9. EXPOSURE ASSESSMENT

Exposure to ETBE is described for six exposure scenarios. The division is based on life cycle stage. In each exposure scenario, different process categories associated with different levels of exposure are presented. The exposure assessment is based on the EU RAR (European Commission, 2002) for MTBE (inhalation exposure) and modelled exposure estimates based on ECETOC TRA (version 2.0) for human exposure assessment (ECETOC, 2009) and EUSES (version 2.1) for environmental emission assessment (EUSES, 2008). For the risk assessment, it is considered that if the highest exposure estimate within an exposure scenario is safe, the other processes within the scenario are also safe.

The six exposure scenarios are:

1. Manufacturing of ETBE
2. Formulation of ETBE
3. Storage, transport and delivery of ETBE and petrol
4. Use of fuels by industrial workers: fuelling of cars, boats, motorbikes
5. Use of fuels by professional workers: refuelling of cars, boats, motorbikes by service station attendants. Maintenance of fuel pumps at service stations is also included.
6. Use of fuels by consumers: use of vehicles and gasoline operated engines: Filling of engines (cars, bikes, boats, motor saws, etc) with petrol by professional users and by consumers, repair of engines.

The following information has been used for the exposure assessments:

Substance	ETBE
CAS no.	637-92-3
Vapour Pressure	17,000 Pa at 25 ºC
TRA volatility range	High
Biodegradability	Inherently biodegradable, not fulfilling criteria. But adapted sludge is assumed in industrial facilities.
Henry's Law Constant	145,000 Pa/m3/mol at 25 ºC
Molecular Weight	102.18 g/mol
Melting Point	-94 ºC
Boiling Point	73.1 ºC
Water solubility	16,400 at 20 ºC
Log K_{ow}	1.48 at 20 ºC

A summary of the environmental and human expsosure assessment (input parameter and results) is given in Annex A, B (human exposure) and C (environmental exposure).

ETBE is classified “inherently biodegradable, not fulfilling criteria” based on the results from OECD guideline test which have stringent conditions. However, certain adapted micro-organisms are capable of degrading ETBE therefore in the current assessment more realistic degradation rates for adapted sludge were used. For large production and processing sites it can be assumed that continuous emission of ETBE to the STP takes place and that the sewage sludge is adapted. In this case the Monod kinetics is used. Furthermore, the retention time for biological treatment is set at 24 hours, which is a more standard retention time for biological wastewater conditioning in large industrial STPs than the default value from EUSES (6.9 h). A detailed description of the installation of a large industrial STP is given in report from Currenta (2008), where also the retention times for the different cleaning steps are mentioned. According to this information brochure, the retention time during biological treatment amounts to 23-30 h.

9.1. Exposure Scenario 1: Manufacturing

ETBE is manufactured in industrial manufacturing of bulk, large scale chemicals as fuel additive in fuels by use in closed, continuous process with occasional controlled exposure. ETBE is manufactured in petroleum refineries and in plants manufacturing industrial organic chemicals.

The manufacturing process of ETBE resembles that of MTBE. MTBE is typically manufactured in petroleum refineries but also in plants manufacturing industrial organic chemicals, prepared principally by reacting isobutene with methanol over an acidic ion-exchange resin catalyst at 38-93^{o}C and 100-200 psi. It can also be prepared from methanol, *tert*-butyl alcohol (TBA) and diazomethane (European Commission, 2002). For ETBE, ethanol is used as starting material instead of methanol.

As is the case for MTBE, the exposure scenario for the manufacturing of ETBE and formulation of ETBE into petrol is considered to be in an automated and principally closed outdoor system with a connection to central waste gas system.

9.1.1. Exposure scenario

Section 1	**Exposure Scenario Title**
Title	**Manufacture of ETBE; CAS RN 637-92-3**
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 ETBE. 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**
Field for additional statements to explain scenario if required.	
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 *Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures , 4. Personal protection.*
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]. 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 (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 1 hour [OC27], 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].	Provide extract ventilation to material transfer points and other openings [E82].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	
Prudction volume in EU (tones/year):	3,004,450

Fraction of EU tonnage used in region [A1]:	0.226
Regional use tonnage (tonnes/year) [A2]:	679,000
Fraction of regional tonnage used locally [A3]:	0.4
Average local daily tonnage (kg/d) [A5]:	905,333
Annual site tonnage (tonnes/year) [A6]	271,600
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

9.1.2. Exposure estimation – Manufactering (ES1)

9.1.2.1. Worker exposure

The situations leading to exposure include the production of neat ETBE. The worker exposure estimates for the activities associated with the manufacture of ETBE have been assessed using ECETOC TRA version 2 (See Annex A1). 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 A1.1 general information, including the DNELs, of the exposure scenario is presented. In Annex A1.2 the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented. Annex A1.3 is explained in the next section.

When modeling resulted in risk characterization ratios above 1 exposure data of MTBE 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, containing a summary of data from the EU RAR of MTBE).

The workers' exposure to ETBE 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 ETBE 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 ETBE vapours and their hands are in contact with petrol products.

9.1.2.1.1. Acute/Short term exposure

Table A.1-3 contains the two subtables (1&2) describing the mapping of uses in the supply chain (contributing scenarios) (table 1) and the characterising of the risk, the Chemical Safety Assessment (table 2). This table, in de CEFIC-GES format, 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 assessement (Annex B 1.2) is used, this is explained in the free text column of the table. The RMMs associated with the estimated exposure for each contributing scenario are presented in chapter 9.1.1.

Operational conditions and an overview of the exposure data (short term and long term), which corresponds to handling neat MTBE, as a surrogate for handling neat ETBE for inhalatory exposure as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B1.1 and B1.2. Conclusions for MTBE will be sufficiently conservative for ETBE, because of the lower vapour pressure for ETBE.

9.1.2.1.2. Long-term exposure

See references provided in chapter 9.1.2.1.1

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).

9.1.2.2. Consumer exposure

Not applicable.

9.1.2.3. Indirect exposure of humans via the environment

The human intake of ETBE from indirect exposure from production is presented in Table 9.1.2.3-1. All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Table 9.1.2.3-1: Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Fish (mg/kg)	$4.90 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	1.13	EUSES calculation
Leaf crops (mg/kg)	0.122	EUSES calculation
Meat (mg/kg)	$7.13 \cdot 10^{-5}$	EUSES calculation
Milk (mg/l)	$7.13 \cdot 10^{-4}$	EUSES calculation
Drinking water (mg/l)	0.872	EUSES calculation
Air (mg/m^3)	0.274	EUSES calculation

The total daily dose for oral and inhalation exposure of humans via the environment that are taken into account for the exposure estimation are listed in Table 9.1.2.3-2.

Table 9.1.2.3-2: 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	0.034	0.034	EUSES calculation
Inhalation	0.078	0.078	EUSES calculation

9.1.2.4. Environmental exposure

9.1.2.4.1. Environmental releases

ETBE 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.

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 as it can be assumed that the production processes of MTBE and ETBE are similar. The release factor to air is set at 0.001 and the release factor to waste water is set at 0.0003. See also Annex C.1 for a complete overview.

For the regional assessment it is assumed that all waste water is collected by industrial sewage treatment plants. The releases to the environment from production calculated with EUSES (2008) are listed in Table 9.1.2.4-1.

Table 9.1.2.4-1: 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	204	819	EUSES calculation
Surface water	0	83.8	EUSES calculation
Air	679	$1.10 \cdot 10^{4}$	EUSES calculation
Soil (direct releases only)	0	285	EUSES calculation

9.1.2.4.2. 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 production calculated with EUSES (2008) are listed in Table 9.1.2.4-2.

Table 9.1.2.4-2: Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Sewage (mg/l)	0.011	0.011	EUSES calculation
Sewage sludge (mg/kg dw)	625	n.a.	EUSES calculation

n.a. - not applicable

9.1.2.4.3. Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for production calculated with EUSES (2008) are given in Table 9.1.2.4-3.

Table 9.1.2.4-3: Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater (mg/l)	$1.12 \cdot 10^{-3}$	$1.56 \cdot 10^{-3}$	EUSES calculation
Marine water (mg/l)	$1.12 \cdot 10^{-4}$	$1.69 \cdot 10^{-4}$	EUSES calculation

9.1.2.4.4. Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment for production calculated with EUSES (2008) are given in Table 9.1.2.4-4.

Table 9.1.2.4-4: Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater sediments (mg/kg ww)	n.c.	$1.89 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$2.06 \cdot 10^{-4}$	EUSES calculation

n.c. - not calculated in EUSES

9.1.2.4.5. 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 (see Table 9.1.2.4-2).

The concentration of ETBE 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 calculated with EUSES (2008) are given in Table 9.1.2.4-5.

Table 9.1.2.4-5: Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Agricultural soil averaged (mg/kg ww)	0.830	0.830	EUSES calculation
Grassland averaged (mg/kg ww)	0.175	0.175	EUSES calculation
Groundwater(mg/l)	n.c.	0.872	EUSES calculation

n.c. - not calculated in EUSES

9.1.2.4.6. Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source (Reach Guidance R.16, 2008). 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 calculated with EUSES (2008) are given in Table 9.1.2.4-6.

Table 9.1.2.4-6: Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
During emission (mg/m^3)	0.334	n.c.	EUSES calculation
Annual average (mg/m^3)	0.274	0.274	EUSES calculation
Annual deposition ($mg/m^2/d$)	0.396	n.c.	EUSES calculation

n.c. - not calculated in EUSES

9.1.2.4.7. Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for ETBE 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.

9.2. Exposure Scenario 2: Formulation

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

9.2.1. Exposure scenario

Section 1	**Exposure Scenario Title**
Title	**Formulation of ETBE; CAS RN 637-92-3**
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 measures**
Field for additional statements to explain scenario if required.	
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** *Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures , 4. Personal protection.*
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]. 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 (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]. Operation is carried out at elevated temperature (> 20°C above ambient temperature) [OC7].	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]	Provide a good standard of controlled ventilation (10 to 15 air changes per hour) [E40].
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]. 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]
Manual [CS34]. ; Transfer from/pouring from containers [CS22]. Non-dedicated facility [CS82]	Ensure material transfers are under containment or extract ventilation [E66]. 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]
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 1 hour [OC27], 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 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].
Operational conditions	Outdoor use [OOC1].
Amounts used	
Regional use tonnage (tonnes/year) [A2]:	901,000

Fraction of regional tonnage used locally [A3]:	0.05
Average local daily tonnage (kg/d) [A5]:	150,167
Annual site tonnage (tonnes/year) [A6]	45,050
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

9.2.2. Exposure estimation – Formulation (ES2)

9.2.2.1. Worker exposure

The situations leading to exposure include formulation (blending and storing): petrol blending with ETBE. The worker exposure estimates for the activities associated with formulation have been assessed using ECETOC TRA version 2. (See Annex A2). 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 A2.1 general information, including the DNELs, of the exposure scenario is presented. In Annex A2.2 the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented. Annex A2.3 is explained in the next section.

The workers' exposure to ETBE 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 ETBE or blended fuel.

Sampling and laboratory work, handling products containing ETBE 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 ETBE vapours and their hands are in contact with petrol products.

9.2.2.1.1. Acute/Short term exposure

Table A.2-3 contains the two subtables (1&2) describing the mapping of uses in the supply chain (contributing scenarios) (table 1) and the characterising of the risk, the Chemical Safety Assessment (table 2). This table, in de CEFIC-GES format, 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 assessement (Annex B 1.2) is used, this is explained in the free text column of the table.

The RMMs associated with the estimated exposure for each contributing scenario are presented in chapter 9.2.1.

Operational conditions and an overview of the exposure data (short term and long term), which corresponds to handling neat MTBE, as a surrogate for handling neat ETBE for inhalatory exposure as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B1.1 and B1.2. Conclusions for MTBE will be sufficiently conservative for ETBE, because of the lower vapour pressure for ETBE.

9.2.2.1.2. Long-term exposure

See references provided in chapter 9.2.2.1.1.

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).
- Reduction factor of 70% is considered for use of enhanced general ventilation by mechanical means (Provide a good standard of controlled ventilation (10 to 15 air changes per hour) [E40]) (Industrial Ventilation: A Manual of Recommended Practice, ACGIH, 2004);

9.2.2.2. Consumer exposure

Not applicable.

9.2.2.3. Indirect exposure of humans via the environment

The human intake of ETBE from indirect exposure from formulation is presented in Table 9.2.2.3-1. All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Table 9.2.2.3-1: Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Fish (mg/kg)	$4.73 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	0.059	EUSES calculation
Leaf crops (mg/kg)	$5.20 \cdot 10^{-3}$	EUSES calculation
Meat (mg/kg)	$3.42 \cdot 10^{-6}$	EUSES calculation
Milk (mg/l)	$3.42 \cdot 10^{-5}$	EUSES calculation
Drinking water (mg/l)	0.046	EUSES calculation
Air (mg/m^3)	0.012	EUSES calculation

The total daily dose for oral and inhalation exposure of humans via the environment that are taken into account for the exposure estimation are listed in Table 9.2.2.3-2.

Table 9.2.2.3-2: 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	$1.74 \cdot 10^{-4}$	$1.92 \cdot 10^{-4}$	EUSES calculation
Inhalation	$3.33 \cdot 10^{-4}$	$4.04 \cdot 10^{-4}$	EUSES calculation

9.2.2.4. Environmental exposure

9.2.2.4.1. Environmental releases

Formulation of ETBE covers the blending of petrol with ETBE. Emissions into environment are mainly atmospheric.
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 as it can be assumed that the formulation processes of MTBE and ETBE are similar. The release factor to air is set at 0.001 and the release factor to waste water is set at 0.0003. The default fraction of the main source is also replaced by specific data (fraction of the main source is 0.05). See also Annex C.2 for a complete overview.
For the regional assessment it is assumed that all waste water is collected by industrial sewage treatment plants. The releases to the environment from formulation calculated with EUSES (2008) are listed in Table 9.2.2.4-1.

Table 9.2.2.4-1: 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	90	819	EUSES calculation
Surface water	0	83.8	EUSES calculation
Air	300	$1.10 \cdot 10^{4}$	EUSES calculation
Soil (direct releases only)	0	285	EUSES calculation

9.2.2.4.2. 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 formulation calculated with EUSES (2008) are listed in Table 9.2.2.4-2.

Table 9.2.2.4-2: Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Sewage (mg/l)	0.011	0.011	EUSES calculation
Sewage sludge (mg/kg dw)	34.5	n.a.	EUSES calculation

n.a. - not applicable

9.2.2.4.3. Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for formulation calculated with EUSES (2008) are given in Table 9.2.2.4-3.

Table 9.2.2.4-3: Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater (mg/l)	$1.07 \cdot 10^{-3}$	$1.50 \cdot 10^{-3}$	EUSES calculation
Marine water (mg/l)	$1.07 \cdot 10^{-4}$	$1.64 \cdot 10^{-4}$	EUSES calculation

9.2.2.4.4. Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment calculated with EUSES (2008) are given in Table 9.2.2.4-4.

Table 9.2.2.4-4: Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater sediments (mg/kg ww)	n.c.	$1.82 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$1.99 \cdot 10^{-4}$	EUSES calculation

n.c. - not calculated in EUSES

9.2.2.4.5. 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 (see Table 9.2.2.4-2).

The concentration of ETBE 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 calculated with EUSES (2008) are given in Table 9.2.2.4-5.

Table 9.2.2.4-5: Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Agricultural soil averaged (mg/kg ww)	0.045	0.045	EUSES calculation
Grassland averaged (mg/kg ww)	$8.41 \cdot 10^{-3}$	$8.46 \cdot 10^{-3}$	EUSES calculation
Groundwater(mg/l)	n.c.	0.046	EUSES calculation

n.c. - not calculated in EUSES

9.2.2.5.6. Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source (Reach Guidance R.16, 2008). 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 formulation calculated with EUSES (2008) are given in Table 9.2.2.4-6.

Table 9.2.2.4-6: Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
During emission (mg/m^3)	0.014	n.c.	EUSES calculation
Annual average (mg/m^3)	0.011	0.012	EUSES calculation
Annual deposition ($mg/m^2/d$)	0.017	n.c.	EUSES calculation

n.c. - not calculated in EUSES

9.2.2.6. Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for ETBE 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.

9.3. Exposure Scenario 3: Transport and distribution - industrial

ETBE is used in transportation and distribution as fuel additive in fuels by transfer of substance or preparation. Neat ETBE 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.

9.3.1. Exposure scenario

Section 1	**Exposure Scenario Title**
Title	**Distribution of ETBE; CAS RN 637-92-3**
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: ESVOC3 SpERC
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 measures**
Field for additional statements to explain scenario if required.	
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** *Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures , 4. Personal protection.*
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]. 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 (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]. ; 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]	Provide a good standard of controlled ventilation (10 to 15 air changes per hour) [E40].
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]. 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]
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 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 [A1]:	1.00
Regional use tonnage (tonnes/year) [A2]:	901,000
Fraction of regional tonnage used locally [A3]:	0.02
Average local daily tonnage (kg/d) [A5]:	51,486
Annual site tonnage (tonnes/year) [A6]	18,020
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 >97% [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
Storage	
Operational conditions	Outdoor use [OOC1].
Amounts used	
Fraction of EU tonnage used in region [A1]:	1.00
Regional use tonnage (tonnes/year) [A2]:	901,000
Fraction of regional tonnage used locally [A3]:	1
Average local daily tonnage (kg/d) [A5]:	2,468,493
Annual site tonnage (tonnes/year) [A6]	901,000
Frequency and duration of use	
Type of release	Continuous release [FD2].
Emission days (days/year)	365
Other Operational Conditions of use affecting environmental exposure	Use in closed systems.
	Either wet or dry processes.
Release to wastewater from process (kg/d):	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 to air [TCR2].

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].
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

9.3.2. Exposure estimation – Transport and distribution – industrial (ES3)

9.3.2.1. Worker exposure

The situations leading to exposure include loading and unloading railroad car, ship etc. and distribution of petrol containing ETBE 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. (See Annex A3). 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 general information, including the DNELs, of the exposure scenario is presented. In Annex A3.2 the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented. Annex A5.3 is explained in the next section.

Transporting operations concern both neat ETBE 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 ETBE vapours and their hands are in contact with petrol products.

9.3.2.1.1. Acute/Short term exposure

Table A.3-3 contains the two subtables (1&2) describing the mapping of uses in the supply chain (contributing scenarios) (table 1) and the characterising of the risk, the Chemical Safety Assessment (table 2). This table, in de CEFIC-GES format, 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, this is explained in the free text column of the table.

The RMMs associated with the estimated exposure in for each contributing scenario are presented in chapter 9.3.1.

Operational conditions and an overview of the exposure data (short term and long term), which corresponds to handling neat MTBE, as a surrogate for handling neat ETBE for inhalatory exposure as described in the EU RAR of MTBE (European Commission, 2002) are summarized in Annex B1.1 and B1.2. Conclusions for MTBE will be sufficiently conservative for ETBE, because of the lower vapour pressure for ETBE.

The exposure situation includes both handling of neat ETBE and blended fuels. An overview of the assessments, which corresponds to handling neat ETBE, is given. If the situation is safe on this worst case situation, the exposure is assumed to be safe if the concentration of ETBE in the formulation is lower. Exposure during transporting and distributing occurs intermittently.

9.3.2.1.2. Long-term exposure

See references in chapter 9.3.2.1.1

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).
- Reduction factor of 70% is considered for use of enhanced general ventilation by mechanical means (Provide a good standard of controlled ventilation (10 to 15 air changes per hour) [E40]) (Industrial Ventilation: A Manual of Recommended Practice, ACGIH, 2004);

9.3.2.2. Consumer exposure

Not applicable.

9.3.2.3. Indirect exposure of humans via the environment

The human intake of ETBE from indirect exposure from transport and distribution is presented in Table 9.3.2.3-1. All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Table 9.3.2.3-1: Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Transport and delivery of ETBE and petrol		
Fish (mg/kg)	$5.16 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	$1.11 \cdot 10^{-3}$	EUSES calculation
Leaf crops (mg/kg)	$3.12 \cdot 10^{-4}$	EUSES calculation
Meat (mg/kg)	$1.47 \cdot 10^{-7}$	EUSES calculation
Milk (mg/l)	$1.47 \cdot 10^{-6}$	EUSES calculation
Drinking water (mg/l)	$1.43 \cdot 10^{-3}$	EUSES calculation
Air (mg/m^3)	$7.03 \cdot 10^{-4}$	EUSES calculation
Storage		
Fish (mg/kg)	$5.41 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	0.028	EUSES calculation
Leaf crops (mg/kg)	$1.38 \cdot 10^{-4}$	EUSES calculation
Meat (mg/kg)	$9.88 \cdot 10^{-7}$	EUSES calculation
Milk (mg/l)	$9.88 \cdot 10^{-6}$	EUSES calculation
Drinking water (mg/l)	0.022	EUSES calculation
Air (mg/m^3)	$2.74 \cdot 10^{-4}$	EUSES calculation

The total daily dose for oral and inhalation exposure of humans via the environment that are taken into account for the exposure estimation are listed in Table 9.3.2.3-2.

Table 9.3.2.3-2: 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 ETBE and petrol			
Oral	$6.10 \cdot 10^{-5}$	$7.86 \cdot 10^{-5}$	EUSES calculation
Inhalation	$2.01 \cdot 10^{-4}$	$2.03 \cdot 10^{-4}$	EUSES calculation
Storage			
Oral	$7.90 \cdot 10^{-4}$	$8.08 \cdot 10^{-4}$	EUSES calculation
Inhalation	$7.84 \cdot 10^{-5}$	$7.84 \cdot 10^{-4}$	EUSES calculation

9.3.2.4. Environmental exposure

9.3.2.4.1. 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/ETBE 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]). See also Annex C.3 for a complete overview.

For the regional assessment it is assumed that all waste water is collected by industrial sewage treatment plants. The releases to the environment from transport and distribution calculated with EUSES (2008) are listed in Table 9.3.2.4-1.

Table 9.3.2.4-1: 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	3	819	EUSES calculation
Surface water	0	83.8	EUSES calculation
Air	30	$1.10 \cdot 10^4$	EUSES calculation
Soil (direct releases only)	0	285	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 of MTBE (2002) it was assumed that in Europe 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. Similar situations can also occur for ETBE. Because of its water solubility remarkable amounts of ETBE in water are contained at the bottom of tanks storing ETBE 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 ETBE can be assumed in the tank bottom water (see Table 9.3.2.4-2). 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% ETBE (a worst-case assumption as the average level in Europe is about 5% ETBE 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'.

Table 9.3.2.4-2: 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

9.3.2.4.2. 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 calculated with EUSES (2008) are listed in Table 9.3.2.4-3.

Table 9.3.2.4-3: Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Transport and delivery of ETBE and petrol			
Sewage (mg/l)	0.010	0.010	EUSES calculation
Sewage sludge (mg/kg dw)	0.412	n.a.	EUSES calculation
Storage			
Sewage (mg/l)	0.011	0.011	EUSES calculation
Sewage sludge (mg/kg dw)	19.3	n.a.	EUSES calculation

n.a. - not applicable

9.3.2.4.3. Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for transport and distribution calculated with EUSES (2008) are given in Table 9.3.2.4-4.

Table 9.3.2.4-4: Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Transport and delivery of ETBE and petrol			
Freshwater (mg/l)	$1.04 \cdot 10^{-3}$	$1.47 \cdot 10^{-3}$	EUSES calculation
Marine water (mg/l)	$1.04 \cdot 10^{-4}$	$1.61 \cdot 10^{-4}$	EUSES calculation
Storage			
Freshwater (mg/l)	$1.06 \cdot 10^{-3}$	$1.50 \cdot 10^{-3}$	EUSES calculation
Marine water (mg/l)	n.r.	n.r.	

n.r. = not relevant

Storage

The predicted PEC of 1.01 µg/l for freshwater is a worst-case value. In a report prepared by DSC consulting (Wagner and Stupp, 2008) the possible release of a typical tank farm which is located at the river Lippe was investigated. The Lippe is a Rhine influent which flows in the Rhine near Wesel. The loading of ETBE in the Lippe was much lower and often below the detection limit of 0.05 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 ETBE concentrations in the environment.
All these data demonstrate ETBE background levels in urban areas on average of lower than 0.1 µg/l in comparison with 0.05 µg/l or below in rural areas. If tank bottom water is a real issue the data would demonstrate much more industrial effluents as a source of ETBE 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.
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 viewed under www.aqualarm.nl. The geometric mean of ETBE concentrations at the Lobith station since October 2004 is 0.05 µg/l (*n* = 5,772). The highest observed peak of ETBE in the Rhine is 60 µg/l, these peak exposures in the River Rhine occur only very sporadically and can therefore be seen as intermittent releases.
Therefore it can be concluded that 8.4 kg ETBE in tank bottom water adopted from the report by Wagner and Stupp (2008) is a theoretical worst-case scenario.

9.3.2.4.4. Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment for transport and distribution calculated with EUSES (2008) are given in Table 9.3.2.4-5.

Table 9.3.2.4-5: Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Transport and delivery of ETBE and petrol			
Freshwater sediments (mg/kg ww)	n.c.	$1.79 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$1.95 \cdot 10^{-4}$	EUSES calculation
Storage			
Freshwater sediments (mg/kg ww)	n.c.	$1.82 \cdot 10^{-3}$	EUSES calculation
Marine sediments (mg/kg ww)	n.r.	n.r.	

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

9.3.2.4.5. 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 (see Table 9.3.2.4-3).
The concentration of ETBE 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 calculated with EUSES (2008) are given in Table 9.3.2.4-6.

Table 9.3.2.4-6: Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Transport and delivery of ETBE and petrol			
Agricultural soil averaged (mg/kg ww)	$6.28 \cdot 10^{-4}$	$6.82 \cdot 10^{-4}$	EUSES calculation
Grassland averaged (mg/kg ww)	$2.10 \cdot 10^{-4}$	$2.63 \cdot 10^{-4}$	EUSES calculation
Groundwater(mg/l)	n.c.	$8.62 \cdot 10^{-4}$	EUSES calculation
Storage			
Agricultural soil averaged (mg/kg ww)	0.023	0.023	EUSES calculation
Grassland averaged (mg/kg ww)	$2.53 \cdot 10^{-3}$	$1.58 \cdot 10^{-3}$	EUSES calculation
Groundwater(mg/l)	n.c.	0.022	EUSES calculation

n.c. - not calculated in EUSES

9.3.2.4.6. Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source (Reach Guidance R.16, 2008). 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 calculated with EUSES (2008) are given in Table 9.3.2.4-7.

Table 9.3.2.4-7: Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
Transport and delivery of ETBE and petrol			
During emission (mg/m^3)	$4.76 \cdot 10^{-4}$	n.c.	EUSES calculation
Annual average (mg/m^3)	$4.56 \cdot 10^{-4}$	$7.03 \cdot 10^{-4}$	EUSES calculation
Annual deposition ($mg/m^2/d$)	$6.59 \cdot 10^{-4}$	n.c.	EUSES calculation
Storage			
During emission (mg/m^3)	$2.72 \cdot 10^{-5}$	n.c.	EUSES calculation
Annual average (mg/m^3)	$2.72 \cdot 10^{-5}$	$2.74 \cdot 10^{-4}$	EUSES calculation
Annual deposition ($mg/m^2/d$)	$3.92 \cdot 10^{-5}$	n.c.	EUSES calculation

n.c. - not calculated in EUSES

9.3.2.4.7. Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for ETBE 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.

9.4. Exposure Scenario 4: Fuel use – industrial

ETBE used as fuel additive in fuels in industrial applications of fuels. ETBE containing fuels are stored, loaded and unladed in industrial settings and engines are maintenaned.

9.4.1. Exposure scenario

Section 1	**Exposure Scenario Title**
Title	**Use in Fuels of ETBE; CAS RN 637-92-3**
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 measures**
Field for additional statements to explain scenario if required.	
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** *Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures , 4. Personal protection.*
Bulk transfers [CS14]. ; Batch process [CS55]. With sample collection [CS56]. ; Filling / preparation of equipment from drums or containers. [CS45].	Handle substance within a predominantly closed system provided with extract ventilation [E49].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]
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) [CS15].	No specific measures identified [EI18].

General exposures (closed systems) [CS15]. With sample collection [CS56].	Provide extract ventilation to material transfer points and other openings [E82].
General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]. ; With sample collection [CS56].	Provide extract ventilation to points where emissions occur [E54].
(closed systems) [CS107] U of fuel	No specific measures identified [EI18].
(closed systems) [CS107] Btch process [CS55].	Provide extract ventilation to material transfer points and other openings [E82].
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]
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	
Regional use tonnage (tonnes/year) [A2]:	901,000
Fraction of regional tonnage used locally [A3]:	0.02
Average local daily tonnage (kg/d) [A5]:	51,486
Annual site tonnage (tonnes/year) [A6]	18,020
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 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

9.4.2. Exposure estimation – Fuel Use – industrial (ES4)

9.4.2.1. Workers exposure

The release includes handling of blended fuels containing a variety of percentage of ETBE (up to 15%). The worker exposure estimates for the activities associated with the handling of ETBE containing fuel have been assessed using ECETOC TRA version 2. (See Annex A4). 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 general information, including the DNELs, of the exposure scenario is presented. In Annex A4.2 the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented. Annex A4.3 is explained in the next section.

9.4.2.1.1. Acute/Short term exposure

Table A.4-3 contains the two subtables (1&2) describing the mapping of uses in the supply chain (contributing scenarios) (table 1) and the characterising of the risk, the Chemical Safety Assessment (table 2). This table, in de CEFIC-GES format, 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, this is explained in the free text column of the table.
The RMMs associated with the estimated exposure in for each contributing scenario are presented in chapter 9.4.1.
Operational conditions and an overview of the exposure data (short term and long term), which corresponds to MTBE containing fuel, as a surrogate for handling neat ETBE 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/B3.2 (use of vehicles). Exposure data for ±10 vol% MTBE are regarded as reliable surrogate data for at least up to 15 vol% ETBE exposure as the vapour pressure for ETBE is about half of that from MTBE. Conclusions for MTBE will be sufficiently conservative for ETBE.

9.4.2.1.2. Long-term exposure

See references provided in chapter 9.4.2.1.1

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).

9.4.2.2. Consumer exposure

Not applicable.

9.4.2.3. Indirect exposure of humans via the environment

Covered under Exposure Scenario 9.3.

9.4.2.4. Environmental exposure

Covered under Exposure Scenario 9.3. See also Annex C.4 for a complete overview of operational conditions and risk management measures, PECs and resulting RCRs.

9.5. Exposure Scenario 5: Fuel use – professional

ETBE used as fuel additive in fuels in professional applications of fuels. ETBE containing fuels are stored, loaded and unladed in industrial settings and engines are maintenaned.

9.5.1. Exposure scenario

Section 1	**Exposure Scenario Title**
Title	**Use in Fuels of ETBE;CAS RN637-92-3**
Use Descriptor	Sector of Use: Professional (SU22)
	Process Categories: PROC1, PROC2, PROC3, PROC8a, PROC8b, PROC9, PROC16
	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 measures**
Field for additional statements to explain scenario if required.	
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** *Note: list RMM standard phrases according to the control hierarchy indicated in the ECHA template: 1. Technical measures to prevent release, 2. Technical measures to prevent dispersion, 3. Organisational measures , 4. Personal protection.*
Bulk transfers [CS14]. ; Batch process [CS55]. Filling / preparation of equipment from drums or containers. [CS45].	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].
Drum/batch transfers [CS8]. ; Filling / preparation of equipment from drums or containers. [CS45]. Bulk transfers [CS14]. ; Dedicated facility [CS81]	Ensure operation is undertaken outdoors [E69]. ; 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].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].
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]
General exposures (closed systems) [CS15]. ; Use in contained batch processes [CS37]. With sample collection [CS56].	Provide a good standard of controlled ventilation (10 to 15 air changes per hour) [E40].
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 4 hours [OC28], or: Wear a respirator conforming to EN140 with Type A filter or better. [PPE22]
(closed systems) [CS107]use a fuel	Ensure operation is undertaken outdoors [E69]. , or: Provide a good standard of controlled ventilation (10 to 15 air changes per hour) [E40].
Equipment cleaning and maintenance [CS39]. Non-dedicated facility [CS82]e.g fuel pump repair indoor	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].
Equipment cleaning and maintenance [CS39]. Non-dedicated facility [CS82]e.g fuel pump repair outdoor	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].
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):	4.94
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 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 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

9.5.2. Exposure estimation – Fuel Use – professional (ES5)

9.5.2.1. Workers exposure

The release includes handling of blended fuels containing a variety of percentage of ETBE (up to 15%). The worker exposure estimates for the activities associated with the handling of ETBE containing fuel have been assessed using ECETOC TRA version 2. (See Annex A5). 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 general information, including the DNELs, of the exposure scenario is presented. In Annex A5.2 the contributing scenarios with typical mapped operational conditions and Risk Management Measures are presented. Annex A5.3 is explained in the next section.

9.5.2.1.1. Acute/Short term exposure

Table A.5-3 contains the two subtables (1&2) describing the mapping of uses in the supply chain (contributing scenarios) (table 1) and the characterising of the risk, the Chemical Safety Assessment (table 2). This table, in de CEFIC-GES format, 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 are used, this is explained in the free text column of the table.

The RMMs associated with the estimated exposure in for each contributing scenario are presented in chapter 9.5.1.

Operational conditions and an overview of the exposure data (short term and long term), which corresponds to MTBE containing fuel, as a surrogate for handling neat ETBE 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/B3.2 (use of vehicles). Exposure data for ±10 vol% MTBE are regarded as reliable surrogate data for at least up to 15 vol% ETBE exposure as the vapour pressure for ETBE is about half of that from MTBE. Conclusions for MTBE will be sufficiently conservative for ETBE.

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.

9.5.2.1.2. Long-term exposure

See references provided in chapter 9.5.2.1.1

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).
- Reduction factor of 70% is considered for use of enhanced general ventilation by mechanical means (Provide a good standard of controlled ventilation (10 to 15 air changes per hour) [E40]) (Industrial Ventilation: A Manual of Recommended Practice, ACGIH, 2004);

9.5.2.2. Consumer exposure

Not applicable.

9.5.2.3. Indirect exposure of humans via the environment

Covered under Exposure Scenario 9.6.

9.5.2.4. Environmental exposure

Covered under Exposure Scenario 9.6. See also Annex C.5 for a complete overview of operational conditions and risk management measures, PECs and resulting RCRs.

9.6. Exposure Scenario 6: Fuel use – consumer

9.6.1. Exposure scenario

Section 1	**Exposure Scenario Title**	
Title	**Use in Fuels of ETBE;CAS RN637-92-3**	
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 measures**	
Field for additional statements to explain scenario if required.		
Section 2.1	**Control of consumer exposure**	
Product characteristics		
Physical form of product	Liquid, vapour pressure > 10 kPa [OC5].	
Vapour pressure	170 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		Indoor/Outdoor use [OOC3].
Amounts used		
Average daily use over a year for wide dispersive use (kg/d):		4.94
Frequency and duration of use		
Type of release		Dispersive use [FD3].
Emission days (days/year)		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 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 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

9.6.2. Exposure estimation Fuel Use – consumer (ES6)

9.6.2.1. Workers exposure

Not applicable.

9.6.2.2. 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)

Exposure data for ±10 vol% MTBE are regarded as reliable surrogate data for at least up to 15 vol% ETBE exposure as the vapour pressure for ETBE is about half of that from MTBE. Conclusions for MTBE will be sufficiently conservative for ETBE.

9.6.2.2.1. 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% (see further details in section 9.6.2.2.2).

9.6.2.2.2. Long-term exposure

Refuelling of a car or a boat motor may cause exposure to ETBE. Due to lack of measured data of ETBE, the measurement data of MTBE are used, since the substances and the processes at the service stations are both comparable.

The long-term exposure for consumer exposure is summarized in the following table. It is assumed no oral exposure is possible. Refuelling may cause dermal contact with ETBE.

Table 9.6.2-1: 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 modeling (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 (See Annex A.6), 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 (*see Guidance table R15-9*)). When respiration on average 20 m^3 (*see Guidance appendix R.15-4*), the daily airborne exposure is 26 µg/m^3.

A summary of the long-term exposure values for consumers is given in the following table..

Table 9.6.2-6: 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, 2009), it is concluded that dermal exposure is insignificant.
INHALATION EXPOSURE (MG/M^3/DAY)	0.026	The reasonable worst-case (RWC) for inhalation exposure for consumers to blended fuels containing ETBE is based on the MTBE measurement data. Exposure estimation based on short term exposure during 1 minute.

9.6.2.3. Indirect exposure of humans via the environment

The human intake of ETBE from indirect exposure from wide-dispersive uses is presented in Table 9.6.2.3-1. All food products are considered to come from the vicinity of the point source. The estimations are results of EUSES (2008) calculations.

Table 9.6.2.3-1: Local concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Fish (mg/kg)	$5.74 \cdot 10^{-4}$	EUSES calculation
Root crops (mg/kg)	$1.43 \cdot 10^{-8}$	EUSES calculation
Leaf crops (mg/kg)	$1.48 \cdot 10^{-7}$	EUSES calculation
Meat (mg/kg)	$3.39 \cdot 10^{-8}$	EUSES calculation
Milk (mg/l)	$3.39 \cdot 10^{-7}$	EUSES calculation
Drinking water (mg/l)	$7.49 \cdot 10^{-5}$	EUSES calculation
Air (mg/m^3)	$3.14 \cdot 10^{-4}$	EUSES calculation

The total daily dose for oral and inhalation exposure of humans via the environment that are taken into account for the exposure estimation are listed in Table 9.6.2.3-2.

Table 9.6.2.3-2: 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	$1.22 \cdot 10^{-5}$	$2.98 \cdot 10^{-5}$	EUSES calculation
Inhalation	$7.06 \cdot 10^{-5}$	$1.41 \cdot 10^{-4}$	EUSES calculation

9.6.2.4. Environmental exposure

9.6.2.4.1. 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 ETBE 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]). See also Appendix D.6 for a complete overview.

The releases to the environment from wide-dispersive uses calculated with EUSES (2008) are listed in Table 9.6.2.4-1.

Table 9.6.2.4-1: 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	2.4	819	EUSES calculation
Surface water	30.6	83.8	EUSES calculation
Air	$3.00 \cdot 10^{3}$	$1.10 \cdot 10^{4}$	EUSES calculation
Soil (direct releases only)	0	285	EUSES calculation

9.6.2.4.2. 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 calculated with EUSES (2008) are listed in Table 9.6.2.4-3.

Table 9.6.2.4-3: Predicted Exposure Concentrations (PEC) in sewage treatment plants

Compartments	Local concentration	PEC	Justification
Sewage (mg/l)	$5.2 \cdot 10^{-6}$	$5.2 \cdot 10^{-6}$	EUSES calculation
Sewage sludge (mg/kg dw)	$3.93 \cdot 10^{-5}$	n.a.	EUSES calculation

n.a. - not applicable

9.6.2.4.3. Exposure concentration in the aquatic pelagic compartment

The Predicted Exposure Concentrations (PEC) in the aquatic compartment for wide-dispersive uses calculated with EUSES (2008) are given in Table 9.6.2.4-4.

Table 9.6.2.4-4: Predicted Exposure Concentrations (PEC) in the aquatic compartment

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater (mg/l)	$5.20 \cdot 10^{-7}$	$4.34 \cdot 10^{-4}$	EUSES calculation
Marine water (mg/l)	$5.20 \cdot 10^{-8}$	$5.70 \cdot 10^{-5}$	EUSES calculation

9.6.2.4.4. Exposure concentration in sediments

The Predicted Exposure Concentrations (PEC) in sediment for wide-dispersive uses calculated with EUSES (2008) are given in Table 9.6.2.4-3.

Table 9.6.2.4-3: Predicted Exposure Concentrations (PEC) in sediments

Compartments	Local concentration	PEC (local + regional)	Justification
Freshwater sediments (mg/kg ww)	n.c.	$5.27 \cdot 10^{-4}$	EUSES calculation
Marine sediments (mg/kg ww)	n.c.	$6.93 \cdot 10^{-5}$	EUSES calculation

9.6.2.4.5. 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 (see Table 9.6.2.4-2).

The concentration of ETBE 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 calculated with EUSES (2008) are given in Table 9.6.2.4-5.

Table 9.6.2.4-5: Predicted Exposure Concentrations (PEC) in soil and groundwater

Compartments	Local concentration	PEC (local + regional)	Justification
Agricultural soil averaged (mg/kg ww)	$4.73 \cdot 10^{-8}$	$5.35 \cdot 10^{-5}$	EUSES calculation
Grassland averaged (mg/kg ww)	$5.37 \cdot 10^{-9}$	$5.35 \cdot 10^{-5}$	EUSES calculation
Groundwater(mg/l)	n.c.	$1.14 \cdot 10^{-4}$	EUSES calculation

9.6.2.4.6. Atmospheric compartment

The concentration of the substance in air is estimated at a distance of 100 m from a point source (Reach Guidance R.16, 2008). 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 for wide-dispersive uses calculated with EUSES (2008) are given in Table 9.6.2.4-6.

Table 9.6.2.4-6: Predicted Exposure Concentration (PEC) in air

Compartments	Local concentration	PEC (local + regional)	Justification
During emission (mg/m^3)	$7.56 \cdot 10^{-10}$	n.c.	EUSES calculation
Annual average (mg/m^3)	$7.56 \cdot 10^{-10}$	$2.47 \cdot 10^{-4}$	EUSES calculation
Annual deposition (mg/m^2/d)	$1.09 \cdot 10^{-9}$	n.c.	EUSES calculation

9.6.2.4.7. Exposure concentration relevant for the food chain (Secondary poisoning)

Exposure assessment through secondary poisoning has not been carried out for ETBE 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.

9.7. Overall exposure (combined for all relevant emission/release sources)

9.7.1 Human health (combined for all exposure routes)

Combined exposure for human health is addressed in Section 10.3.1.

9.7.2 Environmental emission assessment - regional exposure concentrations

The regional release to the environment calculated with EUSES (2008) are listed in Table 9.7.2-1.

Table 9.7.2.4-1: Summary of the releases to the environment

Compartments	Total release for regional exposure estimation (kg/d)	Justification
Waste water	819	EUSES calculation
Surface water	83.8	EUSES calculation
Air	$1.10 \cdot 10^{4}$	EUSES calculation
Soil (direct releases only)	285	EUSES calculation

9.7.2.1.2. Regional exposure concentrations in the environment

The regional Predicted Exposure Concentrations (PECs) in the environment are listed in Table 9.7.2-2.

Table 9.7.2-2: Regional concentrations in the environment

Compartments	Predicted regional Exposure Concentrations	Explanation / source of measured data
Freshwater (mg/l)	$4.33 \cdot 10^{-4}$	EUSES calculation
Freshwater sediments (mg/kg)	$4.83 \cdot 10^{-4}$	EUSES calculation
Marine water (mg/l)	$5.70 \cdot 10^{-5}$	EUSES calculation
Marine sediments (mg/kg)	$6.38 \cdot 10^{-5}$	EUSES calculation
Agricultural soil (mg/kg ww)	$5.45 \cdot 10^{-6}$	EUSES calculation
Pore water (mg/l)	$1.16 \cdot 10^{-4}$	EUSES calculation

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 ETBE concentrations in the environment.

All these data demonstrate ETBE background levels in urban areas on average of lower than 0.1 µg/l in comparison with 0.05 µg/l or below in rural areas. If tank bottom water is a real issue the data would demonstrate much more industrial effluents as a source of ETBE 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.
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 viewed under www.aqualarm.nl. The geometric mean of ETBE concentrations at the Lobith station since October 2004 is 0.05 µg/l (n = 5,772). The highest observed peak of ETBE in the Rhine is 60 µg/l, these peak exposures in the River Rhine occur only very sporadically and can therefore be seen as intermittent releases.

It can therefore be concluded that the predicted regional PEC of 0.16 µg/l for freshwater with EUSES is in line with reported background levels in urban areas.

9.7.2.1.3 Indirect exposure of humans via the environment (oral)

The regional human intake of ETBE is presented in Table 9.7.2-3. The estimations are results of EUSES (2008) calculations.

Table 9.7.2-3: Regional concentrations for oral exposure of humans via the environment

Human intake media	Exposure concentrations	Justification
Fish (mg/kg)	$1.57 \cdot 10^{-3}$	EUSES calculation
Root crops (mg/kg)	$1.50 \cdot 10^{-4}$	EUSES calculation
Leaf crops (mg/kg)	$1.09 \cdot 10^{-4}$	EUSES calculation
Meat (mg/kg)	$4.88 \cdot 10^{-8}$	EUSES calculation
Milk (mg/l)	$4.88 \cdot 10^{-7}$	EUSES calculation
Drinking water (mg/l)	$4.33 \cdot 10^{-4}$	EUSES calculation

The total regional daily dose for oral and inhalation exposure of humans via the environment that are taken into account for the exposure estimation are listed in Table 9.6.2.3-2.

Table 9.7.2.3-2: 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 regional concentration**	
Oral	$1.76 \cdot 10^{-5}$	EUSES calculation
Inhalation	$7.06 \cdot 10^{-5}$	EUSES calculation