment or extract ventilation	

2.1.2 Contributing scenario controlling worker exposure (PROC2) (Bulk transfers;(closed systems))

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	

Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.3 Contributing scenario controlling worker exposure (PROC8b) (Bulk transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Use drum pumps	
	Ensure material transfers are under containment or extract ventilation	

2.1.4 Contributing scenario controlling worker exposure (PROC1) (Bulk weighing)

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	No specific measures identified	

2.1.5 Contributing scenario controlling worker exposure (PROC2) (Bulk weighing)

PROC2	Use in closed, continuous process with occasional controlled exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Provide extract ventilation to points where emissions occur	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.6 Contributing scenario controlling worker exposure (PROC9) (Small scale weighing)

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

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Use drum pumps	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.7 Contributing scenario controlling worker exposure (PROC3) (Additive premixing)

PROC3	Use in closed batch process (synthesis or formulation)

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Formulate in enclosed or ventilated mixing vessels	
Technical conditions and measures to control dispersion from source towards the worker	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	
	Ensure material transfers are under containment or extract ventilation	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.1.8 Contributing scenario controlling worker exposure (PROC4) (Additive premixing)

PROC4	Use in batch and other process (synthesis) where opportunity for exposure arises

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.9 Contributing scenario controlling worker exposure (PROC5) (Additive premixing)

PROC5	Mixing or blending in batch processes for formulation of preparations and articles (multistage and/or significant contact)

Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Ensure material transfers are under containment or extract ventilation	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Minimise exposure by extracted full enclosure for the operation or equipment	

2.1.10 Contributing scenario controlling worker exposure (PROC8b) (Bulk transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	

Technical conditions and measures to control dispersion from source towards the worker	Provide enhanced general ventilation by mechanical means	
	Ensure material transfers are under containment or extract ventilation	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.11 Contributing scenario controlling worker exposure (PROC9) (Bulk transfers)

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

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Transfer via enclosed lines	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Ensure material transfers are under containment or extract ventilation	

2.1.12 Contributing scenario controlling worker exposure (PROC6) (Calendering (including Banburys))

PROC6	Calendering operations

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Restrict area of openings to equipment	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	

2.1.13 Contributing scenario controlling worker exposure (PROC13) (Production of articles by dipping and pouring)

PROC13	Treatment of articles by dipping and pouring

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Limit the substance content in the mixture to 1 %	
Technical conditions and measures to control dispersion from source towards the worker	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

2.1.14 Contributing scenario controlling worker exposure (PROC14) (Extrusion and masterbatching)

PROC14	Production of preparations or articles by tabletting, compression, extrusion, pelletisation

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated	

	differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Limit the substance content in the mixture to 1 %	
Technical conditions and measures to control dispersion from source towards the worker	Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

2.1.15 Contributing scenario controlling worker exposure (PROC14) (Injection moulding of articles)

PROC14	Production of preparations or articles by tabletting, compression, extrusion, pelletisation
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Restrict area of openings to equipment	
Technical conditions and measures to control	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

dispersion from source towards the worker	Provide extract ventilation to material transfer points and other openings	

2.1.16 Contributing scenario controlling worker exposure (PROC21) (Finishing operations)

PROC21	Low energy manipulation of substances bound in materials and/or articles

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	No specific measures identified	

2.1.17 Contributing scenario controlling worker exposure (PROC8a) (Equipment maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Provide extract ventilation to points where emissions occur	
	Clear spills immediately	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.18 Contributing scenario controlling worker exposure (PROC1) (Storage)

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Provide extract ventilation to points where emissions occur	
	Store substance within a closed system	
	Avoid carrying out activities involving exposure for more than 4 hours	

2.2 Contributing scenario controlling environmental exposure (ERC4, ESVOC SPERC 4.21a.v1)

ERC4	Industrial use of processing aids in processes and products, not becoming part of articles
ESVOC SPERC 4.21a.v1	Polymer production: Industrial (SU10)

Product characteristics		
Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable	
Operational conditions		
Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	100

	Fraction of Regional tonnage used locally:	1
	Annual site tonnage (tons/year):	100
	Maximum daily site tonnage (kg/day):	5000
Frequency and duration of use	Continuous release	
	Emission days (days/year):	20
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.15
	Release fraction to wastewater from process (initial release prior to RMM):	0
	Release fraction to soil from process (initial release prior to RMM):	0.00001
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation)	
	If discharging to domestic sewage treatment plant, no onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Treat air emission to provide a typical removal efficiency of (%):	80
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils	
	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	29000 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	2000
Conditions and measures related to external treatment of waste for disposal	This substance is consumed during use and no waste of the substance is generated	
Conditions and measures related to external recovery of waste	This substance is consumed during use and no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects						
DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 (Bulk transfers,(closed systems))	0.01	0.01	0.34	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Bulk transfers,(closed systems))	0.3	0.3	0.01	0	0.3	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Bulk transfers)	0.9	0.9	0.07	0	0.9	Inhalation.: Used ECETOC TRA model

						Dermal: Used ECETOC TRA model
PROC1 (Bulk weighing)	0.01	0.01	0.34	0	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Bulk weighing)	0.9	0.9	1.37	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC9 (Small scale weighing)	0.8	0.8	0.07	0	0.8	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC3 (Additive premixing)	0.3	0.3	0	0	0.3	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC4 (Additive premixing)	0.6	0.6	0.07	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC5 (Additive premixing)	0.45	0.45	0.07	0	0.45	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Bulk transfers)	0.36	0.36	0.69	0	0.36	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC9 (Bulk transfers)	0.6	0.6	0.07	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC6 (Calendering (including Banburys))	0.75	0.75	1.37	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC13 (Production of articles by dipping and pouring)	0.75	0.75	0.07	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC14 (Extrusion and masterbatching)	0.75	0.75	0.69	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC14 (Injection moulding of articles)	0.75	0.75	0.34	0	0.75	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC21 (Finishing operations)	0	0	2.83	0.01	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Equipment maintenance)	0.15	0.15	1.37	0	0.15	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC1 (Storage)	0.9	0.9	0.14	0	0.9	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)

1. Exposure scenario ES 10

Use of Use of C4, high 1.3-butadiene (>=0.1%) in polymer processing – Professional

ES Ref.: ES 10 ES Type: Worker	

Use descriptors	SU22 PROC1, PROC2, PROC6, PROC8a, PROC8b, PROC14, PROC21 ERC8a, ERC8d ESVOC SPERC 8.21b.v1
Processes, tasks, activities covered	Processing of formulated polymers within closed or contained systems, ncluding incidental exposures during material transfers, additives handling (e.g. pigments, stabilisers, fillers, plasticisers, etc.), moulding, curing and forming activities, material re-works, storage and associated maintenance Professional use

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure (PROC1) (Bulk transfers;(closed systems))

PROC1	Use in closed process, no likelihood of exposure	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Ensure material transfers are under containment or extract ventilation	

2.1.2 Contributing scenario controlling worker exposure (PROC2) (Bulk transfers;(closed systems))

PROC2	Use in closed, continuous process with occasional controlled exposure	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	

Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.3 Contributing scenario controlling worker exposure (PROC8b) (Material transfers)

PROC8b	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Use drum pumps	
	Ensure material transfers are under containment or extract ventilation	
Technical conditions and measures to control	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

dispersion from source towards the worker	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.4 Contributing scenario controlling worker exposure (PROC6) (Injection moulding of articles)

PROC6	Calendering operations

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Restrict area of openings to equipment	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.5 Contributing scenario controlling worker exposure (PROC21) (Rework of articles)

PROC21	Low energy manipulation of substances bound in materials and/or articles

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	No specific measures identified	

2.1.6 Contributing scenario controlling worker exposure (PROC8a) (Equipment maintenance)

PROC8a	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non dedicated facilities

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
	Drain down and flush system prior to equipment break-in or maintenance	
	Retain drain downs in sealed storage pending disposal or for subsequent recycle	
Technical conditions and measures to control dispersion from source towards the worker	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	
	Ensure material transfers are under containment or extract ventilation	
	Clear spills immediately	
	Avoid carrying out activities involving exposure for more than 1 hour	

2.1.7 Contributing scenario controlling worker exposure (PROC1) (Storage)

PROC1	Use in closed process, no likelihood of exposure

Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa at STP	
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)	
Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated	

	differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Store substance within a closed system	

2.1.8 Contributing scenario controlling worker exposure (PROC2) (Storage)

PROC2	Use in closed, continuous process with occasional controlled exposure
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa at STP
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently)

Operational conditions		
Amounts used	Not applicable	
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently)	
Human factors not influenced by risk management	Not applicable	
Other given operational conditions affecting workers exposure	Assumes use at not more than 20°C above ambient temperature, unless stated differently	
	Assumes a good basic standard of occupational hygiene is implemented	
Risk management measures		
Technical conditions and measures at process level (source) to prevent release	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 scenario; clear up spills immediately and dispose of waste 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	
Technical conditions and measures to control dispersion from source towards the worker	Provide extract ventilation to points where emissions occur	
	Store substance within a closed system	
	Provide a good standard of controlled ventilation (10 to 15 air changes per hour)	

2.2 Contributing scenario controlling environmental exposure (ERC8a, ERC8d, ESVOC SPERC 8.21b.v1)

ERC8a	Wide dispersive indoor use of processing aids in open systems
ERC8d	Wide dispersive outdoor use of processing aids in open systems
ESVOC SPERC 8.21b.v1	Polymer production: Professional (SU22)

Product characteristics	
Physical form of product	Substance is complex UVCB, Predominantly hydrophobic, Not readily biodegradable

Operational conditions		
Amounts used	Fraction of EU tonnage used in region:	0.1
	Regional use tonnage (tons/year):	100
	Fraction of Regional tonnage used locally:	0.0005
	Annual site tonnage (tons/year):	0.05
	Maximum daily site tonnage (kg/day):	0.14
Frequency and duration of use	Continuous release	
	Emission days (days/year):	365
Environmental factors not influenced by risk management	Local freshwater dilution factor:	10
	Local marine water dilution factor:	100
Other given operational conditions affecting environmental exposure	Release fraction to air from process (initial release prior to RMM):	0.98
	Release fraction to wastewater from process (initial release prior to RMM):	0.01
	Release fraction to soil from process (initial release prior to RMM):	0.01

Risk management measures		
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used	
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	Risk from environmental exposure is driven by humans via indirect exposure (primarily inhalation)	
	If discharging to domestic sewage treatment plant, no onsite wastewater treatment required	
	Prevent discharge of undissolved substance to or recover from onsite wastewater	
	Treat air emission to provide a typical removal efficiency of (%):	0
	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of ... [3] (%):	0
Organisational measures to prevent/limit release from site	Do not apply industrial sludge to natural soils	
	Sludge should be incinerated, contained or reclaimed	
Conditions and measures related to municipal sewage treatment plant	Estimated substance removal from wastewater via domestic sewage treatment (%):	96.7
	Total efficiency of removal from wastewater after onsite and offsite (domestic treatment plant) RMMs (%):	96.7
	Maximum allowable site tonnage (MSafe) (kg/d):	400 (based on domestic sewage treatment release)
	Assumed domestic sewage treatment plant flow (m3/d):	2000
Conditions and measures related to external treatment of waste for disposal	This substance is consumed during use and no waste of the substance is generated	
Conditions and measures related to external recovery of waste	This substance is consumed during use and no waste of the substance is generated	

3. Exposure estimation and reference to its source

3.1. Health

Information for contributing exposure scenario	
2.1	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted DNELs and the resulting risk characterisation ratios are expected to be less than 1

Long-term - systemic effects						
DNEL	Inhalation.: 2.21 mg/m³/day Dermal:					
Contributing scenario	inhalation exposure	RCR	Dermal exposure	RCR	Sum	Assessment method

	mg/m³		mg/kg bodyweight/day		RCR	
PROC1 (Bulk transfers,(closed systems))	0.1	0.1	0.34	0	0.1	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Bulk transfers,(closed systems))	0.6	0.6	0.01	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8b (Material transfers)	0.3	0.3	0.69	0	0.3	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC6 (Injection moulding of articles)	0.6	0.6	1.37	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC21 (Rework of articles)	0	0	2.83	0.01	0.01	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC8a (Equipment maintenance)	0.6	0.6	0.14	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC1 (Storage)	0.1	0.1	0.34	0	0.1	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model
PROC2 (Storage)	0.6	0.6	1.37	0	0.6	Inhalation.: Used ECETOC TRA model Dermal: Used ECETOC TRA model

3.2. Environment

Information for contributing exposure scenario	
2.2	The Hydrocarbon Block Method has been used to calculate environmental exposure with the Petrorisk model

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the ES

4.1. Health

Guidance - Health	Confirm that RMMs and OCs are as described or of equivalent efficiency

4.2. Environment

Guidance - Environment	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)