

SAFETY DATA SHEET



Date: 07.04.2013

1. IDENTIFICATION OF THE SUBSTANCE / PREPARATION AND OF THE COMPANY / UNDERTAKING

1.1 Identification of the substance or preparation

Trade name: Crude Tall Oil (CTO)
Item number: 10-037

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

Identified use(s):

Processing in order to obtain fatty acids and resin by the way of rectification.

The following scenarios were addressed in the chemical safety report (CSR) for CTO as prepared as part of the registration dossier required by the EU REACH-Regulation.

Scenario 1:
Manufature and on-site-uses of CTO

Scenario 2:
Use in fractionation

Scenario 3:
Use as fuel in energy generation, including formulation

Scenario 4:
Use in generic formulations

1.3 Company / undertaking identification

1.3.1 Manufacturer, importer, other undertaking
UCY business services & trading GmbH

1.3.2 Contact information:
Street address: Am Villepohl 4
Postcode and post office: DE-53347 Alfter
Telephone number: +49 228 2428 732
Faxsimile: +49 228 2428 731
E-mail address: sales@ucy-energy.com

1.4 Emergency telephone

1.4.1 Telephone number, name and address
+49 163 8141789 or +39 0165 43081
UCY business services & trading GmbH
Am Villepohl 4, DE-53347 Alfter

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- 1.4.2 In case of intoxication (consultation in German and English)
Poisoning emergency number (Berlin)
Tel. +49 (0) 30 30686 790
- 1.4.3 Emergency telephone number (consultation in German and English)
Poisoning emergency number (Berlin)
Tel. +49 (0) 30 19240

2 HAZARDS IDENTIFICATION

2.1 Classification if the substance or mixture

- 2.1.1 **According to 67 / 548 / EC**
Xi; R 43
- 2.1.2 **According to 1272 / 2008 / EC**
Skin Sens., 1; H317
- 2.1.3 **Health**
May cause sensitisation (allergic eczema) by skin contact.
- 2.1.4 **Environment**
Contains components that may be harmful to aquatic organisms.
- 2.1.5 **Fire**
Not flammable but combustible. Hot tall oil or tall oil in contact with hot material may self-combust, especially if the tall oil is immersed in mineral wool.

2.2 Label elements

- 2.2.1 **Signal Word**
Warning
- 2.2.2 **Hazard statements**
H317
May cause an allergic skin reaction.
- 2.2.3 **Precautionary statements**
Prevention: P261, P272, P280*, P285*

Avoid breathing dust / fume / gas / mist / vapours / spray.
Contaminated work clothing should not be allowed out of the workplace.
Wear protective gloves / protective clothing / eye protection / face protection
In case of inadequate ventilation wear respiratory protection

Response:
P302+P352*, P333+313*, P321, P363*

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IF ON SKIN:
Wash with plenty of soap and water.

If skin irritation or rash occurs:
Get medical advice / attention.

Specific treatment (see... on this label).
Wash contaminated clothing before reuse.

Disposal:
P501

Dispose of contents/container in accordance with local / regional / national regulations.

*recommended to be used on the label in line with article 28 §3 of Regulation (EC) No. 1272/2008 on the classification, labeling and packaging of substances and mixtures (CLP) limiting the precautionary statements to six; the decision on which 6 precautionary statements to use on the label is however the responsibility of the labeler.

Contains: Crude tall oil

3 COMPOSITION AND INFORMATION ON INGREDIENTS

Crude Tall Oil (CTO): A complex combination of tall oil rosin and fatty acids derived from acidulation of crude tall oil soap and including that which is further refined. Contains at least 10% rosin. Full composition is given in section 16.

3.1 Substances

3.1.1 Classification of substances according to 67/548/EEC

Dangerous substances:	Crude Tall Oil
Content:	100 %
EC No.:	931-433-1
Identification of danger:	Xi
Risk phrases:	R43 = May cause sensitisation by skin contact

3.1.2 Classification of substances according to CLP, 1272/2008/EC

Hazardous substances:	Crude Tall Oil
Content:	100 %
EC No.:	931-433-1
Hazard class(es) / Category code(s):	Skin Sens. 1
Hazard statements:	H317 = May cause an allergic skin reaction

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4 FIRST AID MEASURES

4.1 Description of first aid measures

4.1.1 Inhalation

Move the exposed person to fresh air. Seek medical attention.

4.1.2 Skin contact

Wash off immediately with plenty of soap and water. Remove contaminated clothing. Seek medical attention if irritation or symptoms persist.

4.1.3 Contact with eyes

Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 15 minutes. Seek medical attention if irritation or symptoms persist.

4.1.4 Ingestion

Seek medical attention if irritation or symptoms persist. DO NOT INDUCE VOMITING.

4.2 Most important symptoms and effects, both acute and delayed

4.2.1 Inhalation

Irritating to respiratory system. Inhalation may cause coughing, tightness of the chest and irritation of the respiratory system.

4.2.2 Skin contact

Irritating to skin.

4.2.3 Contact with eyes

Irritating to eyes.

4.2.4 Ingestion

Ingestion may cause nausea and vomiting.

4.3 Indication of any immediate medical attention and special treatment needed

As a general rule, and in all cases of doubt or when symptoms persist, always seek medical attention. Never give anything by mouth to an unconscious person.

5 FIRE-FIGHTING MEASURES

5.1 Extinguishing media:

5.1.1 Suitable extinguishing media

Use extinguishing media appropriate to the surrounding fire conditions.
Use as appropriate: carbon dioxide (CO₂), Foam, Water spray.

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5.1.2 Unsuitable extinguishing media

No specific recommendations.

5.2 Special hazards arising from the substance or mixture

Fire hazards: Burning produces irritating, toxic and obnoxious fumes.

5.3 Advice for fire-fighters

Protective equipment: Wear suitable respiratory equipment when necessary.

6 ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Ensure adequate ventilation of the working area. Wear suitable protective equipment (see section 8).

6.2 Environmental precautions

Do not allow product to enter drains. Prevent further spillage if safe.

6.3 Methods and material for containment and cleaning up

Clean up methods: Absorb with inert, absorbent material. Sweep up. Transfer to suitable, labeled containers for disposal. Clean spillage area thoroughly with plenty of water.

7 HANDLING AND STORAGE

7.1 Precautions for safe handling

CTO can contain small amounts of hydrogen sulphide (H₂S). The gas can accumulate over time in the headspace of CTO storage tanks and truck tanks. Its presence can pose a significant hazard to humans and the risk has to be recognized and managed.

7.1.1 Protective measures

Avoid contact with eyes and skin. Ensure adequate ventilation of the working area. Keep away from heat. Keep away from sources of ignition - No smoking. Adopt best Manual Handling considerations when handling, carrying and dispensing.

7.1.2 Advice on general occupational hygiene

Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

7.2 Conditions for safe storage, including any incompatibilities

Storage: Keep in a cool, dry, well ventilated area. Keep containers tightly closed. Store in correctly labeled containers. Avoid temperatures over 30 °C.

7.3 Specific uses

See exposure scenarios attached to this Safety Data Sheet.

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8 EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Occupational exposure limit value

TLV not established

DNEL for workers

Exposure pattern	Route	Descriptors	DNEL	Most sensitive endpoint
Acute - systemic effects	Dermal	Not quantifiable	-	No effects
	Inhalation	Not quantifiable	-	No effects
	Oral	Not quantifiable	-	No effects
Acute - local effects	Dermal	DNEL	16.75 µg/cm ²	Sensitisation
	Inhalation	Not quantifiable	-	No effects
Long-term - systemic effects	Dermal	DNEL	>10 mg/kg/d	Repeated-dose toxicity
	Inhalation	DNEL	>35.3 mg/m ³	Repeated-dose toxicity
Long-term – local effects	Dermal	Not quantifiable	-	No effects
	Inhalation	Not quantifiable	-	No effects

DN(M)ELs for the general population

Exposure pattern	Route	Descriptors	DNEL/DMEL (appropriate unit)	Most sensitive endpoint
Acute - systemic effects	Dermal	Not quantifiable	-	No effects
	Inhalation	Not quantifiable	-	No effects
	Oral	Not quantifiable	-	No effects
Acute - local effects	Dermal	DNEL	8.2 µg/cm ²	Sensitisation
	Inhalation	Not quantifiable	-	No effects
Long-term - systemic effects	dermal	DNEL	>5 mg/kg/d	Repeated-dose toxicity
	Inhalation	DNEL	>8.7 mg/m ³	Repeated-dose toxicity
	oral	DNEL	>5 mg/kg/d	Repeated-dose toxicity
Long-term – local effects	Dermal (mg/cm ²)	Not quantifiable	-	No effects
	Inhalation (mg/m ³)	Not quantifiable	-	No effects

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Aquatic PNECs

TLV not established

As CTO is a UVCB (Substance is of Unknown or Variable composition, Complex reaction product or Biological origin) derivation of a single, representative PNEC value for this substance using conventional methods is not possible. PNECs for the aquatic compartment should therefore be based on data for the blocks of constituents rather than on data for the whole substance.

Aquatic PNECs for CTO constituent blocks

Block (see section 16)	PNEC for this assessment (mg/L)
1	0.20
2	0.20
3	0.14
4	0.027
5	0.024
6	0.027
7	0.00011
8	0.0078
9	Effects unlikely*
10	0.0054
11	0.010
12	Effects unlikely*
13	Effects unlikely**
14	Effects unlikely**
15	0.013

*Toxic concentrations are above the water solubility of the constituents

**High molecular weight constituents; uptake unlikely

8.2 Exposure controls

8.2.1 Appropriate engineering controls

H₂S gas can accumulate over time in the headspace of CTO storage tanks and tank trucks. Its presence can pose a significant hazard to humans and the risk has to be recognised and managed. Appropriate risk management measures include local exhaust ventilation, the setting of standard protocols for proper venting of the tank before entrance, use of workspace and personal gas detectors, and use of respiratory protective equipment.

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8.2.2 Individual protection measures, such as personal protective equipment

a) Eye / face protection

Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or gases.

b) Skin protection

Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.

c) Respiratory protection

Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard.

8.2.3 Environmental exposure controls

See Section 13

9 PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

9.1.1 Appearance

Liquid (at standard temperature and pressure)

The substance is a UVCB, variations in the physical appearance (colour) of the substance may occur depending on the natural variation in composition of the substance

9.1.2 Colour

Dark brown to dark amber

9.1.3 Odour

Sulphur compounds

9.1.4 Odour threshold

Not determined

9.1.5 pH

Not determined

9.1.6 Melting point / freezing point

- 3.15°C (270 ± 3K) (pour point) (OECD TG 102)

9.1.7 Boiling point / range

346.85°C (620 K) (OECD TG 103)

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- 9.1.8 Flash point**
121 – 185°C (closed cup, ASTM D3278)
- 9.1.9 Evaporation rate**
Not determined
- 9.1.10 Flammability (solid, gas)**
No indication on the basis of structure and experience in handling and use that the substance has pyrophoric properties or is flammable in contact with water.
- 9.1.11 Explosion limits**
Not applicable (no chemical groups associated with explosive properties present in the molecule)
- 9.1.12 Vapour pressure**
22.7 Pa (at 25°C) (PFA 2010b)
- 9.1.13 Vapour density**
Not determined
- 9.1.14 Relative density**
958.7 – 969.4 kg/m³ (ASTM D1475)
- 9.1.15 Solubility in water**
7.35 x 10⁻² g/l 20°C (pH 4.6 - 5.5) (OECD TG 105)
- 9.1.16 Solubility in other solvents**
Acetone, diethyl ether, ethanol (from SDS)
- 9.1.17 Partition coefficient: n-octanol / water**
Log K_{OW} = 4.9 – 7.7 (pH 2.0)
Log K_{OW} = 3.2 – 6.8 (pH 5–6)
- 9.1.18 Auto-ignition temperature**
276°C (at 99.19–100.85 kPa, 19–20°C) (EU method A.15)
- 9.1.19 Decomposition temperature**
Not determined
- 9.1.20 Viscosity**
203–825 cP (at 22°C), 49–121 cP (at 50°C) (ASTM D2196)
- 9.1.21 Explosive properties**
Not applicable (no chemical groups associated with explosive properties present in the molecule)
- 9.1.22 Oxidising properties**
Not applicable (based upon chemical structure of the constituents of CTO, and experience in use and handling, CTO is considered non-oxidising)

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9.2 Other information

Surface tension

66.7 mN/m (at 21°C) (OECD TG 115)

10 STABILITY AND REACTIVITY

10.1 Reactivity

The substance is not reactive under recommended storage and handling conditions (see section 7).

10.2 Chemical Stability

The substance is stable under recommended storage and handling conditions (see section 7).

10.3 Possibility of hazardous reactions

No specific hazardous reactions are expected to occur.

10.4 Conditions to avoid

Avoid high temperatures and direct sunlight. Avoid direct contact with air.

10.5 Incompatible materials

Contact with strong oxidising agents may cause hazardous reactions.

10.6 Hazardous decomposition products

H₂S gas can accumulate over time in the headspace of CTO storage tanks and tank trucks. In contact with air oxidation products with sensitizing properties may be formed.

11 TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

11.1.1 Substances

11.1.1.1 The relevant hazard classes, for which information shall be provided, are:

a) Acute toxicity

CTO is not classified for acute toxicity.

Oral LD₅₀, rat: > 2000 mg/kg.

Dermal LD₅₀, rabbit: > 2000 mg/kg.

There were no clinical signs of toxicity, no signs of local irritation and no necropsy findings in either one of these tests.

b) Skin corrosion/irritation

CTO is judged to be non-irritant to rabbit skin.

No skin reactions were reported in a skin irritation test where observations were made up to and including the 72 hour observation.

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In an in vitro test targeted at skin corrosion (OECD TG 430), the mean TER of CTO treated skins was 21.2 k Ω which is above the threshold of 5 k Ω for classification.

c) Serious eye damage/irritation

CTO is judged to be non-irritant to rabbit eyes.

Minor effects were observed in an eye irritation test at the 1 hour observation, but at no other time point.

d) Respiratory or skin sensitization

CTO is a (weak) skin sensitiser.

The skin sensitizing potential of CTO was shown in the local lymph node assay.

e) Germ cell mutagenicity

CTO is not genotoxic.

The available information for the substance indicates that when tested in vitro, CTO does not induce mutations in bacterial or mammalian cells, nor chromosome aberrations in mammalian cells.

Gene mutation (Bacterial reverse mutation assay / Ames test): negative with and without activation in all strains tested (OECD TG 471).

Cytogenicity in mammalian cells: negative in cultured human lymphocytes (OECD TG 473) Mutagenicity in mammalian cells: negative in L5178Y cells (OECD TG 476).

f) Carcinogenicity

No data are available for the carcinogenicity of CTO. However, further testing is not considered necessary because:

- The substance is not classified for mutagenicity; and
- There is no evidence from the repeated dose studies that constituents of CTO are able to induce hyperplasia or pre-neoplastic lesions.

g) Reproductive toxicity

Not a reproductive toxicant.

Fertility/Developmental toxicity:

No relevant reproductive toxicity or developmental toxicity studies have been conducted for CTO as whole product. However, data are available for the constituent parts of CTO and related substances (unpublished laboratory studies and information published in the public domain). These data are sufficient to demonstrate that none of the constituents of CTO require classification for reproductive toxicity or developmental toxicity. Any effects that were observed on reproductive parameters in the available studies were minor and associated with dose levels where systemic effects were observed.

h) STOT-single exposure

None of the constituents of CTO fulfil the criteria to be classified as STOT SE.

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i) STOT-repeated exposure

None of the constituents of CTO fulfil the criteria to be classified as STOT RE.
No relevant repeated dose toxicity studies have been conducted for CTO as whole product. However, data are available for the constituent parts of CTO and related substances. NOAEL (chronic, rat): 200 mg / kg bw / d.

j) Aspiration hazard

The substance does not fulfil the criteria for aspiration hazard.

12 ECOLOGICAL INFORMATION

12.1 Toxicity

Reliable short-term have been determined in tests conducted with water-accommodated fractions (WAFs):

LL_{50/96h}, fish (Danio rerio): 20 mg / L
NOELr, fish (Danio rerio): 6.25 mg / L
EL_{50/48h}, Daphnia magna: 32 mg / L
EL_{50/72h}, algae (Desmodesmus subspicatus): > 100 mg / L
NOELr, algae (Desmodesmus subspicatus): > 100 mg / L
NOELr_{21d}, Daphnia magna: >= 1 mg / L

There are no data for long-term toxicity to fish but it is not expected that fish would be any more susceptible to the effects of the substance than invertebrates or algae.

12.2 Persistence and degradability

12.2.1 Abiotic degradation

On the basis of structural examination, none of the constituents of CTO contain functional groups that are susceptible to hydrolysis under conditions relevant to the environment. This fate process will not contribute to a measurable degradative loss of these substances from the environment. The substance constituents can therefore be considered as stable under hydrolytic conditions.

12.2.2 Biodegradation

CTO is readily biodegradable.
Five ready biodegradation studies are available for samples of CTO. Ready biodegradation of 79.4 - 83% meeting the '10-day window' criterion (measured as percentage of theoretical oxygen demand, TOD) was achieved in 28 days using a method consistent with OECD Guideline 301 F (manometric respirometer).

12.3 Bioaccumulative potential

There is no data on the bioaccumulation of CTO as a whole substance. There are however data on some of the constituents. Some of the constituents of block 10 (Aldehydes) meet the criteria for PBT (resin aldehydes) or vPvB (neoabietal). Some of the constituents of block 12 (Sitosterol and analogues) meet the criteria for vPvB.

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12.4 Mobility in soil

The adsorption/desorption of CTO as a whole substance is not scientifically necessary or meaningful for the purpose of environmental assessment. Calculated values for the constituents of CTO were obtained using KOCWIN.

The highest individual K_{oc} was calculated for block 12 (Sitosterol and analogues): 4.96E+06

12.5 Results of PBT and vPvB assessment the adverse effects

It is concluded that this typical CTO composition substance should not be considered as a SVHC.

- There are no constituents of CTO that meet the criteria for CMR category 1 or 2
- Some of the constituents of block 10 (Aldehydes) meet the criteria for PBT (resin aldehydes) or vPvB (neoabietal).
- Some of the constituents of block 12 (Sitosterol and analogues) meet the criteria for vPvB.
- Some CTO constituents, in particular β -sitosterol, might also fall into the category of being a substance of very high concern (SVHC) on the grounds that they have potential endocrine disrupting properties. However these constituents occur naturally and endemic organisms are therefore adapted to their presence and indeed may utilise them. Some plant-derived sterols are also present in and/or deliberately added to foodstuffs for human and animal consumption and so unless this practice is stopped it seems unlikely that authorisation could be based on grounds of concerns arising from incidental exposure via the environment.

12.6 Other adverse effects

No other adverse effects are observed.

13 DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product / Packaging disposal:

Product residues and uncleaned empty containers should be packaged, sealed, labelled, and disposed of or recycled according to relevant national and local regulations. Where large quantities are concerned, consult the supplier. When uncleaned empty containers are passed on, the recipient must be warned of any possible hazard that may be caused by residues. For disposal within the EC, the appropriate code according to the European Waste List (EWL) should be used. It is among the tasks of the polluter to assign the waste to waste codes specific to industrial sectors and processes according to the European Waste List (EWL).

13.2 Waste treatment options

Examine possibilities for reutilisation or recycling.

14 TRANSPORT INFORMATION

Not classified as dangerous goods under relevant international transport regulations (ADR, RID, IATA, IMDG).

14.1 UN number:

N/A

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14.2 UN proper shipping name

N/A

14.3 Transport hazard class(es):

N/A

14.4 Packing group

N/A

14.5 Environmental hazards

N/A

14.6 Special precautions for user

N/A

14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code

15 REGULATORY INFORMATION

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

- Regulation (EC) No 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer – not applicable CTO
- Regulation (EC) No 850/2004 of the European Parliament and of the Council of 29 April 2004 on persistent organic pollutants and amending Directive 79/117/EEC – not applicable to CTO
- Regulation (EC) No 689/2008 of the European Parliament and of the Council of 17 June 2008 concerning the export and import of dangerous chemicals – not applicable to CTO

National Inventories:

- USA (TSCA): Listed
- Canada (DSL): Listed
- Canada (NDSL): Not applicable. Listed on the DSL.
- European Union (EINECS/ELINCS): Listed
- Japan (ENCS): Listed
- Korea (ECL): Listed
- Australia (AICS): Listed
- New Zealand (NZ): Listed
- Phillipines (PICCS): Listed
- China (CLECS): Listed

15.2 Chemical Safety Assessment

The supplier has performed a Chemical Safety Assessment (CSA) for this substance as required under the EU REACH Regulation.

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16 OTHER INFORMATION

Key literature references and sources for data:
Chemical Safety Report (CSR) for CTO (REACH)

CTO constituent blocks:

Block number	Constituents
1	Low boiling fatty acids
2	C16 saturated - C18.3 unsaturated fatty acids
3	C18 saturated - C24 saturated and unsaturated fatty acids
4	Abietic acid
5	Palustric acid
6	Pimaric acid
7	Sesquiterpene
8	Abietol
9	Tetracosanol and dehydrated sterol
10	Aldehydes
11	Dimethoxystilbene
12	Sitosterols and analogue
13	Polymeric acids*
14	Polymeric neutrals*
15	Terpenes

*High molecular weight

Further information:

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Annex

Exposure Scenario (taken from section 9 of the Chemical Safety Report (CSR) for CTO)

9.1. Manufacture and on-site uses of CTO

9.1.1. Exposure scenario

1. Short title of Exposure Scenario	
Manufacture and on-site uses of CTO	
2. Description of activities/process(es) covered in the Exposure Scenario	
Sector of use	SU 3 (Industrial uses: uses of substances as such or in preparations at industrial sites) SU 8 (Manufacture of bulk, large scale chemicals)
Product category	Not applicable
Process category	PROC 1 (Use in closed process, no likelihood of exposure) PROC 2 (Use in closed, continuous process with occasional controlled exposure (e.g. sampling)) PROC 3 (Use in closed batch process (synthesis or formulation)) PROC 8b (Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities)
Article category	Not applicable
Environmental release category	ERC 1 (Manufacture of substances)
3. Operational conditions	
3.1 Duration and frequency of use for which the ES ensures control of risk	
Duration of exposure at workplace:	8 h/d (ECHA default)
Frequency of exposure at workplace:	Up to 240 d per year
Annual amount used per site	Up to 30 000 tonnes
Emission days per site:	Up to 300 days/year
4.1 Physical form of product in which the substance is contained	
Typically liquid. Hydrogen sulphide may sometimes be found in the headspace of storage vessels.	
4.2 Concentration of substance in preparation or article	
Not applicable	
4.3 Amount used per time or per activity for which the RMMs, in combination with other operational conditions of use ensure control of risk (if applicable)	
Respiration volume under conditions of use:	10 m ³ /d
Area of skin contact with the substance under conditions of use	PROC 2 and PROC 8b: 480 cm ³ PROC3: 240 cm ³
Body weight	70 kg
5. Other operational conditions determining exposure, e.g. temperature, capacity of receiving environment (water flow; room size x ventilation rate), emission or release factors to the relevant compartments	
See PFA (2010f). Generic approach to exposure of the environment and workers to CTO. Peter Fisk Associates Limited, Kent, UK.	
The referenced document above is available from the supplier of this safety data sheet.	
6. Risk Management Measures that, in combination with the operational conditions of use, ensure control of risk related to the different target groups	
6.1 Risk management Measures related to workers	

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<p>Technical measures</p> <p>Organisational measures</p> <p>Respiratory protection</p> <p>Hand protection</p> <p>Eye protection</p> <p>Hygiene measures</p>	<p>H₂S gas can accumulate over time in the headspace of CTO storage tanks and tank trucks. Its presence can pose a significant hazard to humans and the risk has to be recognised and managed. Appropriate risk management measures include local exhaust ventilation, the setting of standard protocols for proper venting of the tank before entrance, use of workspace and personal gas detectors, and use of respiratory protective equipment. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard.</p> <p>Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.</p> <p>Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or gases.</p> <p>Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.</p>
<p>6.2 Environment related measures; type and efficiency of single options or combination of options on exposure to be quantified; options to be phrased as instructive guidance</p>	
<p>Organisational measures</p> <p>Abatement measures waste water</p> <p>Abatement measures waste air</p> <p>Soil</p>	<p>Standard size waste water treatment plant for highly industrial sites.</p> <p>Substance has low volatility and so releases to air are expected to be minimal.</p> <p>The spreading of sludge is assumed as a worst-case scenario.</p>
<p>7. Waste related measures needed to ensure control of risk at the different life cycle stages of the substances (including preparations or articles at the end of service life)</p>	
<p>Type of waste</p> <p>Disposal technique</p> <p>Fraction released to environment during waste treatment</p>	<p>Aqueous waste</p> <p>Details of the treatment of aqueous waste vary at different production sites but as a minimum it is assumed that the effluent is treated off-site in a waste water treatment plant before discharge to waste water. Discharge to marine water without biological treatment cannot be ruled out, but for such sites the dilution is known to be in excess of 1000.</p> <p>Negligible</p>
<p>8. Prediction of exposure resulting from the conditions described above (entries 3-6) and the substance properties</p>	
<p>Workers (oral)</p> <p>Workers (dermal)</p> <p>PROC 2</p> <p>PROC 3</p> <p>PROC 8b</p> <p>Workers (inhalation)</p> <p>PROC 2</p> <p>PROC 3</p> <p>PROC 8b</p>	<p>No significant oral exposure.</p> <p>Estimated by the means of the ECETOC TRA model. Only values with LEV are shown.</p> <p>1.37 mg/kg/day</p> <p>0.034 mg/kg/day</p> <p>0.69 mg/kg/day</p> <p>CTO is assigned to the 'low fugacity' category according to the ECETOC TRA definitions, based on the estimated vapour pressure of 22.7 Pa. This value represents a contribution from a low fraction of volatiles; many constituents are of lower vapour pressure. Therefore, for human health, the exposures via the vapour phase are overestimates. The Guidance does not set out how to deal with UVCBs in respect of human exposure. Only values with LEV are shown.</p> <p>1.20 mg/m³</p> <p>3.59 mg/m³</p> <p>1.79 mg/m³</p>

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<p>Environment Water (fresh-water) Soil STP Humans via the environment</p>	<p>Some exposures (both dermal and inhalation) without local exhaust ventilation (LEV) lead to possible risk for PROC 3 and 8b. However it is possible to reduce these risks by reducing the exposure time to between 15 minutes and 1 hour.</p> <p>(EUSES 2.1.1) 0.471 mg/kg w.w. (Block 12, maximum value) 0.288 mg/kg w.w. (Block 2, maximum value) 0.032 mg/l (Block 4, maximum value)</p> <p>Calculations for man via the environment have not been carried out owing to the limited dispersive use</p>
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Annex

Exposure Scenario (taken from section 9 of the Chemical Safety Report (CSR) for CTO)

9.2. Use in fractionation

9.2.1. Exposure scenario

1. Short title of Exposure Scenario	
Use in fractionation.	
2. Description of activities/process(es) covered in the Exposure Scenario	
Sector of use	SU 3 (Industrial uses: uses of substances as such or in preparations at industrial sites) SU 8 (Manufacture of bulk, large scale chemicals)
Product category	Not applicable
Process category	PROC 1 (Use in closed process, no likelihood of exposure) PROC 2 (Use in closed, continuous process with occasional controlled exposure (e.g. sampling)) PROC 3 (Use in closed batch process (synthesis or formulation)) PROC 4 (Use in batch and other process (synthesis) where opportunity for exposure arises) PROC 8b (Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities) PROC 9 (Transfer of substance or preparation into small containers (dedicated filling line, including weighing))
Article category	Not applicable
Environmental release category	ERC 1 (Manufacture of substances)
3. Operational conditions	
3.1 Duration and frequency of use for which the ES ensures control of risk	
Duration of exposure at workplace:	8 h/d (ECHA default)
Frequency of exposure at workplace:	Up to 240 d per year
Annual amount used per site	Up to 100 000 tonnes
Emission days per site:	Up to 300 days/year
4.1 Physical form of product in which the substance is contained	
Typically liquid.	
4.2 Concentration of substance in preparation or article	
Not applicable	
4.3 Amount used per time or per activity for which the RMMs, in combination with other operational conditions of use ensure control of risk (if applicable)	
Respiration volume under conditions of use:	10 m ³ /d
Area of skin contact with the substance under conditions of use	PROC 2, 8b and 9: 480 cm ³ PROC3: 240 cm ³
Body weight	70 kg
5. Other operational conditions determining exposure, e.g. temperature, capacity of receiving environment (water flow; room size x ventilation rate), emission or release factors to the relevant compartments	
See PFA (2010g). Generic approach to exposure of the environment from fractionation of crude tall oil. Reach Environmental Exposure Scenarios for Crude Tall Oil. Peter Fisk Associates Limited, Kent, UK.	
The referenced document above is available from the supplier of this safety data sheet.	

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6. Risk Management Measures that, in combination with the operational conditions of use, ensure control of risk related to the different target groups	
6.1 Risk management Measures related to workers	
Technical measures Organisational measures	<p>H₂S gas can accumulate over time in the headspace of CTO storage tanks and tank trucks. Its presence can pose a significant hazard to humans and the risk has to be recognised and managed. Appropriate risk management measures include local exhaust ventilation, the setting of standard protocols for proper venting of the tank before entrance, use of workspace and personal gas detectors, and use of respiratory protective equipment. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard.</p> <p>Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.</p> <p>Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or gases.</p> <p>Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.</p>
Respiratory protection	
Hand protection	
Eye protection	
Hygiene measures	
6.2 Environment related measures; type and efficiency of single options or combination of options on exposure to be quantified; options to be phrased as instructive guidance	
Organisational measures Abatement measures waste water Abatement measures waste air Soil	<p>Standard size waste water treatment plant for highly industrial sites.</p> <p>Substance has low volatility and so releases to air are expected to be minimal.</p> <p>The spreading of sludge is assumed as a worst-case scenario.</p>
7. Waste related measures needed to ensure control of risk at the different life cycle stages of the substances (including preparations or articles at the end of service life)	
Type of waste Disposal technique	<p>Aqueous waste</p> <p>Details of the treatment of aqueous waste vary at different fractionation sites but as a minimum for a generic site it is assumed that the effluent is treated off-site in a waste water treatment plant.</p>
Fraction released to environment during waste treatment	Negligible
8. Prediction of exposure resulting from the conditions described above (entries 3-6) and the substance properties	
Workers (oral) Workers (dermal)	<p>No significant oral exposure.</p> <p>Estimated by the means of the ECETOC TRA model. Only values with LEV are shown, except for PROC 1.</p>
PROC 1	0.343 mg/kg/day (no Local Exhaust Ventilation)
PROC 2	0.137 mg/kg/day
PROC 8b	0.686 mg/kg/day
PROC 9	0.686 mg/kg/day
Workers (inhalation)	<p>CTO is assigned to the 'low fugacity' category according to the ECETOC TRA definitions, based on the estimated vapour pressure of 22.7 Pa. This value represents a contribution from a low fraction of volatiles; many constituents are of lower vapour pressure. Therefore, for human health, the exposures via the vapour phase are overestimates. The Guidance does not set out how to deal with UVCBs in respect of human exposure. Only values with LEV are shown, except for PROC 1.</p>

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<p>PROC 1 PROC 2 PROC 8b PROC 9</p>	<p>0.12 mg/m³ (no Local Exhaust Ventilation) 1.20 mg/m³ 1.80 mg/m³ 5.90 mg/m³</p> <p>Some exposures (both dermal and inhalation) without local exhaust ventilation (LEV) lead to possible risk for PROC 8b and 9. However it is possible to reduce these risks by reducing the exposure time to between 15 minutes and 1 hour. The use of gloves will further reduce the risk.</p>
<p>Environment Water (fresh-water) Soil STP Humans via the environment</p>	<p>(EUSES 2.1.1) 0.264 mg/kg w.w. (Block 12, maximum value) 0.16 mg/kg w.w. (Block 2, maximum value) 0.0178 mg/l (Block 4, maximum value)</p> <p>Calculations for man via the environment have not been carried out owing to the limited dispersive use</p>

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Annex

Exposure Scenario (taken from section 9 of the Chemical Safety Report (CSR) for CTO)

9.3. Use as a fuel in energy generation

9.3.1. Exposure scenario

1. Short title of Exposure Scenario	
Use as a fuel in energy generation	
2. Description of activities/process(es) covered in the Exposure Scenario	
Sector of use	SU 3 (Industrial uses: uses of substances as such or in preparations at industrial sites)
Product category	SU 10 (Formulation [mixing] of preparations and/or re-packaging)
Process category	SU 23 (Recycling)
	PC 13 (Fuels)
	PROC 2 (Use in closed, continuous process with occasional controlled exposure (e.g. sampling))
	PROC 3 (Use in closed batch process (synthesis or formulation))
	PROC 5 (Mixing or blending in batch processes (multistage and/or significant contact))
	PROC 8a (Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities)
	PROC 8b (Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities)
	PROC 9 (Transfer of substance or preparation into small containers (dedicated filling line, including weighing))
	PROC 16 (Using material as fuel sources, limited exposure to unburned product to be expected)
Article category	Not applicable
Environmental release category	ERC 2 (Formulation of preparations)
3. Operational conditions	
3.1 Duration and frequency of use for which the ES ensures control of risk	
Duration of exposure at workplace:	8 h/d (ECHA default)
Frequency of exposure at workplace:	Up to 240 d per year
Annual amount used per site	1000 tonnes
Emission days per site:	300 days/year
4.1 Physical form of product in which the substance is contained	
Typically liquid.	
4.2 Concentration of substance in preparation or article	
Not applicable	
4.3 Amount used per time or per activity for which the RMMs, in combination with other operational conditions of use ensure control of risk (if applicable)	
Respiration volume under conditions of use:	10 m ³ /d
Area of skin contact with the substance under conditions of use	PROC 2, 8b and 9: 480 cm ³ PROC3: 240 cm ³
Body weight	70 kg
5. Other operational conditions determining exposure, e.g. temperature, capacity of receiving environment (water flow; room size x ventilation rate), emission or release factors to the relevant compartments	

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<p>Formulation of fuels: Fraction of applied amount lost from process/use to waste gas</p>	<p>0.0025 kg/kg (Applied to blocks with vapour pressures of between 0.01 Pa and 100 Pa. See PFA (2010h). Use of CTO in energy generation. Reach environmental exposure scenarios for Crude Tall Oil. Peter Fisk Associates Limited, Kent, UK.) 0.01 kg/kg (Applied to blocks with vapour pressures of between 0>100 Pa. See PFA (2010h). Use of CTO in energy generation. Reach environmental exposure scenarios for Crude Tall Oil. Peter Fisk Associates Limited, Kent, UK.</p>
<p>Fraction of applied amount lost from process/use to waste water</p>	<p>0.002 kg/kg (Based on ERC2).</p>
<p>Use of fuels: Fraction of applied amount lost from process/use to waste gas</p>	<p>~0 kg/kg (CTO will be destroyed during combustion)</p>
<p>Fraction of applied amount lost from process/use to waste water</p>	<p>0.0005 kg/kg. See PFA (2010h). Use of CTO in energy generation. Reach environmental exposure scenarios for Crude Tall Oil. Peter Fisk Associates Limited, Kent, UK.</p>
<p>Referenced documents above are available from the supplier of this safety data sheet.</p>	

6. Risk Management Measures that, in combination with the operational conditions of use, ensure control of risk related to the different target groups

6.1 Risk management Measures related to workers

<p>Technical measures Organisational measures</p>	<p>H₂S gas can accumulate over time in the headspace of CTO storage tanks and tank trucks. Its presence can pose a significant hazard to humans and the risk has to be recognised and managed. Appropriate risk management measures include local exhaust ventilation, the setting of standard protocols for proper venting of the tank before entrance, use of workspace and personal gas detectors, and use of respiratory protective equipment. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard. Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or gases. Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.</p>
<p>Respiratory protection</p>	
<p>Hand protection</p>	
<p>Eye protection</p>	
<p>Hygiene measures</p>	

6.2 Environment related measures; type and efficiency of single options or combination of options on exposure to be quantified; options to be phrased as instructive guidance

<p>Organisational measures Abatement measures waste water Abatement measures waste air</p>	<p>Onsite: Bunded areas and oil water separator assumed to be 90% efficient. Default standard waste water treatment plant assumed. CTO will be destroyed during combustion.</p>
<p>Soil</p>	<p>The spreading of sludge is assumed as a worst-case scenario.</p>

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7. Waste related measures needed to ensure control of risk at the different life cycle stages of the substances (including preparations or articles at the end of service life)	
Type of waste	Aqueous waste
Disposal technique	Details of the treatment of aqueous waste will vary at different sites but as a minimum it is assumed that on-site treatment such as an oil-water separator is used and the effluent is treated off-site in a standard waste water treatment plant.
Fraction released to environment during waste treatment	Emissions to waste water are likely to be very low (<<1 kg/day).
8. Prediction of exposure resulting from the conditions described above (entries 3-6) and the substance properties	
Workers (oral)	No significant oral exposure.
Workers (dermal)	Estimated by the means of the ECETOC TRA model. Only values with LEV are shown.
PROC 2	0.137 mg/kg/day
PROC 3	0.034 mg/kg/day
PROC 5	0.067 mg/kg/day
PROC 8a	0.137 mg/kg/day
PROC 8b	0.686 mg/kg/day
PROC 9	0.686 mg/kg/day
PROC 16	0.034 mg/kg/day
Workers (inhalation)	Only values with LEV are shown.
PROC 2	1.2 mg/m ³
PROC 3	3.6 mg/m ³
PROC 5	6.0 mg/m ³
PROC 8a	12.0 mg/m ³
PROC 8b	1.80 mg/m ³
PROC 9	6.0 mg/m ³
PROC 16	1.2 mg/m ³
	Some exposures (both dermal and inhalation) without local exhaust ventilation (LEV) lead to possible risk for PROC 5, 8a,8b and 9. However it is possible to reduce these risks by reducing the exposure time to between 15 minutes and 1 hour. The use of gloves will further reduce the risk.
Environment	(EUSES 2.1.1)
Water (fresh-water)	31.2 mg/kg w.w. (Block 12, maximum value)
Soil	4.8 mg/kg w.w. (Block 2, maximum value)
STP	0.533 mg/l (Block 4, maximum value)
Humans via the environment	Calculations for man via the environment have not been carried out owing to the limited dispersive use

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Annex

Exposure Scenario (taken from section 9 of the Chemical Safety Report (CSR) for CTO)

9.4. Generic formulations/preparations and use of these preparations

9.4.1. Exposure scenario

1. Short title of Exposure Scenario	
Generic formulations/preparations and use of these preparations.	
2. Description of activities/process(es) covered in the Exposure Scenario	
Sector of use	SU 3 (Industrial uses: uses of substances as such or in preparations at industrial sites)
Product category	SU 10 (Formulation [mixing] of preparations and/or re-packaging)
	SU 22 (Professional uses: Public domain (administration, education, entertainment, services, craftsmen))
Process category	PC 9a (Coatings and paints, thinners, paint removers)
	PC 18 (Ink and toners)
Article category Environmental release category	PC 32 (Polymer preparations and compounds)
	PC 35 (Washing and cleaning products (including solvent based products))
	PROC 2 (Use in closed, continuous process with occasional controlled exposure (e.g. sampling))
	PROC 3 (Use in closed batch process (synthesis or formulation))
	PROC 5 (Mixing or blending in batch processes (multistage and/or significant contact))
	PROC 8a (Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at non-dedicated facilities)
	PROC 8b (Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities)
	PROC 9 (Transfer of substance or preparation into small containers (dedicated filling line, including weighing))
	Not applicable
	ERC 2 (Formulation of preparations)
	ERC 4 (Industrial use of processing aids in processes and products, not becoming part of articles)
	ERC 5 (Industrial use resulting in inclusion into or onto a matrix)
3. Operational conditions	
3. 1 Duration and frequency of use for which the ES ensures control of risk	
Duration of exposure at workplace:	8 h/d (ECHA default)
Frequency of exposure at workplace:	Up to 240 d per year
Annual amount used per site	100-300 tonnes
Emission days per site:	100-300 days/year
4. 1 Physical form of product in which the substance is contained	
Typically liquid. Headspace of storage vessels may contain hydrogen sulphide.	
4.2 Concentration of substance in preparation or article	
Not applicable	
4.3 Amount used per time or per activity for which the RMMs, in combination with other operational conditions of use ensure control of risk (if applicable)	
Respiration volume under conditions of use:	10 m ³ /d
Area of skin contact with the substance under	PROC3: 240 cm ³ PROC 2, 5, 8b: 480 cm ³

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conditions of use	PROC 8a: 960 cm ³
Body weight	70 kg
5. Other operational conditions determining exposure, e.g. temperature, capacity of receiving environment (water flow; room size x ventilation rate), emission or release factors to the relevant compartments	
Formulation of preparations: Fraction of applied amount lost from process/use to waste gas	0.0025 kg/kg (Applied to blocks with vapour pressures of between 0.01 Pa and 100 Pa. See PFA (2010i). Use of Crude tall oil in generic formulations/preparations and uses of these preparations. Reach Environmental Exposure Scenarios for crude tall oil. Peter Fisk Associates Limited, Kent, UK.
Fraction of applied amount lost from process/use to waste water	0.01 kg/kg (Applied to blocks with vapour pressures of between 0>100 Pa. See PFA (2010i). Use of Crude tall oil in generic formulations/preparations and uses of these preparations. Reach Environmental Exposure Scenarios for crude tall oil. Peter Fisk Associates Limited, Kent, UK.
Use of preparations: Fraction of applied amount lost from process/use to waste gas	0.02 kg/kg (Based on ERC2).
Fraction of applied amount lost from process/use to waste water	0.0025 kg/kg (Applied to blocks with vapour pressures of between 0.01 Pa and 100 Pa. See PFA (2010d). Predicted No Effect Concentrations (PNECs) for Crude Tall Oil constituent blocks. Reference code: PFA.203.105.001. Peter Fisk Associates Limited, Kent, UK.
Fraction of applied amount lost from process/use to waste water	0.01 kg/kg (Applied to blocks with vapour pressures of between 0>100 Pa. See PFA (2010h). Use of CTO in energy generation. Reach environmental exposure scenarios for Crude Tall Oil. Peter Fisk Associates Limited, Kent, UK.
Fraction of applied amount lost from process/use to waste water	0.02 kg/kg. See PFA (2010i). Use of Crude tall oil in generic formulations/preparations and uses of these preparations. Reach Environmental Exposure Scenarios for crude tall oil. Peter Fisk Associates Limited, Kent, UK.
Referenced documents above are available from the supplier of this safety data sheet.	
6. Risk Management Measures that, in combination with the operational conditions of use, ensure control of risk related to the different target groups	
6.1 Risk management Measures related to workers	
Technical measures	H ₂ S gas can accumulate over time in the headspace of CTO storage tanks and tank trucks. Its presence can pose a significant hazard to humans and the risk has to be recognised and managed. Appropriate risk management measures include local exhaust ventilation, the setting of standard protocols for proper venting of the tank before entrance, use of workspace and personal gas detectors, and use of respiratory protective equipment.
Organisational measures	
Respiratory protection	
Hand protection	
Eye protection	
Hygiene measures	
Respiratory protection	Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard.
Hand protection	Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
Eye protection	Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or gases.
Hygiene measures	Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure

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	that eyewash stations and safety showers are close to the workstation location.
6.2 Environment related measures; type and efficiency of single options or combination of options on exposure to be quantified; options to be phrased as instructive guidance	
Organisational measures	
Abatement measures waste water	Onsite: Oil water separator assumed to be 90% efficient. Default standard waste water treatment plant assumed.
Abatement measures waste air	See section 5.
Soil	The spreading of sludge is assumed as a worst-case scenario.
7. Waste related measures needed to ensure control of risk at the different life cycle stages of the substances (including preparations or articles at the end of service life)	
Type of waste	Aqueous waste
Disposal technique	Details of the treatment of aqueous waste will vary at different sites but as a minimum it is assumed that on-site treatment such as an oil-water separator is used and the effluent is treated off-site in a standard waste water treatment plant.
Fraction released to environment during waste treatment	See section 5.
8. Prediction of exposure resulting from the conditions described above (entries 3-6) and the substance properties	
Workers (oral)	No significant oral exposure.
Workers (dermal)	Estimated by the means of the ECETOC TRA model. Only values with LEV are shown.
PROC 2	0.137 mg/kg/day
PROC 3	0.034 mg/kg/day
PROC 5	0.067 mg/kg/day
PROC 8a	0.137 mg/kg/day
PROC 8b	0.686 mg/kg/day
Workers (inhalation)	Only values with LEV are shown.
PROC 2	1.2 mg/m ³
PROC 3	3.6 mg/m ³
PROC 5	6.0 mg/m ³
PROC 8a	12.0 mg/m ³
PROC 8b	1.80 mg/m ³
	Some exposures (both dermal and inhalation) without local exhaust ventilation (LEV) lead to possible risk for PROC 3, 5, 8a and 8b. However it is possible to reduce these risks by reducing the exposure time to between 15 minutes and 1 hour. The use of gloves will further reduce the risk.
Environment	(EUSES 2.1.1)
Water (fresh-water)	3.12 mg/kg w.w. (Block 12, maximum value)
Soil	0.48 mg/kg w.w. (Block 2, maximum value)
STP	0.533 mg/l (Block 4, maximum value)
Humans via the environment	Calculations for man via the environment have not been carried out owing to the limited dispersive use