SAFETY DATA SHEET

According to Regulation 1907/2006/EC, Article 31.
Version 5 (15 May 2023), Printing date: 15 May 2023

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

1.1 Product identifier

Trade name: HIGH PURITY MTBE
International Chemical Identification: *tert*-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane.
CAS number: 1634-04-4
EC number: 216-653-1
Index number: 603-181-00-X
REACH registration number: 01-2119452786-27-0048

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

Relevant identified uses:
Formulation (industrial).
Use as a process solvent and extraction agent (industrial).
Transport and distribution (industrial).
Use as an intermediate (industrial).
Use as a Fuel (industrial, professional and consumer).

1.3 Details of the supplier of the safety data sheet

Dor Chemicals Ltd.
P.O.B 10036 Haifa
Israel 2624892
Tel: +972-4-8465043
Fax: 972-4-8415194
Email: sales@dorchemicals.com
Web: www.dorchemicals.com

Further information obtainable from:
REACH Only Representative
B-Lands Consulting
WTC, 5 Place Robert Schuman, BP 1516, 38025 Grenoble, France
Tel: +33 476 230 627

1.4 Emergency telephone number

NHS Direct: 111
National Poisons Information Service (NPIS): 0121 507 4123 (healthcare professionals only).
Ireland - National Poisons Information Centre: 01 837 9964 or 01 809 2566 (healthcare professionals only).

SECTION 2: Hazards identification

2.1Classification of the substance or mixture

Classification according to Regulation (EC) No 1272/2008:
Flam. Liq. 2 H225 Highly flammable liquid and vapour.
Skin Irrit. 2 H315 Causes skin irritation.

2.2 Label elements

Labelling according to Regulation (EC) No 1272/2008:

The product is classified and labelled according to the CLP regulation.

Hazard pictograms:

GHS02 GHS07

Signal word: Danger

Hazard statements:
H225 Highly flammable liquid and vapour
H315 Causes skin irritation

Precautionary statements:
P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P243 Take precautionary measures against static discharge.
P302+P352 IF ON SKIN: Wash with plenty of soap and water.
P403+P235 Store in a well-ventilated place. Keep cool.

2.3 Other hazards

Results of PBT and vPvB assessment
PBT: Not applicable.
vPvB: Not applicable.

SECTION 3: Composition/information on ingredients

3.1 Substances

Hazardous components:		
CAS: 1634-04-4 EINECS: 216-653-1 Index number: 603-181-00-X	tert-butyl methyl ether Flam. Liq. 2 H225; Skin Irrit. 2 H315.	99.9%

Additional information: For the wording of the listed risk phrases refer to section 16.

SECTION 4: First aid measures

4.1 Description of first aid measures

General information:
- Always observe self protection methods.
- Move out of dangerous area.
- Remove contaminated shoes and clothing.
- Consult a physician.
- Show this material safety data sheet to the doctor in attendance.

After inhalation:
- Remove to fresh air and keep at rest in a position comfortable for breathing.
- Do not leave the victim unattended.
- Keep patient warm and at rest.
- Immediately seek medical attention.
- If breathing is difficult, give oxygen.
- If unconscious place in recovery position and seek medical advice.
- In the event of unconsciousness , apnea or cardiac arrest (no Pulse) apply cardiopulmonary resuscitation.

After skin contact:
- Immediately flush affected area with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes.
- If irritation persists get medical advice/attention.

After eye contact:
- Flush eyes with water thoroughly and continuously for 15 minutes.
- Remove contact lenses, if present and easy to do. Continue rinsing.
- If irritation persists get medical attention. The patient should be seen by an ophthalmologist.

After swallowing:
- Clean mouth with water and drink afterwards plenty of water.
- Do NOT induce vomiting.
- Do not give milk or alcoholic beverages.
- Never give anything by mouth to an unconscious person.
- If vomiting does occur, have victim lean forward to reduce risk of aspiration.
- Get medical attention immediately.

4.2 Most important symptoms and effects, both acute and delayed
-No further relevant information available.

4.3 Indication of any immediate medical attention and special treatment needed
- If inhalation of high concentrations occur signs and symptoms may include coughing, choking, wheezing, difficulty in - breathing, chest congestion, shortness of breath and/or fever. The onset of respiratory symptoms may be delayed.
- Absorption by Inhalation or Ingestion of high doses may cause CNS symptoms like headache, dizziness, fatigue, muscular, weakness, drowsiness and lack of coordination.
- In case of ingestion the stomach should be emptied by gastric lavage under qualified medical supervision.

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing agents:
- SMALL FIRE: Use dry chemicals, CO2, water spray or alcohol-resistant foam
- LARGE FIRE: Use water spray, water fog or alcohol-resistant foam

For safety reasons unsuitable extinguishing agents: Do not use solid water stream.

5.2 Special hazards arising from the substance or mixture
- Releases flammable vapors below normal ambient temperatures.
- Flammable vapors may be heavier than air.
- May travel long distances along the ground before igniting and flashing back to vapor source.
- When mixed with air and exposed to ignition source, vapors can burn in open or explode if confined.
- Move containers from fire area if you can do it without risk.
- Fight fire from maximum distance or use unmanned hose holders or monitor nozzles.
- Cool containers with flooding quantities of water until well after fire is out.
- Do not use straight streams.
- Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank.
- Always stay away from tanks engulfed in fire.
- For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

5.3 Advice for firefighters

Protective equipment:
- Wear positive pressure self-contained breathing apparatus (SCBA).
- Structural firefighters protective clothing will only provide limited protection.

Additional information:
- 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
- Use personal protective equipment.
- Ensure adequate ventilation.
- Evacuate personnel to safe areas.
- Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas.

6.2 Environmental precautions
- MTBE is highly volatile, partially water soluble and has only a minimal tendency to adhere to soil particles.
- Even small volumes can pose a threat to the environment and nearby water resources.
- Surface spills can reach groundwater through porous soil or cracked surfaces.
- All efforts should be made to prevent any leaks or spills, and to protect water resources.
- Where spills are possible, a comprehensive spill response plan should be developed and implemented.
- If a leak or spill reaches the groundwater, the groundwater may become contaminated.
- If the groundwater is a source of drinking water, the associated drinking water well(s) could become contaminated.
- MTBE can impart an unpleasant taste and odour to water at very low concentrations.

6.3 Methods and material for containment and cleaning up

- Extremely flammable liquid.
- Release can cause fire or explosion.
- Eliminate all sources of ignition.
- All equipment used when handling this product must be grounded.
- Do not touch or walk through spilled material.
- Stop leak if you can do it without risk.
- Prevent entry into waterways, sewers, basements or confined areas.
- A vapor suppressing foam may be used to reduce vapors.
- Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers.
- Use clean non-sparking tools to collect absorbed material.
- Water spray may reduce vapor; but may not prevent ignition in closed spaces.
- Dike large spills and place materials in salvage containers.

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 disposal information.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Information about fire - and explosion protection:

- Keep container tightly closed when not in use.
- Extinguish all ignition sources.
- Wear recommended personal protective equipment.
- Ground/bond container and receiving equipment.
- All electrical equipment should be grounded and conform to applicable electric codes and regulatory requirements.
- Check atmosphere for explosiveness and oxygen deficiencies.
- Ensure adequate ventilation.
- Observe precautions pertaining to confined space entry.
- Use only non-sparking tools.
- Carefully vent any internal pressure before removing closure.
- Isolate, vent, drain, wash and purge systems or equipment before maintenance or repair.
- Handle empty containers with care; vapor/residue may be flammable.
- Avoid contact with incompatible agents.
- Keep away from sources of ignition - No smoking.
- Take measures to prevent the build up of electrostatic charge.

7.2 Conditions for safe storage, including any incompatibilities

Requirements to be met by storerooms and receptacles:

- Container Advice: Carbon steel; avoid most plastics, Viton and Flourel.
- Store only in tightly closed, properly vented containers away from heat, sparks, open flame and strong oxidizing agents.
- Store closed drums with bung in up position.
- Vapor space above stored liquid may be flammable/explosive unless blanketed with inert gas.
- Store in a well-ventilated place.
- Electrical installations / working materials must comply with the technological safety standards.
- No smoking.
- Store in cool place.
- Do not pressurize, cut, weld, braze solder, drill, or grind on containers.
- Do not puncture or incinerate containers.
- Empty pressure vessels should be returned to the supplier.

Information about storage in one common storage facility:

-No further relevant information available.

7.3 Specific end use(s)

-No further relevant information available.

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Workplace Exposure Limits (Ireland)

WEL	Short-term value: 367 mg/m³, 100 ppm Long-term value: 183.5 mg/m³, 50 ppm

DN(M)ELs for workers

Exposure pattern	Route	Descriptor	DNEL / DMEL*	Most sensitive endpoint
Acute - systemic effects	Dermal (mg/kg bw /day)	Not quantifiable		
Acute - systemic effects	Inhalation (mg/m³)	Not quantifiable		
Acute - local effects	Dermal (mg/kg bw /day)	Not quantifiable		irritation / corrosion (eye and skin)
Acute - local effects	Inhalation (mg/m³)	DNEL	357	irritation (respiratory tract)
Long-term - systemic effects	Dermal (mg/kg bw /day)	DNEL	5100	repeated dose toxicity
Long-term - systemic effects	Inhalation (mg/m³)	DNEL	178.5	repeated dose toxicity
Long-term - local effects	Dermal (mg/kg bw /day)	Not quantifiable		
Long-term - local effects	Inhalation (mg/m³)	Not quantifiable		

** Unit as specified in column "Route"*

DN(M)ELs for the general population

Exposure pattern	Route	Descriptor	DNEL / DMEL*	Most sensitive endpoint
Acute - systemic effects	Dermal (mg/kg bw /day)	Not quantifiable		
Acute - systemic effects	Inhalation (mg/m³)	Not quantifiable		
Acute - systemic effects	Oral (mg/kg bw /day)	Not quantifiable		
Acute - local effects	Dermal (mg/kg bw /day)	Not quantifiable		irritation / corrosion (eye and skin)
Acute - local effects	Inhalation (mg/m³)	DNEL	214	irritation (respiratory tract)
Long-term - systemic effects	Dermal (mg/kg bw /day)	DNEL	3570	repeated dose toxicity
Long-term - systemic effects	Inhalation (mg/m³)	DNEL	53.6	repeated dose toxicity
Long-term - systemic effects	Oral (mg/kg bw /day)	DNEL	7.1	repeated dose toxicity
Long-term - local effects	Dermal (mg/kg bw /day)	Not quantifiable		
Long-term - local effects	Inhalation (mg/m³)	Not quantifiable		

** Unit as specified in column "Route"*

PNECs

Compartment	PNEC
Freshwater (mg/l)	5.1
Marine water (mg/l)	0.26
Freshwater sediment (mg/kg sediment dw)	23
Marine water sediment (mg/kg sediment dw)	1.17
Soil (mg/kg ww)	1.56
STP (mg/l)	71

8.2 Exposure controls

Personal protective equipment

General protective and hygienic measures:
- Selection of appropriate personal protective equipment should be based on an evaluation of the performance characteristics of the protective equipment relative to the task(s) to be performed, conditions present, duration of use, and the hazards and/or potential hazards that may be encountered during use.
- Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure.
- Take off contaminated clothing and wash before reuse.
- Handle in accordance with good industrial hygiene and safety practice.
- Wash hands before breaks and at the end of workday.

Respiratory protection:
- In case of dusts/vapours/aerosols being formed or if the limit values like TLV are exceeded: wear respirator conforming to EN140 with type A filter or better".

Protection of hands:
- Chemical-resistant protective gloves (EN 374)
- The selected protective gloves have to satisfy the standard EN 374 derived from it.
Glove material for example, Glove (multi-layer) - PE/EVAL/PE
(PE=Polyethylene; EVAL=Ethylene-vinyl-alcohol-copolymer); Break through time 480 min.
Source: GESTIS substance database (hazardous substance information system of commercial professional associations)
Suitability for specific workplaces should be clarified with protective glove manufacturers.
Gloves should be discarded and replaced if there is any indication of degradation or chemical breakthrough.

Eye protection:
- Wear safety glasses as minimum eye protection (EN 166).
- Conditions may warrant the use of tightly fitting chemical goggles and possibly a face shield.

Body protection:
- Choose body protection according to the amount and concentration of the dangerous substance at the work place.
- Use PPE that is chemical resistant to the product and prevents skin contact.
- Fire retardant clothing is appropriate for routine occupational use.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

General Information

Form:	Liquid
Colour:	Colourless
Odour:	Characteristic terpene-like
Odour threshold:	Not determined
pH-value at 20°C:	Not determined
Melting point/Melting range:	-108.6 ° C
Boiling point/Boiling range:	55.3 ° C

Flash point:	-28° C
Flammability (solid, gaseous):	Not applicable
Self-ignition temperature:	460°C
Decomposition temperature:	Not determined
Danger of explosion:	Product is not explosive. However, formation of explosive air/ vapour mixtures are possible.
Explosion limits	
Lower:	1.6 Vol %
Upper:	8.4 Vol %
Oxidizing properties :	Not determined
Vapour pressure:	33000 Pa
Density at 20°C:	0.74 g/cm³
Vapour density	Not determined
Evaporation rate	Not determined
Solubility in / Miscibility with water:	41850 mg/L
Partition coefficient (n-octanol/water):	1.06
Viscosity:	0.464 mm²/s (static)

9.2 Other information

Appearance:	
Form:	Not determined.
Explosive properties:	Product does not present an explosion hazard.
Softening point/range	
Oxidising properties	Not determined.
Evaporation rate	Not determined.
Information with regard to physical hazard classes	
Explosives	Not applicable.
Flammable gases	Not applicable.
Aerosols	Not applicable.
Oxidising gases	Not applicable.
Gases under pressure	Not applicable.
Flammable liquids	Highly flammable liquid and vapour.
Flammable solids	Not applicable.
Self-reactive substances and mixtures	Not applicable.
Pyrophoric liquids	Not applicable.
Pyrophoric solids	Not applicable.
Self-heating substances and mixtures	Not applicable.
Substances and mixtures, which emit flammable gases in contact with water	Not applicable.
Oxidising liquids	Not applicable.
Oxidising solids	Not applicable.
Organic peroxides	Not applicable.

Corrosive to metals	Not applicable.
Desensitised explosives	Not applicable.

SECTION 10: Stability and reactivity

10.1 Reactivity
-No further relevant information available.

10.2 Chemical stability

Thermal decomposition / conditions to be avoided:
- Heat, sparks, open flame, other ignition sources, and oxidizing conditions.
- May accumulate static electrical charges, and may cause ignition of the vapors.

10.3 Possibility of hazardous reactions
- Not expected to occur.
- Note: This material is stable when properly handled and stored.

10.4 Conditions to avoid
-No further relevant information available.

10.5 Incompatible materials
- Contact with strong acids can decompose this material and generate extremely flammable isobutylene.

10.6 Hazardous decomposition products
- Thermal decomposition may produce carbon monoxide and other toxic vapors

SECTION 11: Toxicological information

11.1 Information on toxicological effects

(a) Acute toxicity

Oral	
Method	Result
Rat (Sprague-Dawley) male/female Oral: gavage OECD Guideline 401 (Acute Oral Toxicity)	LD50: > 2000 mg/kg bw (male/female)
Inhalation	
Method	Result
Rat (Charles River albino) male/female inhalation: vapour Equivalent or similar to OECD Guideline 403 (Acute Inhalation Toxicity)	LC50 (4 h): 85 mg/L air (male/female)
Dermal	
Method	Result
Rat (Sprague-Dawley) male/female Coverage: occlusive Vehicle: unchanged (no vehicle) OECD Guideline 402 (Acute Dermal Toxicity)	LD50: > 2000 mg/kg bw (male/female)

Based on available data, the classification criteria are not met.

(b) Skin corrosion/irritation

Method	Result

Rabbit (Kleine weisse Russen, Chbb-SPF) Coverage: occlusive (shaved) Vehicle: unchanged (no vehicle) OECD Guideline 404 (Acute Dermal Irritation / Corrosion). Deviation: dermal application under occlusive conditions	Erythema score: 2.9 of max. 4; mean; 24+48+72; fully reversible within: 8 days Oedema score: 2.3 of max. 4; mean; 24+28+72; fully reversible within: 8 days Primary irritation score: 5 ; mean; 1-72 hours

Based on available data, the classification criteria are not met.

(c) Serious eye damage/irritation

Method	Result
Rabbit (Kleine weisse Russen, Chbb-SPF) Vehicle: unchanged (no vehicle) OECD Guideline 405 (Acute Eye Irritation / Corrosion)	0 of max. 4; mean; all; no effects were seen at all Iris score: 0 of max. 2; mean; all; no effects were observed at all. Conjunctivae score: 1.3 of max. 3; mean; 24+48+72 hr; fully reversible within: 6 days Chemosis score: 0.4 of max. 4; mean; 24+48+72 hr; fully reversible within: 6 days

Based on available data, the classification criteria are not met.

(d) Respiratory or skin sensitisation

Skin sensitisation	
Method	Result
Guinea pig (Hartley) male Dermal sensitization study in guinea pigs: Landsteiner technique Induction: intradermal Challenge: intradermal Vehicle: saline	MTBE treatment produced no significant increase in the response of the challenge injection as compared to the initial sensitizing or inducing injection. The dose of MTBE used as the initial injection of 0.5 ml of a 0.1% solution did produce a local irritant effect which would indicate that an effective level was used.

Based on available data, the classification criteria are not met.

Respiratory sensitisation	
Method	Result
	No information available. However, respiratory tract sensitisation is not expected since MTBE is not a skin sensitiser and no human data indicative of an effect are known. In addition, no evidence of inflammatory changes indicative of respiratory tract sensitisation were reported in repeated exposure inhalation studies in animals.

(e) Germ cell mutagenicity

In vitro genotoxicity	
Method	Result
Bacterial reverse mutation assay (e.g. Ames test) (gene mutation) EU Method B.13/14 (Mutagenicity – Reverse Mutation Test Using Bacteria).	Test results: negative for TA98, TA100, TA1535, TA1537, TA1538(all strains/cell types tested); met. act.: with and without; cytotoxicity: no.
In vivo genotoxicity	
Method	Result

Drosophila SLRL test (gene mutation) Drosophila melanogaster male OECD Guideline 461	Test results: Genotoxicity: negative (male); toxicity: no effects

Based on available data, the classification criteria are not met.

(f) Carcinogenicity

Carcinogenicity via inhalation	
Method	Result
Rat (Fischer 344) male/female Inhalation: vapour (whole body) 400, 3000, 8000 ppm (target concentration)	NOAEC (carcinogenicity): 400 ppm (male/female) NOAEC (toxicity): 400 ppm (male/female) Neoplastic effects observed in any test group: yes

Based on available data, the classification criteria are not met.

(g) Reproductive toxicity

Effects on fertility	
Method	Result
Rat (Sprague-Dawley) male/female two-generation study. Inhalation: vapour (whole body).	NOAEC (parental toxicity) (P and F1): 400 ppm (male/female) NOAEC (effects on fertility) : 8000 ppm (male/female) NOAEC (developmental toxicity) (F1 and F2 generation): 400 ppm (male/female)
Developmental toxicity	
Method	Result
Rat (Sprague-Dawley) Inhalation: vapour (whole body) Equivalent or similar to OECD Guideline 414 (Prenatal Developmental Toxicity Study)	NOAEC (developmental toxicity): 2500 ppm (No adverse developmental effects were observed) NOAEC (maternal toxicity): 2500 ppm (No adverse effects were observed)

Based on available data, the classification criteria are not met.

(h) STOT-single exposure

- The available human data do not indicate an objective sign of CNS function impairment. Based on all available data, MTBE does not have to be labelled with R67 or Specific Target Organ Toxicity (STOT) – Single exposure, Cat. 3 - H336 (May cause drowsiness or dizziness).

(i) STOT-repeated exposure

- The NOAEC of 800 ppm / 6 hr/day from the inhalation key study (and the NOAEC of 400 ppm / 6 hr/day from the chronic inhalation study), the oral NOAEL of 209 mg/kg bw/day (exposure via drinking water) and the oral NOAEL of 300 mg/kg bw/day (exposure by gavage) are all above the cut-off values that trigger STOT-repeated exposure classification.

(j) Aspiration hazard

-In accordance with Directive 67/548/EEC and EU CLP (Regulation (EC) No. 1272/2008) this substance does not meet the criteria for classification as an aspiration hazard. This substance has a kinematic viscosity of 0.409 mm2/s at 40°C, a surface tension of 18.1 mN/m at 40°C, is partially water soluble (41850 mg/l at 20 °C),and is highly volatile (boiling point of 55.3 °C and vapour pressure of 33 kPa at 25 °C).

11.2 Information on other hazards

11.2.1 Endocrine disrupting properties

Substance is not listed.

11.2.2. Other information

No relevant data found.

SECTION 12: Ecological information

12.1 Toxicity

Aquatic toxicity

Short-term effects on fish	
Method	Result
Pimephales promelas Freshwater Flow-through US EPA 1981	LC50 (96 h): 672 mg/L
Developmental toxicity	
Method	Result
Pimephales promelas Freshwater Early-life stage: reproduction, (sub)lethal effects Flow-through ASTM E1241-92	NOEC (31 d): 299 mg/L test mat. (meas. (not specified)) based on: growth rate. NOEC (31 d): 450 mg/L test mat. (meas. (not specified)) based on: mortality
Short-term toxicity to aquatic invertebrates	
Method	Result
Daphnia magna Freshwater Flow-through EPA OPPTS 850.1010 (Aquatic Invertebrate Acute Toxicity Test, Freshwater Daphnids)	EC50 (48 h): 472 mg/L based on: mobility.
Long-term toxicity to aquatic invertebrates	
Method	Result
Daphnia magna Freshwater Flow-through EPA OPPTS 850.1300 (Daphnid Chronic Toxicity Test)	NOEC (21 d): 51 mg/L test mat. (meas. (geom. mean)) based on: reproduction, length, weight LOEC (21 d): 100 mg/L test mat. (meas. (geom. mean)) based on: reproduction, length, weight

Algae and aquatic plants	
Method	Result
Pseudokirchneriella subcapitata (reported as Selenastrum capricornutum) (algae) Freshwater Static ASTM E1218-90	IC50 (96 h): 491 mg/L IC20 (96 h): 103 mg/L

12.2 Persistence and degradability

Biodegradation in water	
Method	Result
Test type: ready biodegradability Activated sludge, domestic, non-adapted OECD Guideline 301 D (Ready Biodegradability: Closed Bottle Test)	% Degradation of test substance: 0 after 28 d (O2 consumption)
Test type: ready biodegradability OECD Guideline 301 D (Ready Biodegradability: Closed Bottle Test)	% Degradation of test substance: 1.8 after 28 d (O2 consumption)

Test type: ready biodegradability Activated sludge, industrial (adaptation not specified) OECD Guideline 301 D (Ready Biodegradability: Closed Bottle Test)	% Degradation of test substance: 9.24 after 7 d (O2 consumption)
Microbial consortium from a gasoline polluted Soil.	% Degradation of test substance: 100 after 30 h (O2 consumption)
Biodegradation in soil	
Method	Result
Test type: laboratory Soil type: Organic (#1) Sandy loam (#2) Biodegradation in static soil/water microcosms was evaluated under aerobic conditions.	Half-life (DT50): 101.6 d (#1) 79.4 d (#2) % Degradation of test substance: 61 after 151 d 69 after 151 d Evaporation of parent compound: no Volatile metabolites: no Residues: no
Test type: laboratory Soil type: Clay (#1) Sandy loam (#2) Silt loam (#3) Biodegradation in static soil/water microcosms was evaluated under anaerobic conditions.	% Degradation of test substance: ca. 0 after 250 d (Test mat. analysis) ca. 0 after 250 d (Test mat. analysis) ca. 0 after 250 d (Test mat. analysis) Evaporation of parent compound: no Volatile metabolites: no Residues: no Metabolites: No data.
Abiotic degradation	
Degradation for hydrolysis	0 d^{-1}
Degradation for photolysis	0 d^{-1}
Degradation rate in air	0.123 d^{-1}

Abiotic degradation	
Degradation in a non-adapted STP	0 d^{-1}
Degradation rate in surface water	$4.62 \cdot 10^{-3}$ d^{-1}
Degradation rate in aerated sediment	$2.31 \cdot 10^{-3}$ d^{-1}
Degradation rate in soil	$1.00 \cdot 10^{-3}$ d^{-1}

12.3 Bioaccumulative potential

Aquatic bioaccumulation	
Method	Results
Cyprinus carpio aqueous flow-through Total uptake duration: 28 d Total depuration duration: 14 d	BCF: 1.5 (whole body w.w.)

Whole-body bioconcentration factors (BCF) of 1.5 and 1.4 were reported for Japanese carp exposed to 10 and 80 mg/l MTBE in a flow-through system at 25 ºC. Fish exposed for 28 days and then transferred to clean water eliminated almost all MTBE residues within 3 days (Fujiwara et al., 1984). The BCF indicate a low potential for bioconcentration. The BCF of 1.5 l/kg is used in the assessment.

The organic carbon-water partitioning coefficient (Koc) calculated from the octanol-water partition coefficient (log Kow = 1.06) using the equation from the Technical Guidance Document (2003) (predominantly hydrophobics) is 9.1 l/kg (log value = 0.95). This predicted value is used in the assessment.

The Henry's Law constant (H) is calculated as 69.8 Pa m3/mol (log H = 1.84), based on a vapour pressure of 33 kPa at 25 °C and a water solubility of 42,000 mg/l at 25 °C in EUSES, this corresponds to a Henry's Law constant of 33.3 Pa m3/mol at environmental temperature.

The Level I fugacity model is used to calculate the theoretical distribution of MTBE between four environmental compartments (air, water, soil, sediment) at equilibrium in a unit world. The model calculates that 93.9% of MTBE partitions to the atmosphere.

12.4 Mobility in soil
-No further relevant information available.

General notes:
-Water hazard class 1 (German Regulation) (Self-assessment): slightly hazardous for water
-Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.

12.5 Results of PBT and vPvB assessment
PBT: Not applicable.
vPvB: Not applicable.

12.6 Endocrine disrupting properties
The product does not contain substances with endocrine disrupting properties.

12.7 Other adverse effects
Additional environmental information: General notes: Water hazard class 1 (German Regulation) (Self-assessment): Slightly hazardous for water. Do not allow undiluted product or large quantities of it to reach ground water, water course or sewage system.

SECTION 13: Disposal considerations

13.1 Waste treatment methods
- Contaminated product, soil or water may be hazardous waste due to potentially low flash point.
- Dispose of in compliance with respective national and local regulations.
- Assure effluent complies with applicable regulations.
- Landfill solids at permitted sites.
- Use registered transporters.
- Burn concentrated liquids in systems designed for low flash point material.

Uncleaned packaging
-Disposal must be made according to official regulations.
-Packaging that may not be cleansed must be disposed of in the same manner as the product.

SECTION 14: Transport information

14.1 UN Number
ADR, IMDG, IATA UN2398

14.2 UN proper shipping name
ADR 2398 METHYL tert-BUTYL ETHER

IMDG, IATA METHYL tert-BUTYL ETHER

14.3 Transport hazard class(es)
ADR, IMDG, IATA

Class	3 Flammable liquids.
Label	3

14.4 Packing group

ADR, IMDG, IATA	II

14.5 Environmental hazards

Marine pollutant:	No

14.6 Special precautions for user

	Warning: Flammable liquids.
Danger code (Kemler):	33
EMS Number:	F-E,S-D
Stowage Category	**E**

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

Not applicable.

Transport/Additional information:

ADR

Excepted quantities (EQ)	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml
Tunnel restriction code:	D/E

IMDG

Limited quantities (LQ)	1L
Excepted quantities (EQ)	Code: E2 Maximum net quantity per inner packaging: 30 ml Maximum net quantity per outer packaging: 500 ml

SECTION 15: Regulatory information

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

-This safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006.

Directive 2012/18/EU
Named dangerous substances - ANNEX I Substance is not listed.
Seveso category P5c FLAMMABLE LIQUIDS
Qualifying quantity (tonnes) for the application of lower-tier requirements 5,000 t
Qualifying quantity (tonnes) for the application of upper-tier requirements 50,000 t
REGULATION (EC) No 1907/2006 ANNEX XVII Conditions of restriction: 3, 40
DIRECTIVE 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment – Annex II Substance is not listed.

15.2 Chemical safety assessment

-A Chemical Safety Assessment has been carried out.

SECTION 16: Other information

-This information is based on our present knowledge. However, this shall not constitute a guarantee for any specific product features and shall not establish a legally valid contractual relationship.

Relevant phrases

H225	Highly flammable liquid and vapour.
H315	Causes skin irritation.

Abbreviations and acronyms:

ADR: Accord européen sur le transport des marchandises dangereuses par Route (European Agreement concerning the International Carriage of Dangerous Goods by Road)
IMDG: International Maritime Code for Dangerous Goods
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
EINECS: European Inventory of Existing Commercial Chemical Substances
CAS: Chemical Abstracts Service (division of the American Chemical Society)
LC50: Lethal concentration, 50 percent
LD50: Lethal dose, 50 percent
DNEL: derived no-effect level
PNEC: predicted no-effect concentration
NOAEL: No observed adverse effect level LL50: lethal loading rate, 50 percent
NOEC / 21day reproduction study

EL50: effective loading, 50 percent
Flam. Liq. 2: Flammable liquids – Category 2
Skin Irrit. 2: Skin corrosion/irritation – Category 2

Annex: Exposure scenarios

Exposure Scenario 1: Manufacturing

Section 1	**Exposure Scenario Title**
Title	**Manufacture of MTBE; CAS RN1634-04-4**
Use Descriptor	Sector of Use: Industrial (SU3)
	Process Categories: PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15
	Environmental Release Categories: ERC1
Processes, tasks, activities covered	Manufacture of MTBE. Includes recycling/ recovery, material transfers, storage, sampling, associated laboratory activities, maintenance and loading (including marine vessel/barge, road/rail car and bulk container).
Section 2	**Operational conditions and risk management measures**
Section 2.1	**Control of worker exposure**
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	*Not applicable*
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated
Human factors not influenced by risk management	*Not applicable*
Other Operational Conditions affecting worker exposure	Assumes use at not > 20oC above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	**Risk Management Measures**
General measures (skin irritants) [G19].	Avoid all skin contact with product, clean up contamination/spills as soon as they occur. Wear gloves (tested to EN374) if hand contamination likely, wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop [E3].
General exposures (closed systems)	No specific measures identified [EI18].
General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Ensure operation is undertaken outdoors [E69].
General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]. ; With sample collection [CS56].	Provide extract ventilation to points where emissions occur [E54].

General exposures (open systems) [CS16]. Batch process [CS55]. With sample collection [CS56]. ; Filling / preparation of equipment from drums or containers. [CS45].	Ensure material transfers are under containment or extract ventilation [E66].
Process sampling [CS2]. ; Dedicated facility [CS81]	Provide extract ventilation to points where emissions occur [E54].
Laboratory activities [CS36]. Cleaning [CS47] [wiping, brushing, flushing]	Handle in a fume cupboard or under extract ventilation [E83].
bulk open loading and unloading [CS503]Non- dedicated facility [CS82]	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
bulk closed loading and unloading [CS501]Dedicated facility [CS81]	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Equipment cleaning and maintenance [CS39]. Non-dedicated facility [CS82]	Drain down and flush system prior to equipment break-in or maintenance [E55].Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Storage [CS67]; General exposures (closed systems) [CS15].	No specific measures identified [EI18].
Storage [CS67]; General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Section 2.2	**Control of environmental exposure**
Product characteristics	Substance is a unique structure [PrC1]. Predominantly hydrophobic [PrC4a]. Readily biodegradable [PrC5a].
Operational conditions	Outdoor use [OOC1].
Amounts used	
Fraction of EU tonnage used in region	0.25
Regional use tonnage (tonnes/year) [A2]:	290,000
Fraction of regional tonnage used locally [A3]:	0.4
Average local daily tonnage (kg/d) [A5]:	386,667
Annual site tonnage (tonnes/year) [A6]	116,000
Frequency and duration of use	
Type of release	Continuous release [FD2].

Emission days (days/year) [FD4]:	300
Other Operational Conditions of use affecting environmental exposure	Use in closed systems. Either wet or dry processes.
Release fraction to air from process:	1.00E-03
Release fraction to wastewater from process:	3.00E-04
Release fraction to soil from process (regional only):	1.00E-04
RMMs	
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	No air emission controls required; required removal efficiency is 0% [TCR5].
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of >99% [TCR9].
Soil:	No soil emission controls required; required removal efficiency is 0% [TCR7].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1].
Conditions and measures related to municipal sewage treatment plant	Assumed industrial sewage treatment plant effluent flow is 2000 m3/d.
Conditions and measures related to external treatment of waste for disposal	Not applicable
Conditions and measures related to external recovery of waste	Not applicable
Other environmental control measures additional to above	None

Section 3: Exposure estimation – Manufacturing (ES1)

Section 3.1 Worker exposure

The situations leading to exposure include the production of neat MTBE. The worker exposure estimates for the activities associated with the manufacture of MTBE have been assessed using ECETOC TRA version 2. In contrast to the default of the ECETOC TRA model, no influence of local exhaust ventilation (LEV) was taken into account for assessment of dermal exposure.

When modeling resulted in risk characterization ratios above 1 exposure data was used to estimate exposure (tier-2). Only tier-2 data as presented in the EU RAR for MTBE (European Commission, 2002) was used. The workers' exposure to MTBE may principally occur only during incidental leaks and spills from pipeline and valve connections (fugitive emissions) and maintenance operations. Sampling and laboratory work, handling products containing MTBE for analyses, lead to exposure of laboratory assistants. The mechanics are exposed daily during removal of pumps and repairing repellers. They are also doing maintenance on pipelines and vapour recovery equipment. The maintenance tasks are such that the workers are exposed to MTBE vapours and their hands are in contact with petrol products.

Acute/Short term exposure

Table A.1-3 of the Chemical Safety Report contains all operating conditions and the efficiencies of the exposure modifiers including RPE, PPE and LEV (efficiencies are from the ECETOC TRA model, version 2) chosen for estimation of worker exposure (long term and short term). When deviating from the standard ecetoc values or when tier 2 assessment is used. Operational conditions and worker exposure data (short term and long term) corresponding with the handling of neat MTBE for inhalatory exposure as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B1.1 and B1.2 of the Chemical Safety Report.

Long-term exposure

See references provided for Acute/Short term exposure.
Justification for use of additional efficiency factors:
-Draining prior to maintenance (Drain down and flush system prior to equipment break-in or maintenance [E55]) delivers a reduction of 90% of the exposure estimate. Reduction is based on comparison of CONCAWE data on exposures resulting from spills and those arising from same/similar task when SOP invoked (only applicable in industrial settings).

Section 3.2: Consumer exposure

Not applicable.

Section 3.3: Indirect exposure of humans via the environment

All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Fish (mg/kg)	$1.73 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	0.307	EUSES calculation
Leaf crops (mg/kg)	0.021	EUSES calculation
Meat (mg/kg)	$4.02 \cdot 10^{-5}$	EUSES calculation
Milk (mg/l)	$4.02 \cdot 10^{-4}$	EUSES calculation
Drinking water (mg/l)	0.286	EUSES calculation
Air (mg/m^3)	0.274	EUSES calculation

Total daily dose for exposure of humans via the environment

Total daily dose for exposure via the environment (mg/kg bw/d)			Justification
Exposure pathway	Exposed via local concentration	Exposed via local and regional concentration	
Oral	0.010	0.01	EUSES calculation
Inhalation	0.078	0.07	EUSES calculation

Section 3.4: Environmental exposure

Environmental releases

MTBE is produced in closed systems in either wet or dry processes. Atmospheric emissions are expected from both types of processes and release to water primarily from the wet process.

In the wet process of manufacturing MTBE, water is used to wash a hydrocarbon-methanol stream to extract the methanol from the hydrocarbon stream and recycle it. In the dry process, there is no water wash used to extract the methanol. The excess methanol is extracted by other means and recycled to the feed.

During the manufacturing process of MTBE, the product is never in direct contact with water. Water is used in some processes (the so called wet processes) to wash the methanol from the methanol-hydrocarbon stream. The MTBE product is extracted before the wash. However, some traces of MTBE can be present in the MeOH-HC stream. To avoid concentration of the water stream, a very small side stream is extracted from the water stream and led to the wastewater unit. This stream can contain MTBE in small amounts (<0.1 ppm) but these traces are removed in the wastewater unit to levels below detection.

The default emission factors from the Technical Guidance Document (2003) for mineral oil and fuel Industry; fuel additives (IC9, UC28; category 1b) are replaced by specific data regarding emissions to air and wastewater from MTBE. The release factor to air is set at 0.001 and the release factor to waste water is set at 0.0003.

Summary of the releases to the environment

Compartments	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Waste water	116	859	EUSES calculation
Surface water	0	73.8	EUSES calculation
Air	1,20	12,50	EUSES calculation
Soil (direct releases only)	0	293	EUSES calculation

Exposure concentration in sewage treatment plants (STP)

For the determination of the Predicted Exposure Concentrations in the sewage treatment plant (PEC_{STP}), homogeneous mixing in the aeration tank is assumed. The PECstp is therefore equal to the dissolved concentration of the substance.

Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Sewage (mg/l)	0.0	0.01	EUSES calculation
Sewage sludge (mg/kg dw)	12	n.a.	EUSES calculation

Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for production are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater (mg/l)	1.01·10	1.27·10	EUSES calculation
Marine water (mg/l)	1.01·10	1.27·10	EUSES calculation

Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment for production are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater sediments (mg/kg ww)	n.c.	$1.25 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$1.25 \cdot 10^{-4}$	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentrations in soil and groundwater

The exposure routes taken into account in PEC_{local} calculations are application of sewage sludge in agriculture and dry and wet deposition from the atmosphere. Concentration in soil ($Clocal_{soil}$) can be estimated using the aerial deposition flux per kg of soil and the sludge concentration.

The concentration of MTBE in groundwater is calculated for indirect exposure of humans through drinking water. As an indication for potential groundwater levels, the concentration in porewater of agricultural soil is taken. This is a worst-case assumption, neglecting transformation and dilution in deeper soil layers.

The Predicted Exposure Concentrations (PEC) in soil and groundwater for production are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local +	Justification
Agricultural soil averaged (mg/kg ww)	0.16	0.16	EUSES calculation
Grassland averaged (mg/kg ww)	0.05	0.05	EUSES calculation
Groundwater(mg/l)	n.c.	0.28	EUSES calculation

n.c. - not calculated in EUSES

Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source. In the calculation of PEC_{local} for air, both emissions from a point source as well as the emissions from a STP are taken into account. The Predicted Exposure Concentrations (PEC) in air for production are calculated with EUSES (2008).

Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
During emission (mg/m^3)	0.33	n.c.	EUSES calculation
Annual average (mg/m^3)	0.27	0.27	EUSES calculation
Annual deposition ($mg/m^2/d$)	0.39	n.c.	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for MTBE since it has low potential to accumulate to living organisms, and it is not classified as very toxic (T+), toxic (T) or harmful (Xn) according to mammalian toxicity data.

Exposure Scenario 2: Formulation - industrial

Formulation of MTBE covers the blending of petrol with MTBE, both on site and off site. The formulation of MTBE into petrol is considered to be in an automated and principally closed outdoor system with a connection to central waste gas system.

Section 1	**Exposure Scenario Title**
Title	**Formulation of MTBE;CAS RN1634-04-4**
Use Descriptor	Sector of Use: Industrial (SU3)
	Process Categories: PROC1, PROC2, PROC3, PROC4, PROC5, PROC8a, PROC8b, PROC9, PROC15
	Environmental Release Categories: ERC2
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, large and small scale packing, maintenance and associated laboratory activities
Section 2	**Operational conditions and risk management**
Section 2.1	**Control of worker exposure**
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	*Not applicable*
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated
Human factors not influenced by risk management	*Not applicable*
Other Operational Conditions affecting worker exposure	Assumes use at not > 20°C above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	**Risk Management Measures**
General measures (skin irritants) [G19].	Avoid all skin contact with product, clean up contamination/spills as soon as they occur. Wear gloves (tested to EN374) if hand contamination likely, wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop [E3].
General exposures (closed systems)	No specific measures identified [EI18].
General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Provide a good standard of general ventilation (3 to 5 air changes per hour) [E40].

General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]; With sample collection [CS56].	Provide extract ventilation to points where emissions occur [E54].
General exposures (open systems) [CS16]. Batch process [CS55]. With sample collection [CS56]; Filling / preparation of equipment from drums or containers. [CS45].	Provide extract ventilation to points where emissions occur [E54].
General exposures (closed systems) [CS15]. ; Batch processes at elevated temperatures [CS136].With sample collection [CS56].	Formulate in enclosed or ventilated mixing vessels [E46].Provide extract ventilation to points where emissions occur [E54].
Process sampling [CS2].	Provide extract ventilation to points where emissions occur [E54].
Laboratory activities [CS36]. Cleaning [CS47] [wiping, brushing, flushing]	Handle in a fume cupboard or under extract ventilation [E83].
bulk closed loading and unloading [CS501]Dedicated facility [CS81]	Provide extract ventilation to material transfer points and other openings [E82].
Mixing operations (open systems) [CS30]. Batch process [CS55].	Provide extract ventilation to points where emissions occur [E54].
Manual [CS34]. ; Transfer from/pouring from containers [CS22]. Non-dedicated facility [CS82]	Ensure material transfers are under containment or extract ventilation [E66].
Drum/batch transfers [CS8]. Dedicated facility [CS81]	Use drum pumps [E53].Minimise exposure by partial enclosure of the operation or equipment and provide extract ventilation at openings [E60].
Drum and small package filling [CS6]. Dedicated facility [CS81]	Fill containers/cans at dedicated fill points supplied with local extract ventilation [E51]
Equipment cleaning and maintenance [CS39]. Non- dedicated facility [CS82]	Drain down and flush system prior to equipment break-in or maintenance [E55].Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Storage [CS67]; General exposures (closed systems) [CS15].	No specific measures identified [EI18].

Storage [CS67]; General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Section 2.2	**Control of environmental exposure**
Product characteristics	Substance is a unique structure [PrC1]. Predominantly hydrophobic [PrC4a]. Readily biodegradable [PrC5a].
Operational conditions	Outdoor use [OOC1].
Amounts used	
Fraction of EU tonnage used in region	0.57
Regional use tonnage (tonnes/year) [A2]:	659,000
Fraction of regional tonnage used locally	0.05
Average local daily tonnage (kg/d) [A5]:	109,833
Annual site tonnage (tonnes/year) [A6]	32,950
Frequency and duration of use	
Type of release	Continuous release [FD2].
Emission days (days/year) [FD4]:	300
Other Operational Conditions of use affecting	Use in closed systems. Either wet or dry processes.
Release fraction to air from process:	1.00E-03
Release fraction to wastewater from process:	3.00E-04
Release fraction to soil from process (regional only):	1.00E-04
RMMs	
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	No air emission controls required; required removal efficiency is 0% [TCR5].
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of >99% [TCR9].
Soil:	No soil emission controls required; required removal efficiency is 0% [TCR7].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1].
Conditions and measures related to municipal sewage treatment plant	Assumed industrial sewage treatment plant effluent flow is 2000 m3/d.

Conditions and measures related to external treatment of waste for disposal	Not applicable
Conditions and measures related to external recovery of waste	Not applicable
Other environmental control measures additional to above	None

Section 3 Exposure estimation – Formulation - industrial (ES2)

Section 3.1 Worker exposure

The situations leading to exposure include formulation (blending and storing): petrol blending with MTBE. The worker exposure estimates for the activities associated with formulation have been assessed using ECETOC TRA version 2. In contrast to the default of the ECETOC TRA model, no influence of local exhaust ventilation (LEV) was taken into account for assessment of dermal exposure.
When modeling resulted in risk characterization ratios above 1, exposure data was used to estimate exposure (tier-2). Only tier-2 data as presented in the EU RAR for MTBE (European Commission, 2002) was used.
The workers' exposure to MTBE may principally occur only during incidental leaks and spills from pipeline and valve connections (fugitive emissions) and maintenance operations. In formulation (blending and storing) operations, exposure might either concern neat MTBE or blended fuel. Sampling and laboratory work, handling products containing MTBE for analyses, lead to exposure of laboratory assistants. The mechanics are daily exposed during removal of pumps and repairing repellers. They are also doing maintenance on pipelines and vapour recovery equipment. The maintenance tasks are such that the workers are exposed to MTBE vapours and their hands are in contact with petrol products.

Acute/Short term exposure

Table A.2-3 of the Chemical Safety Report contains all operating conditions and the efficiencies of the exposure modifiers including RPE, PPE and LEV (efficiencies are from the ECETOC TRA model, version 2) chosen for estimation of worker exposure (long term and short term). When deviating from the standard ecetoc values or when tier 2 assessment (Annex B 1.2 of the Chemical Safety Report) is used. Operational conditions and worker exposure data (short term and long term) corresponding with the handling of neat MTBE for inhalatory exposure as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B1.1 and B1.2 of the Chemical Safety Report.

Long-term exposure

See references provided for Acute/Short term exposure.
Justification for use of additional efficiency factors:
-Draining prior to maintenance (Drain down and flush system prior to equipment break-in or maintenance [E55]) delivers a reduction of 90% of the exposure estimate. Reduction is

based on comparison of CONCAWE data on exposures resulting from spills and those arising from same/similar task when SOP invoked (only applicable in industrial settings).

Section 3.2: Consumer exposure

Not applicable

Section 3.3: Indirect exposure of humans via the environment

All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Fish (mg/kg)	$1.70 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	0.055	EUSES calculation
Leaf crops (mg/kg)	$1.95 \cdot 10^{-3}$	EUSES calculation
Meat (mg/kg)	$4.82 \cdot 10^{-6}$	EUSES calculation
Milk (mg/l)	$4.82 \cdot 10^{-5}$	EUSES calculation
Drinking water (mg/l)	0.052	EUSES calculation
Air (mg/m^3)	0.025	EUSES calculation

Total daily dose for exposure of humans via the environment

Total daily dose for exposure via the environment (mg/kg bw/d)			Justification
Exposure pathway	Exposed via local concentration	Exposed via local and regional concentration	
Oral	1.82·10	1.83·10	EUSES calculation
Inhalation	7.24·10	7.31·10	EUSES calculation

Section 3.4: Environmental exposure

Environmental releases

Formulation of MTBE covers the blending of petrol with MTBE. Emissions into environment are mainly atmospheric. There are two formulation techniques for blending petrol with MTBE, in-line blending and batch blending. In in-line blending the petrol components (including MTBE) are pumped from their storage tanks to a common line and pumped further through the common line to the product storage tank. The components are blended both during the pumping through the common line and in the product tank. In batch blending the petrol components are pumped through separate lines to the storage tank. The blending of the components hence takes place only in the product tank. When MTBE is blended in to petrol outside the refineries, e.g. in commercial terminals, both techniques can be used for the

blending. Batch blending is however usually more used. There are 4-8 commercial terminals within the EU that do blending of petrol. Approximately 5% or less of the MTBE used in Europe are blended outside the refineries (Fortum, 2000a). It is expected that the MTBE emissions in these terminals should not differ from the emissions from blending activities in the refineries since the techniques used are similar. The default emission factors from the Technical Guidance Document (2003) for mineral oil and fuel Industry; fuel additives (IC9, UC28; category 1b) are replaced by specific data regarding emissions to air and wastewater from MTBE. The release factor to air is set at 0.001, the release factor to waste water is set at 0.0003 and the release factor to surface water is set to zero. The default fraction of the main source is also replaced by specific data (fraction of the main source is 0.05). For the regional assessment it is assumed that all waste water is collected by industrial sewage treatment plants.

Summary of the releases to the environment

Compartments	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Waste water	33	859	EUSES calculation
Surface water	0	73.8	EUSES calculation
Air	110	12,500	EUSES calculation
Soil (direct releases only)	0	293	EUSES calculation

Exposure concentration in sewage treatment plants (STP)

For the determination of the PEC_{STP}, homogeneous mixing in the aeration tank is assumed. The PECstp is therefore equal to the dissolved concentration of the substance. The PEC in the sewage treatment plant for formulation are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Sewage (mg/l)	$9.86 \cdot 10^{-3}$	$9.86 \cdot 10^{-3}$	EUSES calculation
Sewage sludge (mg/kg	34.5	n.a.	EUSES calculation

n.a. - not applicable

Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for formulation are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification

Freshwater (mg/l)	$9.86 \cdot 10^{-4}$	$1.25 \cdot 10^{-3}$	EUSES calculation
Marine water (mg/l)	$9.86 \cdot 10^{-5}$	$1.25 \cdot 10^{-4}$	EUSES calculation

Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater sediments (mg/kg ww)	n.c.	$1.22 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$1.22 \cdot 10^{-4}$	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentrations in soil and groundwater

The exposure routes taken into account in PEClocal calculations are application of sewage sludge in agriculture and dry and wet deposition from the atmosphere. Concentration in soil (Clocalsoil) can be estimated using the aerial deposition flux per kg of soil and the sludge concentration. The concentration of MTBE in groundwater is calculated for indirect exposure of humans through drinking water. As an indication for potential groundwater levels, the concentration in porewater of agricultural soil is taken. This is a worst-case assumption, neglecting transformation and dilution in deeper soil layers. The Predicted Exposure Concentrations (PEC) in soil and groundwater for formulation are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Agricultural soil averaged (mg/kg ww)	0.039	0.039	EUSES calculation
Grassland averaged (mg/kg ww)	$6.53 \cdot 10^{-3}$	$6.54 \cdot 10^{-3}$	EUSES calculation
Groundwater(mg/l)	n.c.	0.052	EUSES calculation

n.c. - not calculated in EUSES

Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source. In the calculation of PEClocal for air, both emissions from a point source as well as the emissions from a STP are taken into account. The Predicted Exposure Concentrations (PEC) in air for formulation are calculated with EUSES (2008).

Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
During emission (mg/m^3)	0.031	n.c.	EUSES calculation
Annual average (mg/m^3)	0.025	0.025	EUSES calculation
Annual deposition ($mg/m^2/d$)	0.036	n.c.	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for MTBE since it has low potential to accumulate to living organisms, and it is not classified as very toxic (T+), toxic (T) or harmful (Xn) according to mammalian toxicity data.

Exposure Scenario 3: Use as an intermediate - industrial

MTBE is used as intermediate for isobutylene production.

Section 1	**Exposure Scenario Title**
Title	**Use MTBE as intermediate; CAS RN1634-04-4**
Use Descriptor	Sector of Use: Industrial (SU3)
	Process Categories: PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15
	Environmental Release Categories: ERC6a
Processes, tasks, activities covered	Use as intermediate. Includes recycling/ recovery, material transfers, storage, sampling, associated laboratory activities, maintenance and loading (including marine vessel/barge, road/rail car and bulk container).
Section 2	**Operational conditions and risk management**
Section 2.1	**Control of worker exposure**
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	*Not applicable*
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated
Human factors not influenced by risk management	*Not applicable*
Other Operational Conditions affecting worker exposure	Assumes use at not > 20oC above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	**Risk Management Measures**
General measures (skin irritants) [G19].	Avoid all skin contact with product, clean up contamination/spills as soon as they occur. Wear gloves (tested to EN374) if hand contamination likely, wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop [E3].
General exposures (closed systems)	No specific measures identified [EI18].
General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Ensure operation is undertaken outdoors [E69].

General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]. ; With sample collection [CS56].	Provide extract ventilation to points where emissions occur [E54].
General exposures (open systems) [CS16]. Batch process [CS55]. With sample collection [CS56]. ; Filling / preparation of equipment from drums or containers. [CS45].	Ensure material transfers are under containment or extract ventilation [E66].
Process sampling [CS2]. ; Dedicated facility [CS81]	Provide extract ventilation to points where emissions occur [E54].
Laboratory activities [CS36]. Cleaning [CS47] [wiping, brushing, flushing]	Handle in a fume cupboard or under extract ventilation [E83].
bulk open loading and unloading [CS503]Non- dedicated facility [CS82]	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
bulk closed loading and unloading [CS501]Dedicated facility [CS81]	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Equipment cleaning and maintenance [CS39]. Non- dedicated facility [CS82]	Drain down and flush system prior to equipment break-in or maintenance [E55].Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Storage [CS67]; General exposures (closed systems) [CS15].	No specific measures identified [EI18].
Storage [CS67]; General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Section 2.2	**Control of environmental exposure**
Product characteristics	Substance is a unique structure [PrC1]. Predominantly hydrophobic [PrC4a]. Readily biodegradable [PrC5a].
Operational conditions	Outdoor use [OOC1].
Amounts used	
Fraction of EU tonnage used in region	0.01
Regional use tonnage (tonnes/year) [A2]:	8,030
Fraction of regional tonnage used locally	1
Average local daily tonnage (kg/d) [A5]:	26,767

Annual site tonnage (tonnes/year) [A6]	8,030
Frequency and duration of use	
Type of release	Continuous release [FD2].
Emission days (days/year) [FD4]:	300
Other Operational Conditions of use affecting environmental exposure	Use in closed systems. Either wet or dry processes.
Release fraction to air from process:	5.00E-02
Release fraction to wastewater from process:	8.00E-06
Release fraction to soil from process (regional only):	1.00E-04

RMMs

Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	No air emission controls required; required removal efficiency is 0% [TCR5].
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of >90% [TCR9].
Soil:	No soil emission controls required; required removal efficiency is 0% [TCR7].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1].
Conditions and measures related to municipal sewage treatment plant	Assumed industrial sewage treatment plant effluent flow is 2000 m3/d.
Conditions and measures related to external treatment of waste for	Not applicable
Conditions and measures related to external recovery of waste	Not applicable
Other environmental control measures additional to above	None

Section 3: Exposure estimation – Use as intermediate - industrial (ES3)

Section 3.1 Worker exposure

The situations leading to exposure include the use of neat MTBE as intermediate. The worker exposure estimates for the activities associated with the use as intermediate have been assessed using ECETOC TRA version 2. In contrast to the default of the ECETOC TRA model, no influence of local exhaust ventilation (LEV) was taken into account for assessment of dermal exposure. In Annex A3.1 of the Chemical Safety Report general information, including the DNELs, of the exposure scenario is presented. In Annex A3.2 of

the Chemical Safety Report the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented. When modeling resulted in risk characterization ratios above 1 exposure data was used to estimate exposure (tier-2). Only tier-2 data as presented in the EU RAR for MTBE (European Commission, 2002) was used.
The workers' exposure to MTBE may principally occur only during incidental leaks and spills from pipeline and valve connections (fugitive emissions) and maintenance operations. Sampling and laboratory work, handling products containing MTBE for analyses, lead to exposure of laboratory assistants. The mechanics are daily exposed during removal of pumps and repairing repellers. They are also doing maintenance on pipelines and vapour recovery equipment. The maintenance tasks are such that the workers are exposed to MTBE vapours and their hands are in contact with petrol products.

Acute/Short term exposure

Table A.3-3 of the Chemical Safety Report contains all operating conditions and the efficiencies of the exposure modifiers including RPE, PPE and LEV (efficiencies are from the ECETOC TRA model, version 2) choosen for estimation of worker exposure (long term and short term). When deviating from the standard ecetoc values or when tier 2 assessment (Annex B 1.2 of the Chemical Safety Report) is used.
Operational conditions and worker exposure data (short term and long term) corresponding with the handling of neat MTBE for inhalatory exposure as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B1.1 and B.1.2 of the Chemical Safety Report.

Long-term exposure

See references for Acute/Short term exposure.
Justification for use of additional efficiency factors:
-Draining prior to maintenance (Drain down and flush system prior to equipment break-in or maintenance [E55]) delivers a reduction of 90% of the exposure estimate. Reduction is based on comparison of CONCAWE data on exposures resulting from spills and those arising from same/similar task when SOP invoked (only applicable in industrial settings).

Section 3.2 Consumer exposure

Not applicable.

Section 3.3: Indirect exposure of humans via the environment

All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure	Justification
Fish (mg/kg)	$1.61 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	0.185	EUSES calculation

Leaf crops (mg/kg)	0.024	EUSES calculation
Meat (mg/kg)	$3.85 \cdot 10^{-5}$	EUSES calculation
Milk (mg/l)	$3.85 \cdot 10^{-4}$	EUSES calculation
Drinking water (mg/l)	0.173	EUSES calculation
Air (mg/m^3)	0.306	EUSES calculation

Total daily dose for exposure of humans via the environment

Total daily dose for exposure via the environment (mg/kg bw/d)			Justification
Exposure pathway	**Exposed via local concentration**	**Exposed via local and regional concentration**	
Oral	$6.40 \cdot 10^{-3}$	$6.41 \cdot 10^{-3}$	EUSES calculation
Inhalation	0.08	0.08	EUSES calculation

Section 3.4: Environmental exposure

Environmental releases

Industrial use covers emissions from the use of MTBE as an intermediate in transformation of MTBE into isobutene. Emissions into environment are mainly atmospheric.
The default emission factor to waste water from the Technical Guidance Document (2003) for chemical industry; chemicals used in synthesis (IC3, UC33) is replaced by specific data. The default fraction of the main source is also replaced by specific data. The release factor to waste water is set at 0.0003, the release factor to surface water is set to zero and the release factor to soil is set to 8•10-6. The default fraction of the main source is also replaced by specific data (fraction of the main source is 1).
For the regional assessment it is assumed that all waste water is collected by industrial sewage treatment plants

Summary of the releases to the environment

Compartments	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Waste water	0.21	859	EUSES calculation
Surface water	0	73.8	EUSES calculation
Air	1,34	12,50	EUSES calculation
Soil (direct releases only)	0	293	EUSES calculation

Exposure concentration in sewage treatment plants (STP)

For the determination of the PECSTP, homogeneous mixing in the aeration tank is assumed.

The PECstp is therefore equal to the dissolved concentration of the substance. The Predicted Exposure Concentrations (PEC) in the sewage treatment plant for use as an intermediate are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Sewage (mg/l)	$9.11 \cdot 10^{-3}$	$9.11 \cdot 10^{-3}$	EUSES calculation
Sewage sludge (mg/kg dw)	0.232	n.a.	EUSES calculation

n.a. - not applicable

Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for use as an intermediate are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater (mg/l)	$9.11 \cdot 10^{-4}$	$1.17 \cdot 10^{-3}$	EUSES calculation
Marine water (mg/l)	$9.11 \cdot 10^{-5}$	$1.17 \cdot 10^{-4}$	EUSES calculation

Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment for use as an intermediate are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater sediments (mg/kg ww)	n.c.	$1.15 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$1.15 \cdot 10^{-4}$	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentrations in soil and groundwater

The exposure routes taken into account in PEClocal calculations are application of sewage

sludge in agriculture and dry and wet deposition from the atmosphere. Concentration in soil (Clocalsoil) can be estimated using the aerial deposition flux per kg of soil and the sludge concentration.

The concentration of MTBE in groundwater is calculated for indirect exposure of humans through drinking water. As an indication for potential groundwater levels, the concentration in porewater of agricultural soil is taken. This is a worst-case assumption, neglecting transformation and dilution in deeper soil layers.

The Predicted Exposure Concentrations (PEC) in soil and groundwater for use as an intermediate are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Agricultural soil averaged (mg/kg	0.04	0.04	EUSES calculation
Grassland averaged (mg/kg ww)	0.05	0.05	EUSES calculation
Groundwater(mg/l)	n.c.	0.17	EUSES calculation

n.c. - not calculated in EUSES

Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source. In the calculation of PEClocal for air, both emissions from a point source as well as the emissions from a STP are taken into account. The Predicted Exposure Concentrations (PEC) in air are calculated with EUSES (2008).

Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
During emission (mg/m^3)	0.37	n.c.	EUSES calculation
Annual average (mg/m^3)	0.30	0.30	EUSES calculation
Annual deposition ($mg/m^2/d$)	0.44	n.c.	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for MTBE since it has low potential to accumulate to living organisms, and it is not classified as very toxic (T+), toxic (T) or harmful (Xn) according to mammalian toxicity data.

Exposure Scenario 4: Use as a process solvent and extraction agent - industrial

Although MTBE is used almost exclusively as an additive to petrol, limited amounts (0.1-0.2%) of produced very pure substance (97.5%) is used as solvent.

MTBE is used as a solvent in different situations. The following activities are included:

The pharmaceutical industry uses MTBE as a solvent for extraction and crystallisation of substances instead of other ethers (Little et al., 1979 as referred in European Commission, 2002).

In laboratories, MTBE is used to some extent as a solvent for chemical analyses (Little et al. 1979; Mount et al., 1991 as referred in European Commission, 2002).

For research and development purposes MTBE has been used for dissolution of gallstones in patients and laboratory animals (Adam et al., 1990; Allen et al., 1985; Ponchon et al., 1988; Teplick et al., 1987 as referred in European Commission, 2002).

Section 1	**Exposure Scenario Title**
Title	**Use MTBE as process solvent or extraction agent;CAS RN1634-04-4**
Use Descriptor	Sector of Use: Industrial (SU3, SU8, SU9)
	Process Categories: PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC15
	Environmental Release Categories: ERC4
Processes, tasks, activities covered	Use as process solvent or extraction agent. Includes recycling/ recovery, material transfers, storage, sampling, associated laboratory activities, maintenance and loading (including marine vessel/barge, road/rail car and bulk container).
Section 2	**Operational conditions and risk management**
Section 2.1	**Control of worker exposure**
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	*Not applicable*
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated
Human factors not influenced by risk management	*Not applicable*
Other Operational Conditions affecting worker exposure	Assumes use at not > 20oC above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].

Contributing Scenarios	Risk Management Measures
General measures (skin irritants) [G19].	Avoid all skin contact with product, clean up contamination/spills as soon as they occur. Wear gloves (tested to EN374) if hand contamination likely, wash off any skin contamination immediately.
	Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop [E3].
General exposures (closed systems) [CS15].	No specific measures identified [EI18].
General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Ensure operation is undertaken outdoors [E69].
General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]. ; With sample collection [CS56].	Provide extract ventilation to points where emissions occur [E54].
General exposures (open systems) [CS16]. Batch process [CS55]. With sample collection [CS56]. ; Filling / preparation of equipment from drums or containers. [CS45].	Ensure material transfers are under containment or extract ventilation [E66].
Process sampling [CS2]. ; Dedicated facility [CS81]	Provide extract ventilation to points where emissions occur [E54].
Laboratory activities [CS36]. Cleaning [CS47] [wiping, brushing, flushing]	Handle in a fume cupboard or under extract ventilation [E83].
bulk open loading and unloading [CS503]Non- dedicated facility [CS82]	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
bulk closed loading and unloading [CS501]Dedicated facility [CS81]	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Equipment cleaning and maintenance [CS39]. Non- dedicated facility [CS82]	Drain down and flush system prior to equipment break-in or maintenance [E55].Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Storage [CS67]; General exposures (closed systems) [CS15].	No specific measures identified [EI18].

Storage [CS67]; General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Section 2.2	**Control of environmental exposure**
Product characteristics	Substance is a unique structure [PrC1]. Predominantly hydrophobic [PrC4a]. Readily biodegradable [PrC5a].
Operational conditions	Outdoor use [OOC1].
Amounts used	
Fraction of EU tonnage used in region [A1]:	0.00
Regional use tonnage (tonnes/year) [A2]:	2,010
Fraction of regional tonnage used locally	0.3
Average local daily tonnage (kg/d) [A5]:	1,834
Annual site tonnage (tonnes/year) [A6]	603
Frequency and duration of use	
Type of release	Continuous release [FD2].
Emission days (days/year) [FD4]:	120
Other Operational Conditions of use affecting environmental exposure	Use in closed systems. Either wet or dry processes.
Release fraction to air from process:	2.50E-01
Release fraction to wastewater from process:	1.00E-02
Release fraction to soil from process (regional only):	1.00E-03
RMMs	
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	No air emission controls required; required removal efficiency is 0% [TCR5].
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of >99% [TCR9].
Soil:	No soil emission controls required; required removal efficiency is 0% [TCR7].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1].

Conditions and measures related to municipal sewage treatment plant	Assumed industrial sewage treatment plant effluent flow is 2000 m3/d.
Conditions and measures related to external treatment of waste for disposal	Not applicable
Conditions and measures related to external recovery of waste	Not applicable
Other environmental control measures additional to above	None

Section 3: Exposure estimation – Use as process solvent or extraction agent - industrial (ES4)

Section 3.1: Worker exposure

The situations leading to exposure include the use of neat MTBE as process solvent for the extraction and crystallisation of substances, as a solvent in chemical analyses and in research and development activities. The worker exposure estimates for the activities associated with this use has been assessed using ECETOC TRA version 2. In contrast to the default of the ECETOC TRA model, no influence of local exhaust ventilation (LEV) was taken into account for assessment of dermal exposure. In Annex A4.1 of the Chemical Safety Report general information, including the DNELs, of the exposure scenario is presented. In Annex A4.2 of the Chemical Safety Report the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented .No exposure data for this ES was available in the EU RAR for MTBE (European Commission, 2002).

Acute/Short term exposure

Table A.4-3 of the Chemical Safety Report contain the two subtables containing all operating conditions and the efficiencies of the exposure modifiers including RPE, PPE and LEV (efficiencies are from the ECETOC TRA model, version 2) choosen for estimation of worker exposure (long term and short term). Tier-2 data from the manufacturing process was used to estimate exposure during loading and unloading activities.

Long-term exposure

See references provided for Acute/Short term exposure.
Justification for use of additional efficiency factors:
-Draining prior to maintenance (Drain down and flush system prior to equipment break-in or maintenance [E55]) delivers a reduction of 90% of the exposure estimate. Reduction is based on comparison of CONCAWE data on exposures resulting from spills and those arising from same/similar task when SOP invoked (only applicable in industrial settings).

Section 3.2: Consumer exposure

Not applicable.

Section 3.3: Indirect exposure of humans via the environment

All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure	Justification
Fish (mg/kg)	$9.34 \cdot 10^{-4}$	EUSES calculation
Root crops (mg/kg)	0.307	EUSES calculation
Leaf crops (mg/kg)	$8.85 \cdot 10^{-3}$	EUSES calculation
Meat (mg/kg)	$1.69 \cdot 10^{-5}$	EUSES calculation
Milk (mg/l)	$1.69 \cdot 10^{-4}$	EUSES calculation
Drinking water (mg/l)	0.121	EUSES calculation
Air (mg/m^3)	0.115	EUSES calculation

Total daily dose for exposure of humans via the environment

Total daily dose for exposure via the environment (mg/kg bw/d)			Justification
Exposure pathway	Exposed via local concentration	Exposed via local and regional concentration	
Oral	9.20·10	9.21·10	EUSES calculation
Inhalation	0.03	0.03	EUSES calculation

Section 3.4: Environmental exposure

Environmental releases

High purity MTBE is used for the production of intermediates for pharmaceutical active ingredients because of technical advantages to other solvents. The main advantage of MTBE in comparison with other solvents is the stability against oxidation processes and nearly no formation of peroxides. So, MTBE is used as a specialist solvent for closed special processes. The extraction solvent is recycled after usage. Only a small amount of the overall amount of MTBE is disposed to wastewater or burned in waste incineration plants. Exhaust air is typically treated in exhaust air burning facilities.

The default emission factors from the Technical Guidance Document (2003) for chemical industry; solvents (IC2, UC48) are replaced by specific data regarding emissions to wastewater. The release factor to waste water is set at 0.0003, the release factor to surface water is set to zero and the release factor to soil is set to 0.0001. For the regional assessment it is assumed that all waste water is collected by industrial sewage treatment plants.The releases to the environment from use as a process and extraction agent are calculated with EUSES (2008).

Summary of the releases to the environment

Compartments	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Waste water	50.2	859	EUSES calculation
Surface water	0	73.8	EUSES calculation
Air	125	12,50	EUSES calculation
Soil (direct releases only)	0	293	EUSES calculation

Exposure concentration in sewage treatment plants (STP)

For the determination of the PEC_{STP}, homogeneous mixing in the aeration tank is assumed. The PECstp is therefore equal to the dissolved concentration of the substance.

Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Sewage (mg/l)	$9.91 \cdot 10^{-3}$	$9.91 \cdot 10^{-3}$	EUSES calculation
Sewage sludge (mg/kg dw)	52.5	n.a.	EUSES calculation

n.a. - not applicable

Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for use as a process and extraction agent are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater (mg/l)	$9.91 \cdot 10^{-4}$	$1.25 \cdot 10^{-3}$	EUSES calculation
Marine water (mg/l)	$9.91 \cdot 10^{-5}$	$1.25 \cdot 10^{-4}$	EUSES calculation

Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment for use as a process and extraction agent are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater sediments (mg/kg ww)	n.c.	$1.23 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$1.23 \cdot 10^{-4}$	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentrations in soil and groundwater

The exposure routes taken into account in PEC_{local} calculations are application of sewage sludge in agriculture and dry and wet deposition from the atmosphere. Concentration in soil ($Clocal_{soil}$) can be estimated using the aerial deposition flux per kg of soil and the sludge concentration.

The concentration of MTBE in groundwater is calculated for indirect exposure of humans through drinking water. As an indication for potential groundwater levels, the concentration in porewater of agricultural soil is taken. This is a worst-case assumption, neglecting transformation and dilution in deeper soil layers.

The Predicted Exposure Concentrations (PEC) in soil and groundwater for use as a process and extraction agent are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Agricultural soil averaged (mg/kg	0.07	0.07	EUSES calculation
Grassland averaged (mg/kg ww)	0.02	0.02	EUSES calculation
Groundwater(mg/l)	n.c.	0.12	EUSES calculation

n.c. - not calculated in EUSES

Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source. In the calculation of PEC_{local} for air, both emissions from a point source as well as the emissions from a STP are taken into account. The Predicted Exposure Concentrations (PEC) in air for use as a process and extraction agent are calculated with EUSES (2008).

Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
During emission (mg/m^3)	0.349	n.c.	EUSES calculation
Annual average (mg/m^3)	0.115	0.11	EUSES calculation
Annual deposition ($mg/m^2/d$)	0.165	n.c.	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for MTBE since it has low potential to accumulate to living organisms, and it is not classified as very toxic (T+), toxic (T) or harmful (Xn) according to mammalian toxicity data.

Exposure Scenario 5: Transport and distribution - industrial

MTBE is used in transportation and distribution as fuel additive in fuels BY transfer of substance or preparation. Neat MTBE and the blended petrol products are transported from the refinery to the depot-terminals and distributed from the depot area (bulk station) to service stations. The products can be transported in an airplane, railcar, truck and ship.

Section 1	**Exposure Scenario Title**
Title	**Distribution of MTBE;CAS RN1634-04-4**
Use Descriptor	Sector of Use: Industrial (SU3)
	Process Categories: PROC1, PROC2, PROC3, PROC4, PROC8a, PROC8b, PROC9, PROC15
	Environmental Release Categories: ERC1, ERC2
	Specific Environmental Release Categories:
Processes, tasks, activities covered	Loading (including marine vessel/barge, rail/road car and IBC loading) and repacking (including drums and small packs) of substance, including its distribution and associated laboratory activities
Section 2	**Operational conditions and risk management**
Section 2.1	**Control of worker exposure**
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 100 % (unless stated differently) [G13].
Amounts used	*Not applicable*
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	*Not applicable*
Other Operational Conditions affecting worker exposure	Assumes use at not > 20oC above ambient [G15]; Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	**Risk Management Measures**
General measures (skin irritants) [G19].	Avoid all skin contact with product, clean up contamination/spills as soon as they occur. Wear gloves (tested to EN374) if hand contamination likely, wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop [E3].
General exposures (closed systems) [CS15].	No specific measures identified [EI18].
General exposures (closed systems) [CS15]. ;	Ensure operation is undertaken outdoors [E69].

General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]. ; With sample collection [CS56].	Ensure operation is undertaken outdoors [E69]. Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
General exposures (open systems) [CS16]. Batch process [CS55]. With sample collection [CS56]. ; Filling / preparation of equipment from drums or containers. [CS45].	Provide extract ventilation to points where emissions occur [E54]; Ensure samples are obtained under containment or extract ventilation [E76]
Process sampling [CS2].	Avoid carrying out activities involving exposure for more than 15 minutes [OC26], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Laboratory activities [CS36]. Cleaning [CS47] [wiping, brushing, flushing]	Handle in a fume cupboard or under extract ventilation [E83].
Bulk closed loading and unloading [CS501]. Dedicated facility [CS81]	Ensure operation is undertaken outdoors [E69]. Avoid carrying out activities involving exposure for more than 1 hour [OC27], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Bulk open loading and unloading [CS503]. Non- dedicated facility [CS82]	Ensure material transfers are under containment or extract ventilation [E66]. , or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Drum and small package filling [CS6]. Dedicated facility [CS81]	Fill containers/cans at dedicated fill points supplied with local extract ventilation [E51]
Equipment cleaning and maintenance [CS39]. Non- dedicated facility [CS82]	Drain down and flush system prior to equipment break-in or maintenance [E55].
Storage [CS67]; General exposures (closed systems) [CS15].	No specific measures identified [EI18].
Storage [CS67]; General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Avoid carrying out activities involving exposure for more than 1 hour [OC27], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Section 2.2	**Control of environmental exposure**
Product characteristics	Substance is a unique structure [PrC1].
	Predominantly hydrophobic [PrC4a].
	Readily biodegradable [PrC5a].
Transport and distribution	
Operational conditions	Outdoor use [OOC1].
Amounts used	
Fraction of EU tonnage used in region	0.57

Regional use tonnage (tonnes/year) [A2]:	659,000
Fraction of regional tonnage used locally [A3]:	0.02
Average local daily tonnage (kg/d) [A5]:	37,657
Annual site tonnage (tonnes/year) [A6]:	13,180
Frequency and duration of use	
Type of release	Continuous release [FD2].
Emission days (days/year) [FD4]:	350
Other Operational Conditions of use affecting environmental exposure	Use in closed systems. Either wet or dry processes.
Release fraction to air from process:	1.00E-04
Release fraction to wastewater from process:	1.00E-05
Release fraction to soil from process (regional only):	1.00E-05
RMMs	
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	No air emission controls required; required removal efficiency is 0% [TCR5].
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of >95% [TCR9].
Soil:	No soil emission controls required; required removal efficiency is 0% [TCR7].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1].
Conditions and measures related to municipal sewage treatment plant	Assumed industrial sewage treatment plant effluent flow is 2000
Conditions and measures related to external treatment of waste for disposal	-
Conditions and measures related to external recovery of waste	-
Other environmental control measures additional to above	-
Storage	
Operational conditions	Outdoor use [OOC1].
Amounts used	
Fraction of EU tonnage used in region	0.57
Regional use tonnage (tonnes/year) [A2]:	659,000
Fraction of regional tonnage used locally [A3]:	1

Average local daily tonnage (kg/d) [A5]:	1,805,479
Annual site tonnage (tonnes/year) [A6]	659,000
Frequency and duration of use	
Type of release	Continuous release [FD2].
Emission days (days/year)	365
Other Operational Conditions of use affecting	Use in closed systems.
	Either wet or dry processes.
Release to wastewater from process	8.4
RMMs	
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	Air emission controls are not appliable as there is no direct release
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of >99% [TCR9].
Soil:	Soil emission controls are not applicable as there is no direct release to soil [TCR4].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1]. Prevent leakages and spillages to soil.
Conditions and measures related to municipal sewage treatment plant	Assumed industrial sewage treatment plant effluent flow is 2000 m3/d.
Conditions and measures related to external treatment of waste for disposal	Not applicable
Conditions and measures related to external recovery of waste	Not applicable
Other environmental control measures additional to above	None

Section 3: Exposure estimation – Transport and distribution – industrial (ES5)

Section 3.1: Workers exposure

The situations leading to exposure include loading and unloading railroad car, ship etc. and distribution of petrol containing MTBE to service stations (loading and unloading tank trucks). The worker exposure estimates for the activities associated with transport and distribution have been assessed using ECETOC TRA version 2. In contrast to the default of the ECETOC TRA model, no influence of local exhaust ventilation (LEV) was taken into account for assessment of dermal exposure. In Annex A5.1 of the Chemical Safety Report general information, including the DNELs, of the exposure scenario is presented. In Annex A5.2 of

the Chemical Safety Report the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented.
When modelling resulted in risk characterization ratios above 1 exposure data was used to estimate exposure (tier-2). Only tier-2 data as presented in the EU RAR for MTBE (European Commission, 2002) was used (see Annex B1.2 of the Chemical Safety Report, containing a summary of data from the EU RAR of MTBE).

Transporting operations concerns both neat MTBE and mixed fuel. The exposed workers are bulk terminal, railcar, truck and marine employees. Leaks from the fittings and dry break mating surfaces contribute to the operators' exposure during the loading/unloading operations. The severity of drivers' exposure to petrol vapours depends on the method of loading (top loading or bottom loading), and how the vapours from the empty tanks are displaced, recovered or vented.

Exposure can be the result of the following loading/unloading activities (as described in the RAR, European Commission, 2002):

Unloading of a railroad car (disconnecting the bottom cap from the rail car, connecting a male unloading elbow, and connecting a female unloading dry break to the male elbow for product transfer to a storage tank), *Loading and delivery operations* (The major part of exposure of road tanker drivers takes place during loading and delivery operations. The principal source for workers' exposure at depot area is created by the flow of petrol into the truck tank. The petrol flow displaces petrol vapours from the truck tank into the atmosphere or into a vapour recovery system. Leaking from the filling lines or spillage of petrol may also produce vapours through evaporation), *disconnecting the bottom cap from the truck* (at service stations for product transfer to the storing tank), connecting a male unloading elbow, and connecting a female unloading dry break to the male elbow. Spills and leaks from the fittings and dry break mating surfaces contribute to the driver's exposure. The highest short-term exposures may occur during the connecting and disconnecting the dry break valves. Saturated petrol vapours escaping from the tanks when the tanks are filled with new liquid likely causes the main exposure.

Taking samples During transportation, also samplings for laboratory analyses are required by removal an unloading valve cap located underneath the car, installing a sample valve, and filling a glass bottle for sampling. The operators' exposures increase especially while handling the wetted valves. After finishing the sampling, the valves become plugged and then cleaned. The bucket used to drain the overflow of the sampling increases the exposure. Mechanics are daily exposed during removal of pumps and repairing repellers, during replacement of railroad car dry break couplings, and while repairing and calibrating fuel meters at transport loading racks and at service stations. They are also doing maintenance on pipelines and vapour recovery equipment. The maintenance tasks are such that the workers are exposed to MTBE vapours and their hands are in contact with petrol products.

Acute/Short term exposure

Table A.5-3 of the Chemical Safety Report contains all operating conditions and the efficiencies of the exposure modifiers including RPE, PPE and LEV (efficiencies are from the ECETOC TRA model, version 2) chosen for estimation of worker exposure (long term and short term).
Operational conditions and worker exposure data (short term and long term) corresponding

with the handling of neat
MTBE for inhalatory exposure as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B1.1 and B.1.2 of the Chemical Safety Report. The exposure situation includes both handling of neat MTBE and blended fuels. An overview of the data, which corresponds to handling neat MTBE, is given. If the situation is safe on this worst case situation, the exposure is assumed to be safe if the concentration of MTBE in the formulation is lower. Exposure during transporting and distributing occurs intermittently.

Long-term exposure

See references in Acute/Short term exposure.
Justification for use of additional efficiency factors:
-Draining prior to maintenance (Drain down and flush system prior to equipment break- in or maintenance [E55]) delivers a reduction of 90% of the exposure estimate. Reduction is based on comparison of CONCAWE data on exposures resulting from spills and those arising from same/similar task when SOP invoked (only applicable in industrial settings).

Section 3.2: Consumer exposure

Not applicable.

Section 3.3: Indirect exposure of humans via the environment

All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Transport and delivery of MTBE and petrol		
Fish (mg/kg)	$1.85 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	$1.10 \cdot 10^{-3}$	EUSES calculation
Leaf crops (mg/kg)	$9.68 \cdot 10^{-5}$	EUSES calculation
Meat (mg/kg)	$1.78 \cdot 10^{-7}$	EUSES calculation
Milk (mg/l)	$1.78 \cdot 10^{-6}$	EUSES calculation
Drinking water (mg/l)	$1.16 \cdot 10^{-3}$	EUSES calculation
Air (mg/m^3)	$1.26 \cdot 10^{-3}$	EUSES calculation
Storage		

Fish (mg/kg)	$1.97 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	0.010	EUSES calculation
Leaf crops (mg/kg)	$2.61 \cdot 10^{-5}$	EUSES calculation
Meat (mg/kg)	$4.51 \cdot 10^{-7}$	EUSES calculation
Milk (mg/l)	$4.51 \cdot 10^{-6}$	EUSES calculation
Drinking water (mg/l)	$9.56 \cdot 10^{-3}$	EUSES calculation
Air (mg/m^3)	$3.25 \cdot 10^{-4}$	EUSES calculation

Total daily dose for exposure of humans via the environment

Total daily dose for exposure via the environment (mg/kg bw/d)			Justification
Exposure pathway	**Exposed via local concentration**	**Exposed via local and regional concentration**	
Transport and delivery of MTBE and petrol			
Oral	$4.40 \cdot 10^{-5}$	$5.27 \cdot 10^{-5}$	EUSES calculation
Inhalation	$3.59 \cdot 10^{-4}$	$4.32 \cdot 10^{-4}$	EUSES calculation
Storage			
Oral	$3.33 \cdot 10^{-4}$	$3.42 \cdot 10^{-4}$	EUSES calculation
Inhalation	$9.29 \cdot 10^{-5}$	$1.66 \cdot 10^{-4}$	EUSES calculation

Section 3.4 : Environmental exposure

Environmental releases

Emissions during transport and distribution are mainly atmospheric, even if emission to all environmental compartments are possible during storage, loading/reloading, transportation and delivery of petrol at service stations.

Release to the aquatic environment may occur during transportation of petrol/MTBE through waterways and refuelling of watercrafts.

Transport and distribution

The default emission factors from the Technical Guidance Document (2003) for mineral oil and fuel Industry; fuel additives (IC9, UC28) are replaced by the emission factors from the ESVOC3 SpERC (SpERC no. 78 [ECETOC, 2010]). For the regional assessment it is assumed that all waste water is collected by industrial sewage treatment plants.

Summary of the releases to the environment from transport and distribution

Compartments	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Waste water	0.37	859	EUSES calculation
Surface water	0	73.8	EUSES calculation
Air	3.76	12,50	EUSES calculation
Soil (direct releases only)	0	293	EUSES calculation

Storage

In refinery, marketing and border depots petrol is stored in tanks of different construction, i.e., fixed roof tanks, fixed roof tank with internal floating covers or floating roof tanks as well as in some countries, also in underground manmade caverns in basement rock. The size of marketing and border terminal storage tanks is highly variable and typical size is 5,000-50,000 m^3. In the current assessment the worst-case tank size of 100,000 m^3 is assumed.

In the EU RAR (2002) it was assumed that in Europe the MTBE is stored in pure form and in blended gasoline in tanks which may be floating roof tanks with only one sealing. If the sealing is not upgraded to a recent technical standard, in case of rainfall relevant amounts of water may penetrate into the tank. Phase separation will lead to a water phase which is found at the bottom of the tank and has to be removed from time to time. Because of its water solubility remarkable amounts of MTBE in water are contained at the bottom of tanks storing MTBE containing gasoline.

On a delivery rate of 100,000 m^3 of gasoline about 20 m^3 of tank bottom water is set free. This tank bottom water is corrosive and should be regularly discharged to prevent corrosion. The bottom of the gasoline tank is not fully horizontal, but holds a cone-down device for the collection of tank bottom water. The level of tank bottom water can be read off from a gauge outside the tank. Discharge of tank bottom water may be done fully automatically by gauging equipment, which transfers the tank bottom water to a sewer system, connected to an industrial or a municipal waste water treatment plant. It is never discharged directly to surface water. Where there is no automatic control of the tank bottom water in a gasoline storage tank for instance in a regional gasoline tank park, operators check daily the level and switch on manually the drain of tank bottom water to the municipal sewer system, mostly every other day but at least once per week.

For a tank of 100,000 m^3 a worst-case amount of 8.4 kg MTBE can be assumed in the tank bottom water. This is a worst-case scenario regarding tank volume, tank bottom water volume (20 m^3), the ratio between gasoline and water of 0.039 (v/w) and a weekly release of the tank bottom water. If gasoline contains 15% MTBE (a worst-case
assumption as the average level in Europe is about 5% MTBE in gasoline), the tank bottom water contains about 6 gram per litre.

It can be generally accepted that STPs in Western Europe situated near tank farms have a hydraulic retention time of 1 day in the aerator, as opposed to the 6.9 hour which is taken into account in standard municipal STPs.

It is assumed that the tonnage for the regional assessment is already covered under the sub-scenario 'Transport and distribution'.

Summary of the releases to the environment from storage

Compartment	Release from point source (kg/d) (local exposure estimation)	Justification
Waste water	8.4	See above

Exposure concentration in sewage treatment plants (STP)

For the determination of the PEC_{STP}, homogeneous mixing in the aeration tank is assumed. The PECstp is therefore equal to the dissolved concentration of the substance. The Predicted Exposure Concentrations (PEC) in the sewage treatment plant for transport and distribution are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Transport and delivery of MTBE and petrol			
Sewage (mg/l)	$9.38 \cdot 10^{-3}$	$9.38 \cdot 10^{-3}$	EUSES calculation
Sewage sludge (mg/kg dw)	0.40	n.a.	EUSES calculation
Storage			
Sewage (mg/l)	$9.78 \cdot 10^{-3}$	$9.78 \cdot 10^{-3}$	EUSES calculation
Sewage sludge (mg/kg dw)	8.8	n.a.	EUSES calculation

n.a. - not applicable

Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for transport and distribution are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Transport and delivery of MTBE and petrol			
Freshwater (mg/l)	$9.38 \cdot 10^{-4}$	$1.20 \cdot 10^{-3}$	EUSES calculation
Marine water (mg/l)	$9.38 \cdot 10^{-5}$	$1.20 \cdot 10^{-4}$	EUSES calculation
Storage			
Freshwater (mg/l)	$9.78 \cdot 10^{-4}$	$1.24 \cdot 10^{-3}$	EUSES calculation

Marine water (mg/l)	n.r.	n.r.	

n.r. = not relevant

Storage

The predicted PEC of 1.24 µg/l for freshwater is in line with reportede background concentrations. In a report prepared by DSC consulting (Wagner and Stupp, 2008) in which the possible release of a typical tank farm located at the river Lippe was investigated, MTBE concentrations are detected typically up to 3 µg/l.

A comprehensive summary of existing concentration measurements in German rivers is available in a report from the Rhine water works association (IAWR, 2008). This report contains the information about MTBE concentrations in the environment for example from two theses from the university of Frankfurt (Achten, 2001 and Kolb, 2004), as well as publications from Pahlke et al. (2000), Schmidt et al. (2001), Klinger et al. (2002) and others.

All these data demonstrate MTBE background levels in urban areas in the range of 0.1 up to 0.2 µg/l in comparison with 0.05 µg/l or below in rural areas. If tank bottom water is a real issue these comprehensive data would demonstrate much more industrial effluents as a source of MTBE concentrations in rivers in urban areas. This is not the case and again confirms that for tank farms in general the discharges are similar or less than those of the tank farm near Hünxe at the Lippe.

A typical location for a MTBE release is the MIRO refinery in Karlsruhe at the Rhine which is the second biggest MTBE production facility in Germany. The IAWR report 2008 demonstrated that the concentrations north of Karlsruhe are increased in comparison with the rural area south of Karlsruhe. But this increase can be explained by diffuse sources of MTBE use in cars which occurs more in urban areas and they are in the same range as usual in industrial or urban areas. From 2004 to 2007 only one exceptional measurement value above typical background for urban areas with 2.8 µg/l was observed north of Karlsruhe. Therefore for the refinery in Karlsruhe the same conclusion is valid as for the tank farm at the Lippe.

Additionally, monitoring data (daily measurements) from the Dutch monitoring station near Lobith is available. The data of this monitoring station is available to the public and can be extracted from www.aqualarm.nl, also monitoring data from other Dutch sites is available from www.waterbase.nl. The geometric mean of MTBE concentrations at the Lobith station since September 2000 is 0.22 µg/l (*n* = 9,560). The highest observed peak of MTBE in the Rhine is 62 µg/l, these peak exposures in the River Rhine occur only very sporadically and can therefore be seen as intermittent releases. Also monthly averages on MTBE concentrations are available for three Dutch sites (including the above-mentioned Lobith station) from www.waterbase.nl. The geometric mean of MTBE concentrations in Maasluis from 2001 to 2008 is 0.39 µg/l (*n* = 103) and in Nieuwegein the geometric mean of the concentrations from 2004 to 2008 is 0.17 µg/l (*n* = 64).

Therefore it can be concluded that 8.4 kg MTBE in tank bottom water adopted from the report by Wagner and Stupp
(2008) is a theoretical worst-case scenario.

Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment for transport and distribution are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Transport and delivery of MTBE and petrol			
Freshwater sediments (mg/kg ww)	n.c.	$1.18 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$1.18 \cdot 10^{-4}$	EUSES calculation
Storage			
Freshwater sediments (mg/kg ww)	n.c.	$1.22 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.r.	n.r.	

n.c. - not calculated in EUSES
n.r. = not relevant

Exposure concentrations in soil and groundwater

The exposure routes taken into account in PEC_{local} calculations are application of sewage sludge in agriculture and dry and wet deposition from the atmosphere. Concentration in soil ($Clocal_{soil}$) can be estimated using the aerial deposition flux per kg of soil and the sludge concentration.

The concentration of MTBE in groundwater is calculated for indirect exposure of humans through drinking water. As an indication for potential groundwater levels, the concentration in porewater of agricultural soil is taken. This is a worst-case assumption, neglecting transformation and dilution in deeper soil layers.

The Predicted Exposure Concentrations (PEC) in soil and groundwater for transport and distribution are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Transport and delivery of MTBE and petrol			
Agricultural soil averaged (mg/kg ww)	$5.65 \cdot 10^{-4}$	$5.72 \cdot 10^{-4}$	EUSES calculation
Grassland averaged (mg/kg ww)	$1.97 \cdot 10^{-4}$	$2.04 \cdot 10^{-4}$	EUSES calculation
Groundwater(mg/l)	n.c.	$1.01 \cdot 10^{-3}$	EUSES calculation
Storage			
Agricultural soil averaged (mg/kg ww)	$8.90 \cdot 10^{-3}$	$8.91 \cdot 10^{-3}$	EUSES calculation
Grassland averaged (mg/kg ww)	$5.86 \cdot 10^{-4}$	$5.93 \cdot 10^{-4}$	EUSES calculation
Groundwater(mg/l)	n.c.	$9.56 \cdot 10^{-3}$	EUSES calculation

n.c. - not calculated in EUSES

Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source. In the calculation of PEC_{local} for air, both emissions from a point source as well as the

emissions from a STP are taken into account. The Predicted Exposure Concentrations (PEC) in air for transport and distribution are calculated with EUSES (2008).

Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
Transport and delivery of MTBE and petrol			
During emission (mg/m^3)	$1.05 \cdot 10^{-3}$	n.c.	EUSES calculation
Annual average (mg/m^3)	$1.00 \cdot 10^{-3}$	$1.26 \cdot 10^{-3}$	EUSES calculation
Annual deposition ($mg/m^2/d$)	$1.45 \cdot 10^{-3}$	n.c.	EUSES calculation
Storage			
During emission (mg/m^3)	$7.07 \cdot 10^{-5}$	n.c.	EUSES calculation
Annual average (mg/m^3)	$7.07 \cdot 10^{-5}$	$3.25 \cdot 10^{-4}$	EUSES calculation
Annual deposition ($mg/m^2/d$)	$1.02 \cdot 10^{-4}$	n.c.	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for MTBE since it has low potential to accumulate to living organisms, and it is not classified as very toxic (T+), toxic (T) or harmful (Xn) according to mammalian toxicity data.

Exposure Scenario 6: Fuel use – industrial

MTBE used in as fuel additive in fuels in industrial applications of fuels. MTBE containing fuels are stored, loaded and unloaded in industrial settings and engines are maintained.

Section 1	**Exposure Scenario Title**
Title	**Use in Fuels of MTBE;CAS RN1634-04-4**
Use Descriptor	Sector of Use: Industrial (SU3)
	Process Categories: PROC1, PROC2, PROC3, PROC8a, PROC8b, PROC16
	Environmental Release Categories: ERC8b
	Specific Environmental Release Categories: ESVOC3 SpERC
Processes, tasks, activities covered	Covers the use as a fuel (or fuel additive) and includes activities associated with its transfer, use, equipment maintenance and handling of waste.
Section 2	**Operational conditions and risk management**
Section 2.1	**Control of worker exposure**
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 15% [Gnew].
Amounts used	*Not applicable*
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	*Not applicable*
Other Operational Conditions affecting worker exposure	Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	**Risk Management Measures**
General measures (skin irritants) [G19].	Avoid all skin contact with product, clean up contamination/spills as soon as they occur. Wear gloves (tested to EN374) if hand contamination likely, wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop [E3].
Bulk transfers [CS14]. ; Batch process [CS55]. With sample collection [CS56]. ; Filling / preparation of equipment from drums or containers. [CS45].	Ensure material transfers are under containment or extract ventilation [E66].

Drum/batch transfers [CS8]. ; Filling / preparation of equipment from drums or containers. [CS45]. Bulk transfers [CS14]. ; Dedicated facility [CS81]	Use drum pumps [E53].
General exposures (closed systems)	No specific measures identified [EI18].
General exposures (closed systems) [CS15]. ;	No specific measures identified [EI18].
General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]. ; With sample collection [CS56].	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
(closed systems) [CS107] Use of fuel	No specific measures identified [EI18].
(closed systems) [CS107] Batch process [CS55].	Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Equipment cleaning and maintenance [CS39]. Non-dedicated facility [CS82] e.g fuel pump repair indoor	Avoid carrying out activities involving exposure for more than 4 hours [OC28] Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Storage [CS67]; General exposures (closed systems) [CS15].	No specific measures identified [EI18].
Storage [CS67]; General exposures (closed systems) [CS15]. ; With sample collection [CS56].	Ensure operation is undertaken outdoors [E69].
Section 2.2	**Control of environmental exposure**
Product characteristics	Substance is a unique structure [PrC1].
	Predominantly hydrophobic [PrC4a].
	Readily biodegradable [PrC5a].
Operational conditions	Outdoor use [OOC1].
Amounts used	
Fraction of EU tonnage used in region	0.57
Regional use tonnage (tonnes/year)	659,000
Fraction of regional tonnage used	0.02
Average local daily tonnage (kg/d) [A5]:	37,657
Annual site tonnage (tonnes/year) [A6]	13,180
Frequency and duration of use	
Type of release	Continuous release [FD2].
Emission days (days/year) [FD4]:	350
Other Operational Conditions of use affecting	Use in closed systems.
	Either wet or dry processes.
Release fraction to air from process:	1.00E-04
Release fraction to wastewater from process:	1.00E-05
Release fraction to soil from process (regional only):	1.00E-05

RMMs	
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	No air emission controls required; required removal efficiency is 0% [TCR5].
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of >95% [TCR9].
Soil:	No soil emission controls required; required removal efficiency is 0% [TCR7].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1].
Conditions and measures related to municipal sewage treatment plant	Assumed industrial sewage treatment plant effluent flow is 2000 m3/d.
Conditions and measures related to external treatment of waste for disposal	Not applicable
Conditions and measures related to external recovery of waste	Not applicable
Other environmental control measures additional to above	None

Section 3: Exposure estimation – Fuel Use – industrial (ES6)

Section 3.1: Workers exposure

The release includes handling of blended fuels containing a variety of percentage of MTBE (up to 15%). The worker exposure estimates for the activities associated with the handling of MTBE containing fuel have been assessed using ECETOC TRA version 2. In contrast to the default of the ECETOC TRA model, no influence of local exhaust ventilation (LEV) was taken into account for assessment of dermal exposure. In Annex A6.1 of the Chemical Safety Report general information, including the DNELs, of the exposure scenario is presented. In Annex A6.2 of the Chemical Safety Report the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented.

When modeling resulted in risk characterization ratios above 1 exposure data was used to estimate exposure (tier-2). Only tier-2 data as presented in the EU RAR for MTBE (European Commission, 2002) was used (see Annex B2.2 and B3.2 of the Chemical Safety Report, containing a summary of data from the EU RAR of MTBE).

Acute/Short term exposure

Table A.6-3 of the Chemical Safety Report contains all operating conditions and the efficiencies of the exposure modifiers including RPE, PPE and LEV (efficiencies are from the ECETOC TRA model, version 2) choosen for estimation of worker exposure (long term and short term). Operational conditions and worker exposure data (short term and long term) corresponding with the handling MTBE
containing fuel as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B2.1/B2.2 of the Chemical Safety Report (activities at service stations) and B3.1/B3.2 of the Chemical Safety Report (use of vehicles).

Long-term exposure

See references provided for Acute/Short term exposure.
Justification for use of additional efficiency factors:

- The Mandatory use of Stage I Vapour Recovery systems is calculated to result in the same efficiency as LEV 80%).
  This is considered a good estimate as the minimal efficiency for environmental exposure is already 70% (BUA, 1996, as reported in Euriopean Commission, 2002)
- The use of drum pumps are considered to provide an inhalation efficency reduction of 80%, because it is considered to be equivalent to contained transfer (only applicable for material transfers).

Section 3.2 : Consumer exposure

Not applicable.

Section 3.3: Indirect exposure of humans via the environment

Covered under Exposure Scenario 5 (Transport and distribution – industrial).

Section 3.4: Environmental exposure

Covered under Exposure Scenario 5 (Transport and distribution – industrial).

Exposure Scenario 7: Fuel use – professional

MTBE used in as fuel additive in fuels in professional applications of fuels.

Section 1	**Exposure Scenario Title**
Title	**Use in Fuels of MTBE;CAS RN1634-04-4**
Use Descriptor	Sector of Use: Professional (SU22)
	Process Categories: PROC1, PROC2, PROC3, PROC8a, PROC8b,
	Environmental Release Categories: ERC8b, ERC8e
	Specific Environmental Release Categories: ESVOC30 SpERC
Processes, tasks, activities covered	Covers the use as a fuel (or fuel additive) and includes activities associated with its transfer, use, equipment maintenance and handling of waste.
Section 2	**Operational conditions and risk management**
Section 2.1	**Control of worker exposure**
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Concentration of substance in product	Covers percentage substance in the product up to 15% [Gnew].
Amounts used	*Not applicable*
Frequency and duration of use	Covers daily exposures up to 8 hours (unless stated differently) [G2]
Human factors not influenced by risk management	*Not applicable*
Other Operational Conditions affecting worker exposure	Assumes a good basic standard of occupational hygiene is implemented [G1].
Contributing Scenarios	**Risk Management Measures**
General measures (skin irritants) [G19].	Avoid all skin contact with product, clean up contamination/spills as soon as they occur. Wear gloves (tested to EN374) if hand contamination likely, wash off any skin contamination immediately. Provide basic employee training to prevent / minimise exposures and to report any skin problems that may develop [E3].
Bulk transfers [CS14]. ; Batch process [CS55]. Filling / preparation of equipment from drums or containers. [CS45].	Ensure material transfers are under containment or extract ventilation [E66].

Drum/batch transfers [CS8]. ; Filling / preparation of equipment from drums or containers. [CS45]. Bulk transfers [CS14]. ; Dedicated facility [CS81]	Ensure material transfers are under containment or extract ventilation [E66].
Refuelling [CS507]	Provide a good standard of controlled ventilation (10 to 15 air changes per hour) [E40].
General exposures (closed systems) [CS15]. ; With sample collection [CS56].	No specific measures identified [EI18].
General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]. ; With sample collection [CS56].	Ensure operation is undertaken outdoors [E69].
Drum and small package filling [CS6]. Dedicated facility [CS81]	Use drum pumps or carefully pour from container [E64].Avoid carrying out activities involving exposure for more than 1 hour [OC27], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
(closed systems) [CS107]use a fuel	No specific measures identified [EI18].
Equipment cleaning and maintenance [CS39]. Non-dedicated facility [CS82]e.g fuel pump repair indoor	Drain down system prior to equipment break-in or maintenance [E65].Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Equipment cleaning and maintenance [CS39]. Non-dedicated facility [CS82]e.g fuel pump repair outdoor	Drain down system prior to equipment break-in or maintenance [E65].Avoid carrying out activities involving exposure for more than 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
Storage [CS67]; General exposures (closed systems) [CS15].	No specific measures identified [EI18].
Section 2.2	**Control of environmental exposure**
Product characteristics	Substance is a unique structure [PrC1].
	Predominantly hydrophobic [PrC4a].
	Readily biodegradable [PrC5a].
Operational conditions	Outdoor use [OOC1].
Amounts used	
Average daily use over a year for wide dispersive use (kg/d):	3.61
Frequency and duration of use	
Type of release	Dispersive use [FD3].
Emission days (days/year) [FD4]:	365

Other Operational Conditions of use affecting environmental exposure	Use in open systems.
Release fraction to air from wide dispersive use (regional only):	1.00E-02
Release fraction to wastewater from wide dispersive use:	1.00E-05
Release fraction to surface water from wide dispersive use (regional only):	1.00E-04
Release fraction to soil from wide dispersive use (regional only):	1.00E-05
RMMs	
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	No air emission controls required; required removal efficiency is 0% [TCR5].
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency of 37% [TCR9].
Soil:	No soil emission controls required; required removal efficiency is 0% [TCR7].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1].
Conditions and measures related to municipal sewage treatment plant	Assumed domestic sewage treatment plant effluent flow is 2000 m3/d [STP7].
Conditions and measures related to external treatment of waste for disposal	Not applicable
Conditions and measures related to external recovery of waste	Not applicable
Other environmental control measures additional to above	None

Section 3: Exposure estimation – Fuel Use - Professional (ES7)

Section 3.1: Workers exposure

The release includes handling of blended fuels containing a variety of percentage of MTBE (up to 15%). The worker exposure estimates for the activities associated with the handling of MTBE containing fuel have been assessed using ECETOC TRA version 2. In contrast to the default of the ECETOC TRA model, no influence of local exhaust ventilation (LEV) was taken into account for assessment of dermal exposure. In Annex A7.1 of the

Chemical Safety Report general information, including the DNELs, of the exposure scenario is presented. In Annex A7.2 of the Chemical Safety Report the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented.

When modelling resulted in risk characterization ratios above 1 exposure data was used to estimate exposure (tier-2). Only tier-2 data as presented in the EU RAR for MTBE (European Commission, 2002) was used (see Annex B2.2 and B3.2 of the Chemical Safety Report, containing a summary of data from the EU RAR of MTBE).

Acute/Short term exposure

Table A.7-3 of the Chemical Safety Report contains all operating conditions and the efficiencies of the exposure modifiers including RPE, PPE and LEV (efficiencies are from the ECETOC TRA model, version 2) chosen for estimation of worker exposure (long term and short term).

Operational conditions and worker exposure data (short term and long term) corresponding with the handling of MTBE containing fuel as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B2.1/B2.2 (activities at service stations) and B3.1 and B3.2 (use of vehicles) of the Chemical Safety Report. Only data for refuelling of cars and for car mechanics was available. It is assumed that when refuelling or repairing other vehicles (boats, motor bikes, jet skis or other two or four stroke engines) or fuel tanks, the exposure is comparable or lower. If the situation is safe for refuelling or repairing cars, the situation is also safe for refuelling in other situations. No data for exposure among forest, agri- and horticultural workers refuelling (e.g. by cans) is available either.

Long-term exposure

See references provided for
Acute/Short term exposure

Justification for use of
additional efficiency factors:

- The Mandatory use of Stage I Vapour Recovery systems is calculated to result in the same efficiency as LEV (80%).
  This is considered a good estimate as the minimal efficiency for environmental exposure is already 70% (BUA,
  1996, as reported in Euriopean Commission, 2002)
- The use of drum pumps are considered to provide an inhalation efficency reduction of 80%, because it is considered to be equivalent to contained transfer (only applicable for material transfers).
- Draining prior to maintenance (Drain down and flush system prior to equipment break-in or maintenance [E55]) delivers a reduction of 90% of the exposure estimate. Reduction is based on comparison of CONCAWE data on exposures resulting from spills and those arising from same/similar task when SOP invoked (only applicable in industrial settings).

Section 3.2: Consumer exposure

Not applicable.

Section 3.3: Indirect exposure of humans via the environment

Covered under Exposure Scenario 8 (Fuel use – consumer).

Section 3.4: Environmental exposure

Covered under Exposure Scenario 8 (Fuel use – consumer).

Exposure Scenario 8: Fuel use – consumer

Section 1	**Exposure Scenario Title**
Title	**Use in Fuels of MTBE; CAS RN1634-04-4**
Use Descriptor	Sector of Use: Consumer (SU21)
	Product Categories: PC13
	Environmental Release Categories: ERC8d
	Specific Environmental Release Categories: ESVOC30 SpERC
Processes, tasks, activities covered	Use of fuel for refuelling 2-stroke and 4-stroke engines
Section 2	**Operational conditions and risk management**
Section 2.1	**Control of consumer exposure**
Product characteristics	
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].
Vapour pressure	330 hPa at 25 ºC
Concentration of substance in product	Gasoline, containing <15% of substance
Amounts used	Up to 60 litres per refuelling
Frequency and duration of use/exposure	Up to 3 times a week
Other Operational Conditions affecting exposure	Unless otherwise stated assumes use at ambient temperatures [ConsOC15]
Technical conditions and measures at process level (source) to prevent release	
Product Categories	PC13: Fuels
OC	Unless otherwise stated, covers concentrations up to 15% [ConsOC1]; covers use up to 150 days/year[ConsOC3]; covers use up to 1 time/on day of use[ConsOC4]; for each use event, covers exposure up to 15 min/event[ConsOC14];
RMM	No specific RMMs identified beyond those OCs stated
Section 2.2	**Control of environmental exposure**
Product characteristics	Substance is a unique structure [PrC1]. Predominantly hydrophobic [PrC4a]. Readily biodegradable [PrC5a].
Operational conditions	Outdoor use [OOC1].
Amounts used	
Average daily use over a year for wide dispersive use (kg/d):	3.61

Frequency and duration of use	
Type of release	Dispersive use [FD3].
Emission days (days/year)	365
Other Operational Conditions of use affecting	Use in open systems.
Release fraction to air from wide dispersive use (regional only):	1.00E-02
Release fraction to wastewater from wide dispersive use:	1.00E-05
Release fraction to surface water from wide dispersive use (regional only):	1.00E-04
Release fraction to soil from wide dispersive use (regional only):	1.00E-05
RMMs	
Technical conditions and measures at process level (source) to prevent release	Common practices vary across sites thus conservative process release estimates used [TCS 1].
Technical onsite conditions and measures to reduce or limit discharges, air emissions and releases to soil	
Air:	No air emission controls required; required removal efficiency is 0% [TCR5].
Wastewater:	Treat onsite wastewater (prior to receiving water discharge) to provide the required removal efficiency
Soil:	No soil emission controls required; required removal efficiency is 0% [TCR7].
Organisation measures to prevent/limit release from site	Prevent discharge of undissolved substance to or recover from wastewater [OMS1].
Conditions and measures related to municipal sewage treatment plant	Assumed domestic sewage treatment plant effluent flow is 2000 m3/d [STP7].
Conditions and measures related to external treatment of waste for disposal	Not applicable
Conditions and measures related to external recovery of waste	Not applicable
Other environmental control measures additional to above	None

Section 3: Exposure estimation Fuel Use – consumer (ES8)

Section 3.1: Workers exposure

Not applicable.

Section 3.2: Consumer exposure

Only exposure data for refuelling of cars was available. It is assumed that when refuelling other vehicles (boats, motor bikes, jet skis or other two or four stroke engines) or fuel tanks, the exposure is comparable or lower. The reason is that these activities take place less

frequent. If the situation is safe for refuelling cars, the situation is also safe for refuelling in other situations. Even if the RCRs for refuelling other engines would be comparable to the RCR for refuelling of cars, the risk would still be negligible (RCR for car fuelling is <<1).

Acute/Short term exposure

It is assumed that a reasonable worst case concentration in Stage 1 station refuelling is 29 mg/m^3 MTBE for 1 minute, occurring maximal 3 times a week, when average MTBE content is around 11%.

Long-term exposure

For the long-term exposure value for consumer exposure it is assumed no oral exposure is possible. Refuelling may cause dermal contact with MTBE.

Long term exposure concentrations to consumers

Routes of exposure	Estimated Exposure Concentrations		Measured exposure concentrations		Explanation / source of measured data
	Value	Unit	Value	Unit	
Dermal exposure	11.4	µg/kg bw/day			The reasonable worst-case scenario presented (for concentration of 0.08 g/cm^3) and duration of contact: 0.5 hour) is based on modelling (presented as described in the RAR, European Commission, 2002). Dermal deposition/exposure was estimated using EUSES (EUSES, 1997).
	2.9	µg/cm^2/day			

Inhalation exposure	26	µg/m^3			Great variation is observed in the studies (European Commission, 2002), due to environmental factors. Considering different references, it is assessed that the normal concentration of MTBE during refuelling is 10 mg/m^3. It is assumed that a reasonable worst case concentration in Stage 1 station refuelling is 29 mg/m^3 MTBE for 1 minute, per day of refuelling, when average MTBE content is around 11%. The reasonable worst-case daily MTBE dose by inhalation for refuelling is 522 µg/day, assuming 1 minute exposure inhaling 0.018 m^3 in 1 minute (assuming light activity and short term exposure). When respiration on average 20 m^3, the daily airborne exposure is 26 µg/m^3.

Summary of long term exposure concentrations to consumers

Routes of exposure	Concentrations	Justification
Oral exposure (in mg/kg bw/d)	-	No oral exposure is expected.
Dermal local exposure (in mg/cm^2 /d)	0.0029	In the RAR it is concluded that real skin exposure can be regarded as insignificant (European commission, 2002), because: 1) skin contact during refuelling is exceptional rather than normal, 2) refuelling occurs infrequently and, 3) rapid evaporation from the skin and brief contact time reduce the potential absorption through the skin. Dermal exposure regarded as insignificant.
Dermal systemic exposure (in mg /kg bw/d)	0.0114	Conclusion is adopted from the RAR (European Commission, 2002). In the RAR (European Commission, 2002), it is concluded that dermal exposure is insignificant.
Inhalation exposure (mg/m^3/d)	0.026	The reasonable worst-case (RWC) for inhalation exposure for consumers to blended fuels containing MTBE is based on the above described measurement data. Exposure estimation based on short term exposure during 1 minute, 3 times a week.

Section 3.3: Indirect exposure of humans via the environment

All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Fish (mg/kg)	$4.17 \cdot 10^{-4}$	EUSES calculation
Root crops (mg/kg)	$2.56 \cdot 10^{-5}$	EUSES calculation
Leaf crops (mg/kg)	$1.96 \cdot 10^{-5}$	EUSES calculation
Meat (mg/kg)	$3.72 \cdot 10^{-8}$	EUSES calculation
Milk (mg/l)	$3.72 \cdot 10^{-7}$	EUSES calculation
Drinking water (mg/l)	$2.63 \cdot 10^{-4}$	EUSES calculation
Air (mg/m^3)	$2.54 \cdot 10^{-4}$	EUSES calculation

Total daily dose for exposure of humans via the environment

Total daily dose for exposure via the environment (mg/kg bw/d)			Justification
Exposure pathway	Exposed via local concentration	Exposed via local and regional concentration	
Oral	$8.70 \cdot 10^{-5}$	$1.74 \cdot 10^{-5}$	EUSES calculation
Inhalation	$7.27 \cdot 10^{-5}$	$1.45 \cdot 10^{-4}$	EUSES calculation

Section 3.4 : Environmental exposure

Environmental releases

Private use scenario covers emissions from the use of petrol as a fuel in spark ignition engines (cars, boats, stationary engines, etc.). Emissions to all environmental compartments are possible although emissions into environment are mainly atmospheric. Emissions to air from the use of petrol are the main source of MTBE released to the environment. It covers the majority of the total emitted mass volume. Emissions are divided into two main categories: evaporative emissions and exhaust emissions.

The default emission factors from the Technical Guidance Document (2003) for mineral oil and fuel Private use; fuel additives (IC9, UC28) are replaced by the emission factors from the ESVOC30 SpERC (SpERC no. 105 [ECETOC, 2010]). The releases to the environment from wide-dispersive uses are calculated with EUSES (2008).

Summary of the releases to the environment

Compartments	Release from point source (kg/d) (local exposure estimation)	Total release for regional exposure estimation (kg/d)	Justification
Waste water	$1.15 \cdot 10^{-5}$	859	EUSES calculation
Surface water	0	73.8	EUSES calculation
Air	0	12,50	EUSES calculation
Soil (direct releases only)	0	293	EUSES calculation

Exposure concentration in sewage treatment plants (STP)

For the determination of the PEC_{STP}, homogeneous mixing in the aeration tank is assumed. The PECstp is therefore equal to the dissolved concentration of the substance. The Predicted Exposure Concentrations (PEC) in the sewage treatment plant for wide-dispersive uses are calculated with EUSES (2008).

Summary of the releases to the environment

Compartments	Local concentration	PEC	Justification
Sewage (mg/l)	$3.65 \cdot 10^{-6}$	$3.65 \cdot 10^{-6}$	EUSES calculation
Sewage sludge (mg/kg dw)	$5.96 \cdot 10^{-5}$	n.a.	EUSES calculation

n.a. - not applicable

Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for wide-dispersive uses are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater (mg/l)	$3.65 \cdot 10^{-7}$	$2.63 \cdot 10^{-4}$	EUSES calculation
Marine water (mg/l)	$3.65 \cdot 10^{-8}$	$2.63 \cdot 10^{-5}$	EUSES calculation

Road traffic

Because of the extensive and wide use of petrol as a fuel in road traffic, direct releases to surface water from road traffic are likely. Direct releases may take place especially from bridges, ferry boards etc. in connection with malfunctioning petrol distribution systems in vehicles like leaking carburettors, piping etc. Runoff from roads after rain may also contain trace amounts of petrol components.

Of the 592 samples that were analysed from 1991 through 1995, 41 contained MTBE. The

MTBE concentrations ranged from 0.2 to 8.7 µg/l, with a median of 1.5 µg/l.

As a realistic worst-case situation, the PEC for MTBE can be estimated in a small stream receiving drainage from a long stretch of motorway. According to existing studies the PEC of MTBE is most probably less than 10 µg/l and the influence of other road traffic based contaminants (BTEX, PAH, heavy metals) in terms of aquatic toxicity potential or concentration exceeds that of MTBE's. Based on the monitoring data, and if additional dilution in receiving surface water is not taken into account, the PEClocal$_{aquatic,\ road\ runoff}$ is:

PEClocal $_{aquatic,\ road\ runoff}$ = 1.5 µg/l

Petrol fueled watercrafts

Motorboating and comparable activities lead to direct emissions of petrol to the aquatic environment through spills and exhaust gases.

Certain types of watercrafts (most outboard motors and jet skis) direct their exhaust gases directly under the water surface. Two cycle engines commonly used on recreational watercrafts are particularly inefficient in their use of fuel. Even >>25% of the fuel is passed through properly functioning engines and into the water via exhausts. Exhaust TOC emissions from four-stroke engines (and injection fuelled two-stroke engines) are normally far lower than from traditional two-stroke engines.

Petrol can be spilled directly into the surface water while switching or loading of petrol tanks and carburettor overflow while tilting the motor. This release is estimated to be less than 0.1% of total fuel consumption and very low compared to exhaust emissions.

Average measured concentrations of MTBE in surface water where boating is the major source of MTBE are <0.1-12 µg/l. Depending on local conditions "moderate" boat traffic seems to cause 2-3 µg/l and high traffic >10 µg/l concentration. Maximum measured values 100 µg/l are considered as short-term peak values. It is assumed that the high traffic period average concentration represents realistic local concentrations, therefore the PEClocal$_{surface\ water\ boating}$ is:

PEClocal $_{surface\ water\ boating}$ = 12 µg/l

Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment for wide-dispersive uses are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater sediments (mg/kg ww)	n.c.	$2.57 \cdot 10^{-4}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$2.58 \cdot 10^{-5}$	EUSES calculation

n.c. - not calculated in EUSES

Exposure concentrations in soil and groundwater

The exposure routes taken into account in PEC_{local} calculations are application of sewage sludge in agriculture and dry and wet deposition from the atmosphere. Concentration in soil ($Clocal_{soil}$) can be estimated using the aerial deposition flux per kg of soil and the sludge concentration.

The concentration of MTBE in groundwater is calculated for indirect exposure of humans through drinking water. As an indication for potential groundwater levels, the concentration in pore water of agricultural soil is taken. This is a worst-case assumption, neglecting transformation and dilution in deeper soil layers.

The Predicted Exposure Concentrations (PEC) in soil and pore water for wide-dispersive uses are calculated with EUSES (2008).

Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Agricultural soil averaged (mg/kg ww)	$6.03 \cdot 10^{-8}$	$6.72 \cdot 10^{-6}$	EUSES calculation
Grassland averaged (mg/kg ww)	$4.08 \cdot 10^{-9}$	$6.67 \cdot 10^{-6}$	EUSES calculation
Groundwater (mg/l)	n.c.	$2.39 \cdot 10^{-5}$	EUSES calculation

n.c. - not calculated in EUSES

Road traffic

Direct release

Release to the soil may occur directly from cars because of malfunctioning leaking fuel systems and of car accidents. It can be assumed that environmental concentrations would locally be highest along the roadsides. On the other hand there is not much evidence that leaking fuel systems in vehicles would cause remarkable general petrol based soil contamination on road banks, parking- and related areas. The high volatility rate of petrol and its components from the top surface of ground decreases the possibility of soil contamination contrary to less volatile leaking motor oil and diesel gasoil.

Accidental spillages during transport of petrol (tank trucks) and car accidents are undoubtedly potential sources of soil and groundwater contamination with MTBE. However, quantitative local estimation has not been carried out from sources mentioned above.

Wet precipitation and infiltrated runoff

The release of MTBE to the soil occurs as precipitation after release to the air from different sources. The highest measured concentrations of MTBE in urban wet precipitation in US have been 2-4 µg/l (Rykowski, 1996; Squillace et al., 1997). Highest measured concentration in urban runoff is 8.7 µg/l (0.2 to 8.7 (µg/l) with a median of 1.5 µg/l) (Delzer et al., 1996).

If the runoff is infiltrated to topsoil, the maximum concentration in porewater is 8.7 µg/l. Using the equilibrium partitioning method, the $PEClocal_{soil}$ from wet precipitation and infiltrated runoff (worst-case assumption) would be:

PEC $local_{soil}$ = 67.6 µg/kg ww

Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source. In the calculation of PEC_{local} for air, both emissions from a point source as well as the emissions from a STP are taken into account. The

Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
During emission (mg/m^3)	$1.16 \cdot 10^{-9}$	n.c.	EUSES calculation
Annual average (mg/m^3)	$1.16 \cdot 10^{-9}$	$2.54 \cdot 10^{-4}$	EUSES calculation
Annual deposition (mg/m^2/d)	$1.67 \cdot 10^{-9}$	n.c.	EUSES calculation

n.c. - not calculated in EUSES

Petrol fuelled vehicles

There are monitoring data available from urban air concentrations of MTBE, from rush hour concentrations to long-term averages. Traffic based air concentration is highly dependent on local situations and local fleet composition.

The measured background in the USA is in the range of 0.7-2.7 µg/m^3 (mixed) and the measured average concentrations in highly urbanised areas in the USA are 3.5 to 17 µg/m^3. It is difficult to compare directly regional values and measured US data because of different traffic volumes, vehicle fleet and average concentration of MTBE in petrol. Therefore, large US metropolitan areas are most probable higher consumption and emission areas than the EUSES regional area and monitored and modelled results are in good agreement.

Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for MTBE since it has low potential to accumulate to living organisms, and it is not classified as very toxic (T+), toxic (T) or harmful (Xn) according to mammalian toxicity data.