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

1.1. Product identifier

Product form	:	Substance
Trade name	:	1,3-BUTADIENE
Chemical name	:	Buta-1,3-diene
IUPAC name	:	1,3-butadiene
EC index no	:	601-013-00-X
EC no	:	203-450-8
CAS No.	:	106-99-0
REACH registration No.	:	01-2119471988-16
Formula	:	C4H6
Synonyms	:	Butadiene, biethylene, bivinyl, divinyl, erythrene, vinylethylene
Product group	:	Trade product

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

1.2.1. Relevant identified uses

Use of the substance/preparation	:	Manufacture of substances Distribution Intermediate Rubber production and processing

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 UNIB1 -BA
Rua Eteno, 1561 - Polo Petroquimico de Camacari - Bahia/BA
CEP: 42810-000 - Brazil

BRASKEM S/A UNIB2-RS
BR 386-Rodovia Tabai/Canos - km 419 - Triunfo/RS
CEP: 95853-000 - Brazil

BRASKEMS.A. UNIB 3 SP
Av. Presidente Costa e Silva, 1178 - Capuava
CEP: 09270-001 – Santo André – SP – Brasil

productsafety@braskem.com

1.4. Emergency telephone number

Emergency number	:	+31 10 205 2945 (business hours)

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
Muta. 1B	H340
Carc. 1A	H350
Liquefied gas	H280

Full text of H-phrases: see section 16

Adverse physicochemical, human health and environmental effects

No additional information available

2.2. Label elements

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

Hazard pictograms (CLP) :

GHS02 GHS04 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 (inhalation)
H350 - May cause cancer (inhalation)

Precautionary statements (CLP) : P202 - Do not handle until all safety precautions have been read and understood
P210 - Keep away from heat, sparks, open flames, hot surfaces. - No smoking.
P281 - Use personal protective equipment as required
P377 - Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381 - In case of leaking gas fire, eliminate all ignition sources if safe to do so.
P410+P403 - Protect from sunlight. Store in a well-ventilated place

2.3. Other hazards

No additional information available

SECTION 3: Composition/information on ingredients

3.1. Substances

Name : 1,3-BUTADIENE

CAS No. : 106-99-0

EC no : 203-450-8

EC index no : 601-013-00-X

Name	Product identifier	%	Classification according to Regulation (EC) No. 1272/2008 [CLP]
Butadiene 1,3	(CAS No.) 106-99-0 (EC no) 203-450-8 (EC index no) 601-013-00-X	>99,5	Flam. Gas 1, H220 Carc. 1A, H350 Muta. 1B, H340 Press. Gas

Full text of R-, H- and EUH-phrases: see section 16

3.2. Mixtures

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. Immediately get medical attention.

First-aid measures after skin contact : Remove contaminated clothing and shoes. Rinse immediately with plenty of water (for at least 15 minutes). Seek medical advice.

First-aid measures after eye contact : Rinse immediately and plentifully with water, also under the eyelids, for at least 20 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Seek medical advice.

First-aid measures after ingestion : not applicable.

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

Symptoms/injuries : Symptoms may include dizziness, headache, nausea and loss of co-ordination. Excessive amounts of magnesium may cause central nervous system depression, respiratory paralysis, and cardiac arrest.

Symptoms/injuries after inhalation : May cause irritation to the respiratory tract. irritation of mucous membranes. Asphyxiant in high concentrations. Excessive concentrations may cause nervous system depression, headache, and weakness leading to unconsciousness.

Symptoms/injuries after skin contact : Causes skin irritation.

Symptoms/injuries after eye contact : Causes serious eye irritation.

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: : carbon dioxide (CO2), dry chemical powder, foam. Water.

Unsuitable extinguishing media : None known.

5.2. Special hazards arising from the substance or mixture

Fire hazard : Highly flammable. Risk of ignition at all temperatures. Risk of rapid formation of explosive mixtures when combined with air. On combustion forms: Carbon dioxide. Carbon monoxide.

Explosion hazard : Explosive.

Reactivity : Possibility of polymerization during production, storage and transportation with rapid liberation of heat and pressure. . The reaction may be triggered by high temperatures, rust, or the presence of oxygen and peroxides.

5.3. Advice for firefighters

Firefighting instructions : Cool closed containers exposed to fire with water spray. Keep upwind.

Protective equipment for firefighters : Extra personal protection: complete protective clothing including self-contained breathing apparatus. Refer to section 8.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

6.1.1. For non-emergency personnel

Protective equipment : Wear suitable protective clothing gloves, and eye/face protection. Refer to section 8.

Emergency procedures : Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Evacuate unnecessary personnel.

6.1.2. For emergency responders

Protective equipment : Wear suitable protective clothing, gloves and eye/face protection. Refer to section 8.

Emergency procedures : Eliminate leaks immediately. Eliminate every possible source of ignition. Ventilate affected area. Use ventilation/water spray/fog to disperse vapours.

6.2. Environmental precautions

Avoid discharge to the environment.

6.3. Methods and material for containment and cleaning up

For containment : Ventilate affected area.

Methods for cleaning up : Ventilate affected area.

6.4. Reference to other sections

Refer to sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Use only non-sparking tools. Use grounded electrical/mechanical equipment. Ground/bond container and receiving equipment. Do not transfer under air or oxygen pressure. Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

7.2. Conditions for safe storage, including any incompatibilities

Storage condition(s) : Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Keep stored the least quantity possible. Store in dry, cool, well-ventilated area. Keep the cylinders at vertical position, fixed to the wall or other solid structure. Ensure cylinder valve is closed and not leaking. Do not store in underground level.

Incompatible materials : Air. oxygen. Strong oxidizing agents. Copper. Monel alloy, aluminum tetrahydroborate, vinylacetylene, chrome-aldehyde, boron trifluoride, phenol, concentrated solutions of sodium nitrite(5%), halogen.

Packaging materials : Carbon steel or stainless steel cylinders.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

1,3-BUTADIENE (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

1,3-BUTADIENE (106-99-0)		
Belgium	Remark*	c
Italy - Portugal - USA ACGIH	ACGIH TWA (mg/m³)	4.4 mg/m³
Italy - Portugal - USA ACGIH	ACGIH TWA (ppm)	2 ppm
USA OSHA	OSHA PEL (TWA) (ppm)	1 ppm
USA OSHA	OSHA PEL (STEL) (ppm)	5 ppm
Spain	VLA-ED (mg/m³)	4.5 mg/m³
Spain	VLA-ED (ppm)	2 ppm
Switzerland	VME (mg/m³)	11 mg/m³
Switzerland	VME (ppm)	5 ppm
The Netherlands	MAC TGG 8H (mg/m³)	46.2 mg/m³
United Kingdom	WEL TWA (mg/m³)	22 mg/m³
United Kingdom	WEL TWA (ppm)	10 ppm
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	MK-érték1 mg/m³	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
Norway	Gjennomsnittsverdier (AN) (ppm)	1 ppm
Norway	Merknader (NO)	K
Poland	NDS (mg/m3)	10 mg/m³
Poland	NDSCh (mg/m3)	40 mg/m³
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
Canada (Quebec)	VEMP (mg/m³)	4.4 mg/m³
Canada (Quebec)	VEMP (ppm)	2 ppm

Butadiene 1,3 (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*	c
Italy - Portugal - USA ACGIH	ACGIH TWA (mg/m³)	4.4 mg/m³
Italy - Portugal - USA ACGIH	ACGIH TWA (ppm)	2 ppm
USA OSHA	OSHA PEL (TWA) (ppm)	1 ppm
USA OSHA	OSHA PEL (STEL) (ppm)	5 ppm

Butadiene 1,3 (106-99-0)		
Spain	VLA-ED (mg/m³)	4.5 mg/m³
Spain	VLA-ED (ppm)	2 ppm
Switzerland	VME (mg/m³)	11 mg/m³
Switzerland	VME (ppm)	5 ppm
The Netherlands	MAC TGG 8H (mg/m³)	46.2 mg/m³
United Kingdom	WEL TWA (mg/m³)	22 mg/m³
United Kingdom	WEL TWA (ppm)	10 ppm
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
Norway	Gjennomsnittsverdier (AN) (mg/m3)	2.2 mg/m³
Norway	Gjennomsnittsverdier (AN) (ppm)	1 ppm
Norway	Merknader (NO)	K
Poland	NDS (mg/m3)	10 mg/m³
Poland	NDSCh (mg/m3)	40 mg/m³
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
Canada (Quebec)	VEMP (mg/m³)	4.4 mg/m³
Canada (Quebec)	VEMP (ppm)	2 ppm

1,3-BUTADIENE (106-99-0)	
DNEL/DMEL (Workers)	
Long-term - systemic effects, dermal	324 mg/kg bodyweight/day (reference values)
Long-term - systemic effects, inhalation	1 mg/m³ (reference values)

DNEL : 2.21 mg/m³

PNEC : not applicable

8.2. Exposure controls

Appropriate engineering controls : Provide local exhaust or general room ventilation to minimize vapour concentrations. Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure.

Personal protective equipment : Protective goggles. Protective clothing. Gloves. Self-contained breathing apparatus.

Hand protection : Protective gloves made of PVC.

Eye protection	:	Safety goggles. Contact lenses should not be worn.
Skin and body protection	:	Wear suitable protective clothing.
Respiratory protection	:	Breathing apparatus with high efficiency filter for organic vapours if the concentration is below threshold limit with no oxygen deficiency. Autonomous breathing apparatus if the concentration is above threshold limit or risk of oxygen deficiency.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	:	Gas
Colour	:	colourless.
odour	:	Mildly aromatic.
Odour threshold	:	No data available
pH	:	No data available
Relative evaporation rate (butylacetate=1)	:	No data available
Melting point	:	-108.9 °C
Freezing point	:	No data available
Boiling point	:	-4.41 °C
Flash point	:	-76°C
Self ignition temperature	:	415 - 420 °C
Decomposition temperature	:	No data available
Flammability (solid, gas)	:	Flammable
Vapour pressure	:	2.46 atm (248,9 kPa) at 21°C
Relative vapour density at 20 °C	:	1.87 at 15 °C (air=1)
Relative density	:	0.6452 at 0°C or 0.621 at 20 °C (water=1)
Solubility	:	Water: 735 mg/l. Soluble in ethanol, methanol. Diethyl ether, benzene.
Log Pow	:	No data available
Log Kow	:	No data available
Viscosity, kinematic	:	No data available
Viscosity, dynamic	:	No data available
Explosive properties	:	No data available
Oxidising properties	:	No data available
Explosive limits	:	2 – 11,5 vol %

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

Possibility of polymerization during production, storage and transportation with rapid liberation of heat and pressure. . The reaction may be triggered by high temperatures, rust, or the presence of oxygen and peroxides.

10.2. Chemical stability

This product is stable with an appropriate level of inhibitor, but reactive (unstable) without.

10.3. Possibility of hazardous reactions

capable of strong chemical reaction at high temperatures and pressures, forming explosive polymers or sensetive to shock and heat.

10.4. Conditions to avoid

Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Avoid static electricity discharges.

10.5. Incompatible materials

Air. Oxygen. Strong oxidizing agents. Copper (Cu). Monel alloy, aluminum tetrahydroborate, vinylacetylene, chrome-aldehyde, boron trifluoride, phenol, concentrated solutions of sodium nitrite(5%), halogen.

10.6. Hazardous decomposition products

Carbon monoxide. Carbon dioxide (CO_2).

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Not classified

1,3-BUTADIENE (106-99-0)	
LC50 inhalation rat (mg/l)	285 mg/l/4h

Skin corrosion/irritation : Not classified

Serious eye damage/irritation	:	Not classified
Respiratory or skin sensitisation	:	Not classified
Germ cell mutagenicity	:	May cause genetic defects (inhalation).
Carcinogenicity	:	May cause cancer (inhalation).
Reproductive toxicity	:	Not classified
Specific target organ toxicity (single exposure)	:	Not classified
Specific target organ toxicity (repeated exposure)	:	Not classified

1,3-BUTADIENE (106-99-0)	
NOAEL (inhalation,rat,gas,90 days)	1000 ppmV/6h/day

Aspiration hazard : Not classified

SECTION 12: Ecological information

12.1. Toxicity

1,3-BUTADIENE (106-99-0)	
LC50 fish 1	45 mg/l Data obtained by analogy conclusion, e.g. QSAR.
EC50 other aquatic organisms 1	33 mg/l Data obtained by analogy conclusion, e.g. QSAR.
ErC50 (algae)	33 mg/l Data obtained by analogy conclusion, e.g. QSAR.

12.2. Persistence and degradability

1,3-BUTADIENE (106-99-0)	
Persistence and degradability	not persistent.

12.3. Bioaccumulative potential

1,3-BUTADIENE (106-99-0)	
BCF fish 1	> 2000
Log Pow	1.99

12.4. Mobility in soil

No additional information available

12.5. Results of PBT and vPvB assessment

1,3-BUTADIENE (106-99-0)	
Results of PBT assessment	This substance does not meet the criteria for classification as PBT or vPvB.

12.6. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Regional legislation (waste)	:	Dispose of contents/container to comply with applicable local, national and international regulations. Consult the appropriate authorities about waste disposal.
Waste disposal recommendations	:	Dispose of this material and its container at hazardous or special waste collection point.
Additional information	:	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, STABILIZED
14.3 Class / Division	:	2.1
14.4 Packing group	:	Not applicable
14.5 Environmental hazards	:	Not considered environmentally hazardous based on available data
14.6 Special precautions for user	:	Hazard identification number (Kemler No.): 239

Classification for SEA transport: IMO - IMDG

14.1 UN Number	:	UN1010
14.2 Proper shipping name	:	BUTADIENES, STABILIZED

14.3 Class / Division	:	2.1
14.4 Packing group	:	Not applicable
14.5 Environmental hazards	:	Not considered marine pollutant
14.6 Special precautions for user	:	No supplementary information available
14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IGC Code:		
Product name	:	Butadiene

Classification for AIR transport: IATA - ICAO

14.1 UN Number	:	UN1010
14.2 Proper shipping name	:	Butadienes, stabilized
14.3 Class / Division	:	2.1
14.4 Packing group	:	Not applicable
14.5 Environmental hazards	:	Not considered environmentally hazardous based on available data
14.6 Special precautions for user	:	No supplementary information available

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product therefore it cannot be considered exhaustive. See guidelines of ADR, RID, IMDG and IATA regulations before transporting the product. The transportation organization is responsible for compliance with laws, regulations and rules for the transport 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

Contains no REACH candidate substance

Other regulations, restrictions and prohibition regulations : Compliance with following regulations: Regulation (EC) 1272/2008 as amended. Directive 1999/45/EC as amended. Directive 67/548/EEC as amended. Regulation (EC) 1907/2006 as amended.

15.1.2. National regulations

Regional legislation : Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances) substances.

15.2. Chemical safety assessment

CSA has been established. Exposure scenario is attached.

SECTION 16: Other information

Indication of changes:
Exposure scenarios annexed to the safety data sheet.

Sources of Key data : SDS - Safety Data Sheet.

Abbreviations and acronyms : ACGIH (American Conference of Governement Industrial Hygienists). ASTM - American Society for Testing and Materials . CAS (Chemical Abstracts Service) number. CLP - Classification, Labelling and Packaging. EEC - European Economic Community. EC - European Community. CSR - Chemical Safety Report. GHS - Globally Harmonised System. IARC (International Agency for Research on Cancer). Overland transport (ADR). PVC (Polyvinyl chloride). REACH - Registration, Evaluation, Authorisation and Restriction of Chemicals. SDS - Safety Data Sheet.

Full text of R-, H- and EUH-phrases::

Carc. 1A	Carcinogenicity Category 1A
Flam. Gas 1	Flammable gases Category 1
Liquefied gas	Gases under pressure Liquefied gas
Muta. 1B	flammable liquids Category 1 flammable liquids Category 3
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
R12	Extremely flammable.
R45	May cause cancer.
R46	May cause heritable genetic damage.
F+	Extremely flammable

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.

1. Exposure scenario ES1

Manufacture

ES Ref.: ES1 ES Type: Worker	

Use descriptors	PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15 SU3 ERC1, ERC4
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	Ecetoc TRA model v2

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure

Product characteristics

Physical form of product	Liquid, vapour pressure > 10 kPa at STP.

Operational conditions

Amounts used	Covers percentage substance in the product up to 100 % (unless stated differently).	
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

Organisational measures to prevent /limit releases, dispersion and exposure	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.	General measures (carcinogens)

2.1.2 Contributing scenario controlling worker exposure (PROC1) (Duration: > 4 hours;Without LEV)

PROC1: Use in closed process, no likelihood of exposure

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.	General exposures (closed systems)

2.1.3 Contributing scenario controlling worker exposure (PROC2) (Duration: > 4 hours;With LEV)

PROC2: Use in closed, continuous process with occasional controlled exposure

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	General exposures (closed systems). with sample collection. With occasional controlled exposure.

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a predominantly closed system provided with extract ventilation.,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).	General exposures (closed systems). with sample collection. With occasional controlled exposure.

2.1.4 Contributing scenario controlling worker exposure (PROC2) (Duration: > 4 hours;With LEV)

PROC2: Use in closed, continuous process with occasional controlled exposure

Risk Management Measures		
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 points where emissions occur.,Store substance within a closed system.	Storage. With occasional controlled exposure.

2.1.5 Contributing scenario controlling worker exposure (PROC3) (Duration: > 4 hours;With LEV)

PROC3: Use in closed batch process (synthesis or formulation)

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 15 minutes.	General exposures (closed systems). Use in contained batch processes

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a predominantly closed system provided with extract ventilation.,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).	General exposures (closed systems). Use in contained batch processes

2.1.6 Contributing scenario controlling worker exposure (PROC4) (Duration: > 4 hours;With LEV)

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

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 15 minutes.	General exposures. (open systems). Batch process. with sample collection

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a predominantly closed system provided with extract ventilation.,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).	General exposures (open systems). Batch process. with sample collection

2.1.7 Contributing scenario controlling worker exposure (PROC8a) (Duration: > 4 hours;With LEV)

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

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Drain down and flush system prior to equipment break-in or maintenance.,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.	Equipment cleaning and maintenance
Organisational measures to prevent /limit releases, dispersion and exposure	Retain drain downs in sealed storage pending disposal or for subsequent recycle.	Equipment cleaning and maintenance
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 (PROC8b) (Duration: > 4 hours;With LEV)

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

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 15 minutes.	Process sampling

Risk Management Measures

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).	Process sampling

2.1.9 Contributing scenario controlling worker exposure (PROC8b) (Duration: > 4 hours;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	Bulk transfers. (open systems). With potential for aerosol generation

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use dry break couplings for material transfer.,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).	Bulk transfers. (open systems). With potential for aerosol generation

2.1.10 Contributing scenario controlling worker exposure (PROC8b) (Duration: daily;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	Bulk transfers. (closed systems)

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use dry break couplings for material transfer.	Bulk transfers. (closed systems)

2.1.11 Contributing scenario controlling worker exposure (PROC15) (Duration: > 4 hours;With LEV)

PROC15: Use as laboratory reagent

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use high-performance fume cupboard.,Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure.	Laboratory activities
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better.	

3. Exposure estimation and reference to its source

3.1. Health

Long-term - systemic effects						
DNEL	Inhalation: 1 mg/m³ Dermal: 324 mg/kg bodyweight/day					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 Duration: > 4 hours,Without LEV	0.01	0.01	0.34	0.001	0.011	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC2 Duration: > 4 hours,With LEV	0.7	0.7	0.14	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC2 Duration: > 4 hours,With LEV	0.7	0.7	0.14	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC3 Duration: > 4 hours,With LEV	0.7	0.7	0.03	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC4 Duration: > 4 hours,With LEV	0.7	0.7	0.69	0.002	0.702	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8a	0.18	0.18	1.37	0.004	0.184	Inhalation.: Ecetoc TRA model v2

Duration: > 4 hours,With LEV						Dermal: Ecetoc TRA model v2
PROC8b Duration: > 4 hours,With LEV	0.53	0.53	0.69	0.002	0.532	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8b Duration: > 4 hours,With LEV	0.63	0.63	0.69	0.002	0.632	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8b Duration: daily,With LEV	0.63	0.63	0.69	0.002	0.632	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC15 Duration: > 4 hours,With LEV	0.5	0.5	0.03	0.000	0.500	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2

3.2. Environment

The exposure of aquatic, terrestrial, sediment and sewage treatment microorganisms is considered to be negligible because the substance partitions primarily to air when found in the environment. Emission of butadiene to the air compartment is regulated by the VOC directive and the carcinogen directive. The limits in place of both of these directives would also limit exposure to ecological receptors. Hence the risks are considered to be controlled for ecological receptors.

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

4.1. Health

Guidance - Health	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted PNECs and the resulting risk characterisation ratios are expected to be less than 1.,Confirm that RMMs and OCs are as described or of equivalent efficiency.

4.2. Environment

Not applicable

1. Exposure scenario ES2

Distribution

ES Ref.: ES2 ES Type: Worker	

Use descriptors	PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15 SU3, SU8, SU9 ERC1, ERC2, ERC3, ERC4, ERC5, ERC6a, ERC6b, ERC6c, ERC6d, ERC7
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
Assessment method	Ecetoc TRA model v2

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure

Product characteristics

Physical form of product	Liquid, vapour pressure > 10 kPa at STP.

Operational conditions

Amounts used	Covers percentage substance in the product up to 100 % (unless stated differently).	
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

Organisational measures to prevent /limit releases, dispersion and exposure	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.	General measures (carcinogens)

2.1.2 Contributing scenario controlling worker exposure (PROC1) (Concentration: > 4 hours;With LEV)

PROC1: Use in closed process, no likelihood of exposure

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.	General exposures (closed systems)

2.1.3 Contributing scenario controlling worker exposure (PROC2) (Concentration: > 4 hours;With LEV)

PROC2: Use in closed, continuous process with occasional controlled exposure

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	General exposures (closed systems). with sample collection. With occasional controlled exposure.

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.,Ensure material transfers are under containment or extract ventilation.,Sample via a closed loop or other system to avoid exposure.	General exposures (closed systems). with sample collection. With occasional controlled exposure.

2.1.4 Contributing scenario controlling worker exposure (PROC2) (Concentration: daily;With LEV)

PROC2: Use in closed, continuous process with occasional controlled exposure

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 4 hours.	Storage. With occasional controlled exposure.

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Transfer via enclosed lines,Provide extract ventilation to points where emissions occur.	Storage. With occasional controlled exposure.

2.1.5 Contributing scenario controlling worker exposure (PROC3) (Concentration: > 4 hours;With LEV)

PROC3: Use in closed batch process (synthesis or formulation)

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	General exposures (closed systems). Use in contained batch processes

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.,Ensure material transfers are under containment or extract ventilation.,Sample via a closed loop or other system to avoid exposure.	General exposures (closed systems). Use in contained batch processes

2.1.6 Contributing scenario controlling worker exposure (PROC3) (Concentration: > 4 hours;With LEV)

PROC3: Use in closed batch process (synthesis or formulation)

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.,Sample via a closed loop or other system to avoid exposure.	Process sampling

2.1.7 Contributing scenario controlling worker exposure (PROC4) (Concentration: > 4 hours;With LEV)

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

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 4 hours.	General exposures. (open systems). Batch process. with sample collection

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.,Ensure material transfers are under containment or extract ventilation.,Sample via a closed loop or other system to avoid exposure.,Clear transfer lines prior to de-coupling.,Transfer via enclosed lines	General exposures (open systems). Batch process. with sample collection

2.1.8 Contributing scenario controlling worker exposure (PROC8a) (Concentration: daily;With LEV)

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

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Drain down and flush system prior to equipment break-in or maintenance.,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.	Equipment cleaning and maintenance
Organisational measures to prevent /limit releases, dispersion and exposure	Retain drain downs in sealed storage pending disposal or for subsequent recycle.	Equipment cleaning and maintenance

2.1.9 Contributing scenario controlling worker exposure (PROC8b) (Concentration: > 4 hours;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	Bulk transfers. (closed systems)

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Clear transfer lines prior to de-coupling.,Transfer via enclosed lines,Ensure material transfers are under containment or extract ventilation.	Bulk transfer (closed system)

2.1.10 Contributing scenario controlling worker exposure (PROC8b) (Concentration: daily;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	Bulk transfers. (open systems)

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Clear transfer lines prior to de-coupling.,Transfer via enclosed lines,Ensure material transfers are under containment or extract ventilation.	Bulk transfer (open system)

2.1.11 Contributing scenario controlling worker exposure (PROC9) (Concentration: daily;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	Drum and small package filling

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Transfer via enclosed lines,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.	Drum and small package filling

2.1.12 Contributing scenario controlling worker exposure (PROC15) (Concentration: > 4 hours;With LEV)

PROC15: Use as laboratory reagent

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use high-performance fume cupboard.,Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure.,Provide a good standard of general ventilation (not less than 3 to 5 air changes per hour).	Laboratory activities
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better.	

3. Exposure estimation and reference to its source

3.1. Health

Long-term - systemic effects						
DNEL	Inhalation: 1 mg/m³ Dermal: 324 mg/kg bodyweight/day					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 Concentration: > 4 hours,With LEV	0.01	0.01	0.34	0.001	0.011	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC2 Concentration: > 4 hours,With LEV	0.35	0.35	0.14	0.000	0.350	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC2 Concentration: daily,With LEV	0.9	0.9	1.37	0.004	0.904	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC3 Concentration: >	0.7	0.7	0.03	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2

4 hours,With LEV						
PROC3 Concentration: > 4 hours,With LEV	0.7	0.7	0.03	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC4 Concentration: > 4 hours,With LEV	0.9	0.9	0.69	0.002	0.902	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8a Concentration: daily,With LEV	0.18	0.18	13.71	0.042	0.222	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8b Concentration: > 4 hours,With LEV	0.63	0.63	0.69	0.002	0.632	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8b Concentration: daily,With LEV	0.63	0.63	0.69	0.002	0.632	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC9 Concentration: daily,With LEV	0.72	0.72	0.69	0.002	0.722	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC15 Concentration: > 4 hours,With LEV	0.35	0.35	0.03	0.000	0.350	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2

3.2. Environment

The exposure of aquatic, terrestrial, sediment and sewage treatment microorganisms is considered to be negligible because the substance partitions primarily to air when found in the environment. Emission of butadiene to the air compartment is regulated by the VOC directive and the carcinogen directive. The limits in place of both of these directives would also limit exposure to ecological receptors. Hence the risks are considered to be controlled for ecological receptors.

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

4.1. Health

Guidance - Health	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted PNECs and the resulting risk characterisation ratios are expected to be less than 1.,Confirm that RMMs and OCs are as described or of equivalent efficiency.

4.2. Environment

Not applicable

1. Exposure scenario ES3

Intermediate

ES Ref.: ES3 ES Type: Worker	

Use descriptors	PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15 SU3 ERC1, ERC4
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	Ecetoc TRA model v2

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure

Product characteristics

Physical form of product	Liquid, vapour pressure > 10 kPa at STP.

Operational conditions

Amounts used	Covers percentage substance in the product up to 100 % (unless stated differently).	
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

Organisational measures to prevent /limit releases, dispersion and exposure	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.	General measures (carcinogens)

2.1.2 Contributing scenario controlling worker exposure (PROC1) (Duration: > 4 hours;Without LEV)

PROC1: Use in closed process, no likelihood of exposure

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.	General exposures (closed systems)

2.1.3 Contributing scenario controlling worker exposure (PROC2) (Duration: > 4 hours;With LEV)

PROC2: Use in closed, continuous process with occasional controlled exposure

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	General exposures (closed systems). with sample collection. With occasional controlled exposure.

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a predominantly closed system provided with extract ventilation.,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).	General exposures (closed systems). with sample collection. With occasional controlled exposure.

2.1.4 Contributing scenario controlling worker exposure (PROC2) (Duration: > 4 hours;With LEV)

PROC2: Use in closed, continuous process with occasional controlled exposure

Risk Management Measures		
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 points where emissions occur.,Store substance within a closed system.	Storage. With occasional controlled exposure.

2.1.5 Contributing scenario controlling worker exposure (PROC3) (Duration: > 4 hours;With LEV)

PROC3: Use in closed batch process (synthesis or formulation)

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 15 minutes.	General exposures (closed systems). Use in contained batch processes

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a predominantly closed system provided with extract ventilation.,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).	General exposures (closed systems). Use in contained batch processes

2.1.6 Contributing scenario controlling worker exposure (PROC4) (Duration: > 4 hours;With LEV)

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

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 15 minutes.	General exposures. (open systems). Batch process. with sample collection

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a predominantly closed system provided with extract ventilation.,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).	General exposures (open systems). Batch process. with sample collection

2.1.7 Contributing scenario controlling worker exposure (PROC8a) (Duration: > 4 hours;With LEV)

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

Risk Management Measures		
Technical conditions and measures to control dispersion from source towards the worker	Drain down and flush system prior to equipment break-in or maintenance.,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.	Equipment cleaning and maintenance
Organisational measures to prevent /limit releases, dispersion and exposure	Retain drain downs in sealed storage pending disposal or for subsequent recycle.	Equipment cleaning and maintenance
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 (PROC8b) (Duration: > 4 hours;With LEV)

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

Operational conditions		
Frequency and duration of use	Avoid carrying out activities involving exposure for more than 15 minutes.	Process sampling

Risk Management Measures

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).	Process sampling

2.1.9 Contributing scenario controlling worker exposure (PROC8b) (Duration: > 4 hours;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	Bulk transfers. (open systems). With potential for aerosol generation

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use dry break couplings for material transfer.,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).	Bulk transfers. (open systems). With potential for aerosol generation

2.1.10 Contributing scenario controlling worker exposure (PROC8b) (Duration: daily;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	Bulk transfers. (closed systems)

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use dry break couplings for material transfer.	Bulk transfers. (closed systems)

2.1.11 Contributing scenario controlling worker exposure (PROC15) (Duration: > 4 hours;With LEV)

PROC15: Use as laboratory reagent

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use high-performance fume cupboard.,Handle within a fume cupboard or implement suitable equivalent methods to minimise exposure.	Laboratory activities
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a respirator conforming to EN140 with Type A filter or better.	

3. Exposure estimation and reference to its source

3.1. Health

Long-term - systemic effects						
DNEL	Inhalation: 1 mg/m³ Dermal: 324 mg/kg bodyweight/day					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 Duration: > 4 hours,Without LEV	0.01	0.01	0.34	0.001	0.011	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC2 Duration: > 4 hours,With LEV	0.7	0.7	0.14	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC2 Duration: > 4 hours,With LEV	0.7	0.7	0.14	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC3 Duration: > 4 hours,With LEV	0.7	0.7	0.03	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC4 Duration: > 4 hours,With LEV	0.7	0.7	0.69	0.002	0.702	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8a	0.18	0.18	1.37	0.004	0.184	Inhalation.: Ecetoc TRA model v2

Duration: > 4 hours,With LEV						Dermal: Ecetoc TRA model v2
PROC8b Duration: > 4 hours,With LEV	0.53	0.53	0.69	0.002	0.532	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8b Duration: > 4 hours,With LEV	0.63	0.63	0.69	0.002	0.632	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8b Duration: daily,With LEV	0.63	0.63	0.69	0.002	0.632	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC15 Duration: > 4 hours,With LEV	0.5	0.5	0.03	0.000	0.500	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2

3.2. Environment

The exposure of aquatic, terrestrial, sediment and sewage treatment microorganisms is considered to be negligible because the substance partitions primarily to air when found in the environment. Emission of butadiene to the air compartment is regulated by the VOC directive and the carcinogen directive. The limits in place of both of these directives would also limit exposure to ecological receptors. Hence the risks are considered to be controlled for ecological receptors.

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

4.1. Health

Guidance - Health	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted PNECs and the resulting risk characterisation ratios are expected to be less than 1.,Confirm that RMMs and OCs are as described or of equivalent efficiency.

4.2. Environment

Not applicable

1. Exposure scenario ES4

Rubber production and processing

ES Ref.: ES4 ES Type: Worker	

Use descriptors	PROC1, PROC2, PROC3, PROC4, PROC5, PROC6, PROC7, PROC8a, PROC8b, PROC13, PROC14, PROC21 SU3, SU10 ERC4, ERC6d
Processes, tasks, activities covered	Manufacture of tyres and general rubber articles within closed or contained systems, including incidental exposures during processing of raw (uncured) rubber, handling and mixing of rubber additives, calendaring, vulcanising, cooling and finishing as well as maintenance. Industrial use
Assessment method	Ecetoc TRA model v2

2. Operational conditions and risk management measures

2.1.1 Contributing scenario controlling worker exposure

Product characteristics

Physical form of product	Liquid, vapour pressure > 10 kPa at STP.

Operational conditions

Amounts used	Covers percentage substance in the product up to 100 % (unless stated differently).	
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

Organisational measures to prevent /limit releases, dispersion and exposure	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.	General measures (carcinogens)

2.1.2 Contributing scenario controlling worker exposure (PROC1) (Duration: 15 mins - 1 hour;Without LEV)

PROC1: Use in closed process, no likelihood of exposure

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.	Material transfers

2.1.3 Contributing scenario controlling worker exposure (PROC1) (Duration: 15 mins - 1 hour;Without LEV)

PROC1: Use in closed process, no likelihood of exposure

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Handle substance within a closed system.	Bulk weighing. (closed systems)

2.1.4 Contributing scenario controlling worker exposure (PROC2) (Duration: 15 mins - 1 hour;With LEV)

PROC2: Use in closed, continuous process with occasional controlled exposure

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Transfer via enclosed lines,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).	Material transfers. With occasional controlled exposure.

2.1.5 Contributing scenario controlling worker exposure (PROC2) (Duration: 15 mins - 1 hour;With LEV)

PROC2: Use in closed, continuous process with occasional controlled exposure

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 4 hours.	Bulk weighing. With occasional controlled exposure.

Risk Management Measures

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).	Bulk weighing. With occasional controlled exposure.

2.1.6 Contributing scenario controlling worker exposure (PROC3) (Duration: 15 mins - 1 hour;With LEV)

PROC3: Use in closed batch process (synthesis or formulation)

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 4 hours.	Additive premixing. Batch process. (closed systems)

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Formulate in enclosed or ventilated mixing vessels.,Ensure material transfers are under containment or extract ventilation.,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).	Additive premixing. Batch process. (closed systems)

2.1.7 Contributing scenario controlling worker exposure (PROC4) (Duration: 15 mins - 1 hour;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 1 hour.	Additive premixing

Risk Management Measures

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).	Additive premixing

2.1.8 Contributing scenario controlling worker exposure (PROC5) (Duration: 1 - 4 hours;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 15 minutes.	Additive premixing. Mixing operations (open systems)

Risk Management Measures

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).	Additive premixing. Mixing operations (open systems)
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 (PROC6) (Duration: > 4 hours;With LEV)

PROC6: Calendering operations

Operational conditions

Other given operational conditions affecting workers exposure	Limit the substance content in the mixture to 1 %.	Calendering operations

Risk Management Measures

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 general ventilation (not less than 3 to 5 air changes per hour).	Calendering operations

2.1.10 Contributing scenario controlling worker exposure (PROC6) (Duration: > 4 hours;With LEV)

PROC6: Calendering operations

Operational conditions

Other given operational conditions affecting workers exposure	Limit the substance content in the mixture to 1 %.	Vulcanisation

Risk Management Measures

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 general ventilation (not less than 3 to 5 air changes per hour).	Vulcanisation

2.1.11 Contributing scenario controlling worker exposure (PROC6) (Duration: > 4 hours;With LEV)

PROC6: Calendering operations

Operational conditions

Other given operational conditions affecting workers exposure	Limit the substance content in the mixture to 1 %.	Cooling cured articles

Risk Management Measures

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 general ventilation (not less than 3 to 5 air changes per hour).	Cooling cured articles

2.1.12 Contributing scenario controlling worker exposure (PROC8a) (Duration: 15 mins - 1 hour;With LEV)

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

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Drain down and flush system prior to equipment break-in or maintenance.,Provide a good standard of controlled ventilation (10 to 15 air changes per hour).	Equipment maintenance
Conditions and measures related to personal protection, hygiene and health evaluation	Wear a full face respirator conforming to EN136 with Type A filter or better.	

2.1.13 Contributing scenario controlling worker exposure (PROC8b) (Duration: 15 mins - 1 hour;With LEV)

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

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use drum pumps.,Provide a good standard of controlled ventilation (10 to 15 air changes per hour).,Ensure material transfers are under containment or extract ventilation.	Material transfers. Dedicated facility

2.1.14 Contributing scenario controlling worker exposure (PROC8b) (Duration: 15 mins - 1 hour;With LEV)

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

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Transfer via enclosed lines,Ensure material transfers are under containment or extract ventilation.	Material transfers. Dedicated facility

2.1.15 Contributing scenario controlling worker exposure (PROC9) (Duration: 15 mins - 1 hour;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 4 hours.	Small scale weighing. Dedicated facility

Risk Management Measures

Technical conditions and measures to control	Transfer via enclosed lines,Ensure material transfers	Small scale weighing.

dispersion from source towards the worker	are under containment or extract ventilation.,Provide a good standard of controlled ventilation (10 to 15 air changes per hour).	Dedicated facility

2.1.16 Contributing scenario controlling worker exposure (PROC9) (Duration: 15 mins - 1 hour;With LEV)

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

Operational conditions

Frequency and duration of use	Avoid carrying out activities involving exposure for more than 4 hours.	Material transfers

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Transfer via enclosed lines,Ensure material transfers are under containment or extract ventilation.,Provide a good standard of controlled ventilation (10 to 15 air changes per hour).	Material transfers

2.1.17 Contributing scenario controlling worker exposure (PROC14) (Duration: 1 - 4 hours;With LEV)

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

Operational conditions

Other given operational conditions affecting workers exposure	Limit the substance content in the mixture to 1 %.	Pressing uncured rubber blanks

Risk Management Measures

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).	Pressing uncured rubber blanks

2.1.18 Contributing scenario controlling worker exposure (PROC15) (Duration: < 15 mins ;With LEV)

PROC15: Use as laboratory reagent

Risk Management Measures

Technical conditions and measures to control dispersion from source towards the worker	Use high-performance fume cupboard.	Laboratory activities

3. Exposure estimation and reference to its source

3.1. Health

Long-term - systemic effects						
DNEL	Inhalation: 1 mg/m³ Dermal: 324 mg/kg bodyweight/day					
Contributing scenario	inhalation exposure mg/m³	RCR	Dermal exposure mg/kg bodyweight/day	RCR	Sum RCR	Assessment method
PROC1 Duration: 15 mins - 1 hour,Without LEV	0.01	0.01	0.03	0.000	0.010	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC1 Duration: 15 mins - 1 hour,Without LEV	0.01	0.01	0.03	0.000	0.010	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC2 Duration: 15 mins - 1 hour,With LEV	0.7	0.7	0.01	0.000	0.700	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC2 Duration: 15 mins - 1 hour,With LEV	0.9	0.9	0.01	0.000	0.900	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC3 Duration: 15 mins - 1 hour,With LEV	0.9	0.9	0.03	0.000	0.900	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC4 Duration: 15 mins - 1 hour,With LEV	0.6	0.6	0.69	0.002	0.602	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC5 Duration: 1 - 4 hours,With LEV	0.75	0.75	0.14	0.000	0.750	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2

PROC6 Duration: > 4 hours,With LEV	0.88	0.88	1.37	0.004	0.884	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC6 Duration: > 4 hours,With LEV	0.88	0.88	1.37	0.004	0.884	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC6 Duration: > 4 hours,With LEV	0.88	0.88	1.37	0.004	0.884	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8a Duration: 15 mins - 1 hour,With LEV	0.75	0.75	13.71	0.042	0.792	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8b Duration: 15 mins - 1 hour,With LEV	0.9	0.9	0.69	0.002	0.902	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC8b Duration: 15 mins - 1 hour,With LEV	0.9	0.9	0.69	0.002	0.902	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC9 Duration: 15 mins - 1 hour,With LEV	0.72	0.72	0.69	0.002	0.722	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC9 Duration: 15 mins - 1 hour,With LEV	0.72	0.72	0.69	0.002	0.722	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC14 Duration: 1 - 4 hours,With LEV	0.75	0.75	0.34	0.001	0.751	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2
PROC15 Duration: < 15 mins ,With LEV	0.5	0.5	0.03	0.000	0.500	Inhalation.: Ecetoc TRA model v2 Dermal: Ecetoc TRA model v2

3.2. Environment

The exposure of aquatic, terrestrial, sediment and sewage treatment microorganisms is considered to be negligible because the substance partitions primarily to air when found in the environment. Emission of butadiene to the air compartment is regulated by the VOC directive and the carcinogen directive. The limits in place of both of these directives would also limit exposure to ecological receptors. Hence the risks are considered to be controlled for ecological receptors.

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

4.1. Health

Guidance - Health	When the recommended risk management measures (RMMs) and operational conditions (OCs) are observed, exposures are not expected to exceed the predicted PNECs and the resulting risk characterisation ratios are expected to be less than 1.,Confirm that RMMs and OCs are as described or of equivalent efficiency.

4.2. Environment

Not applicable