Section 1 Identification of the substance/mixture and of the company/undertaking

1.1 Product identifier:

Identification on the label/Trade name: TCPP

Additional identification: Nanoform is NOT covered by this eSDS.

Identification of the product: CAS#1244733-77-4 EC#807-935-0

Index Number: N/A

REACH registration No.: 01-2119486772-26-XXXX

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

1.2.1 Identified uses:

Formulation

Rigid foam - Industry applications

Rigid foam- Professional applications

Rigid foam Service life

1.2.2 Uses advised against:

No uses advised against are identified.

1.3 Details of the supplier of the safety data sheet:

Supplier(Only representative): Chemical Inspection & Regulation Service Limited

Supplier: Bloomchemag BV

Address: Sint - Antoniusstraat 16 b1, B-2400 Mol, Belgium.

Contact person(E-mail): info@bloomchemag.com

Telephone: +917291999329

1.4 Emergency telephone Number:

+917291999329 Only available during office hours (9:00a.m.-17:30p.m.)

Available outside office hours? YES [ ] NO [X]

Section 2 Hazards Identification

2.1 Classification of the substance or mixture:

2.1.1 Classification of the substance:

The substance is classified as following according to REGULATION (EC) No 1272/2008:

REGULATION (EC) No 1272/2008	
Hazard classes/Hazard categories	Hazard statement
Acute Tox. 4	H302
Aquatic Chronic 3	H412

For full text of H- phrases: see section 2.2.

2.2 Label elements:

Hazard pictogram(s):

Signal word: Warning

Hazard statement(s):	H302: Harmful if swallowed. H412: Harmful to aquatic life with long lasting effects.
Precautionary statement(s):	P264: Wash hands thoroughly after handling. P270: Do not eat, drink or smoke when using this product. P273: Avoid release to the environment. P301+P312: IF SWALLOWED: Call a POISON CENTRE/doctor if you feel unwell. P330: Rinse mouth. P501: Dispose of contents/container in accordance with local regulations.
Supplemental Hazard information (EU)	Not applicable.

2.3 Other hazards:

The substance is not PBT / vPvB.

The substance is not identified as having endocrine disrupting properties.

Section 3 Composition/information on ingredients

Substance/Mixture: Substance

Ingredient(s):

Chemical Name	Registration No.	CAS No.	EC No.	Concentration	Specific Concentration limits, M-Factors, Acute Toxicity Estimates (ATE)
tris(2-chloro-1-methyl ethyl) phosphate	01-2119486772-26-****	13674-84-5	237-158-7	75.2254 % (w/w)	N/A
bis(2-chloropropyl)-1chloro-2-propyl phosphate		76649-15-5	616-366-5	2.1517 % (w/w)	N/A
bis(1-chloro-2-propyl) -2-chloropropyl phosphate		76025-08-6	616-283-4	20.8427 % (w/w)	N/A
Unknown impurities	N/A	N/A	N/A	1.7801 % (w/w)	N/A

Section 4 First aid measures

4.1 Description of first aid measures:

In all cases of doubt, or when symptoms persist, seek medical attention.

4.1.1 In case of inhalation:

If breathed in, move person into fresh air. If unconscious, place in recovery position and seek medical advice. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Consult a physician after significant exposure. Maintain open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

4.1.2 In case of skin contact:

After contact with skin, wash immediately with plenty of soap and water. Remove contaminated clothing and shoes. In the case of skin irritation or allergic reactions see a physician. Wash contaminated clothing before re-use.

4.1.3 In case of eyes contact:

Immediately flush eye(s) with plenty of water. Remove contact lenses. Protect unharmed eye. Keep eye wide open while rinsing. If eye irritation persists, consult a specialist.

4.1.4 In case of ingestion:

Rinse mouth with water. Give small amounts of water to drink. Stop if the exposed person feels sick as vomiting may be

dangerous. DO NOT induce vomiting unless directed to do so by a physician or poison control center. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Keep respiratory tract clear. Loosen tight clothing such as a collar, tie, belt or waistband. If symptoms persist, call a physician.

Induce vomiting, but only if victim is fully conscious.

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

Harmful if swallowed.

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

Treatment: Treat symptomatically.

If skin irritation or rash occurs, get medical advice/attention.

Section 5 Firefighting measures

5.1 Extinguishing media: Suitable extinguishing media:

Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Unsuitable extinguishing media: None known.

5.2 Special hazards arising from the substance or mixture

In case of fire, the following can be released: Carbon dioxide (CO2); Carbon monoxide; Oxides of phosphorus; Halogenated compounds

5.3 Advice for firefighters:

Special protective equipment for firefighters:

Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Further information:

Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Standard procedure for chemical fires. Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.

Section 6 Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures:

6.1.1 For non-emergency personnel:

No action shall be taken involving any personal risk or without suitable training. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Do not breathe vapours or spray mist. Provide adequate ventilation. In case of inadequate ventilation wear respiratory protection. Use personal protective equipment.

6.1.2 For emergency responders:

Wear an appropriate NIOSH/MSHA approved respirator if vapor is generated. If specialised clothing is required to deal with the spillage, take note of any information on suitable and unsuitable materials. See also the information in "For non-emergency personnel".

6.2 Environmental Precautions:

Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Prevent product from entering drains. Prevent further leakage or spillage if safe to do so. If the product contaminates rivers and lakes or drains inform respective authorities.

6.3 Methods and material for Containment and Cleaning up:

Stop the leak if it can be done without risk. Soak up with inert absorbent material (e.g. sand, silica gel, acid binder, universal binder, sawdust). Contaminated absorbent material may pose the same hazard as the spilled product. Keep in suitable, closed containers for disposal. Dispose of wastes in an approved waste disposal facility.

6.4 Reference to other sections:

See Section 7 for information on safe handling.
See Section 8 for information on personal protection equipment.
See Section 13 for information on disposal.

Section 7 Handling and storage

7.1 Precautions for safe handling:

7.1.1 Protective measures:

Handle in accordance with good industrial hygiene and safety practice. Do not breathe dusts/vapor. Avoid contact with skin and eyes Handle in well ventilated areas. Eliminate all sources of ignition, and do not generate flames or sparks. Take precautionary measures against static discharges.

7.1.2 Advice on general occupational hygiene:

Do not get in eyes or mouth or on skin. Avoid inhalation of vapour or mist. Smoking, eating and drinking should be prohibited in the ap-plication area. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Put on appropriate personal protection equipment. Empty containers retain product residue; observe all precautions for product. Do not re-use empty containers. Dispose of rinse water in accordance with local and national regulations.

7.2 Conditions for safe storage, including any incompatibilities:

Requirements for storage areas and containers.
Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials and food and drink. Keep containers sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate container to avoid environmental contamination. Electrical installations / working materials must comply with the technological safety standards. Storage class (TRGS 510): 10, Combustible liquids
Recommended storage temperature: < 50 °C

7.3 Specific end use(s):

Not applicable.

Section 8 Exposure Controls/Personal Protection

8.1 Control parameters:

8.1.1 Occupational exposure limits: Not available. **8.1.2**

Additional exposure limits under the conditions of use: Not available.

8.1.3 DNEL/DMEL and PNEC-Values:

Workers - Hazard via inhalation route	Systemic effects-Long term exposure	DNEL=8.2 mg/m^3
Workers - Hazard via dermal route	Systemic effects-Long term exposure	DNEL=2.91 mg/kg bw/day
General Population - Hazard via inhalation route	Systemic effects-Long term exposure	DNEL=1.45 mg/m^3
General Population - Hazard via dermal route	Systemic effects-Long term exposure	DNEL=1.04 mg/kg bw/day
General Population - Hazard via oral route	Systemic effects-Long term exposure	DNEL=0.52 mg/kg bw/day
Hazard for aquatic organisms	Freshwater	PNEC=0.32 mg/L
Hazard for aquatic organisms	Marine water	PNEC=0.032 mg/L
Hazard for aquatic organisms	STP	PNEC=19.1 mg/L
Hazard for aquatic organisms	Sediment (freshwater)	PNEC=11.5 mg/kg sediment dw
Hazard for aquatic organisms	Sediment (marine water)	PNEC=1.15 mg/kg sediment dw
Hazard for terrestrial organisms	Soil	PNEC=0.34 mg/kg soil dw
Hazard for predators	Secondary poisoning	PNEC=11.6 mg/kg food

8.2 Exposure controls:

8.2.1 Appropriate engineering controls: If user operations generate dust, fumes, gas, vapour or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits

8.2.2 Individual protection measures, such as personal protective equipment:

Eye/face protection: Wear safety glasses with side shields or goggles

Skin protection

Hand protection: Material: Polyvinyl chloride - PVC

Wearing time: < 60 min Remarks:

The suitability for a specific workplace should be discussed with the producers of the protective gloves. After contamination with product change the gloves immediately and dispose of them according to relevant national and local regulations

Body protection: Wear suitable protective clothing.

Respiratory protection: In the case of vapour formation use a respirator with an approved filter. Filter type: Full-face respirator with ABEK-filter. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Thermal hazards: Wear suitable protective clothing to prevent heat.

8.2.3 Environmental exposure controls: Avoid discharge into the environment. According to local regulations, Federal and official regulations.

Section 9 Physical and chemical properties

9.1 Information on basic physical and chemical properties:

Physical state:	liquid
Colour:	Clear colourless
Odour:	odourless
Melting point/freezing point (°C):	< -20 °C at 1013 hPa
Boiling point or initial boiling point and boiling range (°C):	288 °C (at 1014.2 hPa) with decomposition.
Flammability (gas, liquid, solid):	Non flammable
Lower and upper explosion limit:	Not available
Flash point (°C):	For TCPP no flash point was determined below decomposition (245°C).
Auto-ignition temperature:	>400 °C
Decomposition temperature:	245 °C
pH:	Not available
Kinematic viscosity (mm^2/s):	68.5 mPa · s (dynamic) at 20 °C
Solubility in water (g/l, 20°C):	1.08 g/L (20 °C; pH = 5.7)
Solubility in other polar and non-polar solvents (g/l, 20°C):	Not available
Partition coefficient n-octanol/water (log Po/w, 20°C):	The experimentally determined logKow for TCPP was 2.68 at 30 °C and pH 7.1.
Vapour pressure (20°C):	0.000014 hPa at 25 °C
Bulk density (kg/m^3):	Not available
Relative Density (g/cm^3):	1.29 at 20 °C
Relative vapour density:	Not available
Particle characteristics:	Not applicable

Evaporation rate:	Not available
Flammability limit - lower (%):	Not available
Ignition temperature (°C):	Not available
Explosive properties:	Non explosive
Oxidising properties:	Non oxidising
Molecular Formula:	C9H18Cl3O4P
Molecular Weight:	327.57

9.2. Other information:

Fat solubility(solvent-oil to be specified) etc:	Not available
Surface tension:	Not available
Dissociation constant in water(pKa):	Not available
Oxidation-reduction Potential:	Not available

Section 10 Stability and reactivity

10.1 Reactivity:	No specific test data related to reactivity available for this product or its ingredients.
10.2 Chemical stability:	Stable under normal conditions. Possibility of hazardous reactions.
10.3 Possibility of hazardous reactions:	Under normal conditions of storage and use, hazardous reactions will not occur.
10.4 Conditions to avoid:	Incompatible materials. Keep away from heat. Proximity to sources of ignition.
10.5 Incompatible materials:	Strong oxidizers.
10.6 Hazardous decomposition products:	No hazardous decomposition products are known.

Section 11 Toxicological information

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

Acute toxicity: **LD50(Oral, Rat):**	> 500 - < 2000 mg/kg bw
LD50(Dermal, Rabbit):	> 2000 mg/kg bw
LC50(Inhalation, Rat):	> 7 mg/L air (4h)
Skin corrosion/Irritation:	Not classified
Serious eye damage/irritation:	Not classified
Respiratory or skin sensitization:	Not classified
Germ cell mutagenicity:	Not classified
Carcinogenicity:	Not classified
Reproductive toxicity:	Not classified
STOT- single exposure:	Not classified
STOT-repeated exposure:	Not classified
Aspiration hazard:	Not classified

11.2 Information on other hazards

Endocrine disrupting properties	The substance is not identified as having endocrine disrupting properties.
Other information	Not applicable

Section 12 Ecological information

12.1 Toxicity:

Acute (short-term) toxicity:

LC50(96h, Fish):	51 mg/L
LC50(48h, Daphnia magna):	131 mg/L
EC50(72h, Algae/aquatic plants):	82 mg/L

Chronic (long-term) toxicity:

NOEC(Fish):	Not available
NOEC(Daphnia magna):	32 mg/L
EC50(Algae/aquatic plants):	13 mg/L

12.2 Persistence and degradability: not ready biodegradable

TCPP has no potential on bioaccumulation in both aquatic and terrestrial organisms.

12.3 Bioaccumulative potential:

12.4 Mobility in soil: Koc at 20 °C: 324.2

12.5 Results of PBT and vPvB assessment: The substance is not PBT / vPvB.

12.6 Endocrine disrupting properties: The substance is not identified as having endocrine disrupting properties.

12.7 Other adverse effects: Not available.

12.8 Additional information Not available.

Section 13 Disposal considerations

13.1 Waste treatment methods: Dispose of in accordance with all applicable local and national regulations. Use recovery/recycling where feasible, otherwise incineration is the recommended method of disposal. Empty containers may contain hazardous residues. Do not cut, puncture or weld on or near to the container. Labels should not be removed from containers until they have been cleaned. Contaminated containers must not be treated as household waste. Containers should be cleaned by appropriate methods and then re-used or disposed of by landfill or incineration as appropriate. Do not incinerate closed containers.

Section 14 Transport information

	Land transport (ADR/RID)	Inland waterways (ADN)	Sea transport (IMDG)	Air transport (ICAO/IATA)
14. 1 UN number or ID number	Not regulated	Not regulated	Not regulated	Not regulated
14.2 UN Proper shipping name	Not regulated	Not regulated	Not regulated	Not regulated
14.3 Transport hazard Class(es)	Not regulated	Not regulated	Not regulated	Not regulated
14.4 Packing group	Not regulated	Not regulated	Not regulated	Not regulated
14.5 Environmental hazards	No	No	No	No

14.6 Special precautions for user	See section 2.2	See section 2.2	See section 2.2	See section 2.2
14.7 Maritime transport in bulk according to IMO instruments	Not regulated	Not regulated	Not regulated	Not regulated

Section 15 Regulatory information

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

X NO

Relevant information regarding authorization: Not applicable.
Relevant information regarding restriction: Not applicable.
Other EU regulations: Employment restrictions concerning young person must be observed. For use only by technically qualified individuals.

Other National regulations: Not applicable
15.2 Chemical safety assessment YES

Section 16 Other information

16.1 Indication of changes:

Version 1.0 Amended by (EU) 2020/878

Version 2.0 Exposure scenarios are placed after section 16.

16.2 Abbreviations and acronyms:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road

RID: Regulation for rail International transportation of Dangerous goods

ADN: European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways

IMDG: Code international maritime dangerous goods code

ICAO: International Civil Aviation Organization

IATA: International Air Transport Association

LC50: median lethal concentration

EC50: The effective concentration of substance that causes 50% of the maximum response.

NOEC: No Observed Effect Concentration

DNEL: derived no-effect level

PNEC: predicted no-effect concentration

16.3 Key literature references and sources for data

ECHA Registered substances data

16.4 Classification and procedure used to derive the classification for mixtures according to Regulation (EC) 1272/2008 [CLP]

Classification according to Regulation (EC) No. 1272/2008		Classification procedure
Acute Tox. 4	H302	On basis of test data
Aquatic Chronic 3	H412	On basis of test data

16.5 Relevant H-statements (number and full text):

H302: Harmful if swallowed.

H412: Harmful to aquatic life with long lasting effects.

16.6 Training instructions:

Not applicable.

16.7 Further information:

This information is based upon the present state of our knowledge. This SDS has been compiled and is solely intended for this product.

16.8 Notice to reader:

Employers should use this information only as a supplement to other information gathered by them, and should make independent judgment of suitability of this information to ensure proper use and protect the health and safety of employees. This information is furnished without warranty, and any use of the product not in conformance with this Safety Data Sheet, or in combination with any other product or process, is the responsibility of the user.

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The exposed scenario section is extracted from the CSR.

1 Exposure assessment

In May 2008, the European Union finalised the Risk Assessment Report on TCPP in accordance with Council Regulation (EEC) 793/93 on the evaluation and control of the risks of "existing" substances. The EU-RAR was developed by the Member States Ireland (lead) and United Kingdom in close cooperation with the companies manufacturing, importing and/or using the chemical substance. The Chemical Safety Report here is mainly based on the existing EU Risk Assessment Report. Therefore, the publically available information from the EU-RAR served as a basis for the assessment of the different use scenarios in this CSR. Nevertheless, it was necessary to implement some deviations from the EU-RAR (2008). This was mainly due to changes in the production volume and differences in the approach to develop the use scenarios. The deviations are discussed at their respective section within this report.

The environmental exposures were either calculated manually (manufacturing, generic scenario) or by EUSES v. 2.1 (all other scenarios). Two different EUSES files were created (one containing the manufacturing scenario, and one containing all other scenarios). A regional PEC for air was recalculated for both files, covering releases from in-service life of different uses (see section 错误! 未找到引用源。 for more details). In addition, the regional emissions for wastewater and surface water were also added to cover emissions from waste after in-service life of articles (see section 错误!未找到引用源。 or more details). After these corrections, the regional PEC values were calculated as the sum of the regional PEC values from both EUSES files and manually adjusted in all files. Measured environmental concentrations in the different compartments overall showed good agreement with estimated values (EU-RAR, 2008). Therefore, only EUSES calculated values are used in the current exposure and risk assessment.

The following substance specific values have been entered in the exposure model EUSES v.2.1.

Molecular weight	327.57 g/mol
Vapour pressure	1.4E-06 kPa @ 25° C (minimum value in EUSES)
Water solubility	1080 mg/L @ 20°C
Octanol/water partition coefficient	logPow = 2.68
Soil adsorption coefficient	Koc = 174 L/kg
BCF for fish	2.7 L/kg wwt
Biodegradability	inherently biodegradable – not fulfilling the criteria

The following substance specific values have been entered in the exposure model ECETOC TRA version April 2010.

Molecular weight	327.57 g/mol
Vapour pressure	0.0014 Pa

Table 1-1: Overview on exposure scenarios and coverage of substance life cycle

ES number	Refined life cycle stage (as reported for environmental exposure in EU-RAR, 2008)	Manufacture	Identified uses			Resulting life cycle stage		Linked to Identified Use	Sector of Use (SU)	Preparation Category (PC)	Process Category (PROC)	Article Category (AC)	Environmental Release Category (ERC)
			Formulation	End use	Consumer use	Service life (for articles)	Waste stage						
ES 2: Formulation	*A1a Large Systems Houses* *A2 Medium Systems Houses* *A3 Small Systems Houses A4 Systems Houses* *preformulated polyol* *E One-component Foam*		*X*						3, 10	*32*	*1, 2, 3, 4, 5, 8a, 8b, 9*		*2, 3*
ES 3: Rigid foam – Industry applications	*C1 large sites* *C2 small sites*			*X*					3, 12	*32*	*1, 2, 3, 4, 5, 7, 8a, 8b, 9, 19, 21*		*2, 3, 5*
ES 4: Rigid foam – Service life						*X*			21		*14,21,24*	*1, 2, 7, 11, 13*	*10a, 11a*
ES 5: Rigid foam – Professional applications				*X*					22	*32*	*5, 8a, 10, 11, 21*	*1, 2, 13*	*8c, 8f*

1.1 Exposure scenario 1: Manufacture of TCPP

Not relevant

1.2 Exposure scenario 2: Formulation

1.2.1 Exposure scenario

Polyurethane (PUR) is produced from the reaction of di-isocyanates with polyols. Most producers of PUR for foams buy polyols, di-isocyanates and other raw materials, such as flame retardants, direct from manufacturers, while others purchase pre-formulated, ready-to-use systems. PUR systems consist of 2 components: the polyol component (containing TCPP) and the isocyanate component. TCPP is added to polyols in the formulation of PUR systems (EU-RAR, 2008).

Exposure Scenario 2: Formulation	
1. Title	
Free short title	Formulation
Systematic title based on use descriptor	SU 3, 10 PROC 1, 2, 3, 4, 5, 8a, 8b, 9 ERC 2, 3 PC 32
Processes, tasks activities covered	Formulation, packing and re-packing of the substance and its mixtures in batch or continuous operations, including storage, materials transfers, mixing, sampling, and maintenance.
Assessment Method*	Worker's Assessment Method: ECETOC TRA version April 2010 Environmental Assessment Method: EUSES v. 2.1
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
Crude TCPP is liquid at room temperature with a low vapour pressure at 25°C. The calculated saturated vapour concentration is 0.19 mg/m³ at 21°C.	
Frequency and duration of use/exposure	
Duration: > 4h per day Frequency: 240 days per year	
Other given operational conditions affecting workers exposure	
The work is carried out indoor at ambient temperatures.	
Technical conditions and measures to control dispersion from source towards the worker	
Local exhaust ventilation is required, except for PROC1,2,3 (use in closed (batch) processes where occasional exposure could arise).	
Conditions and measures related to personal protection, hygiene and health evaluation	
No specific personal protection is required. However, dermal exposure will be reduced if the operators wear suitable gloves and change them regularly.	
2.2 Control of environmental exposure	
Refined life cycle stage, as reported for environmental exposure of TCPP in EU-RAR, 2008.	

A1a: Large system houses (using raw chemicals) A2: Medium system houses (using raw chemicals) A3: Small system houses (using raw chemicals) A4: System houses pre-formulated polyol
Product characteristics
In case TCPP is used raw, it is applied as a liquid.
Exposure Scenario 2: Formulation
Amounts used
Total relevant tonnage for application: A: 22975 tpa
Frequency and duration of use
Continuous formulation, 300 emission days in 1 year, except for scenario A4: 205 emission days a year.
Environment factors not influenced by risk management
Default dilution factor of 10 to river water, and an additional default dilution factor of 10 to marine water.
Other given operational conditions affecting environmental exposure
Indoor formulation.
Technical conditions and measures at process level (source) to prevent release
No detailed information available in EU-RAR (2008) for ES; release factors are taken from the Emission Scenario Document (OECD, 2004), as referred to in the EU-RAR (2008).
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
It is anticipated that wastewater is treated via a municipal sewage treatment plant (STP).
Organizational measures to prevent/limit release from site
It is assumed that a minimal standard set of release preventing measures are applied.
Conditions and measures related to municipal sewage treatment plant
A default municipal sewage treatment plants was assumed present, thus default STP settings were applied.
Conditions and measures related to external treatment of waste for disposal
It is assumed that any waste for disposal is treated as hazardous waste and will be treated accordingly.
Conditions and measures related to external recovery of waste
Not applicable.

1.2.2 Exposure estimation

1.2.2.1 Workers exposure

Exposure was modelled with ECETOC TRA (version April 2010). All PROCs relevant for this exposure scenario (i.e. PROC 1, 2, 3, 4, 5, 8a, 8b and 9) were entered in the model. Only the PROC resulting in the highest exposure estimates, are listed in the table below. The other PROCs resulted in lower exposure estimates.

The duration of the activity is full shift (> 4h per day) with a frequency of 240 days per year. The work is carried out indoor at ambient temperatures. Local exhaust ventilation is required, except for PROC1, 2 and 3 (use in closed (batch) processes where occasional exposure could arise). For the exposure estimations, LEV was only assumed when necessary.

1.2.2.1.1 Acute/Short term exposure

For acute effects, the full shift estimations based on ECETOC TRA calculations, can be used to derive acute exposure estimates. Since full shift estimates in ECETOC TRA are assumed to represent the 90th percentile of the exposure distribution and since in general the variability is not very high, a multiplying factor of 2 is recommended to estimate the 95th percentile of the related short team exposure distribution.

Summary of the short-term exposure values.

Table 1-2: Summary of acute exposure concentrations to workers

Routes of exposure	Concentrations	Justification
Dermal systemic exposure (in mg/kg bw/d)	2.743	based on ECETOC TRA calculations (PROC 2)
Inhalation exposure (in mg/m3)	2.730	based on ECETOC TRA calculations (PROC 2&3)

1.2.2.1.2 Long-term exposure

In the EU-RAR (2008), some monitoring data are reported. The reasonable worst case and/or typical exposure values that were reported there, are included in the table below. For details on the methodology of the monitoring data, please see the EU-RAR (2008).

Table 1-3: Long-term exposure concentrations to workers

Routes of exposure	Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
	value	unit	Value	unit	
Dermal exposure	1.371	mg/kg bw/d			based on ECETOC TRA calculations (PROC 2)
					no monitoring data available.
Inhalation exposure	1.365	mg/m³			based on ECETOC TRA calculations (PROC 2&3)
			5	µg/m³	personal inhalation monitoring (8h TWA) taken during formulation of polyols containing TCPP (EU-RAR, 2008, p.165). Reasonable worst case (all data were below the limit of detection = 5 µg/m³)
			2.5	µg/m³	personal inhalation monitoring (8h TWA) taken during formulation of polyols containing TCPP (EU-RAR, 2008, p.165). Typical exposure value (half of the limit of detection = 5 µg/m³)

In practice, dermal exposure will be reduced if the operators wear suitable gloves and change them regularly.

Summary of the long-term exposure values.

Table 1-4: Summary of long-term exposure concentration to workers

Routes of exposure	Concentrations	Justification
Dermal systemic exposure (in mg/kg bw/d)	1.371	based on ECETOC TRA calculations (PROC 2)
Inhalation exposure (in mg/m3)/8h workday	1.365	based on ECETOC TRA calculations (PROC 2&3)

1.2.2.2 Indirect exposure of humans via the environment (oral)

Table 1-5: Concentration for oral exposure of humans via the environment

	Exposure Scenario	Estimated exposure concentrations		Explanation
		value	unit	
Wet fish	A1a	1.53E-03	mg/kg	
	A2	0.103		
	A3	0.027		
	A4	3.59E-03		
Drinking water	A1a	0.0245	mg/l	
	A2	0.0382		
	A3	0.01		
	A4	2.47E-03		
Meat	A1a	4.87E-03	mg/kg w.w	
	A2	1.26E-03		
	A3	3.29E-04		
	A4	4.46E-05		
Milk	A1a	3.22E-03	mg/kg w.w	
	A2	8.29E-04		
	A3	2.17E-04		
	A4	2.94E-05		

Summary of the exposure concentration in to be used for the risk characterisation of indirect exposure of man via the environment

Table 1-6: Total daily dose for oral exposure of humans via the environment

Exposure Scenario	Total daily dose for oral exposure via the environment (mg/kg bw/d)	Justification

	Exposed via local concentration	Exposed via local and regional concentration	
A1a	0.107	1.07E-01	Regional total daily intake for humans: 2.41E-04 mg/kg bw/d
A2	0.0294	2.96E-02	
A3	7.73E-03	7.97E-03	
A4	1.11E-03	1.35E-03	

1.2.2.3 Environmental exposure

Environmental exposure estimates for formulation were obtained from EUSES v. 2.1. The following parameters were set for this exposure scenario:

Industry Category 11 Polymers industry

Use Category 22 Flame-retardants and fire preventing agents

Extra details on use category Polymer processing
Thermoplastics: additives, pigments, fillers

Tonnage (2009) total tonnage for uses A1a – A4: 22975 tpa

Fraction of the main local source A1a: confidential (remark: in accordance with the approach of the TCPP EU-RAR (2008), the release settings for this scenario were kept confidential and further calculations were based on output values that were 'set' in EUSES.)
A2: 1
A3: 0.45
A4: 1

Number of emission days A1a: confidential, see remark above
A2: 300 days
A3: 300 days
A4: 205 days

For scenario A1a, other environmental release settings are kept confidential as explained above (see remark).

For the scenarios A2, A3 and A4, environmental releases as a result of handling (as opposed to compounding) are set to 0 %. In addition, emissions to industrial soil are set to 0 % and release fractions to air and wastewater are both set to 0.025. This is in accordance with the EU-RAR (2008).

All other parameters were used as default settings in EUSES v. 2.1., according to the A- and B-emission tables.

1.2.2.3.1 Environmental releases

Summary of the releases taken into account for the exposure estimation. **Table 1-7: Summary of the releases to the environment**

Compartments	Exposure Scenario	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Aquatic (without STP)	A1a	Confidential*	26.26	*See remark above.
	A2	0.936		
	A3	0.235		
	A4	0.028		
Aquatic (after STP)	A1a	Confidential*	25.82	*See remark above.
	A2	0.916		
	A3	0.230		
	A4	0.0274		
Air (direct + STP)	A1a	Confidential*	151.5	*See remark above.
	A2	0.936		
	A3	0.235		
	A4	0.0280		
Soil (direct releases only)	All	0	0.97	

1.2.2.3.2 Exposure concentration in sewage treatment plants (STP)

Summary of the exposure concentration in sewage treatment plants taken into account for further exposure estimation (water and soil concentrations) or risk characterisation for micro organisms in the STP

Table 1-8: Predicted Exposure Concentrations (PEC) in sewage

		Value	Justification
Concentration in sewage (PECstp)(in mg/l)	A1a	0.671	
	A2	0.458	
	A3	0.115	
	A4	0.0137	
Concentration in sewage sludge (in mg/kg d.w.)	A1a	Confidential*	*See remark above.
	A2	25.2	
	A3	6.33	
	A4	0.755	

1.2.2.3.3 Exposure concentration in aquatic pelagic compartment

Summary of the Predicted Exposure Concentrations (PEC) in the aquatic pelagic compartment taken into account for risk characterisation

Table 1-9: Predicted Exposure Concentrations (PEC) in aquatic compartment

Compartments	Exposure Scenario	Local concentration	PEC aquatic (local+regional)	Justification
Freshwater (in mg/l)	A1a	5.97E-06	5.67E-04	
	A2	0.0458	0.0464	
	A3	0.0115	0.0121	
	A4	1.37E-03	1.93E-03	
Marine water (in mg/l)	A1a	6.12E-06	6.21E-05	
	A2	4.68E-03	4.74E-03	
	A3	1.17E-03	1.23E-03	
	A4	1.4E-04	1.96E-04	
Intermittent releases to water (in mg/l)	all	Not applicable	Not applicable	

1.2.2.3.4 Exposure concentration in sediments

Summary of the exposure concentration in aquatic sediments taken into account for risk characterisation

Table 1-10: Predicted Exposure Concentrations (PEC) in sediments

Compartments	Exposure Scenario	Local concentration	PEC sediment (local+regional)	Justification
Freshwater sediments (in mg/kg w.w)	A1a	Not reported in EUSES	0.0119	
	A2		0.974	
	A3		0.253	
	A4		8.82E-03	
Marine water sediments (in mg/kg w.w.)	A1a	Not reported in EUSES	1.3E-03	
	A2		0.0995	
	A3		0.0258	
	A4		8.96E-04	

1.2.2.3.5 Exposure concentrations in soil and groundwater

Summary of the Predicted Exposure Concentration (PEC) in soil and groundwater taken into account for risk characterisation.

Table 1-11: Predicted Exposure Concentrations (PEC) in soil and groundwater

	Exposure Scenario	Local concentration	PEC soil/groundwater (local+regional)	Justification

Agricultural soil averaged (mg/kg ww)	A1a	0.0863	0.0928	Averaged over 30 days.
	A2	0.0577	0.0641	
	A3	0.0145	0.0209	
	A4	1.71E-03	8.17E-03	
Grassland averaged (mg/kg ww)	A1a	0.0312	0.0377	Averaged over 180 days.
	A2	0.0191	0.0255	
	A3	4.79E-03	0.0112	
	A4	5.45E-04	7E-03	
Groundwater(mg/l)	A1a	Not reported in EUSES	0.0245	Groundwater under agricultural soil.
	A2		0.017	
	A3		5.78E-03	
	A4		2.47E-03	

1.2.2.3.6 Atmospheric compartment

Summary of the Predicted Exposure Concentration in air

Table 1-12: Predicted Exposure Concentration (PEC) in air

	Exposure Scenario	Local concentration	PEC air (local+regional)	Justification
During emission (mg/m3)	A1a	1.2E-03	Not reported in EUSES	
	A2	2.6E-04		
	A3	6.53E-05		
	A4	7.8E-06		
annual average (mg/m3)	A1a	8.76E-04	8.76E-04	100 m from point source.
	A2	2.14E-04	2.14E-04	
	A3	5.37E-05	5.39E-05	
	A4	4.38E-06	4.53E-06	
Annual deposition (mg/m2/d)	A1a	3.57E-03	Not reported in EUSES	Annual average total deposition flux.
	A2	1.5E-03		
	A3	3.76E-04		
	A4	3.06E-05		

1.2.2.3.7 Exposure concentration relevant for the food chain (Secondary poisoning)

Summary of the Predicted Exposure Concentration in food for secondary poisoning taken into account for risk characterisation

Table 1-13: Predicted Exposure Concentration in food (PECoral) for secondary poisoning

	Exposure Scenario	Local concentration	PEC oral (local+regional)	Justification

PECoral predator (in mg/kg w.w)	A1a	Not reported in EUSES	1.52E-03* 1.57E-04**	* freshwater ** marine water
	A2		0.0523* 5.34E-03**	
	A3		0.0143* 1.45E-03**	
	A4		2.55E-03* 2.57E-04**	
PECoral top predator (in mg/kg w.w.)	A1a	Not reported in EUSES	1.52E-04	Fish-eating marine top-predator.
	A2		1.19E-03	
	A3		4.12E-04	
	A4		1.72E-04	
Concentration in earthworm (in mg/kg w.w.)	A1a	Not reported in EUSES	0.0793	Earthworms from agricultural soils.
	A2		0.0558	
	A3		0.0209	
	A4		0.0106	

1.3 Exposure scenario 5: Rigid foam – Industry applications

Rigid foams are mainly produced for insulation purposes at construction sites. For PUR insulation foams in general, 90% of the usage of additive flame retardants is currently accounted for by TCPP (Leisewitz A, Hermann K and Schram E, 2001).

Some of the key products associated with PUR insulating foam are the following: flexible-faced laminate, sandwich panels, discontinuous panels, block foams and injected foams. The majority of external panels used on modern commercial and industrial buildings use rigid PUR.
There are many other applications of rigid PUR, but industry has indicated that the only rigid foam application in which TCPP is used, is in construction panels for roofs, walls and floors. Other applications use either no flame retardants or other types of flame retardants.
Deliveries of TCPP are usually made via road tankers, although intermediate bulk containers (IBCs) can also be used. Deliveries take approximately between 1.5 and 2 hours to offload the 10-20 tonnes.

For the production of PUR rigid foam, diphenylmethane-di-isocyanate is mixed with a polyol component in a mixing head. Influenced of catalysts, the reaction starts within seconds while the mixture is poured on a transport belt, shielded by flexible or rigid facings, depending on the type of rigid foam required. The foam rises and cures and after several meters, the foam is sufficiently stable to be cut into blocks or panels.

More details on the production and use of rigid foam can be found in Appendix A (section 4) of the EU-RAR (2008).

1.3.1 Exposure scenario

Exposure Scenario 5: Rigid foam – Industry applications	
1. Title	
Free short title	Rigid foam – Industry applications
Systematic title based on use descriptor	SU 3, 12 PROC 1, 2, 3, 4, 5, 7, 8a, 8b, 9, 19, 21 ERC 2, 3, 5 PC 32
Processes, tasks activities covered	Industrial production of rigid foam
Assessment Method*	Worker's Assessment Method: ECETOC TRA version April 2010 Environmental Assessment Method: EUSES v. 2.1
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
TCPP is liquid at room temperature with a low vapour pressure at 25°C. The calculated saturated vapour concentration is 0.19 mg/m³ at 21°C.	
Amounts used	
The TCPP content in rigid foams is usually in the range of 2-9%.A maximal concentration of 30% was considered for all uses.	
Frequency and duration of use/exposure	
Duration: >4h per day Frequency: 240 days per year	
Human factors not influenced by risk management	
The occurrence of any TCPP vapour during the production process will be limited in quantity and duration, as the foam cells have to be closed to retain the blowing agent which also acts as the insulating gas.	
Exposure Scenario 5: Rigid foam – Industry applications	
Other given operational conditions affecting workers exposure	
High temperatures (typically in the range 120-140°C) are only reached when the foam cells are already closed and thus any TCPP will be kept within the foam. In the liquid phase, before the cells are formed, the temperature is up to 35°C. Ventilation is provided in the production area as di-isocyanates (MDI) and, often, pentane, are used in the process.	
Technical conditions and measures to control dispersion from source towards the worker	
Local exhaust ventilation is required, except for PROC 1, 2, 3	
Conditions and measures related to personal protection, hygiene and health evaluation	
During specific processes, such as handmixing or manual cutting, operators are advised to wear suitable gloves. In the case of spray applications whereas aerosols can be formed, and if the concentration of TCPP in the foam is more than 15%, operators are advised either to wear self-sustained breathing apparatus or air-supplied masks or to reduce the duration of the activity significantly.	
2.2 Control of environmental exposure	
Refined life cycle stage, as reported for environmental exposure of TCPP in EU-RAR, 2008.	
C1: rigid foaming large sites C2: rigid foaming small sites	
Product characteristics	
TCPP is enclosed as an additive flame retardant in a liquid formulation into the solid, rigid foam.	

Amounts used
Total relevant tonnage for application: 29941 tpa C1: 8.9836E+03 tpa C2: 2.1E+04 tpa Total regional tonnage for application: C1 + CASE (ES11): 2.18E+03 C2 + CASE (ES11): 2.54E+03 In the EUSES v. 2.1. calculations, the tonnage for Exposure Scenario 11 (CASE – industry applications) was added to the tonnages for rigid foam applications. Note that this CASE-tonnage is included in the above mentioned figure for total regional tonnage of rigid foam and that the PECs reported in this section also reflect the total tonnage of rigid foam plus CASE industrial applications. Further details, see section 错误!未找到引用源。.
Frequency and duration of use
Continuous application, 300 emission days in 1 year.
Environment factors not influenced by risk management
Default dilution factor of 10 to river water, and an additional default dilution factor of 10 to marine water.
Other given operational conditions affecting environmental exposure
- Indoor production of rigid foam. - Use of rigid foam in construction panels for insulation in roofs, walls and floors.
Technical conditions and measures at process level (source) to prevent release
During the production of rigid foam panels, volatilisation and cleaning of equipment can be considered not relevant based on site visits and information provided by the industry (EU-RAR, 2008).
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
It is anticipated that wastewater is treated via a municipal sewage treatment plant (STP).
Organizational measures to prevent/limit release from site
It is assumed that a minimal standard set of release preventing measures are applied.
Conditions and measures related to municipal sewage treatment plant
A default municipal sewage treatment plants was assumed present, thus default STP settings were applied.
Conditions and measures related to external treatment of waste for disposal
It is assumed that any liquid waste for disposal is treated as hazardous waste and will be treated accordingly.
Conditions and measures related to external recovery of waste
Approximately 400 tpa of TCPP contained in rigid foam scrap go to adhesive pressing. For adhesive pressing of waste rigid foam, see section 错误!未找到引用源。.

1.3.2 Exposure estimation

1.3.2.1 Workers exposure

Exposure was modelled with ECETOC TRA (version April 2010). All PROCs relevant for this exposure scenario (i.e. PROC 1, 2, 3, 4, 5, 7, 8a, 8b, 9, 19, 21) were entered in the model. Only the PROCs resulting in the higher exposure estimates, are listed in the tables below. The other PROCs resulted in lower exposure estimates.

The duration of the activity is full shift (> 4h per day) with a frequency of 240 days per year. The work is carried out indoor at ambient temperatures. Local exhaust ventilation is required, except for PROC1, 2 and 3 (use in closed (batch) processes where occasional exposure could arise). The concentration of TCPP in the foam is limited to 30%. Suitable dermal protection (gloves) is required.

The highest exposure estimation was found for PROC 19 (handmixing). The dermal exposure assessed with ECETOC TRA is 14.143 mg/kg bw/d. Also PROC 7 (industrial spraying) resulted in a high dermal exposure estimate assessed with ECETOC TRA, namely 2.143 mg/kg bw/d. Both results are considered to be overestimations of reality.

Dermal exposure estimates were manually refined for PROC 7 and PROC 19. Reasons for refinement are the following:

- The concentration in the foam usually varies between 2-9% and will not exceed 30% in the foam. But, ECETOC TRA does not take the actual TCPP concentration into account for dermal exposure. For the refinement calculations, a maximal concentration of 30% was used.
- Dermal absorption of TCPP is 40%, while 100% is the default value in the ECETOC TRA model.
- During these activities, operators are advised to wear overalls, suitable gloves and boots in order to reduce dermal exposure significantly. A factor of 0.25 was used to take this reduction into account.

1.3.2.1.1 Acute/Short term exposure

For acute effects, the full shift estimations based on ECETOC TRA calculations, can be used to derive acute exposure estimates. Since full shift estimates in ECETOC TRA are assumed to represent the 90th percentile of the exposure distribution and since in general the variability is not very high, a multiplying factor of 2 is recommended to estimate the 95th percentile of the related short team exposure distribution.

Summary of the short-term exposure values.

Table 1-14: Summary of acute exposure concentrations to workers

Routes of exposure	Concentrations	Justification
Dermal systemic exposure (in mg/kg bw/d)	2.742	based on ECETOC TRA calculation (PROC 2)
Inhalation exposure (in mg/m3)	2.730	based on ECETOC TRA calculation (PROC 2&3)

1.3.2.1.2 Long-term exposure

In the EU-RAR, monitoring data are reported for exposure via inhalation. The reasonable worst case and/or typical exposure values that were reported there, are included in the table below. For details on the methodology of the monitoring data, please see the EU-RAR.

Table 1-15: Long-term exposure concentrations to workers

Routes of exposure	Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
	value	unit	Value	unit	

Dermal exposure	1.371	mg/kg bw/d			based on ECETOC TRA calculation: PROC 2, no LEV, full shift exposure.
	0.424	mg/kg bw/d			based on ECETOC TRA calculation: refinement of PROC 19 (see above): LEV, max. concentration 30%, dermal protection
	0.064	mg/kg bw/d			based on ECETOC TRA calculation: refinement of PROC 7 (see above): LEV, max. concentration 30%, dermal protection
Inhalation exposure	1.365	mg/m³			based on ECETOC TRA calculation (PROC 2&3)
			0.15	mg/m³	personal inhalation monitoring (8h TWA). Reasonable worst case (half of the highest detection limit) (EU-RAR, p.172).
			20	µg/m³	personal inhalation monitoring (8h TWA). Typical exposure value (P50 of monitoring data) (EU-RAR, p.172).

Summary of the long-term exposure values.

Table 1-16: Summary of long-term exposure concentration to workers

Routes of exposure	Concentrations	Justification
Dermal systemic exposure (in mg/kg bw/d)	1.371	based on ECETOC TRA calculation (PROC 2)
Inhalation exposure (in mg/m3)/8h workday	1.365	based on ECETOC TRA calculation (PROC 2&3)

1.3.2.2 Indirect exposure of humans via the environment (oral)

Table 1-17: Concentration for oral exposure of humans via the environment

	Exposure Scenario	Estimated exposure concentrations		Explanation / source of measured data
		value	unit	
Wet fish	C1	2.46E-03	mg/kg	
	C2	0.0176		
Drinking water	C1	2.16E-03	mg/l	
	C2	6.52E-03		
Meat	C1	3.04E-05	mg/kg w.w	
	C2	2.89E-05		

Milk	C1	2.01E-05	mg/kg w.w	
	C2	1.91E-05		

Summary of the exposure concentration in to be used for the risk characterisation of indirect exposure of man via the environment

Table 1-18: Total daily dose for oral exposure of humans via the environment

Exposure Scenario	Total daily dose for oral exposure via the environment (mg/kg bw/d)		Justification
	Exposed via local concentration	Exposed via local and regional concentration	
C1	7.63E-04	1.00E-03	Regional total daily intake for humans: 2.41E-04 mg/kg bw/d
C2	1.13E-03	1.37E-03	

1.3.2.3 Environmental exposure

Environmental exposure estimates for industry application of rigid foams were obtained from EUSES v. 2.1. The following parameters were set for this exposure scenario:

Industry Category 11 Polymers industry

Use Category 22 Flame-retardants and fire preventing agents

Extra details on use category Polymer processing

Thermoplastics: additives, pigments, fillers

Tonnage (2009) total tonnage for uses C1 and C2: 29941 tpa

Fraction of chemical in formulation C: 0.1

Fraction of the main local source C1: 1

C2: 0.175

Number of emission days (default) 300 days

Release fractions to air C1: 1.2E-06

C2: 4.8E-08

Release fractions to wastewater C1: 1.2E-06

C2: 1.00048E-04

In addition, emissions to industrial soil are set to 0 % for all refined life cycle stages of this exposure scenario, according to the EU-RAR (2008).

All other parameters were used as default settings in EUSES v. 2.1., according to the A- and B-emission tables.

1.3.2.3.1 Environmental releases

Table 1-19: Summary of the releases to the environment

Compartments	Exposure Scenario	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Explanation / source of measured data
Aquatic (without STP)	C1	8.72E-03	26.26	
	C2	0.148		
Aquatic (after STP)	C1	8.54E-03	25.82	
	C2	1.45E-01		
Air (direct + STP)	C1	8.72E-03	151.5	
	C2	7.17E-05		
Soil (direct only)	All	0	0.97	

1.3.2.3.2 Exposure concentration in sewage treatment plants (STP)

Summary of the exposure concentration in sewage treatment plants taken into account for further exposure estimation (water and soil concentrations) or risk characterisation for micro organisms in the STP.

Table 1-20: Predicted Exposure Concentrations (PEC) in sewage

	Exposure Scenario	Value	Justification
Concentration in sewage (PECstp)(in mg/l)	C1	4.27E-03	
	C2	0.0725	
Concentration in sewage sludge (in mg/kg d.w.)	C1	0.235	
	C2	3.99	

1.3.2.3.3 Exposure concentration in aquatic pelagic compartment

Summary of the Predicted Exposure Concentrations (PEC) in the aquatic pelagic compartment taken into account for risk characterisation.

Table 1-21: Predicted Exposure Concentrations (PEC) in aquatic compartment

Compartments	Exposure Scenario	Local concentration	PEC aquatic (local+regional)	Justification
Freshwater (in mg/l)	C1	4.27E-04	9.87E-04	
	C2	7.25E-03	7.81E-03	

Marine water (in mg/l)	C1	4.36E-05	9.96E-05	
	C2	7.41E-04	7.97E-04	
Intermittent releases to water (in mg/l)	All	Not applicable	Not applicable	

1.3.2.3.4 Exposure concentration in sediments

Summary of the exposure concentration in aquatic sediments taken into account for risk characterisation.

Table 1-22: Predicted Exposure Concentrations (PEC) in sediments

Compartments	Exposure Scenario	Local concentration	PEC sediment (local+regional)	Justification
Freshwater sediments (in mg/kg w.w)	C1	Not reported in EUSES	4.51E-03	
	C2		0.0357	
Marine water sediments (in mg/kg w.w.)	C1	Not reported in EUSES	4.55E-04	
	C2		3.64E-03	

1.3.2.3.5 Exposure concentrations in soil and groundwater

Summary of the Predicted Exposure Concentration (PEC) in soil and groundwater taken into account for risk characterisation.

Table 1-23: Predicted Exposure Concentrations (PEC) in soil and groundwater

	Exposure Scenario	Local concentration	PEC soil/groundwater (local+regional)	Justification
Agricultural soil averaged (mg/kg ww)	C1	5.37E-04	6.99E-03	Averaged over 30 days.
	C2	8.87E-03	0.0153	
Grassland averaged (mg/kg ww)	C1	1.78E-04	6.63E-03	Averaged over 180 days.
	C2	2.59E-03	9.04E-03	
Groundwater(mg/l)	C1	Not reported in EUSES	2.16E-03	Groundwater under agricultural soil.
	C2		4.31E-03	

1.3.2.3.6 Atmospheric compartment

Summary of the Predicted Exposure Concentration in air

Table 1-24: Predicted Exposure Concentration (PEC) in air

	Exposure Scenario	Local concentration	PEC air (local+regional)	Justification
During emission (mg/m3)	C1	2.42E-06	Not reported in EUSES	
	C2	1.98E-08		

annual average (mg/m3)	C1	1.99E-06	2.14E-06	100 m from point source.
	C2	1.63E-08	1.62E-07	
Annual deposition (mg/m2/d)	C1	1.39E-05	Not reported in EUSES	Annual average total deposition flux.
	C2	1.15E-07		

1.3.2.3.7 Exposure concentration relevant for the food chain (Secondary poisoning)

Summary of the Predicted Exposure Concentration in food for secondary poisoning taken into account for risk characterisation

Table 1-25: Predicted Exposure Concentration in food (PECoral) for secondary poisoning

	Exposure Scenario	Local concentration	PEC oral (local+regional)	Justification
PECoral predator (in mg/kg w.w)	C1	Not reported in EUSES	1.99E-03* 2E-04**	* freshwater ** marine water
	C2		9.56E-03* 9.73E-04**	
PECoral top predator (in mg/kg w.w.)	C1	Not reported in EUSES	1.61E-04	Fish-eating marine top-predator
	C2		3.16E-04	
Concentration in earthworm (in mg/kg w.w.)	C1	Not reported in EUSES	9.66E-03	Earthworms from agricultural soils.
	C2		0.0164	

1.4 Exposure scenario 6: Rigid foam – Service Life

Rigid foams are mainly produced for insulation purposes at construction sites. For PUR insulation foams in general, 90% of the usage of additive flame retardants is currently accounted for by TCPP (Leisewitz A, Hermann K and Schram E, 2001).
Some of the key products associated with PUR insulating foam are the following: flexible-faced laminate, sandwich panels, discontinuous panels, block foams and injected foams. The majority of external panels used on modern commercial and industrial buildings use rigid PUR.

1.4.1 Exposure scenario

Exposure Scenario 6: Rigid foam – Service life	
1. Title	
Free short title	Rigid foam – Service life
Systematic title based on use descriptor for article service life	SU 21 ERC 10a, 11a AC 1, 2, 7, 11, 13
Processes, tasks activities covered	TCPP is present in rigid foams, often used for insulation purposes in all types of buildings.

Assessment Method	Consumer Assessment: chamber-test results Environment Assessment: Qualitative Assessment / Expert Judgement

2. Operational conditions and risk management measures

ERC 10a, 11a
AC 1, 2, 7, 11,13
No specific risk management measures are required for service life.

2.1 Control of consumers exposure

Product (article) characteristic

TCPP is liquid at room temperature with a low vapour pressure at 25°C. The calculated saturated vapour concentration is 0.19 mg/m³ at 21°C.

Amounts used

The TCPP content in rigid foams is usually in the range of 2-9%, and shall not exceed 30%. In the test-chamber a concentration of 9% TCPP was used.

Frequency and duration of use/exposure from service life

Duration: 24h per day
Frequency: 365 d/year

Human factors not influenced by risk management

The general population does not come in direct contact with the rigid foams, nor with the TCPP in these foams, since the foam is enclosed.

Other given operational conditions affecting consumers exposure from article service life

The test chamber had a volume of 119 L. The air exchange rate was 0.5/h.

Conditions and measures at level of article production to prevent release during service life

No specific measures need to be taken by the general public

2.2 Control of environmental exposure

Refined life cycle stage, as reported for environmental exposure of TCPP in EU-RAR, 2008.

Rigid foam – in-service (not defined as a separate exposure scenario in EU-RAR, 2008).
Industry indicated that the sole application of TCPP in rigid foams are in construction panels, i.e. PUR panels and insulation boards. Production, installation and use can be identified as the three main processes of these construction panels, based on the description of the key products as reported in section 4 of Appendix A (EU-RAR, 2008). The rigid foam panels are effectively sealed within building walls. Therefore, air circulation is considered negligible around the exposed foam and edges of panels, and releases to the environment from panels in service do not need to be taken into account in the risk assessment (EU-RAR, 2008).

1.4.1.1 Consumer exposure

Rigid foam is mainly used for insulation purposes. In the EU-RAR (2008), inhalation exposure estimates were based on results from a chamber-test. The foam had a thickness of 10 cm, which is the upper limit for indoor applications, and contained 9% TCPP. The surface to volume ratio of the test-specimen was 1.4m/²m,³ which is considered to be a reflection of a typical real-life situation. The volume of the test chamber was 119 litres, temperature 23°C and relative humidity 50%. The air exchange rate was 0.5/h. Air samples were taken after 3 and 28 days. The detection limit was 1µg/m³ and no TCPP could be measured.

Based on these data, it can be concluded that consumers are potentially exposed to negligible amounts of TCPP in rooms containing closed-cell rigid foam (EU-RAR, p184).

Dermal exposure and acute or short term exposure are considered to be not relevant.

1.4.1.2 Indirect exposure of humans via the environment (oral)

Not relevant. For more details, see section 1.4.1.3.

1.4.1.3 Environmental exposure

Rigid foams containing TCPP are used as insulation panels and window frame sealant foams, which are effectively sealed within building walls. Therefore, air circulation is considered negligible around the exposed foam and edges of panels, and releases to soil or water are not occurring (EU-RAR, 2008).

1.5 Exposure Scenario 7: Rigid foam – Professional applications

Rigid PUR foams are mainly produced for insulation purposes at construction sites. They are used in both interior and exterior construction applications. For PUR insulation foams in general, 90% of the usage of additive flame retardants is currently accounted for by TCPP (Leisewitz A, Hermann K and Schram E, 2001). They are used in building construction and maintenance and repair and are not available for use by the general public. They are usually applied *in situ* to walls, roofs, tanks, and pipes (EU-RAR, 2008).
Some of the key products associated with PUR insulating foam are the following: flexible-faced laminate, sandwich panels, discontinuous panels, block foams and injected foams. The majority of external roof and wall panels used on modern commercial and industrial buildings use rigid PUR. Spray polyurethane foam (SPF) is formed via an exothermic (heat-releasing) chemical reaction between approximately equal amounts of two liquid components, the A-component (polyol) and the B-component (diphenylmethane diisocyanate – MDI). The temperature reached in the spray 'gun' is typically 49 to 60 °C (EU-RAR, 2008).

Workers from the specialist applicator companies that apply these spray foams may be occupationally exposed to TCPP within the A-component during their work. Therefore, the workers wear RPE as they are working with diisocyanates and amine-based catalysts. In addition, the work is normally an outdoor operation. The operators could be engaged in this work for up to several hours a day. There is no measured personal monitoring data available for this process. (EU-RAR, 2008).

Within a few minutes of application, the foam achieves a tack-free state when the foam surface is no longer sticky. Respirators and other protective equipment are needed to minimize exposure to vapours, aerosols, and particulates of MDI and other chemicals during the spray application and subsequent operations. Depending on the characteristics of the foam including the composition of the polyol, the heat dissipated during the exothermic reaction, and ambient conditions including temperature and humidity, it can take an additional 23 to 72 hours before the foam is fully cured (i.e. optimum physical properties of the foam are achieved). Follow the manufacturer's instructions regarding the amount of time between applying layers or passes (American Chemistry Council, March 15, 2010).
The A-component, or resin, is a mixture of polyols and other chemicals that have specific roles in the reaction process or impart important characteristics to the finished foam insulation. These chemicals may include catalysts, blowing agents, fire retardants (such as TCPP), or surfactants (EU-RAR, 2008). Flame retardants modify the characteristics of the foam to increase fire resistance characteristics of the finished foam. It is reported by the manufacturers that the TCPP content in rigid foams is usually in the range 2 – 9% (EU-RAR, 2008). However, some companies indicated that higher concentrations

of TCPP can be used. As a consequence, for the calculations in ECETOC TRA, a maximal concentration of 30% was considered.

The B-component is typically a mixture of 50% MDI and 50% polymeric MDI (pMDI), which is generally considered to present the greatest potential hazard due to its potential to produce respiratory and dermal sensitization.

1.5.1 Exposure scenario

Exposure Scenario Format 7: Rigid foam – Professional applications	
1. Title	
Free short title	Rigid foam – Professional applications
Systematic title based on use descriptor	SU 22 PROC 5, 8a, 10, 11, 21 ERC 8c, 8f AC 1, 2, 13 PC 32
Processes, tasks activities covered	Production, installation and use of insulation panels containing rigid foam: on-site mixing of foams, application of so-called “spray” foams, manually cutting of insulation panels containing rigid foam (containing TCPP)
Assessment Method*	Worker’s Assessment Method: ECETOC TRA version April 2010 No assessment method used for environmental exposure.
2. Operational conditions and risk management measures	
2.1 Control of workers exposure	
Product characteristic	
TCPP is liquid at room temperature with a low vapour pressure at 25°C. The calculated saturated vapour concentration is 0.19 mg/m³ at 21°C.	
Amounts used	
The TCPP content in rigid foam usually varies between 2-9% and will not exceed 30%.	
Frequency and duration of use/exposure	
Duration: > 4h per day Frequency: 240 days per year	
Other given operational conditions affecting workers exposure	
The work is often carried out outdoor (at construction sites) where natural ventilation is present. Work can also be performed indoor.	
Technical conditions and measures to control dispersion from source towards the worker	
Local exhaust ventilation is not required.	
Conditions and measures related to personal protection, hygiene and health evaluation	
Exposure Scenario Format 7: Rigid foam – Professional applications	
During activities except Spaying (PROC 11) operators are advised to wear suitable gloves. In the case of spray applications (PROC 11) whereas aerosols can be formed, and if the concentration of TCPP in the foam is more than 15%, operators are advised either to wear self-sustained breathing apparatus or air-supplied masks or to reduce the duration of the activity significantly.	
2.2 Control of environmental exposure	
Refined life cycle stage, as reported for environmental exposure of TCPP in EU-RAR, 2008.	

Rigid foam – professional application (not explicitly defined in EU-RAR, 2008).

Exposure during professional application as described by the TCPP consortium could, however, be covered based on the more detailed information regarding the key products of rigid foam in Appendix A (EU-RAR, 2008). Industry indicated that the sole application of TCPP in rigid foam are in construction panels, i.e. PUR panels and insulation boards. Production, installation and use can be identified as the three main processes of these construction panels, based on the description of the key products as reported in section 4 of Appendix A (EU-RAR, 2008). The installation of insulation boards is primarily performed by professionals and requires intensive handling by the installers. The closed-cell nature of the rigid foam, however, and the fact that the boards are covered by (semi-)impermeable barriers at the point of manufacturing minimizes exposure to TCPP losses from the boards at this step.

Therefore, environmental exposure during professional application is not considered relevant and thus not further taken into account in the risk assessment.

1.5.2 Exposure estimation

1.5.2.1 Workers exposure

There is potential for worker exposure during the professional use of rigid PUR foam by e.g. construction workers, especially if they cut the foam on site. A specific type of rigid PUR foams (flexible-faced laminates) are used in the insulation of the walls and roofs of buildings and might be cut on site by construction workers. The work takes place generally in open air. However, it is very unlikely that a worker would spend all day cutting foam, as only a small percentage of panels would need to be cut on site. It is most likely that these panels would be cut using a handsaw or by scoring with a knife and snapping. The cutting with a saw will generate some dust. When large amounts of foam would need to be cut on site, the foam would be cut using a circular saw, fitted with extraction (EU-RAR).
Another type of rigid foams (the metal-faced panels or sandwich panels) are used to construct many types of buildings, including factories and stores. However, the steel facings on the panels fully protect the core. Also in discontinuous panels, the steel facings on these panels fully protect the core. As a consequence, occupational exposure of construction workers to TCPP contained within the rigid foam (metal- and steel-faced panels) is considered negligible. Moreover, it was indicated that these panels are mainly cut in the production facility, and not cut by the construction workers on site (EU-RAR).

Exposure was modelled with ECETOC TRA (version April 2010). All PROCs relevant for this exposure scenario (i.e. PROC 5, 8a, 10, 11, 21) were entered in the model. Only the PROCs resulting in the higher exposure estimates, are listed in the table below. The other PROCs resulted in lower exposure estimates.

The duration of the activity is full shift (> 4h per day) with a frequency of 240 days per year. The work is carried out outdoor at construction sites, where natural ventilation is present. Local exhaust ventilation is not required.

The concentration of TCPP in the foam is limited to 30%. Suitable dermal protection (gloves) is required. In the case of spray applications (PROC 11) whereas aerosols can be formed, and if the concentration of TCPP in the foam is more than 15%, operators are advised either to wear self-sustained breathing apparatus or air-supplied masks or to reduce the duration of the activity significantly.

The highest exposure estimation was found for PROC 11 (non-industrial spraying, both outdoor and indoor without LEV). The dermal exposure assessed with ECETOC TRA is 107.1 mg/kg bw/d. For PROC 10 (roller application / brushing) dermal exposure is assessed to be 27.4 mg/kg bw/d. For both PROC 5 (mixing) and PROC 8a (transfer) the exposure estimates are 13.7 mg/kg bw/d. For PROC

21 (manual cutting) the exposure estimate is 2.8 mg/kg bw/d. Dermal exposure estimates are considered to be overestimations of reality.

Dermal exposure estimates were manually refined for PROC 5, 8a, 10, 11 and 21.
Reasons for refinement are the following:

- The concentration in the foam usually varies between 2-9% and will not exceed 30% in the foam. But, ECETOC TRA does not take the actual TCPP concentration into account for dermal exposure. For the refinement calculations, a maximal concentration of 30% was used for all processes, except PROC 11 (non-industrial spraying).
- Dermal absorption of TCPP is 40%, while 100% is the default value in the ECETOC TRA model.
- During these activities, operators are advised to wear overalls, suitable gloves and boots in order to reduce dermal exposure significantly. A factor of 0.25 was used to take this reduction into account.

1.5.2.1.1 Acute/Short term exposure

For acute effects, the full shift estimations based on ECETOC TRA calculations, can be used to derive acute exposure estimates. Since full shift estimates in ECETOC TRA are assumed to represent the 90th percentile of the exposure distribution and since in general the variability is not very high, a multiplying factor of 2 is recommended to estimate the 95th percentile of the related short team exposure distribution.

Summary of the short-term exposure values.

Table 1-26: Summary of acute exposure concentrations to workers

Routes of exposure	Concentrations	Justification
Dermal systemic exposure (in mg/kg bw/d)	3.214	based on ECETOC TRA calculations (PROC 11)
Inhalation exposure (in mg/m3)	4.200	based on ECETOC TRA calculation (PROC 21)

1.5.2.1.2 Long-term exposure

In the EU-RAR (2008), no monitoring data are reported for exposure during cutting rigid foam. However, it can be assumed that the exposure will be similar as during cutting flexible foam. Therefore, the monitoring data for flexible foam will be used for rigid foam. The reasonable worst case and/or typical exposure values that were reported there, are included in the table below. For details on the methodology of the monitoring data, please see the EU-RAR (2008).

Table 1-27: Long-term exposure concentrations to workers

Routes of exposure	Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
	value	unit	Value	unit	

Dermal exposure	0.411	mg/kg bw/d			based on ECETOC TRA calculation: refinement of PROC 5 & 8a (see above): max. concentration 30%, dermal protection
	0.823	mg/kg bw/d			based on ECETOC TRA calculation: refinement of PROC 10 (see above): max. concentration 30%, dermal protection
	1.607	mg/kg bw/d			based on ECETOC TRA calculation: refinement of PROC 11 (see above): max. concentration 15%, dermal protection
	0.041	mg/kg bw/d			based on ECETOC TRA calculation: refinement of PROC 21 (see above): max. concentration 30%, dermal protection
Inhalation exposure	1.365	mg/m³			based on ECETOC TRA calculation (PROC 5, 8a, 10)
	0.955	mg/m³			based on ECETOC TRA calculation (PROC 11)
	2.100	mg/m³			based on ECETOC TRA calculation (PROC 21)
			4.1	µg/m³	personal inhalation monitoring (duration: unspecified) during the cutting of flexible PUR foam (EU-RAR, p.175). Reasonable worst case (P90 of monitoring data).
			1.9	µg/m³	personal inhalation monitoring (duration: unspecified) during the cutting of flexible PUR foam (EU-RAR, p.175). Typical exposure (P50 of monitoring data).

Summary of the long-term exposure values.

Table 1-28: Summary of long-term exposure concentration to workers

Routes of exposure	Concentrations	Justification
Dermal systemic exposure (in mg/kg bw/d)	1.607	based on refined ECETOC TRA calculation (PROC 11)
Inhalation exposure (in mg/m³)/8h workday	2.100	based on ECETOC TRA calculation (PROC 21)

1.5.2.2 Indirect exposure of humans via the environment (oral)

Not relevant. For more details, see section 1.5.2.3.

1.5.2.3 Environmental exposure

Industry indicated that the sole application of TCPP in rigid foams are in construction panels, i.e. PUR panels and insulation boards. Production, installation and use can be identified as the three main processes of these construction panels, based on the description of the key products as reported in

section 4 of Appendix A (EU-RAR, 2008). The installation of insulation boards is primarily performed by professionals and requires intensive handling by the installers. The closed-cell nature of the rigid foam, however, and the fact that the boards are covered by (semi-) impermeable barriers at the point of manufacturing minimizes exposure to TCPP losses from the boards at this step.

1.5.2.3.1 Environmental releases

Environmental exposure during professional application is not considered relevant.

1.6 Regional exposure concentrations

Regional exposure concentrations are estimated by using EUSES v. 2.1 using the before-mentioned use scenarios, defaults and overwritten default values.

Table 1-29: Regional concentrations in the environment

	Predicted regional Exposure Concentrations		Explanation / source of measured data
	value	unit	
Freshwater	5.61E-04	mg/l	total = dissolved
Marine water	5.6E-05	mg/l	total = dissolved
Freshwater sediments	2.72E-03	mg/kg w.w	total (dissolved not reported in EUSES)
Marine sediments	2.56E-04	mg/kg w.w	total (dissolved not reported in EUSES)
Agricultural soil	2.98E-03	mg/kg w.w	total
Natural soil	6.46E-03	mg/kg w.w	total
Industrial soil	6.94E-03	mg/kg w.w	total
Air	1.42E-07	mg/m³	total

Table 1-30: Regional concentrations in food and drinking water

	Predicted regional Exposure Concentrations		Explanation / source of measured data
	value	unit	
Wet fish	1.51E-03	mg/kg	
Drinking water	9.35E-04	mg/l	
Meat	9.2E-06	mg/kg	
Milk	6.08E-06	mg/kg	

2 Risk characterisation

Following reference values were considered for the calculation of the Risk Characterisation Ratio for workers:

long term, systemic, inhalation DNEL	5,82 mg/m³/8h
long term, systemic, dermal DNEL	2,08 mg/kg bw/d
short term, systemic, inhalation DNEL	22.4 mg/m³
short term, systemic, dermal DNEL	8 mg/kg bw/d (PUR foam)
short term, systemic, dermal DNEL	14 mg/kg bw/d (neat compound)

Following reference values were considered for the calculation of the Risk Characterisation Ratio for the general population:

long term, systemic, inhalation DNEL	1.46 mg/m³/24h
long term, systemic, dermal DNEL	1.04 mg/kg bw/d
long term, systemic, oral DNEL	0.52 mg/kg bw/d
short term, systemic, inhalation DNEL	11.2 mg/m³
short term, systemic, dermal DNEL	4 mg/kg bw/d (PUR foam)
short term, systemic, dermal DNEL	7 mg/kg bw/d (neat compound)

TCPP has no local irritation or sensitization potential. Therefore, no DNEL was derived for local effects. As a consequence, no RCR will be calculated for local effects.

In this chapter, RCRs are calculated using the highest exposure estimates of the different workplace scenarios only. All other exposures and RCRs are below the values that are mentioned in this chapter.

Following reference values were considered for the calculation of the Risk Characterisation Ratio for environmental compartments:

PNEC for aquatic organisms	0.64 mg/l
PNEC for marine organisms	0.064 mg/l
PNEC for fresh-water sediment-dwelling organisms	13.4 mg/kg w.w
PNEC for marine sediment organisms	1.34 mg/kg w.w
PNEC for terrestrial organisms	1.5 mg/kg w.w
PNEC for secondary poisoning	< 11.6 mg/kg
PNEC for micro-organisms in a STP	7.84 mg/l

According to the ECHA Guidance Document on the “Characterization of Dose-Response for the Environment” (2008), biotic and abiotic effects are considered for the risk characterization of air. So far, methods for the determination of effects of chemicals on species originating from atmospheric contamination are not yet fully developed. This means that the methodology used for hazard assessment and risk characterization of chemicals in water and soil cannot be applied in the same manner for the atmospheric compartment. Consequently, no PNEC(air) can be derived and as such no RCR can be calculated.

2.1 Exposure scenario 1: Manufacture of TCPP

Not relevant

2.2 Exposure scenario 2: Formulation

2.2.1 Human health

2.2.1.1 Workers

Table 2-1: (Semi) Quantitative risk characterisation for workers

	Route	RCR	based on
Acute - systemic effects	Dermal	0.196	PROC 2, no LEV, full shift, > 25% conc, no PPE
	Inhalation	0.122	PROC 2, no LEV, full shift, > 25% conc, no PPE
Long-term - systemic effects	Dermal	0.659	PROC 2, no LEV, full shift, > 25% conc, no PPE
	Inhalation	0.235	PROC 2, no LEV, full shift, > 25% conc, no PPE
	Combined routes	0.894	PROC 2, no LEV, full shift, > 25% conc, no PPE

2.2.1.2 Indirect exposure of humans via the environment

Table 2-2: Quantitative risk characterisation for humans exposed via the environment

Route	exposure concentrations	Quantitative risk characterisation
Dermal- systemic (acute or long term)		not relevant
Inhalation- systemic (long term)	8.76E-4 mg/m³	6.00 E-4
Oral- systemic (long term)	0.107 mg/kg bw/d	0.206
Combined routes		RCR Inhalation- systemic + RCR Oral- systemic 0.206

2.2.2 Environment

2.2.2.1 Aquatic compartment (including sediment and secondary poisoning)

Table 2-3: Risk characterisation for the aquatic compartment

Compartments	Exposure Scenario	PEC/PNEC	Discussion
Freshwater	A1a	8.85E-04	
	A2	0.0725	

	A3	0.0188	
	A4	3.02E-03	
Marine water	A1a	9.7E-04	
	A2	0.074	
	A3	0.0192	
	A4	3.07E-03	
Sediment	A1a	1.93E-04* 2.12E-04**	* freshwater ** marine water
	A2	0.0158* 0.0161**	
	A3	4.11E-03* 4.19E-03**	
	A4	6.58E-04* 6.68E-044**	
Aquatic freshwater food chain	A1a	>1.31E-04	
	A2	>4.53E-03	
	A3	>1.24E-03	
	A4	>2.21E-04	
Aquatic marine water food chain	A1a	>1.36E-04* >1.32E-05**	* fish-eating birds and mammals ** top predators
	A2	>4.63E-04* >1.03E-04**	
	A3	>1.26E-04* >3.56E-05**	
	A4	>2.23E-05* >1.49E-05**	

2.2.2.2 Terrestrial compartment (including secondary poisoning) **Table 2-4: Risk characterisation for the terrestrial compartment**

Compartments	Exposure Scenario	PEC/PNEC	Discussion
Agricultural soil	A1a	0.0618	

	A2	0.0427	
	A3	0.014	
	A4	1.75E-03	
Grassland	A1a	2.51E-02	
	A2	1.70E-02	
	A3	7.47E-03	
	A4	4.67E-03	
Terrestrial food chain	A1a	>6.86E-03	Worm-eating birds and mammals.
	A2	>4.83E-03	
	A3	>1.81E-03	
	A4	>9.18E-04	

2.2.2.3 Microbiological activity in sewage treatment systems

Compartments	Exposure Scenario	PEC/PNEC	Discussion
STP	A1a	0.0856	
	A2	0.0584	
	A3	0.0147	
	A4	1.75E-03	

2.3 Exposure scenario 5: Rigid foam – Industry applications

2.3.1 Human health

2.3.1.1 Workers

Table 2-5: (Semi) Quantitative risk characterisation for workers

	Route	RCR	based on
Acute - systemic effects	Dermal	0.196	PROC 2, no LEV, full shift, > 25% conc, no PPE
	Inhalation	0.122	PROC 2, no LEV, full shift, > 25% conc, no PPE
Long-term - systemic effects	Dermal	0.659	PROC 2, no LEV, full shift, > 25% conc, no PPE
	Inhalation	0.235	PROC 2, no LEV, full shift, > 25% conc, no PPE

	Combined routes	0.894	PROC 2, no LEV, full shift, > 25% conc, no PPE

2.3.1.2 Indirect exposure of humans via the environment

Table 2-6: Quantitative risk characterisation for humans exposed via the environment

Route	exposure concentrations	Quantitative risk characterisation
Dermal- systemic (acute or long term)		not relevant
Inhalation- systemic (long term)	1.99E-06 mg/m³	1.36E-06
Oral- systemic (long term)	1.37E-03 mg/kg bw/d	0.003
Combined routes		RCR Inhalation- systemic + RCR Oral- systemic 0.003

2.3.2 Environment

2.3.2.1 Aquatic compartment (including sediment and secondary poisoning) **Table 2-7: Risk characterisation for the aquatic compartment**

Compartments	Exposure Scenario	PEC/PNEC	Discussion
Freshwater	C1	1.54E-03	
	C2	0.0122	
Marine water	C1	1.56E-03	
	C2	0.0125	
Sediment	C1	3.36E-04* 3.36E-04**	* freshwater ** marine water
	C2	2.66E-03* 2.72E-03	
Aquatic freshwater food chain	C1	>1.72E-04	
	C2	>8.27E-04	

Aquatic marine water food chain	C1	>1.73E-05* >1.39E-05**	* fish-eating birds and mammals ** top predators
	C2	>8.42E-05* >2.73E-05**	

2.3.2.2 Terrestrial compartment (including secondary poisoning) **Table 2-8: Risk characterisation for the terrestrial compartment**

Compartments	Exposure Scenario	PEC/PNEC	Discussion
Agricultural soil	C1	4.66E-03	
	C2	0.0102	
Grassland	C1	4.42E-03	
	C2	6.03E-03	
Terrestrial food chain	C1	>8.36E-04	Worm-eating birds and mammals.
	C2	>1.42E-03	

2.3.2.3 Microbiological activity in sewage treatment systems

Compartments	Exposure Scenario	PEC/PNEC	Discussion
STP	C1	5.44E-04	
	C2	9.25E-03	

2.4 Exposure scenario 6: Rigid foam – Service life

Exposure via service life is considered to be negligible. Therefore, no risk characterisation was performed.
For more details, see section 1.4.1.1 for the general population and section 1.4.1.3 for the environment.

2.5 Exposure scenario 7: Rigid foam – Professional applications

2.5.1 Human health

2.5.1.1 Workers

Table 2-9: (Semi) Quantitative risk characterisation for workers

	Route	RCR	based on
Acute - systemic effects	Dermal	0.402	PROC 11, no LEV, <15% TCPP, dermal protection
	Inhalation	0.188	PROC 21, no LEV, <30% TCPP
Long-term - systemic effects	Dermal	0.773	PROC 11, no LEV, <15% TCPP, dermal protection
	Inhalation	0.141	PROC 11, no LEV, <15% TCPP
	Combined routes	0.914	PROC 11, no LEV, <15% TCPP, dermal protection
	Dermal	0.041	PROC 21, no LEV, <30% TCPP, dermal protection
	Inhalation	0.361	PROC 21, no LEV, <30% TCPP
	Combined routes	0.402	PROC 21, no LEV, <30% TCPP, dermal protection

2.5.1.2 Indirect exposure of humans via the environment

Not relevant. For more details, see section 1.5.2.3.

2.5.2 Environment

Not relevant. For more details, see section 1.5.2.3