

MATERIAL SAFETY DATA SHEET

SHALE OIL GRADE C

Created: 2 March 2009

Revised: 24 November 2014
12 June 2015
23 January 2017
24 May 2017
17 November 2017
03 September 2018
12 February 2019

**SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY /
UNDERTAKING**

1.1 Product identifier: Shale oil, grade C

Mixture components: Shale oil, middle fraction
Shale oil, light fraction

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

Relevant identified uses: fuel oil
Uses advised against: none

1.3 Details of the supplier of the safety data sheet

Supplier: Enefit Energiatootmine AS
Address: Auvere küla, Narva- Jõesuu linn,
40107 Ida-Virumaa
Estonia
Phone number: 372 46 67 222
E-mail address: tootmine@energia.ee

1.4 Emergency Telephone Number

Emergency Centre: 112 (within Estonia)

SECTION 2: HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

2.1.1 Classification according to Regulation (EC) No 1272/2008 (CLP)

Flam. Liq. 2, H225
Acute Tox. 3, H301
Asp. Tox. 1, H304
Acute Tox. 3, H311
Skin Corr. 1B, H314
Skin Sens. 1, H317
Eye Dam. 1, H318
Acute Tox. 4, H332
STOT SE 3, H335
Muta. 1B, H340
Carc. 1B, H350
Repr. 1B, H360
Aquatic Chronic 2, H411

2.2 Label elements

2.2.1 Labelling according to Regulation (EC) No 1272/2008 (CLP)



Hazard statements:

H225 Highly flammable liquid and vapor
H301 Toxic if swallowed
H304 May be fatal if swallowed and enters airways
H311 Toxic in contact with skin
H314 Causes severe skin burns and eye damage
H318 Causes serious eye damage
H332 Harmful if inhaled
H340 May cause genetic defects
H350 May cause cancer
H360 May damage fertility or the unborn child
H411 Toxic to aquatic life with long lasting effects

Precautionary statements:

P201: Obtain special instructions before use.
P202: Do not handle until all safety precautions have been read and understood.

P210: Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking.
P241: Use explosion-proof [electrical/ventilating/lighting/...] equipment.
P261: Avoid breathing dust/fume/gas/mist/vapors/spray.
P262: Do not get in eyes, on skin, or on clothing.
P270: Do not eat, drink or smoke when using this product.
P273: Avoid release to the environment.
P280: Wear protective gloves/protective clothing/eye protection/face protection
P312: Call a POISON CENTER/doctor if you feel unwell.

2.3 Other hazards

None known

The substance does not meet the criteria to be identified as a PBT or vPvB substance in accordance with Annex XIII of Regulation (EC) No. 1907/2006 (REACH).

SECTION 3: COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances: Not applicable

3.2 Mixture: Composition

Component substances	EC No	Classification according to Regulation (EC) No 1278/2008 (CLP)	Composition, %	REACH Registration No
Shale oil, light fraction	923-592-0	Flam. Liq. 2, H225 Acute Tox. 3, H301 Asp. Tox. 1, H304 Acute Tox. 3, H311 Skin Corr. 1B, H314 Skin Sens. 1, H317 Eye Dam. 1, H318 Acute Tox. 4, H332 STOT SE 3, H335 Muta. 1B, H340 Carc. 1B, H350 Repr. 1B, H360 Aquatic Chronic 2, H411	47-50%	01-2119769887-11-0002
Shale oil, middle fraction	269-646-0	Acute Tox. 3, H301 Asp. Tox. 1, H304 Acute Tox. 3, H311 Skin Corr. 1B, H314 Skin Sens. 1, H317 Eye Dam. 1, H318 Acute Tox. 4, H332 STOT SE 3, H335 Muta. 1B, H340 Carc. 1B, H350 Repr. 1B, H360 Aquatic Chronic 2, H411	50-53%	01-2119552464-38-0004

SECTION 4: FIRST AID MEASURES

4.1 Description of first aid measures

Exposure by Inhalation:	Remove victim to fresh air. If necessary, seek medical attention.
Exposure by Ingestion:	Do not induce vomiting unless directed to do so by medical personnel. Keep victim warm and quiet. Seek medical attention.
Exposure by Skin:	Wash contaminated skin with soap and water. Seek medical attention if necessary.
Exposure by Eye:	Flush the eyes with copious amounts of water. Seek medical attention.

4.2 Most important symptoms and effects, both acute and delayed

May cause an allergic skin reaction.
Causes skin irritation.
Causes serious eye irritation.
May cause cancer.

4.3 Indication of any immediate medical attention and special treatment needed

The shale oil includes hydrogen sulphide (H₂S)
After contact with the substance, symptomatic treatment is recommended.

Special recommendation in case of contact with hydrogen sulphide:

Casualties suffering ill effects because of exposure to hydrogen sulphide should be immediately removed to fresh air and medical assistance obtained without delay. Unconscious casualties must be placed in the recovery position. Monitor breathing and pulse rate and if breathing has failed, or is deemed inadequate, respiration must be assisted, preferably by the mouth to mouth method. Administer external cardiac massage if necessary. Seek medical attention immediately. It is advisable that all who are engaged in operations in which contact with hydrogen sulphide may reasonably be anticipated, should be trained in the techniques of emergency resuscitation and in the care of an unconscious patient. Inhalation of hydrogen sulphide may cause central respiratory depression leading to coma and death. It is an irritant to the respiratory tract causing chemical pneumonitis and pulmonary edema. The onset of pulmonary edema may be delayed for 24 to 48 hours. The odor of hydrogen sulphide (H₂S) gas is offensive and similar to rotten eggs. hydrogen sulphide gas deadens the sense of smell, even at low concentrations. DO NOT depend on odor to detect presence of gas.

SECTION 5: FIRE-FIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media:	foam extinguishers, atomized water, powder-type extinguishers and carbon dioxide extinguishers, sand.
Unsuitable extinguishing media:	water.

5.2 Special hazards arising from the substance or mixture

During the pyrolysis process the following components are produced: short-chained hydrocarbons (alkanes and alkenes) and aromatic hydrocarbons. Vapors of the substance are hazardous.

The shale oil includes hydrogen sulphide (H₂S), very toxic and highly flammable gas, which may accumulate in a vaporous form in the product storage area. Hydrogen sulphide (H₂S) is a gas with unpleasant odor, reminding a rotten egg. Even in small concentrations, gas H₂S reduces olfaction. Do not use your sense of smell to detect the substance in the air!

5.3 Advice for firefighters

Protective equipment for firefighters: Full protective clothing and self-contained breathing apparatus should be worn.

Be aware that hydrogen sulphide may accumulate upon prolonged storage of the substance in a confined space

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

6.1.1 For non-emergency personnel

Evacuate from the immediate area of the spillage. Contact emergency responders.

6.1.2 For emergency responders

Evacuate all non-essential personnel from the immediate area. Wear impervious protective clothing and/or gloves, face visor or goggles and approved respiratory equipment.

6.2 Environmental precautions

Protect drains from spillage and prevent entry of product. Do not wash into drain, since this may result in blockage when product cools. If blockage occurs, notify the appropriate authorities immediately. If spillage occurs in a confined space, ensure adequate ventilation and check that a safe, breathable atmosphere is present before entry.

6.3 Methods and material for containment and cleaning up

6.3.1 Advice on containment of spillage

Contain spillage by bunding to avoid release to drain or water courses.

6.3.2 Advice on clean-up of spillage

Recover spilled product from the surface with sand or other suitable inert absorbent material. Spilled product must be destroyed by either combustion or removal to the refuse site in accordance with the appropriate legislation.

6.4 Reference to other sections

See subsection 8.2 regarding personal protective equipment.

SECTION 7: HANDLING AND STORAGE

7.1 Precautions for safe handling

7.1.1 Recommendations for safe handling

The substance must be handled using only appropriate technical equipment. Appropriate individual protective and technical control means are defined as risk management measures in the attached exposure scenarios.

7.1.2 Recommendations for general occupational hygiene

Do not eat, drink and smoke in work areas, wash hands after use and remove contaminated clothing before entering eating areas.

7.2 Conditions for safe storage, including any incompatibilities

Conditions of Storage: Store in hermetic tightly closed reservoirs. In case of long-term storage, depending on ash and solid concentration bottom settlements appear in terminal tanks below suction pipes. In case of prolonged contact with the air oxygen, they might lead to spontaneous combustion. It is necessary to keep a proper level up in tanks to prevent contact between bottom settlements and the air (oxygen) and remove settlements from a tank in proper time.

Packaging Materials: Hermetic metallic reservoir or cisterns.

Shale oil production premises and laboratories shall be equipped with a combined extract and input ventilation.

7.3 Specific end uses

Refer to the attached exposure scenarios.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

Refer to the attached exposure scenarios for full details.

8.1 Control parameters

Maximum permissible concentration in working area air:

- phenol – 8 mg/m³
- aromatic hydrocarbons (in benzene equivalent) – 1.5 mg/m³
- oil shale gasoline (heptane-type) – 800 mg/m³

Derivation of DNELs

For none of the identified health hazards quantitative dose-response information is available, and it is not possible to derived appropriate DNELs/DMELs.

Derivation of PNECs

PNEC aqua (freshwater): 0.002 mg/L

PNEC aqua (marine water): 0.0002 mg/L

PNEC aqua (intermittent releases): 0.057 mg/L

PNEC sediment (freshwater): 0.0125 mg/kg
PNEC sediment (marine water): 0.00125 mg/kg
PNEC soil: 0.009 mg/kg soil
PNEC STP: 4.7 mg/L

8.2 Exposure controls

8.2.1 Appropriate engineering controls: Engineering controls such as local exhaust ventilation are recommended to reduce exposure to the substance

8.2.2 Individual protection measures, such as personal protective equipment

8.2.2.1 Respiratory protection: 3M 6000 series full face mask with a filter or equivalent ones that are in conformity with EN 403 : 2004 and EN 14387 : 2004 + A1:2008

8.2.2.2 Hand protection: Protective gloves (for example: nitrile, neoprene, PVC). Time of penetration of the product through the glove material > 480, protection class 6. Protective gloves in accordance with EN 388, EN 420, EN 374-2 and EN 374-3. Protective gloves should be replaced regularly.

8.2.2.3 Eye protection: protective goggles

8.2.2.4 Skin protection: protective clothing and boots.

8.2.3 Environmental exposure control: Avoid release to the environment

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance:	brown liquid
Odor:	bitter/irritating
Odor threshold:	not determined
pH:	ca. 4.8 at the solubility limit in water I (read-across from oil shale gasoline fraction)
Melting point/freezing point:	< -50°C (read-across from oil shale gasoline fraction)
Initial boiling point and boiling range:	54.9°C (read-across from oil shale gasoline fraction)
Flash point:	in open cup min. (-10)°C
Evaporation rate:	not determined
Flammability (solid, gas):	not applicable
Upper/lower flammability or explosive limits:	not determined
Vapor pressure:	13.5 kpa at 25 °C (read-across from oil shale gasoline fraction)
Vapor density:	not determined
Relative density:	900-950 kg/m ³ at 15 °C
Solubility(ies): solubility in water:	5.74 g/L at 20 °C and 6.51 g/L at 30 °C (read-across from oil shale gasoline fraction)
Partition coefficient: n-octanol/water:	32.84 at 23 °C (read-across from oil shale gasoline fraction)
Auto-ignition temperature:	238 °C at 1013 hPa (read-across from oil shale gasoline fraction)

Decomposition temperature:	not determined
Viscosity:	at 40 °C min 5 mm ² /s (kinematic)
Explosive properties:	predicted not to be explosive (read-across from oil shale gasoline fraction)
Oxidizing properties:	predicted not to be oxidizing (read-across from oil shale gasoline fraction)

9.2 Other information

Surface tension	11.5 mN/m at 20°C (read-across from oil shale gasoline fraction)
Adsorption coefficient	log K _{oc} : -0.2 — 6.4 at 25 °C (soil), log K _{oc} : 0.4 — 6.3 at 25 °C (sediment) (read-across from shale oil middle fraction).

SECTION 10: STABILITY AND REACTIVITY

10.1 Reactivity:	The substance has no particular reactivity hazards
10.2 Chemical stability:	The substance is stable under normal conditions
10.3 Possibility of hazardous reactions:	Hazardous polymerization will not occur
10.4 Conditions to avoid:	None specified
10.5 Incompatible materials:	None specified
10.6 Hazardous decomposition products:	Hydrogen sulphide (H ₂ S) gas may be released upon prolonged storage.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

11.1.1 Acute toxicity

Acute oral toxicity: LD₅₀ > 2000 mg/kg bw in the rat OECD Test Guidelines 423 (Acute Oral Toxicity - Acute Toxic Class Method)

Acute dermal toxicity: LD₅₀ > 2000 mg/kg bw in the rat (OECD Test Guidelines 402, read-across from shale oil middle fraction).

Acute inhalation toxicity: the average lethal dose for mice at exposure duration of 2 hours = 19 mg/L (The test has no guidelines; read-across from generator shale oil).

11.1.2 Skin corrosion/irritation

Skin irritation/corrosion: (OECD Test Guidelines 404, tested on the albino rabbit, read-across from shale oil middle fraction).

No skin corrosion according to the results of the test conducted.

11.1.3 Serious eye damage/irritation

Eye irritation: irritating (OECD Test Guideline 405, tested on the albino rabbit, read-across from shale oil middle fraction)

11.1.4 Respiratory or skin sensitization

The substance causes skin sensitization (positive result in OECD Test Guideline 429 Local Lymph Node Assay, read-across from shale oil middle fraction).
No information about respiratory sensitization is available.

11.1.5 Germ cell mutagenicity

An Ames test (OECD Guideline 471 (Bacterial Reverse Mutation Assay) was negative
An *in vitro* mouse lymphoma assay (OECD Guideline 476 (In vitro Mammalian Cell Gene Mutation test) was negative (read-across from Shale oil heavy fraction)

11.1.6 Carcinogenicity

Potentially carcinogenic, based on IARC: Monographs on the Evaluation of Carcinogenic Risks to Humans: Volume 35: Polynuclear Aromatic Compounds, Part 4, Bitumens, Coal-tars and Derived Products, Shale-oils and Soots, VOL.: 35 (1985) (p. 161). (read-across from oil shale gasoline fraction)

11.1.7 Reproductive toxicity

Maternal toxicity: NOAEL 250 mg/kg bw/day (actual dose received) rats OECD Guideline 414 (Prenatal Developmental Toxicity Study) (read-across from oil shale gasoline fraction)
Embryotoxicity: NOAEL 50 mg/kg bw/day (actual dose received) rats OECD Guideline 414 (Prenatal Developmental Toxicity Study) (read-across from oil shale gasoline fraction)
Teratogenicity: NOAEL 100 mg/kg bw/day (actual dose received) rats OECD Guideline 414 (Prenatal Developmental Toxicity Study) (read-across from oil shale gasoline fraction)

11.1.8 STOT-single exposure

No significant effects observed

11.1.9 STOT-repeated exposure

Not available

11.1.10 Aspiration hazard

Not available

SECTION 12: ECOLOGICAL INFORMATION

12.1 Toxicity

Fish 96h LC₅₀ = 5.7 mg/l (read-across from shale oil middle fraction)
Daphnia 48h EC₅₀ = 9.71 mg/l
Daphnia 21-day NOELR = 0.10 mg/l (read-across from shale oil middle fraction)
Algae E_pC₅₀ = 20 mg/l, E_rC₅₀ = 32 mg/l (read-across from shale oil middle fraction)
Wastewater microorganisms: 3h EC₃₀ = 154 mg/l (read-across from shale oil middle fraction)

12.2 Persistence and degradability

12.2.1 Abiotic degradability

No data on the hydrolysis of shale oil (light fraction) are available. Based on the properties of the test substance (it is a mixture of various compounds, not chemically well defined with no main component) a hydrolysis study is technically not feasible.

12.2.2 Biotic degradability

22% degradation after 28-days in an inherent biodegradability study to the OECD 302C guideline (read-across from Shale oil middle fraction).

The substance is considered to be inherently biodegradable, not fulfilling specific criteria

12.3 Bioaccumulative potential

The substance has low log POW of 2.84 at 23 °C. In that case, the substance is considered to have low bioaccumulative potential, (read-across from oil shale gasoline fraction)

12.4 Mobility in soil

Moderate aggregation with ground/soil is expected, (read-across from oil shale gasoline fraction)

12.5 Results of PBT and vPvB assessment

The substance is identified as toxic.

The substance is not identified as persistent or bioaccumulative.

The substance does not meet the criteria to be identified as a PBT or vPvB substance.

12.6 Other adverse effects

Not known

SECTION 13: DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

No specific measures are required prior to disposal.

Spills are adsorbed with earth or sand, collected and disposed of at the company's own licensed waste treatment plant.

SECTION 14: TRANSPORT INFORMATION

14.1 UN number:	1288
14.2 UN proper shipping name:	Shale oil
14.3 Transport hazard class(es):	Class 3
14.4 Packing group:	II
14.5 Environmental hazards:	environmentally hazardous substance, chron. 2, marine pollutant
14.6 Special precautions for user:	no special precautions

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

The product transportation is according to MARPOL Annex 1.

SECTION 15: REGULATORY INFORMATION

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

The mixture is not subject to authorization or limitations under REACH regulation.

15.2 Chemical safety assessment

The chemical safety of the main substance has been assessed in accordance with REACH regulation.

SECTION 16: Other information

This Material Safety Data Sheet was updated on 24th November, 2014 in order to comply with requirements of Regulation (EC) No 1272/2008 of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.

This safety data sheet has been updated 12 June 2015 on the basis of the updated registration data of shale oil light fraction.

This safety data sheet has been updated 23 January 2017 on the basis of the changes the information of the supplier of the safety data sheet.

This safety data sheet has been updated 24 May 2017 on the basis of the changes the classification of Shale oils.

This safety data sheet has been updated 17 November 2017 on the basis of the updated exposure scenarios.

This safety data sheet has been updated 03 September 2018 in order to comply with Guidance on the compilation of safety data sheets.

This safety data sheet has been updated 12 February 2019 in order to harmonize all safety data sheets.

16.1 Classification in accordance with Regulation (EC) No 1272/2008 (CLP)

Flam. Liq. 2, H225
Acute Tox. 3, H301
Asp. Tox. 1, H304
Acute Tox. 3, H311
Skin Corr. 1B, H314
Skin Sens. 1, H317
Eye Dam. 1, H318
Acute Tox. 4, H332
STOT SE 3, H335
Muta. 1B, H340
Carc. 1B, H350
Repr. 1B, H360
Aquatic Chronic 2, H411

SDS distribution: The information in this document should be available to everyone who may handle this substance.

DISCLAIMER: This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

ANNEX I FOR EXTENDED SAFETY DATA SHEET

EXPOSURE SCENARIOS

Substance Name: Distillates (shale oil), light fraction

EC Number: 923-592-0

Registrant's Identity: VKG Oil AS

Contents

ES 1: Manufacture of substance	14
ES 2: Formulation into shale oil blends	18
ES 3: Formulation of shale oil blends into marine fuel	23
ES 4: Industrial use of shale oil blends as a heating oil	27
ES 5: Professional use of shale oil in marine fuel	29
ES 6: Professional use of shale oil in heating oil	32

1. ES 1: Manufacture of substance

1.1. Manufacture of substance

Sector of Use: SU 8 – Manufacture of bulk, large scale chemicals

Environment contributing scenario(s):		
M-1	Manufacture of substance	ERC 1
Worker contributing scenario(s):		
M-1	Use in closed batch process (synthesis or formulation)	PROC 3

1.2. Conditions of use affecting exposure

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

Product characteristics
<ul style="list-style-type: none"> Substance is manufactured as a liquid
Amount used, frequency and duration of use (or from service life)
<ul style="list-style-type: none"> Annual use: 167274 tonnes/year Highest daily site use: 320.8 tonnes (assuming use on 365 days) 365 days per year
Technical conditions and measures at process level (source) to prevent release
<ul style="list-style-type: none"> Process is enclosed with measures to prevent exposure of the environment Indoor use
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
<ul style="list-style-type: none"> Waste air scrubbed prior to release (0.026% released) Water pretreated to remove phenols and other organic compounds and then treated at on site WWTP before being discharged into surface water (0.015% released) Efficiency: of wwtp of treatment from oils 92-95%, from phenols 94-95% Sewage sludge sent to third party incineration Flow of ca. 2 million L/day assumed through STP
Organizational measures to prevent/limit release from site
<ul style="list-style-type: none"> Discharges to wastewater, surface water and air must comply with local regulations/restrictions on the release of the specific compounds into the environment.
Conditions and measures related to municipal sewage treatment plant
<ul style="list-style-type: none"> Size of municipal sewage system/treatment plant: 2000 m³/d
Environment factors not influenced by risk management
<ul style="list-style-type: none"> Receiving surface water flow rate: >= 18000 m³/day
Conditions and measures related to external treatment of waste for disposal
<ul style="list-style-type: none"> Shale oil ash/coke and the sludge from sewage treatment sent to third party incineration. Losses to landfill and incineration <1%.

1.2.2. Control of worker exposure: *Manufacture of substance (PROC 3)*

Product (Article) characteristics

<ul style="list-style-type: none"> • Substance is manufactured as a liquid
<p>Amount used (or contained in articles), frequency and duration of use/exposure</p>
<ul style="list-style-type: none"> • Annual use: 167274 tonnes/year • Highest daily site use: 320.8 tonnes (assuming use on 365 days) • Duration of exposure per event: <2 minutes. The manufacturing process is closed with potential for worker exposure limited to QC sampling.
<p>Technical and organisational conditions and measures</p>
<ul style="list-style-type: none"> • Appropriate PPE ensures no body parts are potentially exposed to the chemical • The manufacturing process is closed, with worker exposure limited to QC sampling • Measurements of VOCs are taken at regular intervals at the manufacturing facility and documented/controlled by the Occupational Hygienist • Indoors with Good General Ventilation
<p>Organisational measures to prevent /limit releases, dispersion and exposure</p>
<p>The facility has established a comprehensive occupational hygiene monitoring program with the following RMMs in place pertaining to continual training and monitoring of the health of the workers:</p> <ul style="list-style-type: none"> • The facility is compliant with the following Integrated Management Systems: ISO 9001 (Quality), 14001 (Environment), OHSAS 18001 (Occupational Health and Safety). Certified by Lloyds (see Appendix 1); • For every production unit and work place, an OHS risk assessment has been compiled. All workers are fully trained and familiarised with the necessary OC/RMMs; • Every production process is clearly described with company SOPs (Standard Operating Procedures). These documents (also referred to as Technological Card or Technological Rules of Procedure) include all relevant technical and operational RMMs (environmental and occupational); • All production processes have instructions on safe use for workers; • Workers' proficiency in the process instructions is periodically reviewed (quarterly) by managers and the occupational safety manager; • For every worker instructing card is kept and will be kept after he has left the company for 55 years; • Internal and 3rd party audits according to ISO standards; • All workers have to pass medical check periodically (every 1-3 years, depending on the occupation); • On production site, workers have access to medical cabinet; • 10 All technical equipment is checked, maintained and repaired periodically accordingly to maintenance plans that have been put together by technical staff; • 11 In order to ensure fluent production processes (24/7) a system of journals has been established to coordinate work between shifts.
<p>Conditions and measures related to personal protection, hygiene and health evaluation</p>
<ul style="list-style-type: none"> • PPE is chosen and implemented in order to eliminate worker exposure. Personal Protective Equipment (PPE): <ul style="list-style-type: none"> ○ General work wear (not coveralls) ○ Goggles ○ Gloves • Typically, workers wear goggles and gloves at all stages when there is the potential for exposure. Gloves are selected with adequate permeation rates such that exposure is eliminated (European Standard EN 374:2003).

1.3. Exposure estimation and reference to its source

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

Compartment	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Aquatic (without STP)	48.1	68.7	Based on releases to air being reduced to 0.015%
Aquatic (after STP)	-	-	Not relevant
Air (direct + STP)	83.4	119	Based on releases to air being reduced to 0.026%
Soil (direct releases only)	-	0	Release refined to zero

Aquatic compartment

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	0.484 mg/l	2×10^{-3} mg/l	242	RCRs are >1 and thus indicate a potential risk from the manufacturing process. But the discharges from the manufacturing plant are controlled and analysed and levels of hazardous compounds are required to remain below thresholds established by the local regulatory authorities. Discharges at these low levels are considered to present no risk to the environment.
Marine water	0.0484 mg/l	2×10^{-4} mg/l	242	
Sediment	3.03 mg/kg ww	0.0125 mg/kg ww	242	
Marine sediment	0.303 mg/kg ww	1.25×10^{-3} mg/kg ww	242	
Agricultural soil	0.0117 mg/kg ww	0.009 mg/kg ww	1.3	
Grassland	0.0134 mg/kg ww	0.009 mg/kg ww	1.49	
STP	4.85 mg/l	4.7 mg/l	1.03	
Aquatic freshwater food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	
Terrestrial food chain	-	-	-	

Waste – landfill

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	1.54×10^{-3} mg/l	2×10^{-3} mg/l	0.77	<1 acceptable risk indicated
Marine water	1.53×10^{-4} mg/l	2×10^{-4} mg/l	0.77	<1 acceptable risk indicated
Sediment	9.61×10^{-3} mg/kg ww	0.0125 mg/kg ww	0.77	<1 acceptable risk indicated
Marine sediment	9.59×10^{-3} mg/kg ww	1.25×10^{-3} mg/kg ww	0.77	<1 acceptable risk indicated
Aquatic	-	-	-	Substance has a negligible

Protection target	PEC	PNEC	RCR	Discussion
freshwater food chain				potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	
Terrestrial food chain	-	-	-	
Agricultural soil	6.01 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.67	<1 acceptable risk indicated
Grassland	8.87 x 10 ⁻⁴ mg/kg wwt	0.009 mg/kg wwt	0.1	<1 acceptable risk indicated
STP	0.0151 mg/l	4.7 mg/l	<0.01	<1 acceptable risk indicated

Waste – incineration

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	5.1 x 10 ⁻⁴ mg/l	2 x 10 ⁻³ mg/l	0.26	<1 acceptable risk indicated
Marine water	5.1 x 10 ⁻⁵ mg/l	2 x 10 ⁻⁴ mg/l	0.26	<1 acceptable risk indicated
Sediment	3.19 x 10 ⁻³ mg/kg wwt	0.0125 mg/kg ww	0.26	<1 acceptable risk indicated
Marine sediment	3.19 x 10 ⁻⁴ mg/kg wwt	1.25 x 10 ⁻³ mg/kg ww	0.26	<1 acceptable risk indicated
Aquatic freshwater food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	
Terrestrial food chain	-	-	-	
Agricultural soil	2.04 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.23	<1 acceptable risk indicated
Grassland	3.04 x 10 ⁻⁴ mg/kg wwt	0.009 mg/kg wwt	0.03	<1 acceptable risk indicated
STP	5.11 x 10 ⁻³	4.7 mg/l	<0.01	<1 acceptable risk indicated

1.3.2. Worker exposure: *Manufacture of substance (PROC 3)*

Long-term exposure concentrations to workers

Routes of exposure	Measured exposure concentrations		Explanation / source of measured data
	Value	unit	
Dermal exposure			Not quantified – qualitative approach
Inhalation exposure	50 (max for vapours of benzene)	mg/m ³	

2. ES 2: Formulation into shale oil blends

2.1. Formulation into shale oil blends

Sector of use: SU 10 – Formulation [mixing] of preparations and/or re-packaging

Environment contributing scenario(s):		
F-2	Formulation of preparations	ERC 2
Worker contributing scenario(s):		
F-2	Use in closed batch process (synthesis or formulation) PROC 3	

2.2. Conditions of use affecting exposure

2.2.1. Control of environmental exposure: *Formulation into shale oil blends (ERC 2)*

Product characteristics
<ul style="list-style-type: none"> Substance is manufactured as a liquid Concentration of shale oil (light) in shale oil blend is ca. up to ca. 50%
Amount used, frequency and duration of use (or from service life)
<ul style="list-style-type: none"> Annual use: 167274 tonnes/year Highest daily site use: 320.8 tonnes (assuming use on 365 days) 365 days per year
Technical conditions and measures at process level (source) to prevent release
<ul style="list-style-type: none"> Process is enclosed with measures to prevent exposure of the environment Indoor use
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
<ul style="list-style-type: none"> Waste air scrubbed prior to release (0.001% released). Water pretreated to remove phenols and other organic compounds and then treated at on site WWTP before being discharged into surface water (0.00015% released). Efficiency: of wwtp of treatment from oils 92-95%, from phenols 94-95%. Sewage sludge sent to third party incineration. Flow of ca. 2 million L/day assumed through STP.
Organizational measures to prevent/limit release from site
<ul style="list-style-type: none"> Discharges to wastewater., surface water and air must comply with local regulations/restrictions on the release of the specific compounds into the environment.
Conditions and measures related to municipal sewage treatment plant
<ul style="list-style-type: none"> Size of municipal sewage system/treatment plant: 2000 m³/d
Environment factors not influenced by risk management
<ul style="list-style-type: none"> Receiving surface water flow rate: >= 18000 m³/day
Conditions and measures related to external treatment of waste for disposal
<ul style="list-style-type: none"> Shale oil ash/coke and the sludge from sewage treatment sent to third party incineration. Losses to landfill and incineration <1%.

2.2.2. Control of worker exposure: *Formulation into shale oil blends (PROC 3)*

Product (Article) characteristics
<ul style="list-style-type: none"> • Substance is manufactured as a liquid • Concentration of shale oil (light) in shale oil blend is ca. up to ca. 50%
Amount used (or contained in articles), frequency and duration of use/exposure
<ul style="list-style-type: none"> • Annual use: 167274 tonnes/year • Highest daily site use: 320.8 tonnes (assuming use on 365 days) • Duration of exposure per event: <2 minutes. The manufacturing process is closed with potential for worker exposure limited to QC sampling.
Technical and organisational conditions and measures
<ul style="list-style-type: none"> • Appropriate PPE ensures no body parts are potentially exposed to the chemical. • The manufacturing process is closed, with worker exposure limited to QC sampling. • Measurements of VOCs are taken at regular intervals at the manufacturing facility and documented/controlled by the Occupational Hygienist. • Indoors with Good General Ventilation.
Organisational measures to prevent /limit releases, dispersion and exposure
<p>The facility has established a comprehensive occupational hygiene monitoring program with the following RMMs in place pertaining to continual training and monitoring of the health of the workers:</p> <ul style="list-style-type: none"> • The facility is compliant with the following Integrated Management Systems: ISO 9001 (Quality), 14001 (Environment), OHSAS 18001 (Occupational Health and Safety). Certified by Lloyds (see Appendix 1); • For every production unit and work place, an OHS risk assessment has been compiled. All workers are fully trained and familiarised with the necessary OC/RMMs; • Every production process is clearly described with company SOPs (Standard Operating Procedures). These documents (also referred to as Technological Card or Technological Rules of Procedure) include all relevant technical and operational RMMs (environmental and occupational); • All production processes have instructions on safe use for workers; • Workers' proficiency in the process instructions is periodically reviewed (quarterly) by managers and the occupational safety manager; • For every worker instructing card is kept and will be kept after he has left the company for 55 years; • Internal and 3rd party audits according to ISO standards; • All workers have to pass medical check periodically (every 1-3 years, depending on the occupation); • On production site, workers have access to medical cabinet; • 10 All technical equipment is checked, maintained and repaired periodically accordingly to maintenance plans that have been put together by technical staff; • 11 In order to ensure fluent production processes (24/7) a system of journals has been established to coordinate work between shifts.
Conditions and measures related to personal protection, hygiene and health evaluation
<ul style="list-style-type: none"> • PPE is chosen and implemented in order to eliminate worker exposure. Personal Protective Equipment (PPE): <ul style="list-style-type: none"> ○ General work wear (not coveralls) ○ Goggles ○ Gloves • Typically, workers wear goggles and gloves at all stages when there is the potential for exposure. Gloves are selected with adequate permeation rates such that exposure is

eliminated (European Standard EN 374:2003).

2.3. Exposure estimation and reference to its source

2.3.1. Environmental release and exposure: *Formulation into shale oil blends (ERC 2)*

Compartment	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Aquatic (without STP)	0.192	0.275	Based on releases to air being reduced to 0.001%
Aquatic (after STP)	-	-	Not relevant
Air (direct + STP)	3.21	4.58	Based on releases to air being reduced to 0.00006%
Soil (direct releases only)	-	45.8	Release refined to zero

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	1.94 x 10 ⁻³ mg/l	2 x 10 ⁻³ mg/l	0.97	<1 acceptable risk indicated
Marine water	1.94 x 10 ⁻⁴ mg/l	2 x 10 ⁻⁴ mg/l	0.97	<1 acceptable risk indicated
Sediment	0.0121 mg/kg ww	0.0125 mg/kg ww	0.97	<1 acceptable risk indicated
Marine sediment	1.21 x 10 ⁻³ mg/kg ww	1.25 x 10 ⁻³ mg/kg ww	0.97	<1 acceptable risk indicated
Aquatic freshwater food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	
Terrestrial food chain	-	-	-	
Agricultural soil	3.25 x 10 ⁻⁴ mg/kg ww	0.009 mg/kg ww	0.04	<1 acceptable risk indicated
Grassland	3.72 x 10 ⁻⁴ mg/kg ww	0.009 mg/kg ww	0.04	<1 acceptable risk indicated
STP	3.27 x 10 ⁻⁴ mg/l	4.7 mg/l	<0.01	<1 acceptable risk indicated

Waste – landfill

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	1.54 x 10 ⁻³ mg/l	2 x 10 ⁻³ mg/l	0.77	<1 acceptable risk indicated
Marine water	1.53 x 10 ⁻⁴ mg/l	2 x 10 ⁻⁴ mg/l	0.77	<1 acceptable risk indicated
Sediment	9.61 x 10 ⁻³ mg/kg ww	0.0125 mg/kg ww	0.77	<1 acceptable risk indicated

Protection target	PEC	PNEC	RCR	Discussion
Marine sediment	9.59 x 10 ⁻³ mg/kg wwt	1.25 x 10 ⁻³ mg/kg ww	0.77	<1 acceptable risk indicated
Aquatic freshwater food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	
Terrestrial food chain	-	-	-	
Agricultural soil	6.01 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.67	<1 acceptable risk indicated
Grassland	8.87 x 10 ⁻⁴ mg/kg wwt	0.009 mg/kg wwt	0.1	<1 acceptable risk indicated
STP	0.0151 mg/l	4.7 mg/l	<0.01	<1 acceptable risk indicated

Waste – incineration

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	5.1 x 10 ⁻⁴ mg/l	2 x 10 ⁻³ mg/l	0.26	<1 acceptable risk indicated
Marine water	5.1 x 10 ⁻⁵ mg/l	2 x 10 ⁻⁴ mg/l	0.26	<1 acceptable risk indicated
Sediment	3.19 x 10 ⁻³ mg/kg wwt	0.0125 mg/kg ww	0.26	<1 acceptable risk indicated
Marine sediment	3.19 x 10 ⁻⁴ mg/kg wwt	1.25 x 10 ⁻³ mg/kg ww	0.26	<1 acceptable risk indicated
Aquatic freshwater food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	
Terrestrial food chain	-	-	-	
Agricultural soil	2.04 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.23	<1 acceptable risk indicated
Grassland	3.04 x 10 ⁻⁴ mg/kg wwt	0.009 mg/kg wwt	0.03	<1 acceptable risk indicated
STP	5.11 x 10 ⁻³	4.7 mg/l	<0.01	<1 acceptable risk indicated

2.3.2. Worker exposure: Formulation into shale oil blends (PROC 3)

Long-term exposure concentrations to workers

Routes of exposure	Measured exposure concentrations		Explanation / source of measured data
	Value	unit	
Dermal exposure			Not quantified – qualitative approach
Inhalation exposure	50 (max for vapours of benzine)	mg/m ₃	

3. ES 3: Formulation of shale oil blends into marine fuel

3.1. Formulation of shale oil blends into marine fuel

Sector of use: SU 8 – Manufacture of bulk, large scale chemicals

Environment contributing scenario(s):		
F-2	Formulation of preparations	ERC 2
Worker contributing scenario(s):		
F-3	Use in closed batch process (synthesis or formulation)	PROC 3
F-3	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities	PROC 8b

3.2. Conditions of use affecting exposure

3.2.1. Control of environmental exposure: *Formulation of shale oil blends to produce marine fuels (ERC 2)*

Product characteristics
<ul style="list-style-type: none"> Substance is formulated as a liquid Concentration of shale oil (light) in marine fuel is maximum 40%
Amount used, frequency and duration of use (or from service life)
<ul style="list-style-type: none"> Annual use: 16727 tonnes/year Highest daily site use: 28.48 tonnes (assuming use on 365 days) 365 days per year
Technical conditions and measures at process level (source) to prevent release
<ul style="list-style-type: none"> Process is enclosed with measures to prevent exposure of the environment Indoor use
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
<ul style="list-style-type: none"> Waste air scrubbed prior to release (0.001% released) Water treated at on site WWTP before being discharged into surface water (0.0005% released). Flow of ca. 2 million L/day assumed through STP
Organizational measures to prevent/limit release from site
<ul style="list-style-type: none"> Discharges to wastewater, surface water and air must comply with local regulations/restrictions on the release of the specific compounds into the environment.
Conditions and measures related to municipal sewage treatment plant
<ul style="list-style-type: none"> Size of municipal sewage system/treatment plant: 2000 m³/d
Environment factors not influenced by risk management
<ul style="list-style-type: none"> Receiving surface water flow rate: >= 18000 m³/day

3.2.2. Control of worker exposure: *Formulation of shale oil blends to produce marine fuels (PROC 3; PROC 8b)*

Product (Article) characteristics

<ul style="list-style-type: none"> • Substance is manufactured as a liquid • Concentration of shale oil (heavy) in marine fuel is 40%
<p>Amount used (or contained in articles), frequency and duration of use/exposure</p>
<ul style="list-style-type: none"> • Annual use: 16727 tonnes/year • Highest daily site use: 28.48 tonnes (assuming use on 365 days) • Duration of exposure per event: <1 minute (QC sampling – PROC 3); 10 minutes (PROC 8b) • The formulating process is closed with only potential for worker exposure limited to QC sampling and transfer of the preparation to/from the storage tanks
<p>Technical and organisational conditions and measures</p>
<ul style="list-style-type: none"> • Appropriate PPE ensures no body parts are potentially exposed to the chemical. • The formulating process is closed, with worker exposure limited to QC sampling and transfer to/from storage tanks. • Indoors with Good General Ventilation (PROC 3) • Outdoors (PROC 8B)
<p>Organisational measures to prevent /limit releases, dispersion and exposure</p>
<p>The facility has established a comprehensive occupational hygiene monitoring program with the following RMMs in place pertaining to continual training and monitoring of the health of the workers:</p> <ul style="list-style-type: none"> • The facility is compliant with the following Integrated Management Systems: ISO 9001 (Quality), 14001 (Environment), OHSAS 18001 (Occupational Health and Safety). Certified by Lloyds (see Appendix 1); • For every production unit and work place, an OHS risk assessment has been compiled. All workers are fully trained and familiarised with the necessary OC/RMMs; • Every production process is clearly described with company SOPs (Standard Operating Procedures). These documents (also referred to as Technological Card or Technological Rules of Procedure) include all relevant technical and operational RMMs (environmental and occupational); • All production processes have instructions on safe use for workers; • Workers' proficiency in the process instructions is periodically reviewed (quarterly) by managers and the occupational safety manager; • For every worker instructing card is kept and will be kept after he has left the company for 55 years; • Internal and 3rd party audits according to ISO standards; • All workers have to pass medical check periodically (every 1-3 years, depending on the occupation); • On production site, workers have access to medical cabinet; • 10 All technical equipment is checked, maintained and repaired periodically accordingly to maintenance plans that have been put together by technical staff; • 11 In order to ensure fluent production processes (24/7) a system of journals has been established to coordinate work between shifts.
<p>Conditions and measures related to personal protection, hygiene and health evaluation</p>
<ul style="list-style-type: none"> • PPE is chosen and implemented in order to eliminate worker exposure. Personal Protective Equipment (PPE): <ul style="list-style-type: none"> ○ General work wear (not coveralls) ○ Goggles ○ Gloves • Typically, workers wear goggles and gloves at all stages when there is the potential for exposure. Gloves are selected with adequate permeation rates such that exposure is

eliminated (European Standard EN 374:2003).

3.3. Exposure estimation and reference to its source

3.3.1. Environmental release and exposure: *Formulation of shale oil blends to produce marine fuels (ERC 2)*

Compartment	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Aquatic (without STP)	0.17	0.275	Based on releases to wastewater being reduced to 0.0006%
Aquatic (after STP)	-	-	Not relevant
Air (direct + STP)	0.284	0.458	Based on releases to air being reduced to 0.001%
Soil (direct releases only)	-	4.58	Release refined to zero

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	1.72 x 10 ⁻³ mg/l	2 x 10 ⁻³ mg/l	0.86	<1 acceptable risk indicated
Marine water	1.72 x 10 ⁻⁴ mg/l	2 x 10 ⁻⁴ mg/l	0.86	<1 acceptable risk indicated
Sediment	0.0107	0.0125 mg/kg ww	0.86	<1 acceptable risk indicated
Marine sediment	1.07 x 10 ⁻³ mg/kg wwt	1.25 x 10 ⁻³ mg/kg ww	0.86	<1 acceptable risk indicated
Aquatic freshwater food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	
Terrestrial food chain	-	-	-	
Agricultural soil	6.86 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.76	<1 acceptable risk indicated
Grassland	1.04 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.12	<1 acceptable risk indicated
STP	1.72 x 10 ⁻² mg/l	4.7 mg/l	<0.01	<1 acceptable risk indicated

3.3.2. Worker exposure: *Formulation of shale oil blends to produce marine fuels (PROC 3; PROC 8b)*

Long-term exposure concentrations to workers

Routes of exposure	Estimated Exposure Concentrations		Explanation / source of measured/modelled data
	value	unit	
Dermal exposure		mg/kg/d	Not quantified (qualitative assessment)
Inhalation exposure	2.2	mg/m ³	PROC 8b – ART
	0.089	mg/m ³	PROC 3 - ART

4. ES 4: Industrial use of shale oil blends as a heating oil

4.1. Industrial use of shale oil blends as a heating oil

Sector of use: SU 8 – Manufacture of bulk, large scale chemicals

Environment contributing scenario(s):		
IW-4	Industrial use of substances in closed systems	ERC 7
Worker contributing scenario(s):		
IW-4	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities	PROC 8b

4.2. Conditions of use affecting exposure

4.2.1. Control of environmental exposure: *Industrial use of shale oil blends as heating oil (ERC 7)*

Product characteristics
<ul style="list-style-type: none"> • Substance is used as a liquid • Concentration in heating oil is up to 100%
Amount used, frequency and duration of use (or from service life)
<ul style="list-style-type: none"> • Wide dispersive use. • Annual use: 150547 tonnes/year • Daily use: 412.5 tonnes/day • 365 days per year
Technical conditions and measures at process level (source) to prevent release
<ul style="list-style-type: none"> • Combustion of fuel oil is an enclosed process • Indoor use
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
<ul style="list-style-type: none"> • No specific technical measures. However, general measures and practice employed to avoid environmental exposure
Organizational measures to prevent/limit release from site
<ul style="list-style-type: none"> • Discharges to wastewater, surface water and air must comply with local regulations/restrictions on release of fuel oils.
Conditions and measures related to municipal sewage treatment plant
<ul style="list-style-type: none"> • Size of municipal sewage system/treatment plant: 2000 m³/d
Environment factors not influenced by risk management
<ul style="list-style-type: none"> • Receiving surface water flow rate: >= 18000 m³/day

4.2.2. Control of worker exposure: *Industrial use of shale oil blends as heating oil (PROC 8b)*

Product (Article) characteristics
<ul style="list-style-type: none"> • Substance is used as a liquid • Concentration in heating oil is up to 100%

Amount used (or contained in articles), frequency and duration of use/exposure
<ul style="list-style-type: none"> • Wide dispersive use • Annual use: 150547 tonnes/year • Daily use: 412.5 tonnes/day • Duration of exposure per event: 10 minutes (PROC 8b). Worker exposure limited to transfer of the preparation to/from the storage tanks.
Technical and organisational conditions and measures
<ul style="list-style-type: none"> • Appropriate PPE ensures no body parts are potentially exposed to the chemical. • Worker exposure limited to transfer to/from storage tanks. • Process is conducted outdoors.
Conditions and measures related to personal protection, hygiene and health evaluation
<ul style="list-style-type: none"> • PPE is chosen and implemented in order to eliminate worker exposure. • Typically, workers wear goggles, RPE and gloves at all stage where there is the potential for exposure. • Gloves are selected with adequate permeation rates such that exposure is eliminated.

4.3. Exposure estimation and reference to its source

4.3.1. Environmental release and exposure: *Industrial use of shale oil blends as heating oil (ERC 7)*

Compartment	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Aquatic (without STP)	0.165	82.5	Based on releases to water being reduced to 0.02% and use considered wide dispersive
Aquatic (after STP)	-	-	Not relevant
Air (direct + STP)	0.824	412	Based on releases to air being reduced to 0.1% and use considered wide dispersive
Soil (direct releases only)	-	82.5	Based on releases to soil being reduced to 0.02%

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	1.72 x 10 ⁻³ mg/l	2 x 10 ⁻³ mg/l	0.86	<1 acceptable risk indicated
Marine water	1.72 x 10 ⁻⁴ mg/l	2 x 10 ⁻⁴ mg/l	0.86	<1 acceptable risk indicated
Sediment	0.0108	0.0125 mg/kg ww	0.86	<1 acceptable risk indicated
Marine sediment	1.08 x 10 ⁻³ mg/kg wwt	1.25 x 10 ⁻³ mg/kg ww	0.86	<1 acceptable risk indicated
Aquatic freshwater food	-	-	-	Substance has a negligible potential for bioaccumulation,

Protection target	PEC	PNEC	RCR	Discussion
chain				the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Terrestrial food chain	-	-	-	
Agricultural soil	6.70 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.74	<1 acceptable risk indicated
Grassland	1.07 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.12	<1 acceptable risk indicated
STP	1.66 x 10 ⁻² mg/l	4.7 mg/l	<0.01	<1 acceptable risk indicated

4.3.2. Worker exposure: Industrial use of shale oil blends as heating oil (PROC 8b)

Long-term exposure concentrations to workers

Routes of exposure	Estimated Exposure Concentrations		Explanation / source of measured/modelled data
	value	unit	
Dermal exposure		mg/kg/d	Not quantified (qualitative assessment)
Inhalation exposure	2.2	mg/m ³	PROC 8b – ART

5. ES 5: Professional use of shale oil in marine fuel

5.1. Professional use of shale oil in marine fuel

Product category: PC 13 - Fuels

Environment contributing scenario(s):		
PW-5	Wide dispersive outdoor use of substances in closed systems	ERC 9b
Worker contributing scenario(s):		
PW-5	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities	PROC 8b

5.2. Conditions of use affecting exposure

5.2.1. Control of environmental exposure: Professional use of shale oil blends in marine fuel (ERC 9b)

Product characteristics
<ul style="list-style-type: none"> Substance is used as a liquid
Amount used, frequency and duration of use (or from service life)

<ul style="list-style-type: none"> • Wide dispersive use • Annual use: 16727 tonnes/year • Daily use: 45.8 tonnes/day • 365 days per year
Technical conditions and measures at process level (source) to prevent release
<ul style="list-style-type: none"> • Combustion of fuel oil is an enclosed process. • Indoor use.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
<ul style="list-style-type: none"> • No specific technical measures. However, general measures and practice employed to avoid environmental exposure.
Organizational measures to prevent/limit release from site
<ul style="list-style-type: none"> • Discharges to wastewater, surface water and air must comply with local regulations/restrictions on release of fuel oils.

5.2.2. Control of worker exposure: *Professional use of shale oil blends in marine fuel (PROC 8b)*

Product (Article) characteristics
<ul style="list-style-type: none"> • Substance is used as a liquid • Concentration of shale oil (light) in marine fuel is 40%
Amount used (or contained in articles), frequency and duration of use/exposure
<ul style="list-style-type: none"> • Wide dispersive use • Annual use: 16727 tonnes/year • Daily use: 45.8 tonnes/day • Duration of exposure per event: 10 minutes (PROC 8b). Worker exposure limited to transfer of the preparation to/from the storage tanks.
Technical and organisational conditions and measures
<ul style="list-style-type: none"> • Appropriate PPE ensures no body parts are potentially exposed to the chemical. • Worker exposure limited to transfer to/from storage tanks. • Process is conducted outdoors.
Organisational measures to prevent /limit releases, dispersion and exposure
The Occupational Health and Safety Act requires that all employers must compile an OHS risk assessment, with appropriate worker introduction and training. The facilities where professional workers use hazardous substances must comply to SEVESO II Directive (i.e., compile Safety Report and train its workers).
Conditions and measures related to personal protection, hygiene and health evaluation
PPE is chosen and implemented in order to eliminate worker exposure. Typically, workers wear goggles, RPE and gloves at all stage where there is the potential for exposure. Gloves are selected with adequate permeation rates such that exposure is eliminated.

5.3. Exposure estimation and reference to its source

5.3.1. Environmental release and exposure: *Professional use of shale oil blends in marine fuel (ERC 9b)*

Compartment	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Aquatic (without STP)	-	82.5	Based on releases to the marine environment being reduced to 1%
Aquatic (after STP)	-	-	Not relevant
Air (direct + STP)	-	229	Not refined
Soil (direct releases only)	-	-	Not relevant

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	5.16 x 10 ⁻⁷ mg/l	2 x 10 ⁻³ mg/l	<0.01	<1 acceptable risk indicated
Marine water	5.37 x 10 ⁻⁵ mg/l	2 x 10 ⁻⁴ mg/l	0.27	<1 acceptable risk indicated
Sediment	3.57 x 10 ⁻⁶ mg/kg wwt	0.0125 mg/kg ww	<0.01	<1 acceptable risk indicated
Marine sediment	3.36 x 10 ⁻⁴ mg/kg wwt	1.25 x 10 ⁻³ mg/kg ww	0.27	<1 acceptable risk indicated
Aquatic freshwater food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	
Terrestrial food chain	-	-	-	
Agricultural soil	2.02 x 10 ⁻⁶ mg/kg wwt	0.009 mg/kg wwt	<0.01	<1 acceptable risk indicated
Grassland	2.48 x 10 ⁻⁶ mg/kg wwt	0.009 mg/kg wwt	<0.01	<1 acceptable risk indicated
STP	-	4.7 mg/l	-	Not applicable

5.3.2. Worker exposure: Professional use of shale oil blends in marine fuel (PROC 8b)

Long-term exposure concentrations to workers

Routes of exposure	Estimated Exposure Concentrations		Explanation / source of measured/modelled data
	value	unit	

Routes of exposure	Estimated Exposure Concentrations		Explanation / source of measured/modelled data
	value	unit	
Dermal exposure		mg/kg/d	Not quantified (qualitative assessment)
Inhalation exposure	0.87	mg/m ³	PROC 8b - ART

6. ES 6: Professional use of shale oil in heating oil

6.1. Professional use of shale oil in heating oil

Product category: PC 13 - Fuels

Environment contributing scenario(s):		
PW-6	Wide dispersive outdoor use of substances in closed systems	ERC 9b
Worker contributing scenario(s):		
PW-6	Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities	PROC 8b

6.2. Conditions of use affecting exposure

6.2.1. Control of environmental exposure: *Professional use of shale oil blends in heating oil (ERC 9b)*

Product characteristics
<ul style="list-style-type: none"> Substance is used as a liquid Concentration in heating oil is up to 100%
Amount used, frequency and duration of use (or from service life)
<ul style="list-style-type: none"> Wide dispersive use Annual use: 150547 tonnes/year Daily use: 412.4 tonnes/day 365 days per year
Technical conditions and measures at process level (source) to prevent release
<ul style="list-style-type: none"> Combustion of fuel oil is an enclosed process. Indoor use.
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil
<ul style="list-style-type: none"> No specific technical measures. However, general measures and practice employed to avoid environmental exposure.
Organizational measures to prevent/limit release from site
<ul style="list-style-type: none"> Discharges to wastewater, surface water and air must comply with local regulations/restrictions on release of fuel oils.
Conditions and measures related to municipal sewage treatment plant

<ul style="list-style-type: none"> Size of municipal sewage system/treatment plant: 2000 m³/d
Environment factors not influenced by risk management
<ul style="list-style-type: none"> Receiving surface water flow rate: >= 18000 m³/day

6.2.2. Control of worker exposure: *Professional use of shale oil blends in heating oil (PROC 8b)*

Product (Article) characteristics
<ul style="list-style-type: none"> Substance is used as a liquid Concentration in heating oil is up to 100%
Amount used (or contained in articles), frequency and duration of use/exposure
<ul style="list-style-type: none"> Wide dispersive use Annual use: 150547 tonnes/year Daily use: 412.4 tonnes/day Duration of exposure per event: 10 minutes (PROC 8b). Worker exposure limited to transfer of the preparation to/from the storage tanks.
Technical and organisational conditions and measures
<ul style="list-style-type: none"> Appropriate PPE ensures no body parts are potentially exposed to the chemical. Worker exposure limited to transfer to/from storage tanks. Process is conducted outdoors.
Organisational measures to prevent /limit releases, dispersion and exposure
The Occupational Health and Safety Act requires that all employers must compile an OHS risk assessment, with appropriate worker introduction and training. The facilities where professional workers use hazardous substances must comply to SEVESO II Directive (i.e., compile Safety Report and train its workers).

6.3. Exposure estimation and reference to its source

6.3.1. Environmental release and exposure: *Professional use of shale oil blends in heating oil (ERC 9b)*

Compartment	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Aquatic (without STP)	0.165	82.5	Based on releases to water being reduced to 0.2%
Aquatic (after STP)	-	-	Not relevant
Air (direct + STP)	0.165	82.5	Based on releases to air being reduced to 0.2%
Soil (direct releases only)	-	-	Not relevant

Protection target	PEC	PNEC	RCR	Discussion
Freshwater	1.71 x 10 ⁻³ mg/l	2 x 10 ⁻³ mg/l	0.86	<1 acceptable risk indicated
Marine water	1.71 x	2 x 10 ⁻⁴	0.86	<1 acceptable risk indicated

Protection target	PEC	PNEC	RCR	Discussion
	10 ⁻⁴ mg/l	mg/l		
Sediment	0.0107 mg/kg wwt	0.0125 mg/kg ww	0.86	<1 acceptable risk indicated
Marine sediment	1.07 x 10 ⁻³ mg/kg wwt	1.25 x 10 ⁻³ mg/kg ww	0.86	<1 acceptable risk indicated
Aquatic freshwater food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Aquatic marine water food chain	-	-	-	Substance has a negligible potential for bioaccumulation, the risk of secondary poisoning is therefore low.
Terrestrial food chain	-	-	-	
Agricultural soil	6.63 x 10 ⁻³ mg/kg wwt	0.009 mg/kg wwt	0.74	<1 acceptable risk indicated
Grassland	9.94 x 10 ⁻⁴ mg/kg wwt	0.009 mg/kg wwt	0.11	<1 acceptable risk indicated
STP	0.0166 mg/l	4.7 mg/l	<0.01	<1 acceptable risk indicated

6.3.2. Worker exposure: Professional use of shale oil blends in heating oil (PROC 8b)

Long-term exposure concentrations to workers

Routes of exposure	Estimated Exposure Concentrations		Explanation / source of measured/modelled data
	value	unit	
Dermal exposure		mg/kg/d	Not quantified (qualitative assessment)
Inhalation exposure	2.2	mg/m ³	PROC 8b – ART