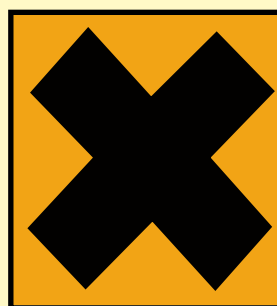


# ETHYL ACRYLATE

E.U. Classification:

F: Highly flammable

Xn: Harmful



UN N°: 1917 (stabilised)

SEBC Classification: ED (evaporates/dissolves)

MARPOL classification: A until 31/12/2006

Y from 01/01/2007





# ETHYL ACRYLATE

*PRACTICAL GUIDE*

*INFORMATION*

*DECISION-MAKING*

*RESPONSE*

This document was drafted by *Cedre* (the Centre of Documentation, Research and Experimentation on Accidental Water Pollution) with financial support and technical guidance from ARKEMA.

## **Caution**

Certain data, regulations, values and norms may be liable to change subsequent to publication. We recommend that you check them.

The information contained within this guide is a result of *Cedre's* research and experience. *Cedre* cannot be held responsible for the consequences resulting from the use of this information.

Published: October 2006

Translated by Sally Ferguson

## Purpose of this guide

As part of the research funded, ARKEMA and *Cedre* (the Centre of Documentation, Research and Experimentation on Accidental Water Pollution) have produced a series of response guides for chemical hazards. They can be used to assist in emergency response in the event of an incident involving a vessel carrying hazardous substances which may cause water pollution.

These guides are updates of the 61 "mini response guides" published by *Cedre* in the early 1990s.

These guides are designed to allow rapid access to the necessary initial information (see chapter entitled "First line emergency data"), in addition to providing relevant bibliographical sources to obtain further information.

They also contain the results of scenarios relating to incidents which have occurred in the Channel, the Mediterranean and in ports and rivers. These scenarios are only intended to provide response authorities with indications of what to do in an emergency. Each real incident should be analysed individually and the response authorities should not underestimate the importance of taking in-situ measurements (air, water, sediment and marine fauna) in order to determine exclusion areas.

These guides are intended primarily for specialists who know about the techniques to use in the event of an emergency in addition to the relevant operational response measures. The main concern is to mitigate the consequences of a spill, however we cannot afford to overlook responder safety and human toxicology.

**To contact the duty engineer at *Cedre* (24/7)**  
Please call: + 33 (0)2 98 33 10 10

### National toxicology surveillance system in the event of a major toxicological threat.

In France, a hotline is manned around the clock by Division 7 of the General Department of Health (SD7/DGS).

During opening hours please call:  
Tel.: + 33 (0)1 40 56 47 95  
Fax: + 33 (0)1 40 56 50 56

Outside normal working hours please call the relevant authority.

### Poison Control Centres in France

Angers (Centre Hospitalier d'Angers) Tel.: + 33 (0)2 41 48 21 21  
Bordeaux (Hôpital Pellegrin-Tripode) Tel.: + 33 (0)5 56 96 40 80  
Grenoble (Hôpital Albert Michallon) Tel.: + 33 (0)4 76 76 56 46  
Lille (Centre Hospitalier Universitaire) Tel.: + 33 (0)8 25 81 28 22  
Lyon (Hôpital Edouard Herriot) Tel.: + 33 (0)4 72 11 69 11  
Marseille (Hôpital Salvator) Tel.: + 33 (0)4 91 75 25 25  
Nancy (Hôpital Central) Tel.: + 33 (0)3 83 32 36 36  
Paris (Hôpital Fernand Widal) Tel.: + 33 (0)1 40 05 48 48  
Reims (Hôpital Maison Blanche) Tel.: + 33 (0)3 26 78 48 21  
Rennes (Hôpital de Pontchaillou) Tel.: + 33 (0)2 99 59 22 22  
Rouen (Hôpital Charles Nicolle) Tel.: + 33 (0)2 35 88 44 00  
Strasbourg (Hôpitaux Universitaires) Tel.: + 33 (0)3 88 37 37 37  
Toulouse (Hôpital de Purpan) Tel.: + 33 (0)5 61 77 74 47

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A

B

C

D

E

# What you need to know about ethyl acrylate

A

## Definition

Ethyl acrylate is a colourless, volatile liquid with a pungent odour which can be perceived by most individuals. The olfactory threshold is very low: 0.0012 ppm.

## Use

Ethyl acrylate is mainly used in to make copolymers for the manufacture of textiles, paper, leather, adhesives and elastomers.

## Risks

- Polymerisation in the absence of air or an inhibitor and in high temperatures. This reaction is exothermic and is liable to degenerate into an uncontrolled reaction.
- Explosion: ethyl acrylate is a highly flammable liquid (flash point: 8°C in a closed cup) and the vapours form explosive mixtures with air.
- Toxicity: this chemical is harmful and the vapours can cause irritation of mucous membranes.

## Behaviour in the environment

Ethyl acrylate is a product which evaporates and which dissolves in water (solubility in fresh water = 17.5 g/L at 25°C).

Ethyl acrylate is not bioaccumulable in aquatic organisms.

# First line emergency data

- First aid information \_\_\_\_\_ **B1**
- ID card \_\_\_\_\_ **B2**
- Physical data \_\_\_\_\_ **B3**
- Flammability data \_\_\_\_\_ **B4**
- Toxicological data \_\_\_\_\_ **B5**
- Ecotoxicological data \_\_\_\_\_ **B6**
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- Classification \_\_\_\_\_ **B8**
- Particular risks \_\_\_\_\_ **B9**
- Transportation, handling, storage \_\_\_\_\_ **B10**

**B**

## First aid information (ICSC, 1999)

Immediately remove all soiled or spotted clothes with suitable gloves.

In all cases of intoxication, consult a doctor.

### Intoxication by inhalation

- Move the victim into the fresh air and prop up to a half-sitting position.
- Give the victim oxygen if they have breathing difficulties and consult a doctor.

### Skin contact

- Remove contaminated clothing.
- Rinse the skin with plenty of water or have a shower.

### Eye contact

- Rinse immediately with plenty of water for several minutes keeping the eyelids open (remove contact lenses in possible).

### Intoxication by ingestion

- Rinse out the mouth.
- Give plenty of water to drink and consult a doctor.

Where necessary, contact the nearest poison control centre (cf. page 4).

## ID card<sup>1</sup>

# Ethyl acrylate

Gross formula:  $C_5H_8O_2$

Semi-developed formula:  $CH_2=CHCOOC_2H_5$

### Synonyms

Acrylic ester  
Ethyl propenoate  
Ethyl ester  
Acrylic acid ethyl ester  
2-propenoic acid  
Ethyl 2-propenoate  
EA  
Ethoxycarbonylethene

CAS n°: 140-88-5  
EC N° (EINECS): 205-438-8  
Index n°: 607-032-00-X

### Classification for transportation

UN n°: 1917  
Class: 3

### E.U. Classification

**F: highly flammable**  
**Xn: harmful**  
R11: highly flammable  
R20/21/22: harmful by inhalation, in contact with skin and if swallowed.  
R36/37/38: irritating to eyes, respiratory system and skin.  
R43: may cause sensitisation by skin contact.  
S9: keep container in a well ventilated place.  
S16: keep away from sources of ignition. No smoking.  
S33: take precautionary measures against static discharges.  
S36/37/39: wear suitable protective clothing, gloves and eye/face protection.

B2

<sup>1</sup> Additional data and sources in annex 1

## Physical data

Conversion factors:    1 ppm = 4.09 mg/m<sup>3</sup>    1 mg/m<sup>3</sup> = 0.24 ppm (air: 20°C)  
1 atm = 1.013×10<sup>5</sup> Pa

Melting point	- 72°C (INRS, 1992; ARKEMA SDS, 2004)
Boiling point	99.5°C (DIPPR, 2005)
Critical temperature	279.9°C (DIPPR, 2005)
Relative density (water = 1)	0.922 at 20°C (ARKEMA SDS, 2004)
Relative vapour density (air = 1)	3.45 (ICSC, 2003; INRS, 1992)
Solubility in seawater	13.8 g/L at 10°C 10 g/L at 25°C (CEDRE, 2005)
Solubility in fresh water	19 g/L at 10°C 17.5 g/L at 25°C (CEDRE, 2005)
Vapour pressure/tension	38 hPa (mbar) at 20°C 164 hPa (mbar) at 50°C (DIPPR, 2005)
Olfactory threshold	0.0012 ppm (ECETOC, 1994)
Evaporation rate (n-butyl acetate = 1)	3.3 (takes 3.3 times longer to evaporate than n-butyl acetate) (INRS, 1992)
Diffusion coefficient in water	no data available
Diffusion coefficient in air	no data available
Henry's law constant	25.3 Pa.m <sup>3</sup> /mol at 20°C (calculated) (ECETOC, 1994)
Molar mass	100.1 g/mol (INRS, 1992; ARKEMA SDS, 2004)
Surface tension	25.2 mN/m at 20°C (ECETOC, 1994)

B3

## Flammability data

<b>Explosive limits by volume (% in air):</b> Lower limit: 1.4 % or 14 000 ppm Upper limit: 15.8 % or 158 000 ppm	ARKEMA SDS, 2004
<b>Regression speed:</b> 4.3 mm/min	CHRIS, 1999
<b>Flash point:</b> closed cup: 8°C open cup: 16°C (DIN 51 755)	ARKEMA SDS, 2004
<b>Self-ignition point:</b> 345°C	ICSC, 2003 ECETOC, 1994
<b>Decomposition products:</b> pungent fumes and irritating vapours	LEWIS, 2002

**B4**

## Toxicological data

### Acute human toxicity

(ICS, 1999; ARKEMA SDS, 2004)

- By inhalation: burning sensation, coughing, breathing difficulties, shortness of breath, sore throat and in high concentrations nausea and vomiting may occur.
- By skin contact: redness, burns to the skin, pains.
- By ingestion: stomach pains, sore throat, vomiting.
- By eye contact: redness, pains, eyesight difficulties.

### Chronic human toxicity

(ICS, 1999; ARKEMA SDS, 2004)

Repeated exposure to high concentrations of vapours and/or mist can cause irritation of the upper respiratory tract. Temporary olfactory problems are also possible. Repeated contact can cause sensitization of the skin.

### Threshold toxicological values

#### Occupational exposure values

MEV: 5 ppm (20 mg/m<sup>3</sup>) (France)

TLV-TWA: 5 ppm (20 mg/m<sup>3</sup>) (USA)

TLV-STEL: 15 ppm (61.4 mg/m<sup>3</sup>) (USA)

TLV-ceiling: 15 ppm (61.4 mg/m<sup>3</sup>) (USA)

#### Risk management values for the population

IDLH\*: 300 ppm (1227 mg/m<sup>3</sup>) (USA)

TEEL 0: 15 ppm (61.4 mg/m<sup>3</sup>) (USA)

TEEL 1: 15 ppm (61.4 mg/m<sup>3</sup>)

TEEL 2: 30 ppm (123 mg/m<sup>3</sup>)

TEEL 3: 300 ppm (1227 mg/m<sup>3</sup>) (USA)

ERPG 1: no data available

ERPG 2: 30 ppm (123 mg/m<sup>3</sup>) (USA)

ERPG 3: 300 ppm (1227 mg/m<sup>3</sup>) (USA)

Given AEGLs (USA) (EPA, 2005)

concentration (ppm)	10 min	30 min	60 min	240 min	480 min
AEGL 1	8.3	8.3	8.3	8.3	8.3
AEGL 2	66	45	36	19	9.4
AEGL 3	950	410	240	71	41

### Specific effects

Carcinogenic effects: carcinogenic effect on animals which cannot be applied to humans.

Effects on fertility: no effect on reproductive organs.

Teratogenic effects and/or effects on foetal development: no evidence of teratogenic effects.

Genotoxic effects: no evidence of genotoxic effects.

\* IDLH is a value commonly used by fire brigades and first aid services when no Lethal and Irreversible Effect Thresholds are available.

## Ecotoxicological data

(ARKEMA SDS, 2004; ECB, 2003)

### Acute ecotoxicity

Bacteria ( <i>Pseudomonas putida</i> )	EC <sub>50</sub> (17h) = 1,500 mg/L (fresh water)
Algae ( <i>Scenedesmus subspicatus</i> )	EC <sub>50</sub> (72h) = 48 mg/L (fresh water)
Algae ( <i>Selenastrum capricornutum</i> )	EC <sub>50</sub> (72h) = 5.5 mg/L (fresh water)
Crustacean ( <i>Daphnia magna</i> )	EC <sub>50</sub> (48h) = 7.9 mg/L (fresh water)
Fish ( <i>Oncorhynchus mykiss</i> )	LC <sub>50</sub> (96h) = 4.6 mg/L (fresh water)
Invertebrate ( <i>Artemia salina</i> )	EC <sub>50</sub> (24h) = 12 mg/L (seawater)

B6

### Chronic ecotoxicity

Fish ( <i>Poecilia reticulata</i> )	LC <sub>50</sub> (14 d) = 0.74 mg/L (fresh water)
Crustacean ( <i>Daphnia magna</i> )	NOEC (21 d) = 0.19 mg/L (fresh water)

**PNEC** (Predicted No-Effect Concentration): according to the Technical Guidance Document corresponding to commission regulation (EC) 1488/94 on risk assessment of chemical substances, the calculated PNEC for water is 0.0019 mg/L. A safety factor of 100 is applied to the lowest value (data for the crustacean *Daphnia magna*).

## Persistence in the environment

### Volatilisation (ECETOC, 1994)

When spilt in the environment, the majority of the ethyl acrylate (90%) evaporates into the atmosphere.

This chemical will not reach the stratosphere and does not lead to risks of ozone depletion.

### Mobility (ARKEMA SDS, 2004)

Ethyl acrylate is highly mobile in soils.

In water, the time needed for half of a given quantity to evaporate ranges from a few hours in a river to around 3 days in a pool.

### Breakdown

In water, ethyl acrylate is easily biodegraded: BOD5/COD = 0.74.

In seawater, biodegradation is measured at 53% after 20 days (aerobic). Aerobic biodegradation gives a result of 57% after 28 days (MITI Test – OECD 301 D, 1991) (ECETOC, 1994).

In air, ethyl acrylate is broken down by photo-oxidation by hydroxyl radicals and tropospheric ozone. Breakdown of ethyl acrylate by hydroxyl radicals is very rapid:

$t_{1/2}$  life = 6 to 11 hours (SIDS OCDE, 2004).

### Bioaccumulation (ARKEMA SDS, 2004)

Ethyl acrylate is not bioaccumulable.

B7

#### Organic carbon/water partition coefficient

Log K<sub>oc</sub> = 1.32

ARKEMA SDS, 2004

#### Octanol/water partition coefficient

Log K<sub>ow</sub> = 1.18

ARKEMA SDS, 2004

#### Bioconcentration factor

BCF calculated using TGD 1996 method = 2

BCF calculated by ECETOC = 5 to 6

# Classification

## IBC Classification (IMO, 2004)

- hazards: S/P (safety/pollution risk)
- ship type: 2
- tank type: 2G (integral gravity tank)
- tank vents: controlled
- tank environmental control: no
- electrical equipment:
  - temperature class: T2
  - apparatus group: IIB
  - flash point < 60°C
- gauging: R (restricted gauging)
- vapour detection: F-T (flammable and toxic vapours)
- fire protection
  - A: Alcohol-resistant foam or multipurpose foam
- materials of construction: no instruction
- emergency equipment: yes

B8

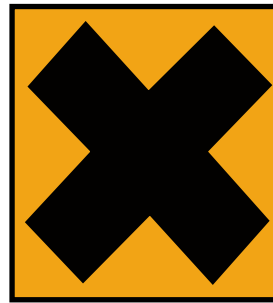
SEBC classification: ED (evaporates/dissolves)

MARPOL classification: A until 31/12/2006 (definition in annex 3)  
Y from 01/01/2007 (definition in annex 3b)

E.U. Classification:



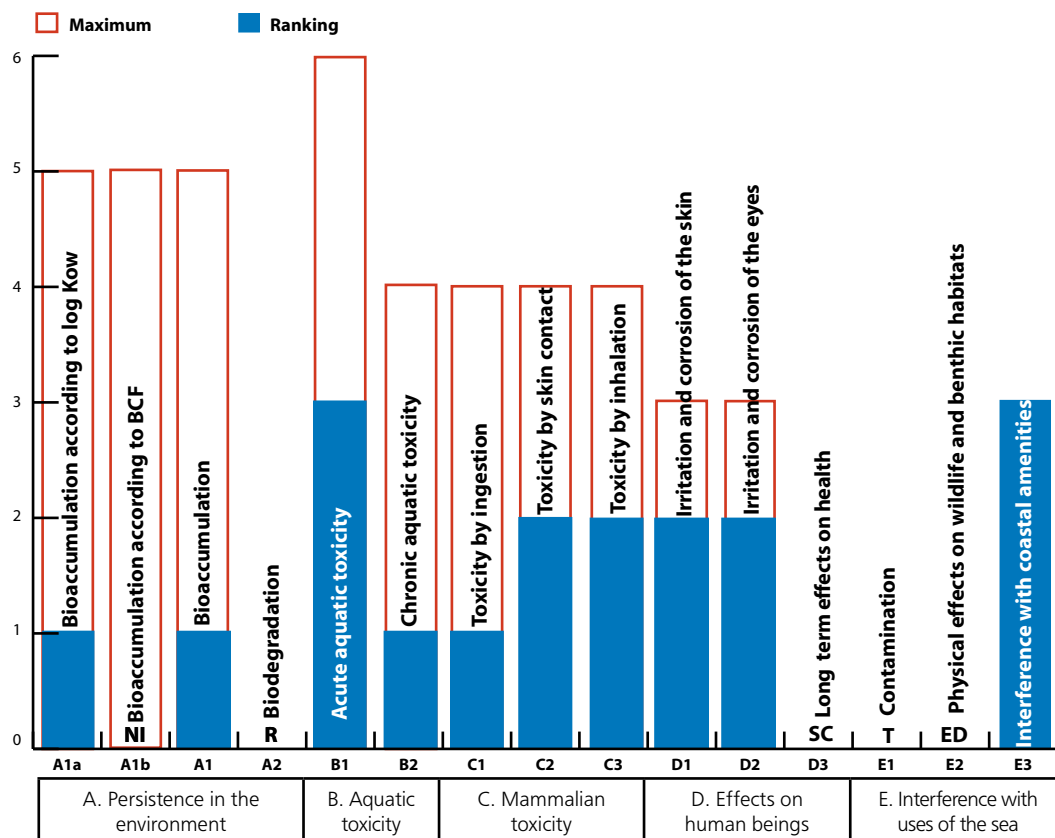
F: Highly flammable



Xn: Harmful

R11	Highly flammable.
R20/21/22	Harmful by inhalation, in contact with skin and if swallowed.
R36/37/38	Irritating to eyes, respiratory system and skin.
R43	May cause sensitisation by skin contact.
S9	Keep container in a well ventilated place.
S16	Keep away from sources of ignition. No smoking.
S33	Take precautionary measures against static discharges.
S36/37/39	Wear suitable protective clothing, gloves and eye/face protection.
EC n°	205-438-8

## GESAMP classification of ethyl acrylate (GESAMP, 2006)



A1a: Very slight potential to bioaccumulate in aquatic organisms

A1b: No Information

A1: very slight potential to bioaccumulate in aquatic organisms

A2: Readily biodegradable substance.

B1: moderate acute aquatic toxicity.

B2: slight chronic aquatic toxicity

C1: slightly toxic when ingested by mammals

C2: moderately toxic by skin contact with mammals

C3: moderately toxic through inhalation by mammals.

D1: irritant to skin

D2: irritant to eyes

D3: S: Sensitizer

C: Carcinogen

E1: T: Tainting. The chemical causes a change in taste or a significant odour in fish after exposure to 1 mg/L for at least 24 hours.

E2: E/D. Substance which Evaporates and Dissolves.

E3: highly objectionable, closure of amenity.

## Particular risks

### Polymerisation (ARKEMA SDS, 2004)

Polymerisation is stabilised by phenolic derivatives, most often 10 to 15 ppm of hydroquinone monomethyl ether. For inhibition to be effective, oxygen is required (5 to 7%). Inhibition greatly decreases if the temperature is greater than 30°C.

Ethyl acrylate polymerises easily at room temperature if it is not properly inhibited. Heat, light, contact with oxidants such as peroxides or nitrates and the presence of rust cause or accelerate polymerisation.

### Danger (CEFIC ERICARD, 2003)

- Heating the recipient can cause an increase in pressure and the recipient may shatter.
- A spontaneous increase in pressure or auto-ignition may be caused by exposure to heat, light, impact or contact with other chemicals.
- Ethyl acrylate can form explosive mixtures with air.
- Toxic and irritating fumes are given off during heating and combustion.
- Vapours are invisible and heavier than air. They spread out over the ground and can infiltrate drains and underground systems.
- A stabilising additive may be destroyed by heat.

### Stability and reactivity (ARKEMA SDS, 2004)

Ethyl acrylate must be protected from light and kept at temperatures lower than 30°C.

The temperature can reach boiling point without polymerisation occurring, if the concentration of inhibitor is maintained.

In normal storage conditions (temperature of less than 30°C, in the presence of a polymerisation inhibitor and an atmosphere of oxygen-reduced air), ethyl acrylate can be stored for two years without any stability problems.

B9

## Transportation, handling, storage

### Transportation (ARKEMA SDS, 2004)

Identification n° (UN): 1917

#### Land transportation:

RID (rail)/ADR (route)

Danger n°: 339

Class: 3

Packaging group: II

Classification code: F1

Labels: 3

#### Transportation via inland waterways:

ADN/ADNR

Danger n°: 339

Class: 3

Labels: 3

Classification code: F1

#### Maritime transport: IMDG

Class: 3

Packaging group: II

Marine pollutant (MP): no

Labels: 3

#### Air freight: IATA

Class: 3

Packaging group: II

Labels: 3

### Handling (ARKEMA SDS, 2004)

- Ventilate and evacuate appropriately.
- Do not use activated carbon to trap acrylate odours.
- Provide showers and eye washers.
- Transfer as much as possible by pump, or

if unavailable by pressure using a reduced oxygen gas mixture (5 to 7%).

- Never transfer using inert gas.
- Take precautionary measures against static discharges.
- Keep away from flames.
- Provide a retention tank.
- Only use fireproof equipment.

### Substances to keep out of contact with ethyl acrylate




- Combustive substances.
- Natural or synthetic rubber.

### Storage (ARKEMA SDS, 2004)

- Keep container in a well ventilated place.
- Keep away from sources of ignition. Do not smoke.
- Store in an atmosphere of oxygen-reduced air (5 to 7%).
- Keep away from light.
- Do not store for long periods of time; restrict the storage duration to two years from the date of manufacture.
- Keep below 30°C.
- Permanently monitor the temperature of the product.
- Monitor the product's clarity.
- Maintain inhibitor levels.
- Ground the material and electric equipment used in explosive atmospheres.
- Provide a retention tank.

B10

# Results of accident scenarios

- Reminder of properties  C1
- Accident scenarios  C2
- Consumption scenarios  C3



## Reminder of properties

### Transportation

Ethyl acrylate is transported in tanks as a liquid.

### Vapour density and tension

- Relative density: 0.922 at 20°C
- Vapour density: 3.45
- Vapour tension: 38 hPa (mbar) at 20°C

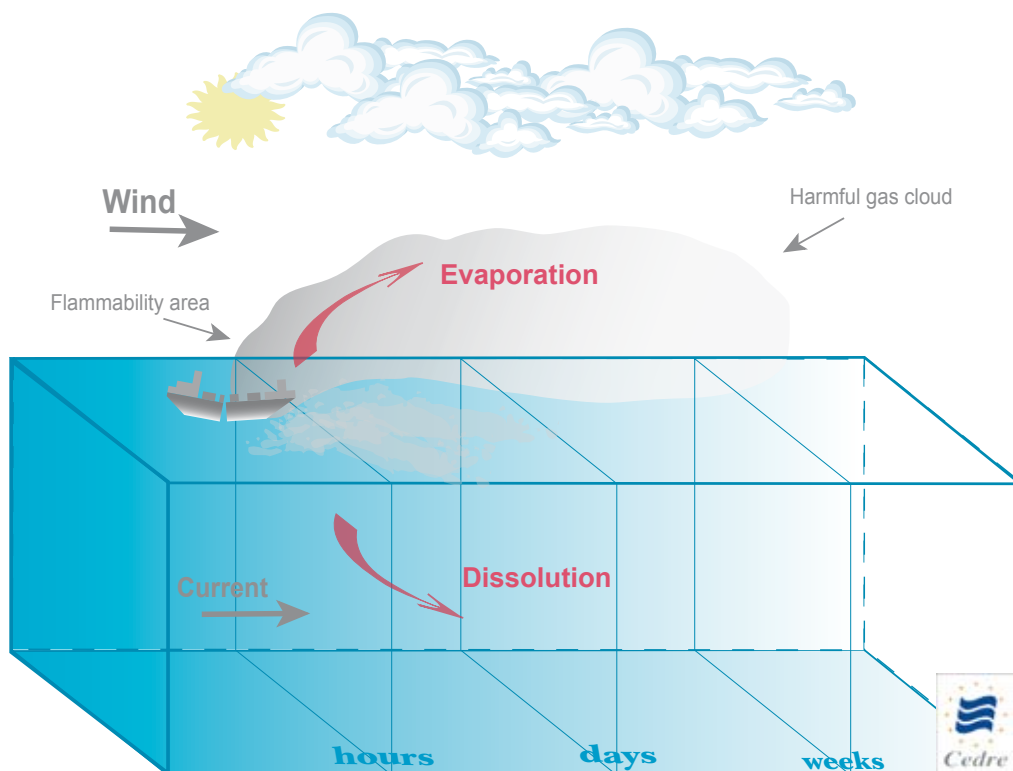
### Solubility

Ethyl acrylate is a water soluble product (solubility in fresh water = 17.5 g/L at 25°C, solubility in seawater = 10 g/L at 25°C). Its solubility and vapour tension mean that this product is classed ED, i.e. it evaporates and dissolves (according to the SEBC classification).

### Behaviour of ethyl acrylate when spilt at sea

When ethyl acrylate is spilt at sea, it briefly forms a colourless slick near the spill location at the water surface. Given its vapour tension and solubility, the product will evaporate rapidly into the atmosphere and part of it will dissolve. The part which dissolves will be less significant when the environmental conditions promote evaporation (wind and sun). Ethyl acrylate vapours are heavier than air. In a stable atmosphere, the cloud will tend to remain at the water surface.

C1



Behaviour of ethyl acrylate spilt at sea

## Accident scenarios

The scenarios defined here are simply designed to give an indication of the possible behaviour of ethyl acrylate. In the event of a real spill, the results of simulations will naturally be different from those given here. The CHEMMAP behaviour model, the emergency response model employed by *Cedre*, was used for these simulations. Other more sophisticated models exist, but require response times which are incompatible with an emergency situation.

Situation: a chemical tanker enters into a collision, causing a breach in one of its wing tanks containing ethyl acrylate.

Two ethyl acrylate spill scenarios are given here with different quantities of the chemical:

- an open sea scenario (Channel) with four different spill rates:

10 kg/h		→ 5 hours
1000 kg/h		
100 t/h		
500 t		

- a river scenario with four different spill rates:

10 kg/h		→ 5 hours
1000 kg/h		
100 t/h		
500 t		

### The scenarios

#### Channel scenario

- Location 50°N, 3°W
- Air and water temperature: 10°C
- Two wind speeds: 3 and 10 m/s (NW)
- Channel currents
- Spill depth: 1 m
- Model time step: 15 minutes
- Duration of spill:
  - 5 hours
  - instantaneous

#### River scenario

- Depth: 4 to 5 m; width: 150 m
- Air and water temperature: 15°C
- Two wind speeds: 3 and 10 m/s (NW)
- Two current speeds: 0.12 and 0.74 m/s
- Model time step: 15 minutes
- Duration of spill:
  - 5 hours
  - 30 minutes

#### Note

The results of the open sea scenario for a spill rate of 10 kg/h over 5 hours are only developed on page 26.

The results of the river scenario for a spill rate of 10 kg/h and 100 t/h over 5 hours are only developed on page 31.

## Modelling

CHEMMAP software was used to model hypothetical spillages of ethyl acrylate in the aquatic environment.

This is a chemical spill model designed by ASA (Applied Science Associates, Inc - USA) which predicts the movement and fate of the spilt product in fresh and sea water.

This model indicates both the movement of the product on the water surface and its distribution in the environment (evaporation, dissolution in the water column...). The time step used for the calculations is fifteen minutes.

Example of the presentation of the results obtained after a spill of 500 tonnes of ethyl acrylate in the Channel.

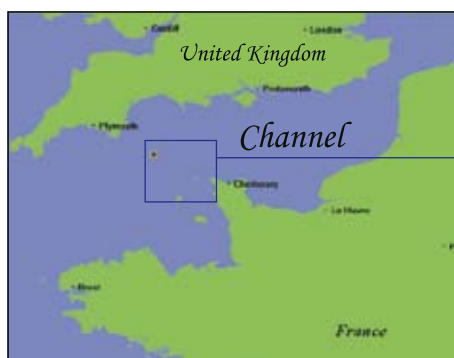



Figure 1

View of the dissolved part



Figure 2

Location of the hypothetical spill in the Channel

 Spill location

 Section line

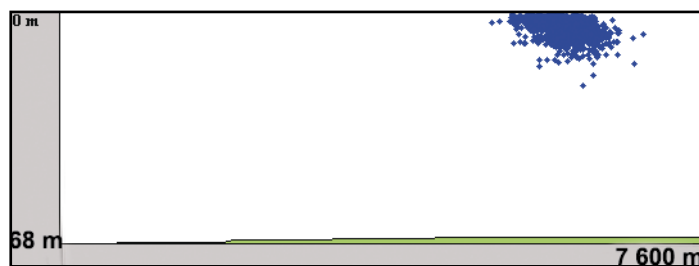


Figure 3

Cross-section of the dissolved part

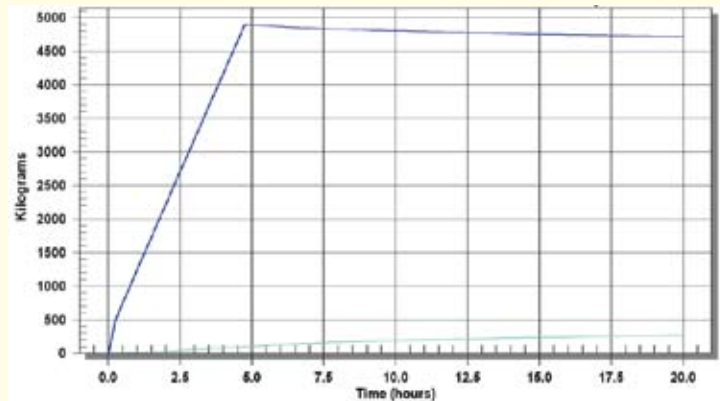
When the spill occurs above the surface:

- For spill rates of 10 kg/h and 1,000 kg/h, the ethyl acrylate forms a slick then spreads over the water surface. The ethyl acrylate evaporates slowly (20%); the rest of the chemical (80%) dissolves in the water column. The dissolved ethyl acrylate concentrations remain below those expected for a spill 1 metre under the surface (page 23).
- For a spill rate of 100 t/h, the substance spreads over the water surface, and by the end of the spill all the chemical spilt can be found in the atmosphere. The IDLH value is not reached.
- For an instantaneous spill of 500 tonnes, all the ethyl acrylate is expected to be found in the atmosphere, without the IDLH value being reached.

The scenarios presented hereafter involve ethyl acrylate being released below the water surface.

## Results of the Channel scenario

**Spill of 1000 kg/h of ethyl acrylate for 5 hours, with a wind speed of 3 m/s.**



Graph 1

— Quantity evaporated — Quantity on the surface — Quantity dissolved

Five hours after the spill, 98% of the product has dissolved in the water column. Twenty hours after the spill, 6% of the ethyl acrylate has evaporated into the atmosphere, after having dissolved in the water column.

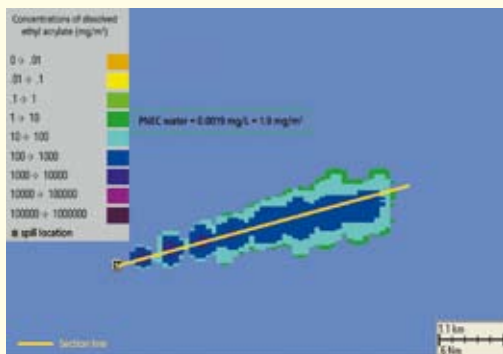


Figure 4



Figure 5

View of the **dissolved** part after a spill of **1000 kg/h of ethyl acrylate** for 5 hours.  
3 m/s wind.

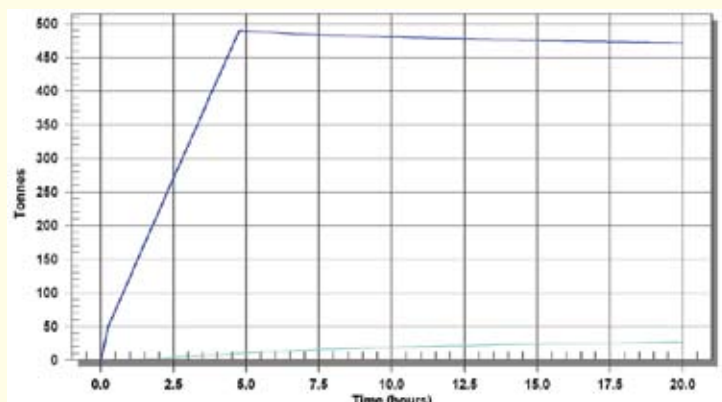
Results obtained 2 hours after the spill begins.

The ethyl acrylate is found dissolved over an area of 5 km, located east of the spill location. The highest concentration of the dissolved part in the water column (between 1,000 and 10,000 mg/m<sup>3</sup>) is observed up to 2 km east of the spill location. A lower concentration, of between 100 and 1,000 mg/m<sup>3</sup>, can be observed up to around 3.5 km from the spill location. Beyond this distance and up to 5 km east, the concentration of ethyl acrylate will be of the order of 10 to 100 mg/m<sup>3</sup>, then between 1 and 10 mg/m<sup>3</sup> on the edges of the plume of spilt chemical (figure 4).

The depth reached 2 hours after the spill is around 14 m (figure 5). The ethyl acrylate almost completely dissolves. A small part of the substance evaporates instantaneously but is not subsequently found in significant concentrations.

## Results of the Channel scenario

Spill of 100 tonnes/h of ethyl acrylate for 5 hours, with a wind speed of 3 m/s.



Graph 2

— Quantity evaporated — Quantity on the surface — Quantity dissolved

Five hours after the spill, 96 % of the product has dissolved in the water column. Twenty hours after the spill, around 5 % of the total volume of ethyl acrylate has evaporated into the atmosphere.

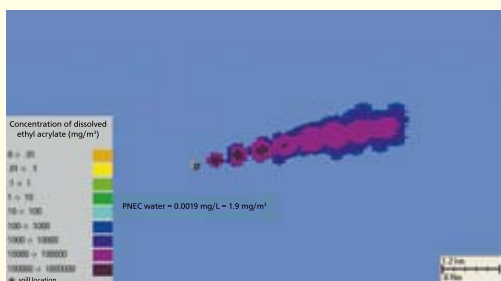


Figure 7

View of the **dissolved** part after a spill of **100 t/h of ethyl acrylate**. 3 m/s wind.

Results obtained 2 hours after the spill begins.

The ethyl acrylate is found dissolved over an area of 5 km, located east of the spill location. The concentrations are high, up to  $10^6$  mg/m<sup>3</sup>, 2 km from the spill location.

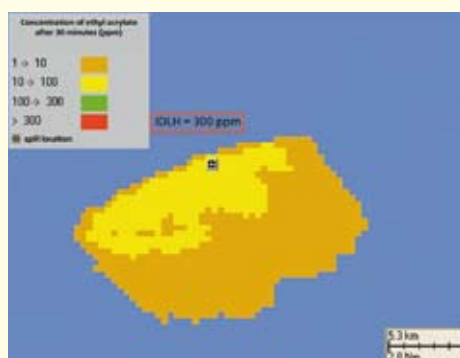


Figure 8

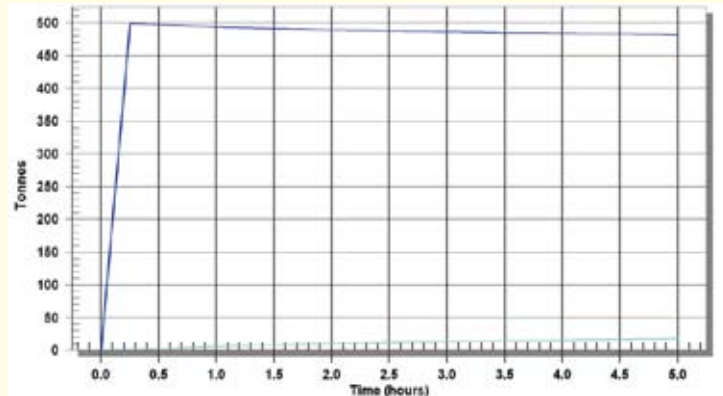
View of the **evaporated** part after a spill of **100 t/h of ethyl acrylate**. 3 m/s wind.

Results obtained 30 minutes after the spill begins.

The atmospheric concentrations 30 minutes after the spill show that the IDLH value is not reached (300 ppm).

## Results of the Channel scenario

**Instantaneous spill of 500 tonnes of ethyl acrylate, with a wind speed of 3 m/s.**



Graph 3

— Quantity evaporated — Quantity on the surface — Quantity dissolved

Twenty minutes after the spill, almost all the ethyl acrylate has dissolved into the water column. The quantity evaporated increases over time (4%).

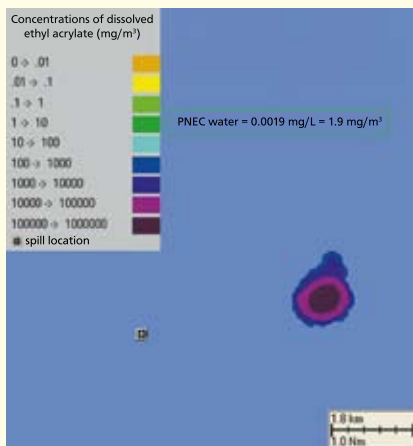


Figure 9

View of the **dissolved** part after an instantaneous spill of **500 tonnes of ethyl acrylate.**

3 m/s wind.

Results obtained 2 hours after the spill begins.

The ethyl acrylate will mainly be found dissolved up to around 4 km east of the spill location, in high concentrations of the order of 100 to 10<sup>6</sup> mg/m<sup>3</sup>, over a diameter of 1.2 km.

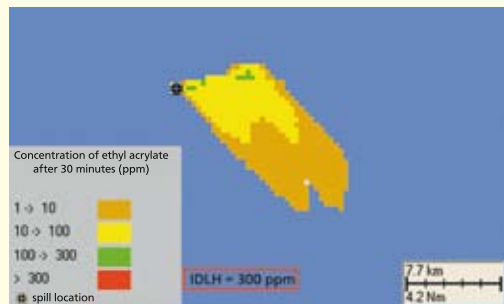


Figure 10

View of the **evaporated** part after an instantaneous spill of **500 tonnes of ethyl acrylate.**

3 m/s wind.

Results obtained 30 minutes after the spill begins.

The atmospheric concentrations 30 minutes after the spill show that the IDLH value is not reached in the area up to 7 km around the spill location.

### Results of the Channel scenario: location of gas cloud

Quantity spilt	Wind	Concentration (ppm)	Maximum distance reached		Protection
			km	Time**	
10 kg/h	3 m/s	5	0.65	2 min	A
		30 (ERPG 2)	*		B
		300 (IDLH)	0.56	1 min	C
		14 000 (LEL)	*		D
		158 000 (UEL)	*		D
	10 m/s	5	*		A
		30 (ERPG 2)	*		B
		300 (IDLH)	*		C
		14 000 (LEL)	*		D
		158 000 (UEL)	*		D
1000 kg/h	3 m/s	5	1.01	10 min	A
		30 (ERPG 2)	0.69	3 min	B
		300 (IDLH)	0.57	0	C
		14 000 (LEL)	0.57	0	D
		158 000 (UEL)	*		D
	10 m/s	5	1.78	2 min	A
		30 (ERPG 2)	1.18	1 min	B
		300 (IDLH)	1.12	1 min	C
		14 000 (LEL)	0.65	0	D
		158 000 (UEL)	*		D
100 t/h	3 m/s	5	15	1 h 16	A
		30 (ERPG 2)	6	31 min	B
		300 (IDLH)	2.54	45 min	C
		14 000 (LEL)	0.64	2 min	D
		158 000 (UEL)	*	0	D
	10 m/s	5	10	13 min	A
		30 (ERPG 2)	5.93	8 min	B
		300 (IDLH)	2.39	3 min	C
		14 000 (LEL)	0.66	0	D
		158 000 (UEL)	*		D
500 t instantaneous spill	3 m/s	5	10	55 min	A
		30 (ERPG 2)	5.93	31 min	B
		300 (IDLH)	2.67	12 min	C
		14 000 (LEL)	0.65	0	D
		158 000 (UEL)	0.63	0	D
	10 m/s	5	9	13 min	A
		30 (ERPG 2)	5.52	8 min	B
		300 (IDLH)	2.42	3 min	C
		14 000 (LEL)	0.67	0	D
		158 000 (UEL)	0.65	0	D

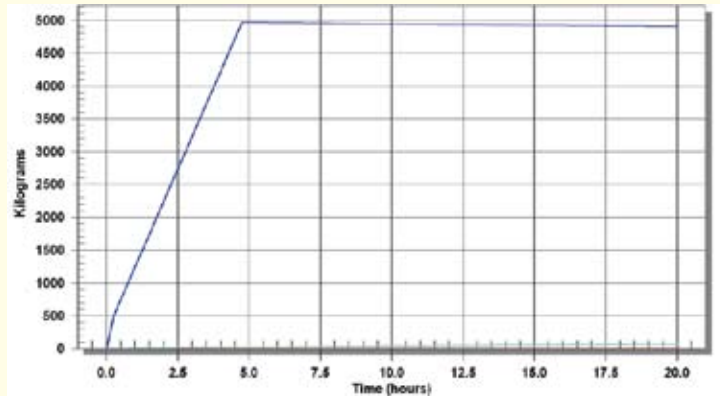
\*: distance too small to be calculated by the model

\*\* : time after the spill

A	No danger.	C	Wear Personal Protective Equipment. Use self-contained breathing apparatus (SCBA).
B	Wear Personal Protective Equipment (PPE). Use a gas mask.	D	Area where the concentration reaches explosive limits. Use self-contained breathing apparatus (SCBA) and fire-proof material.

## Results of the river scenario

**Spill of 1000 kg/h of ethyl acrylate for 5 hours, with a NW wind of 10 m/s and a current speed of 0.74 m/s.**



Graph 4

— Quantity evaporated — Quantity on the surface — Quantity dissolved

Five hours after the spill, almost all the ethyl acrylate has dissolved into the water column.

### Behaviour of the ethyl acrylate 2 hours after the spill



Figure 11

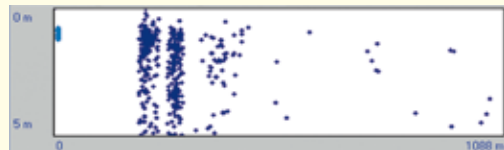
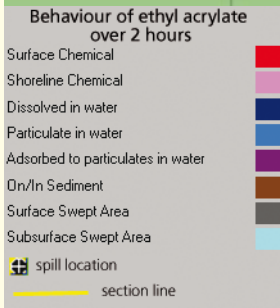


Figure 12



### Behaviour of the ethyl acrylate over 2 hours.

The ethyl acrylate is dissolved in the water column over a distance of 1 km, downstream of the spill location. The vertical cross-section (figure 12) shows the distribution of the product throughout the depth of the water column (5 m).

### Concentrations of dissolved ethyl acrylate 2 hours after the spill

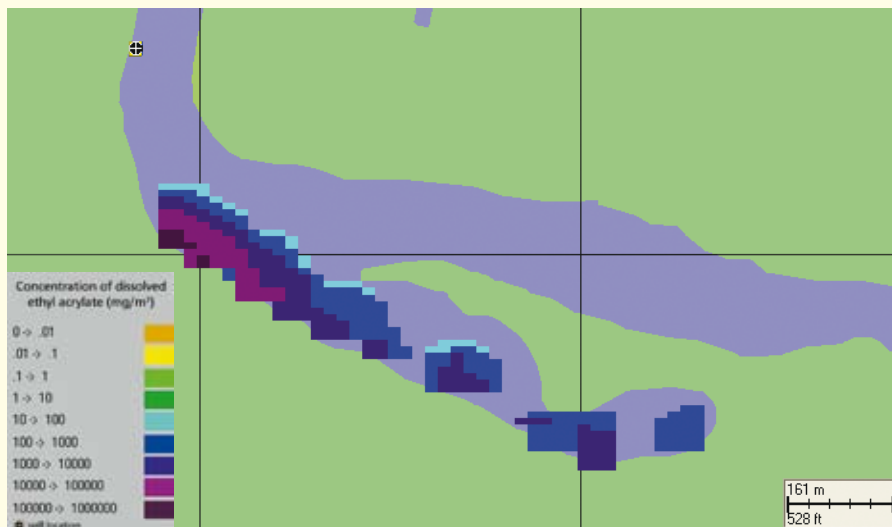


Figure 13

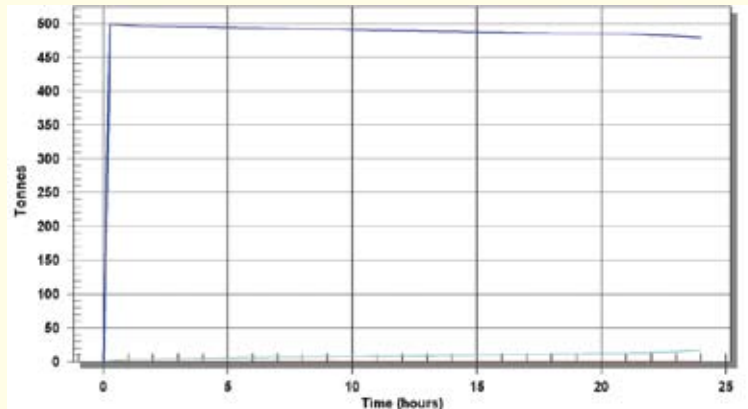
The maximum concentrations are between  $10^4$  and  $10^5$  mg/m<sup>3</sup>, with peaks of over  $10^5$  mg/m<sup>3</sup>. The concentrations are distributed throughout the entire depth of the water column.

### Atmospheric concentrations of ethyl acrylate

The atmospheric concentrations of ethyl acrylate remain below 30 ppm, up to 1 km downstream of the spill location, and are only detected up to 3 minutes after the spill.

## Results of the river scenario

**Spill of 500 tonnes of ethyl acrylate over 30 minutes, with a NW wind of 10 m/s and a current speed of 0.74 m/s.**



Graphique 5

— Quantity evaporated — Quantity on the surface — Quantity dissolved

The ethyl acrylate very quickly dissolves in the water column.

## Behaviour of the ethyl acrylate 2 hours after the spill



Figure 14

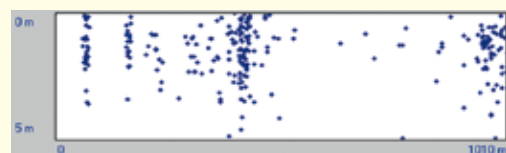


Figure 15

## Behaviour of the ethyl acrylate over 2 hours.

The ethyl acrylate dissolves throughout the entire depth of the water column (5 m) over a distance of up to 1 km downstream of the spill location.

### Concentrations of dissolved ethyl acrylate 2 hours after the spill

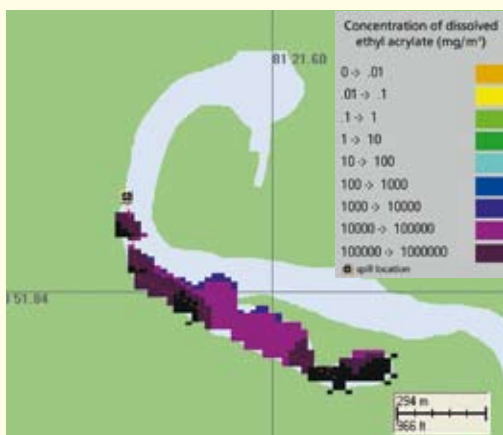


Figure 16

The concentrations of dissolved ethyl acrylate are very high, up to more than  $10^6$  mg/m<sup>3</sup> 1 km downstream of the spill location.

### Atmospheric concentrations of ethyl acrylate immediately after the spill

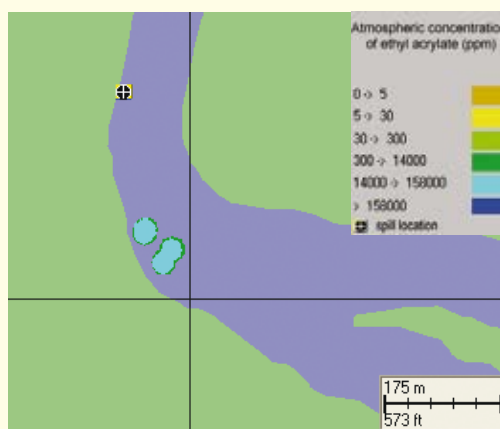


Figure 17

Immediately after the spill, the atmospheric concentrations of ethyl acrylate reach the lower explosive limit (14,000 ppm) 300 metres downstream of the spill location.

### Atmospheric concentrations of ethyl acrylate 30 minutes after the spill

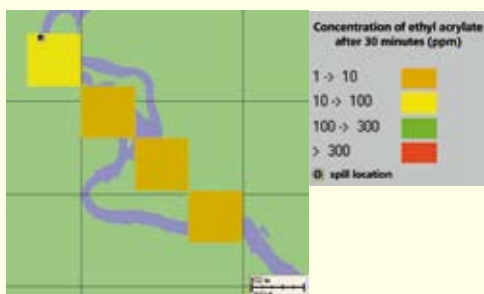


Figure 18

The atmospheric concentrations of ethyl acrylate, 30 minutes after the spill, exceed the IDLH value (300 ppm) up to 1.5 km downstream of the spill location.

### Atmospheric concentrations of ethyl acrylate 2 hours after the spill

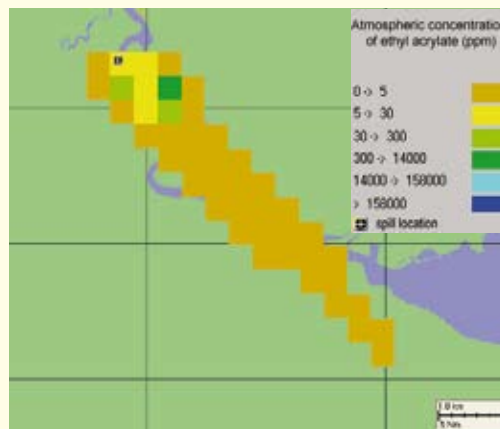


Figure 19

The atmospheric concentrations of ethyl acrylate reach a concentration of 30 ppm up to 600 m downstream of the spill location, 2 hours after the spill.

### Results of the river scenario: location of gas cloud

Quantity spilt	Wind	Concentration (ppm)	Maximum distance reached				Protection
			Slow current (0.12 m/s)		Fast current (0.74 m/s)		
			Distance	Time	Distance	Time	
10 kg/h	3 m/s	5	260 m	2 min	530 m	4 min	A
		30 (ERPG 2)	300 m	1 min	480 m	1 min	B
		300 (IDLH)	130 m	0	250 m	0	C
		14 000 (LEL)	*		*		D
		158 000 (UEL)	*		*		D
	10 m/s	5	130 m	1 min	300 m	1 min	A
		30 (ERPG 2)	250 m	0	310 m	0	B
		300 (IDLH)	250 m	0	310 m	0	C
		14 000 (LIE)	*		*		D
		158 000 (UEL)	*		*		D
1000 kg/h	3 m/s	5	480 m	6 min	690 m	6 min	A
		30 (ERPG 2)	450 m	2 min	640 m	2 min	B
		300 (IDLH)	290 m	1 min	450 m	1 min	C
		14 000 (LEL)	130 m	0	250 m	0	D
		158 000 (LSE)	*		*		D
	10 m/s	5	960 m	1 min	980 m	1 min	A
		30 (ERPG 2)	130 m	1 min	290 m	1 min	B
		300 (IDLH)	260 m	0	310 m	0	C
		14 000 (LIE)	220 m	0	310 m	0	D
		158 000 (UEL)	*		*		D
100 t/h	3 m/s	5	5 730 m	0	5 600 m	0	A
		30 (ERPG 2)	1 970 m	9 min	2 300 m	53 min	B
		300 (IDLH)	520 m	2 min	660 m	5 min	C
		14 000 (LEL)	160 m	0	290 m	0	D
		158 000 (UEL)	*		*		D
	10 m/s	5	5 600 m	2 h 25	2 900 m	4 min	A
		30 (ERPG 2)	1 970 m	9 min	1 610 m	2 min	B
		300 (IDLH)	530 m	2 min	990 m	1 min	C
		14 000 (LEL)	180 m	0	310 m	0	D
		158 000 (UEL)	*		*		D
500 t over 30 minutes	3 m/s	5	8 070 m	45 min	9 000 m	43 min	A
		30 (ERPG 2)	4 110 m	23 min	4 220 m	21 min	B
		300 (IDLH)	1 080 m	51 min	1 270 m	4 min	C
		14 000 (LEL)	180 m	0	550 m	0	D
		158 000 (UEL)	140 m	0	310 m	0	D
	10 m/s	5	7 930 m	12 min	7 900 m	12 min	A
		30 (ERPG 2)	4 150 m	6 min	4 180 m	6 min	B
		300 (IDLH)	1 760 m	2 min	1 770 m	2 min	C
		14 000 (LEL)	460 m	0	540 m	0	D
		158 000 (UEL)	400 m	0	440 m	0	D

\* : distance too small to be calculated by the model

A	No danger.	C	Wear Personal Protective Equipment. Use self-contained breathing apparatus (SCBA).
B	Wear Personal Protective Equipment (PPE). Use a gas mask.	D	Area where the concentration reaches explosive limits. Use self-contained breathing apparatus (SCBA) and fire-proof material.

## Consumption scenarios

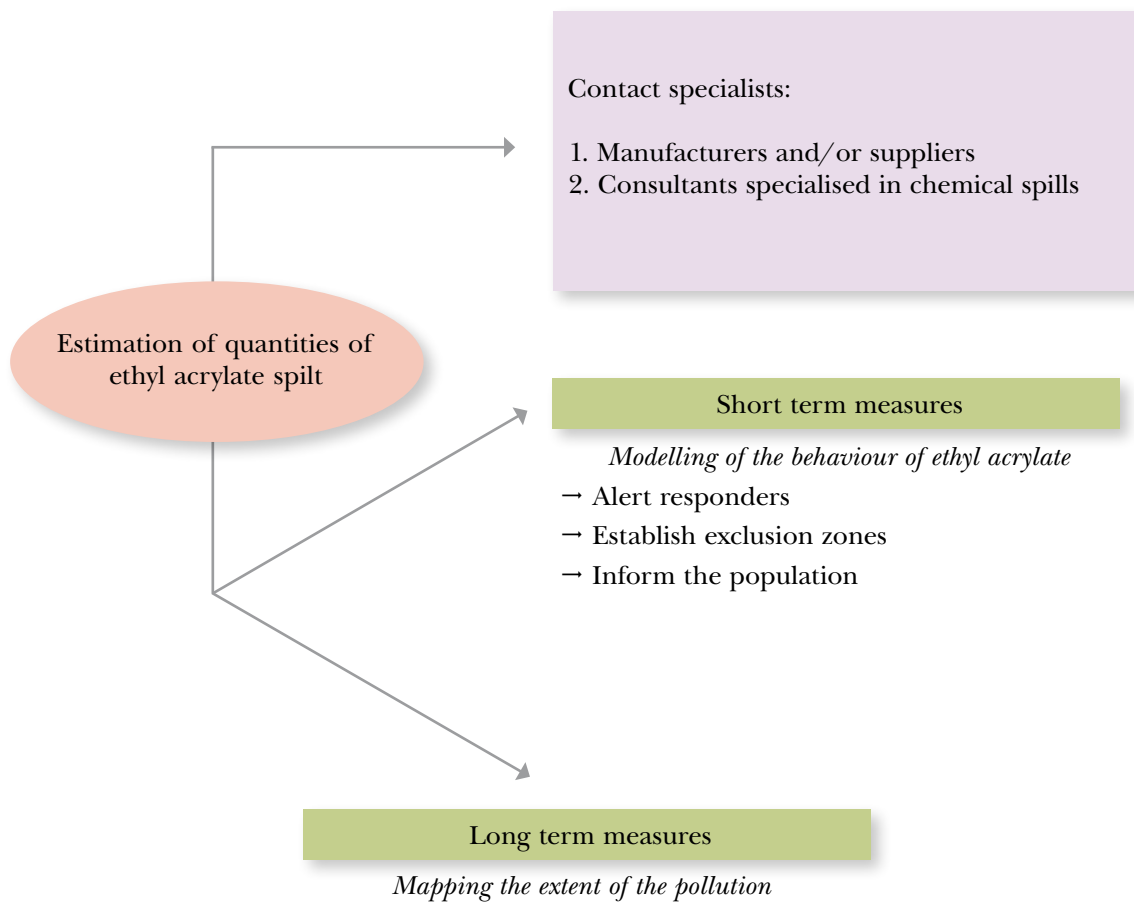
As ethyl acrylate does not bioaccumulate along the food chain, it will therefore not be found in aquatic organisms in high enough concentrations to have an impact on consumers of exposed sea produce.

# Response

- Response recommendations \_\_\_\_\_ **D1**
- Response techniques \_\_\_\_\_ **D2**
- Choosing personal protective equipment (PPE) \_\_\_\_\_ **D3**
- Measuring devices and waste treatment \_\_\_\_\_ **D4**

## Response recommendations

Diagram showing response actions in the event of a spill into a water body



D1

- In the atmosphere
  - Measure atmospheric concentrations
  - Protect responders and the surrounding population

- On the water surface and in the water column
  - Reduce spreading by deploying booms
  - Reduce evaporation by water curtains or foam
  - Sample the water mass
  - Establish exclusion zones (fishing, water intakes)

## Is response possible?

If a fire starts and is too far on, it is essential to evacuate within a radius of 300 metres. Leave the fire to burn, while evacuating any inhabitants liable to be affected by the fumes. Otherwise, intervention may be considered if the following precautions are taken:

- Approach the accident area from upwind (wind behind you), and if possible upstream of the current, equipped with explosimeters, personal protective equipment (PPE), sensing apparatus (HNU photo-ioniser equipped with a 9.5 eV lamp) or Dräger tubes.
- The equipment used must be fireproof. Remove all sources of ignition, sparks or heating.

## Emergency measures in the event of a leak or spill

- Evacuate the area downwind of the leak or the slick of spilt product.
- Find and remove all sources of ignition.
- Close/stop the installation if doing so is not dangerous.
- Locate spilt substances and plug the breach or leak.
- Protect responders from the cloud of ethyl acrylate by spraying water to beat vapours down towards the ground and dilute the cloud of dangerous gases in the atmosphere. Remain upstream of the response area.
- Ventilate before entering if the damaged container is in a confined space.
- If the leak cannot be stopped, move the containers to a well ventilated area in order to transfer the content.

- Avoid all contact with the liquid and do not inhale the vapours.

- If possible, contain the liquid spilt for subsequent recovery and treatment.

## Emergency measures in the case of a tank or container on fire

- Fire involving ethyl acrylate
  - If the leak cannot be stopped, evacuate and leave to burn to prevent accumulation of explosive gases.
  - Hose vapours down with water.
  - Cool the containers exposed to flames by spraying with water. Do not use water on the safety valves or if the tank has discoloured due to the heat.
  - Keep away from the tank ends. Immediately evacuate the area if the safety valves begin to hiss.
  - If the fire becomes uncontrollable or the tank is directly exposed to flames, evacuate within a radius of 800 metres.

(TRANSPORT CANADA, U.S. DEPARTMENT OF TRANSPORTATION, SECRETARIAT OF TRANSPORT AND COMMUNICATIONS OF MEXICO, 1996)

# Response techniques

## Transshipment

- Ethyl acrylate must be unloaded from tanks with extreme caution. Accumulations of static discharges can cause the vapours to ignite.
- Lightering can be carried out by pumping or by discharge using an inert gas (nitrogen or combustion gas). The pressure exerted on the tank should never exceed the working pressure at which the safety valve is set to open.
- Inject the polymerisation inhibitor, diluted prior to injection (phenolic derivative), solid if necessary.
- The equipment used must be fireproof and sparkproof.
- Never enter the tank.

## Response

(FICHES RÉFLEXES D'INTERVENTION ANTIPOLLUTION "PRODUITS EN SURFACE : LIQUIDES ÉVAPORANTS ET FLOTTANTS", "PRODUITS DANS LA COLONNE D'EAU ET SUR LE FOND : LIQUIDES SOLUBLES ET COULANTS", FICHE GUIDE N°3: "LUTTE EN MILIEU AQUATIQUE", FICHES STRATÉGIES ET MOYENS N°4, 5, 7, 12, 13, CEDRE 2004.)

### At sea

In most cases, it will not be possible to respond directly to the spill. Response actions will be limited to stopping the leak, controlling the vapour cloud and the spreading, and even the dissolution, of the substance. The extent of the gas plume can be modelled using provisional models with in situ measurements using gas detectors.

### In port areas

In the case of a spill, the chemical may be able to be recovered in closed, opaque receptacles. This operation should be conducted by trained personnel with appropriate equipment. Containment arrangements should be set up from fixed points (moorings, embankments...) without the use of motorised machinery. The evaporation of the chemical should be reduced by applying foam. The concentration in the air can be restricted by setting up a water curtain.

### In inland waters

The contaminated water can be contained using booms as long as response is organised quickly.

As with spills at sea, recovery should be conducted with extreme caution, otherwise it is preferable to let the chemical evaporate.

The evaporation of the product should be reduced by applying a water mist or foam.

### On land

In the case of a spill:

- construct dams to contain the liquid (sand, earth)
- if the water is sprayed in the form of a protective curtain, the run-off must be contained to prevent it from entering the sewer system or a water course, until most of the ethyl acrylate has evaporated
- seal off drains and gutters.

# Choosing personal protective equipment (PPE)

Ensure maximum protection in the case of high concentrations of the product

## Choosing breathing apparatus

(FINGAS M., 2000; ARKEMA SDS, 2004)

According to maximum use concentrations (MUC)<sup>2</sup>:

- gas mask for up to 300 ppm
- SCBA (Self-Contained Breathing Apparatus): for response in areas of high concentrations or in the case of prolonged exposure.

Wear a hazmat suit if the vapour concentration is likely to be high.

## Selecting protective clothing

(ARKEMA SDS, 2004)

Wear protective clothing which covers the whole body (acid-proof suit).

Protecting breathing apparatus: wear breathing apparatus if the concentration is greater than the MEV (5 ppm).

Eye protection: wear eye protection.

Hand protection: if there is a risk of splashing, wear neoprene gloves with a thickness of 1.1 mm (permeation index according to the European standard EN 374: 5, breakthrough time > 240 min).

## Recommendations for use in the event of a spill

(FINGAS M., 2000)

- SCBA provides the best protection. Its protection factor is around 10,000 (e.g. ELV = 5 ppm, protection up to 50,000 ppm of product in ambient air temperatures).

- Use SCBA to face unknown situations or to enter an area with unknown or high concentrations of a toxic substance or areas where there may be a lack of oxygen (an enclosed space).

- Caution, certain facial characteristics such as a scar, a narrow face shape or facial hair may lead to poor adjustment of the mask and impair the level of protection.

- Problems due to temperature:

-in hot weather, excessive perspiration diminishes the watertightness of the seal between the mask and the skin.

-in cold weather, ice may form on the regulator and the mask may steam up.

- Problems due to corrective lenses: ordinary glasses cannot be worn under the mask (special frames exist). However, contact lenses are permitted with new models of masks which allow gas exchange as the lenses therefore do not dry out or stick to the eye.

- Mask adjustment tests are recommended for new users and regular tests for other users.

## Recommended packaging materials

(ARKEMA SDS, 2004)

Stainless steel, aluminium, polypropylene, PTFE (polytetrafluoroethylene), HDPE (high density polyethylene).

<sup>2</sup> Note that the MUC can vary from one manufacturer and model to another. You should therefore contact the manufacturer for more information.

## Measuring devices and waste treatment

### Methods of detection and measurement in air (INRS, 1992)

Instantaneous response: Dräger apparatus equipped with methyl acrylate 5/a tube after calibration.

Adsorption of vapours with activated carbon, desorption with carbon disulphide and analysis by chromatography in the gas phase with flame ionisation detection.

Long-path infrared spectroscopy can be used for analysis but this method is not specific to acrylates.

### Waste treatment

Ethyl acrylate can be pumped into an inert safety reservoir. The rest must be absorbed with an inert sorbent. The ethyl acrylate, and its packaging, should be disposed of by incineration. Do not release it into the environment and prevent it from entering the sewer system.

### Addresses of special industrial waste treatment plants in France

The organisations able to treat this type of waste are listed at the following address: <http://www.observatoire-dechets-bretagne.org> (French only).

### European manufacturers of ethyl acrylate

ARKEMA, BASF, Hœchst, Rohm and Haas France SA, Union Carbide Benelux.

# Further information

- Bibliography ————— E1
- Glossary ————— E2
- Acronyms ————— E3
- Useful websites ————— E4

# Bibliography

## Documents

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TRANSPORT CANADA, U.S. DEPARTMENT OF TRANSPORTATION, SECRETARIAT OF TRANSPORT AND COMMUNICATIONS OF MEXICO. *1996 North American Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Hazardous Materials/Dangerous Goods Incident*. Ottawa: Transport Canada, 1996.

## Online documents

CHRIS (Chemical Hazards Response Information System) (page visited in July 2006)

*Ethyl acrylate safety data sheet.*

<http://www.chrismanual.com/E/EAC.pdf>

CSST (Commission de la Santé et de la Sécurité au Travail) (page visited in July 2006)

*Informations de la banque de données du Service du répertoire toxicologique sur l'acrylate d'éthyle.*

[http://www.reptox.csst.qc.ca/Produit.asp?no\\_produit=661&nom=Acrylate+d%27%E9thyle](http://www.reptox.csst.qc.ca/Produit.asp?no_produit=661&nom=Acrylate+d%27%E9thyle) (French only)

ECB (European Chemicals Bureau) (page visited in July 2006)

*EINECS (European Inventory of Existing Commercial chemical Substances) information sheet on ethyl acrylate.*

<http://ecb.jrc.it/esis/index.php?PGM=ein>

ICSC (International Chemical Safety Cards) (page visited in July 2006)

*Safety card on ethyl acrylate.*

<http://www.cdc.gov/niosh/ipcsneng/neng0267.html>

US EPA (US Environmental Protection Agency) (page visited in July 2006)

*Acute Exposure Guideline Level (AEGs) for ethyl acrylate.*

<http://www.epa.gov/oppt/aegl/pubs/rest117.htm>

# Glossary

## Acceptable Daily Dose (ADD)

For humans this dose is the quantity of a substance that can be ingested by an organism per day for its entire lifetime without presenting a health hazard for the organism in question.

## Acute Exposure Guideline Levels (AEGLs)

Defined by the National Research Council's Committee on Toxicology (USA), AEGLs are three levels above which the general population may experience certain effects. These three AEGLs are given for five exposure times: 10, 30 min, 1, 4 and 8 hours.

AEGL 1: the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non sensory effects. However, the effects are transient and reversible when exposure ceases.

AEGL 2: the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

AEGL 3: the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

## Adsorption

Elevation of the concentration of a substance dissolved at the interface of a condensed phase and a liquid phase under the influence of surface forces. Adsorption can also occur at the interface of a condensed phase and a gas phase.

## Aerosol

A mass of particles, solids or liquids in suspension in a gaseous environment.

## Bioaccumulation

Continued retention of a substance in the tissue of an organism throughout the course of its existence (the bioaccumulation factor increases all the time).

## Bioamplification

Retention of a substance in the tissue at increasingly higher concentrations the higher one goes in the food chain.

## Bioconcentration

Retention of a substance in the tissue of an organism to the extent that the content of the substance in the tissue exceeds that found in nature at one point in the lifetime of the organism.

## Bioconcentration factor (BCF)

Ratio of the chemical concentration in the exposed organism (minus the concentration in a control organism) to that in surrounding water.

## Biotransformation

Biological transformation of substances in a living organism via enzymatic processes.

## Boiling Liquid Expanding Vapour Explosion (BLEVE)

A violent vapour explosion of a liquid that is significantly above its usual boiling point at atmospheric pressure after a tank has burst.

## Boiling point (measured at a pressure of 1 atmosphere)

Temperature at which a liquid begins to boil. More specifically, when the temperature at which saturating vapour pressure of a liquid is equal to standard atmospheric pressure (1,013.25 hPa). The boiling point measured depends on atmospheric pressure.

## Buffering capacity

Capacity of a solution to absorb a certain quantity of acid or base without causing a significant variation in pH. In the marine environment, the buffering capacity is due to the dihydrogenocarbonate/carbonate balance.

## Combustion rate

Rate at which an object subjected to fire will burn entirely.

## Critical point

Point at which the temperature and pressure at which the intensive properties of a liquid and vapour (density, calorific value...) are equal. It represents the highest temperature (critical temperature) and pressure (critical pressure) at which a gas phase and a liquid phase of a given compound can coexist.

## Critical pressure

Maximum pressure for which the distinction can be made between a gas and a liquid.

#### **Critical temperature**

Temperature at which, when boiling, there is no longer any clear cut transition between the liquid and the gas state.

#### **Daily exposure dose**

Dose (internal or external) of a substance in an organism compared to the weight of the individual and the number of days of exposure (in the case of a non carcinogenic substance) and the number of days lived by the organism (for a carcinogenic substance).

#### **Decomposition products**

Products stemming from chemical or thermal disintegration of a substance.

#### **Diffusion coefficient in air (and in water)**

A constant that describes the movement of a substance in the gas phase (or liquid phase) in response to a concentration differential in the gas phase (or liquid phase).

#### **Effective concentration 50 (EC<sub>50</sub>)**

Concentration causing a given effect (mortality, growth inhibition...) for 50% of the population under consideration during a given period of time.

#### **Emergency Response Planning Guidelines (ERPG)**

The American International Health Alliance (AIHA) set three maximum concentrations in 1988 below which a category of effects is not expected for an exposure duration of one hour, in a bid to protect the general public.

ERPG1: is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly identifiable odour.

ERPG2: is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to protect themselves.

ERPG3: is the maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

#### **Exposure limit value (ELV)**

Ceiling exposure value measured for a maximum duration of 15 minutes.

#### **Flash point**

The lowest temperature at which a substance generates vapours that ignite or burn immediately when in contact with a flame.

#### **Foam**

The foam layer absorbs most of the vapours, physically eliminates vapours and isolates the chemical from sunlight and ambient air which reduces the amount of heat and subsequent vaporisation.

#### **Henry's law constant**

Value indicating a substance's volatility (see graph on p. 41)

#### **Immediately Dangerous to Life or Health (IDLH)**

Level below which a worker can escape to safety in thirty minutes in the event of sudden exposure to a dangerous atmosphere, without respiratory protection and without impairing his ability to escape.

#### **Irreversible effect threshold (IET)**

Concentration, for a stated exposure duration, above which irreversible effects can occur in the exposed population.

#### **Lethal effect threshold (LET)**

Concentration, for a stated exposure duration, above which mortality can be observed in the exposed population.

#### **Lower Explosive Limit (LEL)**

Minimum airborne concentration above which vapours ignite.

#### **Lowest Observed Effect Concentration (LOEC)**

Lowest concentration at which an effect is observed.

#### **Marine pollutant**

Substance, object or matter likely to cause serious damage to the marine environment when spilled.

#### **Maximum Allowable Relief Valve Setting (MARVS)**

Indicates the maximum admissible calibration of pressure relief valves of a cargo tank.

#### **Mean exposure value (MEV)**

Value that has been measured or estimated for a work station lasting 8 hours and is intended to protect workers from long term effects. MEV can be exceeded for very short periods providing the ELV value (should there be one) is not exceeded.

#### **Median lethal concentration (LC<sub>50</sub>)**

Concentration of a substance deduced statistically that should, during or after exposure and for a given period of time, cause the death of 50% of the animals exposed during a given time period.

### Melting point

Temperature at which solid and liquid state coexist. The melting point is a constant for a pure substance and is usually calculated at standard atmospheric pressure (one atmosphere).

### Minimum Risk Level (MRL)

This level is an estimate of daily human exposure to a chemical which probably has no appreciable risk of non-carcinogenic noxious effect on health for a specific exposure duration.

### Miscible

Matter that mixes readily with water

### Nautical Mile

1 nautical mile is the equivalent of 1,852 metres and corresponds to one minute of latitude.

### N-octanol/water partition coefficient (Kow)

Ratio of the equilibrium concentrations of a substance dissolved in a two phase system made up of two solvents that virtually do not mix.

### No Observed Effect Concentration (NOEC)

Concentration of a substance measured during chronic toxicity tests for which no effect is observed, meaning that the substance presents no chronic toxicity below this concentration.

### No Observed Effect Level (NOEL)

The highest dose of a substance that causes no distinct changes as compared with those observed in control animals.

### Olfactory threshold

Minimum air or waterborne concentration to which the human nose is sensitive.

### Partition coefficient for organic carbon and water (Koc) (for organic substances)

Ratio of the amount of compound absorbed per unit mass of organic carbon in the soil or in a sediment and the concentration of the same compound in a water solution in a state of equilibrium.

### Photo-oxidation

Oxidation of a chemical compound caused by exposure to light energy.

### Polymerisation

This term describes the chemical reaction generally associated with the production of plastics. Fundamentally, the individual molecules of a chemical (liquid or gas) react together to form a long chain. These chains can be used for many applications.

### Protective equipment

This refers to the respiratory or physical protection of a human being. Protection levels have been defined, including both protective clothing and breathing apparatus as accepted by response authorities such as the USCG, NIOSH and the EPA (US).

Level A: an SCBA (self contained breathing apparatus/respirator) and fully air and chemical-tight suit (that resists permeation).

Level B: an SCBA and a suit that protects against liquid spray (splash proof).

Level C: a full face mask or goggles and a suit that protects responders against chemicals (splash proof).

Level D: overalls without a respirator.

### Rate of evaporation or volatility (ether = 1)

The rate of evaporation expresses the number of times that a product takes to evaporate as compared with a control substance of an equal volume (ether for instance). This rate varies with the nature of the product and the temperature.

### Regression speed

Speed at which a burning liquid slick reduces in thickness. For a given liquid, this speed is constant regardless of the slick surface (slick diameter greater than 2 metres). Regression speed allows the total duration of a fire to be estimated if no attempt is made to extinguish it.

e.g. a 1,000 mm thick slick, where the regression speed is 10 mm/minute  
duration of fire = 1000/10 = 100 minutes.

### Relative density

Ratio of the mass of a substance to that of water for a liquid or to that of air for a gas.

### Relative vapour density

Weight of a volume of vapour or pure gas (without air) compared to that of an equal volume of dry air at the same temperature and pressure.

A vapour density lower than 1 indicates that the vapour is lighter than air and will have a tendency to rise. When the vapour density is higher than 1, vapour is heavier than air and will tend to stay near ground level and spread.

### Self-ignition temperature

Minimal temperature at which vapours ignite spontaneously.

### Solubility

Quantity of a substance dissolved in water. It will depend on salinity and temperature.



## Acronyms

ACGIH	American Conference of Governmental Industrial Hygienists
ADD	Acceptable Daily Dose
ADNR	European Agreement concerning International Carriage of Dangerous Goods on the Rhine river
ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
AEGLs	Acute Exposure Guideline Levels
AFFF	Aqueous Film-Forming Foam
AFSSA	French National Agency for Food Safety
AIHA	American International Health Alliance
ALOHA	Areal Locations of Hazardous Atmospheres
ATSDR	Agency for Toxic Substances and Disease Registry
AUV	Autonomous Underwater Vehicle
BCF	Bio Concentration Factor
BLEVE	Boiling Liquid Expanding Vapour Explosion
BOD	Biochemical Oxygen Demand
CAS	Chemical Abstracts Service
CEA	French Atomic Energy Commission
CEDRE	Centre of Documentation, Research and Experimentation on Accidental Water Pollution
CEFIC	European Chemical Industry Council
CHRIS	Chemical Hazards Response Information System
COD	Chemical Oxygen Demand
CSST	French Occupational Health and Safety Commission
CSTEE	French Scientific Committee on Toxicity, Ecotoxicity and the Environment
DDASS	French Departmental Health and Social Action Directorate
DDE	French Departmental Equipment Directorate
DRASS	French Regional Department of Health and Social Affairs
DRIRE	French Regional Directorates for Industry, Research and Environment
EC	Effective Concentration
ECB	European Chemicals Bureau
ECETOC	European Centre for Ecotoxicology and Toxicology of Chemicals
EFMA	European Fertilizer Manufacturers Association
EINECS	European Inventory of Existing Chemical Substances
ELV	Exposure Limit Value
EPA	Environmental Protection Agency
ERPG	Emergency Response Planning Guidelines
ETC	Environmental Technology Centre
HSDB	Hazardous Substances Data Bank
IARC	International Agency for Research on Cancer
IATA	International Air Transport Association
IBC	International Bulk chemical Code
ICSC	International Chemical Safety Cards
IDLH	Immediately Dangerous to Life or Health
IFREMER	French Research Institute for Exploitation of the Sea
IGC	International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
INCHEM	International Chemical industries, Inc.
INERIS	French National Institute for Industrial Environment and Risks
INRS	French National Research and Safety Institute for occupational risk prevention
IPCS	International Programme on Chemical Safety

IPSN	French Institute for Nuclear Safety and Protection
IUCLID	International Uniform Chemical Information Database
LC	Lethal Concentration
LEL	Lower Explosive Limit
LET	Lethal Effect Threshold
LLDPE	Linear Low Density PolyEthylene
LOEC	Lowest Observed Effect Concentration
MARPOL	Marine Pollution
MARVS	Maximum Allowable Relief Valve Setting
MCA	Maritime and Coastguard Agency
MEV	Mean Exposure Value
MFAG	Medical First Aid Guide
MP	Marine Pollutant
MRL	Minimum Risk Level
MSDS	Safety Data Sheet
MUC	Maximum Use Concentrations
NIOSH	National Institute for Occupational Safety and Health
NM	Nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOEC	No Observed Effect Concentration
OECD	Organisation for Economic Co-operation and Development
PEC	Predicted Effect Concentration
PID	Photo Ionisation Detector
PNEC	Predicted No-Effect Concentration
PPE	Personal Protective Equipment
ppm	Parts per million
PTBC	Para-tertiary-butylcatechol
PVC	Polyvinyl chloride
PVDC	Polyvinylidene chloride
PVDF	Polyvinylidene fluoride
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
ROV	Remoted Operated Vehicle
SCBA	Self-Contained Breathing Apparatus
SEBC	Standard European Behaviour Classification system of chemicals spilled into the sea
SIDS	Screening Information Data Set
SIW	Special Industrial Waste
TEEL	Temporary Exposure Limits
TGD	Technical Guidance Document
TLV-ceiling	Threshold Limit Values – Ceiling
TLV-STEL	Threshold Limit Values - Short Term Exposure Limit
TLV-TWA	Threshold Limit Values - Time Weighted Average
TNO	Netherlands Organisation for Applied Scientific Research
TRANSAID	Agreement between UIC (French Chemical Industry Association) & the French Government
TROCS	Transport of Chemical Substances - database created by REMPEC
UEL	Upper Explosive Limit
UIISC	French Unit of Instruction and Intervention on Civil Security
US EPA	United States Environmental Protection Agency
UVCE	Unconfined Vapour Cloud Explosion
VCM	Vinyl chloride monomer
VHF	Very High Frequency
v/v	Volume to volume
WHO	World Health Organisation

## Useful websites

**AFSSA** (French National Agency for Food Safety) (French only)  
<http://www.afssa.fr>

**ARKEMA**  
<http://www.arkemagroup.com>

**ATSDR** (Agency for Toxic Substances and Disease Registry)  
<http://www.atsdr.cdc.gov/>

**Bonn Agreement**  
<http://www.bonnagreement.org>

**CEFIC** (European Chemical Industry Council)  
<http://www.ericards.net>

**Chemfinder**  
<http://chemfinder.cambridgesoft.com>

**CHRIS** (Chemical Hazards Response Information System)  
<http://www.chrismanual.com>

**CSST** (Occupational Health and Safety Commission)  
<http://www.reptox.csst.qc.ca>

**ETC** (Environmental Technology Centre, Canada)  
[http://www.etc-cte.ec.gc.ca/etchome\\_e.html](http://www.etc-cte.ec.gc.ca/etchome_e.html)

**European Chemicals Bureau**  
<http://ecb.jrc.it>

**ICSC** (International Chemical Safety Cards)  
<http://www.cdc.gov/niosh/ipcs/ipccard.html>

**INERIS** (French National Institute for Industrial Environment and Risks)  
<http://www.ineris.fr>

**INRS** (French National Research and Safety Institute for Occupational Risk Prevention)  
<http://en.inrs.fr/>

**IPCS** (International Programme on Chemical Safety)  
<http://www.who.int/ipcs/en>

**NIOSH** (US National Institute for Occupational Safety and Health)  
<http://www.cdc.gov/niosh/>

**NOAA** (US National Oceanic and Atmospheric Administration), historical incident search page  
<http://www.incidentnews.gov/>

**TROCS**, REMPEC database (Regional marine pollution emergency response centre for the Mediterranean Sea) on transportation of chemicals  
<http://www.rempec.org/databases.asp?lang=en>

**UIC** (French Chemical Industry Association)  
<http://www.uic.fr/index-us.htm>

**US Department of Energy**, Chemical Safety Program, list of ERPGs  
[http://tis.eh.doe.gov/web/chem\\_safety/teel.html](http://tis.eh.doe.gov/web/chem_safety/teel.html)

**US EPA** (Environmental Protection Agency)  
<http://www.epa.gov> (list of AEGLs)

# **ANNEXES**

**Annex 1:** Summary and additional physical and toxicological data

**Annex 2:** Fax format data card

**Annex 3:** Classification of noxious liquid substances (until 31/12/2006)

**Annex 3b:** New classification of noxious liquid substances (since 01/01/2007)

# ANNEX 1: SUMMARY AND ADDITIONAL PHYSICAL AND TOXICOLOGICAL DATA

## Classification

CAS n°: 140-88-5  
EC n° (EINECS): 205-438-8  
UN n°: 1917  
Index n°: 607-032-00-X  
Class: 3

## Physical data

**Conversion factor:** in air (at 20°C)

ECETOC, 1994

1 ppm = 4.09 mg/m<sup>3</sup>

1 mg/m<sup>3</sup> = 0.24 ppm

1 atm = 1.013×10<sup>5</sup> Pa

**Molar mass:** 100.1 g/mol

INRS 1992 , ARKEMA SDS, 2004

**Volumic mass**

922 kg/m<sup>3</sup> at 20°C

ARKEMA SDS, 2004

**Volumic mass of vapour**

4.16 kg/m<sup>3</sup> at 20°C

ARKEMA SDS, 2004

**Physical state**

In normal temperature and pressure conditions

ARKEMA SDS, 2004

Appearance: liquid

Colour: colourless

Odour: pungent

**Density**

Relative density of liquid (water = 1): 0.922 at 20°C

ARKEMA SDS, 2004

Relative density of air/vapour mixture (air = 1): 3.4

ICSC, 2003; INRS, 1992

**Solubility**

In water:

CEBRE, 2005

	T (°C)	S (‰)	Concentration (g/L)
With agitation and filtration	10	0	19.0
	10	34	13.8
	25	0	17.5
	25	34	10.0

In other compounds:

Soluble in most organic solvents.

ARKEMA SDS, 2004

**Emulsification:**

CEDRE, 2005

	T (°C)	S (‰)	Concentration (g/L)
With forced dispersion (emulsion and solubilisation) Ultraturrax test	10	0	25.6
	10	34	16.6
	25	0	23.3
	25	34	14.0

**Vapour tension**

38 hPa at 20°C  
164 hPa at 50°C

DIPPR, 2005

**Key temperatures**

Boiling point at 1 atm: 99.5°C  
Melting point: -72°C  
Flash point (closed cup): 8°C  
(open cup): 16°C (DIN 51 755)  
Self-ignition point: 345°C  
Critical temperature: 279.9°C

DIPPR, 2005  
INRS, 1992; ARKEMA SDS, 2004  
ARKEMA SDS, 2004  
ISCS, 2003, ECETOC, 1994  
DIPPR, 2005

**Other properties**

Henry's law constant: 25.3 Pa.m<sup>3</sup>/mol (calculated at 20°C)

ECETOC, 1994

Diffusion coefficient in air: no data available

Diffusion coefficient in water: no data available

Dynamic viscosity: 0.56 mPa.s at 20°C

ARKEMA SDS, 2004

Critical pressure: 37 atm

CHRIS, 1999

Surface tension: 25.2 N/m at 20°C

ECETOC, 1994

Interface tension/liquid water: 0.04 N/m at 20°C

CHRIS, 1999

Evaporation rate (n-butyl acetate = 1): 3.3

INRS, 1992

**Olfactory threshold:**

In air: 0.0012 ppm

ECETOC, 1994

## Toxicological data

### Threshold toxicological values

Occupational exposure values

MEV: 5 ppm (20 mg/m<sup>3</sup>)

TLV-TWA: 5 ppm (20 mg/m<sup>3</sup>)

TLV-STEL: 15 ppm (61.4 mg/m<sup>3</sup>)

TLV-ceiling: 15 ppm (61.4 mg/m<sup>3</sup>)

Risk management values for the population

IDLH: 300 ppm (1227 mg/m<sup>3</sup>)

TEEL 0: 15 ppm (61.4 mg/m<sup>3</sup>)

ERPG 1: no data available

ERPG 2: 30 ppm (123 mg/m<sup>3</sup>)

ERPG 3: 300 ppm (1227 mg/m<sup>3</sup>)

ARKEMA SDS 2004

ARKEMA SDS 2004

ARKEMA SDS, 2004

CHRIS, 1999

NIOSH, 1994

US DEPARTMENT OF ENERGY, 2002

US DEPARTMENT OF ENERGY, 2002

### Given AEGLs

concentration (ppm)	10 min	30 min	60 min	240 min	480 min
AEGL 1	8.3	8.3	8.3	8.3	8.3
AEGL 2	66	45	36	19	9.4
AEGL 3	950	410	240	71	41

US EPA, 2004

## General toxicity

### Acute human toxicity

ICSC, 1999; ARKEMA SDS, 2004

- By inhalation: burning sensation, coughing, breathing difficulties, shortness of breath, sore throat and in high concentrations nausea and vomiting may occur.
- By skin contact: redness, burns to the skin, pains.
- By ingestion: stomach pains, sore throat, vomiting.
- By eye contact: redness, pains, eyesight difficulties.

### Chronic human toxicity

ICSC, 1999; ARKEMA SDS, 2004

Repeated exposure to high concentrations of vapours and/or mist can cause irritation of the upper respiratory tract. Temporary olfactory problems are also possible.

Repeated contact can cause sensitization of the skin.

### Specific effects

Carcinogenic effects: carcinogenic effect on animals which cannot be applied to humans.

Effects on fertility: no effect on reproductive organs.

Teratogenic effects and/or effects on foetal development: no evidence of teratogenic effects.

Genotoxic effects: no evidence of genotoxic effects.

## Ecotoxicological data

### Acute ecotoxicity (ARKEMA SDS, 2004; ECB, 2003)

Bacteria ( <i>Pseudomonas putida</i> )	EC <sub>50</sub> (17h)	=	1,500 mg/L (fresh water)
Algae ( <i>Scenedesmus subspicatus</i> )	EC <sub>50</sub> (72h)	=	48 mg/L (fresh water)
Algae ( <i>Selenastrum capricornutum</i> )	EC <sub>50</sub> (72h)	=	5.5 mg/L (fresh water)
Crustacean ( <i>Daphnia magna</i> )	EC <sub>50</sub> (48h)	=	7.9 mg/L (fresh water)
Fish ( <i>Oncorhynchus mykiss</i> )	LC <sub>50</sub> (96h)	=	4.6 mg/L (fresh water)
Invertebrate ( <i>Artemia salina</i> )	EC <sub>50</sub> (24h)	=	12 mg/L (seawater)

### Chronic ecotoxicity

Fish ( <i>Poecilia reticulata</i> )	LC <sub>50</sub> (14 d)	=	0.74 mg/L (fresh water)
Crustacean ( <i>Daphnia magna</i> )	NOEC (21 d)	=	0.19 mg/L (fresh water)

**PNEC** (Predicted No-Effect Concentration): according to the Technical Guidance Document corresponding to commission regulation (EC) 1488/94 on risk assessment of chemical substances, the calculated PNEC for water is 0.0019 mg/L. A safety factor of 100 is applied to the lowest value (given for the crustacean *Daphnia magna*).

## ANNEX 2: FAX FORMAT DATA CARD

<p><b>Ethyl acrylate</b></p> <p>Acrylic ester, ethyl propenoate, ethyl ester, acrylic acid ethyl ester, 2-propenoic acid, ethyl 2-propenoate, EA, ethoxycarbonyl ethene</p>	$C_5H_8O_2$	<p>CAS n°: 140-88-5</p> <p>EC N° (EINECS): 205-438-8</p> <p>Index n°: 607-032-00-X</p> <p>UN N°: 1917</p> <p>Class: 3</p>
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### First aid information

**Intoxication:** Move the victim into the fresh air and prop up to a half-sitting position. Give the victim oxygen if they have breathing difficulties and consult a doctor.

**Skin contact:** Remove contaminated clothing. Rinse the skin with plenty of water or have a shower.

**Eye contact:** Rinse immediately with plenty of water for several minutes keeping the eyelids open (remove contact lenses if possible).

**Intoxication by ingestion:** Rinse out the mouth. Give plenty of water to drink and consult a doctor.

### Physical data

**Melting point:** -72°C

**Boiling point:** 99.5°C

**Relative density (water = 1):** 0.922 at 20°C

**Relative vapour density (air = 1):** 3.45

**Solubility in seawater:** 13.8 g/L at 10°C  
10 g/L at 25°C

**Solubility in fresh water:** 19 g/L at 10°C  
17.5 g/L at 25°C

**Vapour pressure/tension:** 38 hPa at 20°C  
164 hPa at 50°C

**Olfactory threshold:** 0.0012 ppm

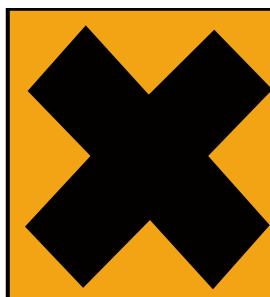
**Evaporation rate (n-butyl acetate = 1):** 3.3

**Diffusion coefficient in water:** no data available

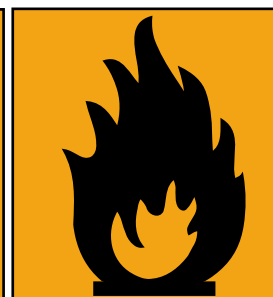
**Diffusion coefficient in air:** no data available

**Henry's law constant:** 25.3 Pa.m<sup>3</sup>/mol at 20°C

**Flash point:** 8°C (closed cup)  
16°C (open cup) DIN 51 755



Xn: Harmful



F: Highly flammable

R11: highly flammable

R20/21/22: harmful by inhalation, in contact with skin and if swallowed.

R36/37/38: Irritating to eyes, respiratory system and skin.

R43: may cause sensitisation by skin contact.

S9: keep container in a well ventilated place.

S16: keep away from sources of ignition. No smoking.

S33: take precautionary measures against static discharges.

S36/37/39: wear suitable protective clothing, gloves and eye/face protection.

### Toxicological data

#### Threshold toxicological values

IDLH: 300 ppm (1227 mg/m <sup>3</sup> )	TEEL 0: 15 ppm (61.4 mg/m <sup>3</sup> )
MEV: 5 ppm (20 mg/m <sup>3</sup> )	ERPG 1: no data available
TLV-ceiling: 15 ppm (61.4 mg/m <sup>3</sup> )	ERPG 2: 30 ppm (123 mg/m <sup>3</sup> )
TLV-STEL: 15 ppm (61.4 mg/m <sup>3</sup> )	ERPG 3: 300 ppm (1227 mg/m <sup>3</sup> )
TLV-TWA: 5 ppm (20 mg/m <sup>3</sup> )	

#### Specific effects

Carcinogenic effects: carcinogenic effect on animals which cannot be applied to humans.

Effects on fertility: no effect on reproductive organs.

Teratogenic effects and/or effects on foetal development: no evidence of teratogenic effects.

Genotoxic effects: no evidence of genotoxic effects.

#### Human toxicity

- Acute human toxicity
- **By inhalation:** burning sensation, coughing, breathing difficulties, shortness of breath, sore throat and in high concentrations nausea and vomiting may occur.
- **By skin contact:** redness, burns to the skin, pains.
- **By ingestion:** stomach pains, sore throat, vomiting.
- **By eye contact:** redness, pains, eyesight difficulties.

- Chronic human toxicity
- Repeated exposure to high concentrations of vapours and/or mist can cause irritation of the upper respiratory tract. Temporary olfactory problems are also possible.
- Repeated contact can cause sensitization of the skin.



## ANNEX 3: CLASSIFICATION OF NOXIOUS LIQUID SUBSTANCES

### Dangerous goods (IMO, 2002)

Regulations governing the carriage in bulk of hazardous liquid substances (MARPOL Annex II) provide valuable indications on the hazards that such substances can produce during transportation.

Noxious liquid substances are divided into 4 categories (A, B, C and D) starting with the most dangerous substances (MARPOL A) and ending with the least dangerous ones (MARPOL D).

The MARPOL classification system is based on risk assessment profiles for chemicals transported in bulk by sea, as defined by a GESAMP working group (Group of Experts on the Scientific Aspects of Marine Pollution).

**Category A** - Noxious liquid substances which, if discharged into the sea from tank washing or deballasting operations, are deemed to present a major hazard to marine resources or human health or can cause serious harm to amenities or other legitimate uses of the sea and therefore justify the implementation of strict pollution response measures.

**Category B** - Noxious liquid substances which, if discharged into the sea during tank washing or deballasting operations, are deemed to present a hazard to marine resources or human health and can harm amenities or other legitimate uses of the sea and therefore justify the implementation of special pollution response measures.

**Category C** - Noxious liquid substances which, if discharged into the sea during tank washing or deballasting operations, are deemed to be a minor risk for marine resources or human health or cause, to some extent, harm to amenities or other legitimate uses of the sea and therefore require special operating conditions.

**Category D** - Noxious liquid substances which, if discharged into the sea during tank washing or deballasting operations, are deemed to be a noticeable risk for marine resources or human health or have a very slight effect on amenities or other legitimate uses of the sea and therefore require certain precautions concerning operating conditions.

## ANNEX 3b: NEW CLASSIFICATION OF NOXIOUS LIQUID SUBSTANCES

### Revised MARPOL Annex II (IMO, 2005)

The revised Annex II Regulations for the control of pollution by noxious liquid substances in bulk was adopted in October 2004. It includes a new four-category categorization system for noxious and liquid substances. The revised annex entered into force on 1 January 2007.

The new categories are:

**Category X:** Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a major hazard to either marine resources or human health and, therefore, justify the prohibition of the discharge into the marine environment;

**Category Y:** Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a hazard to either marine resources or human health or cause harm to amenities or other legitimate uses of the sea and therefore justify a limitation on the quality and quantity of the discharge into the marine environment;

**Category Z:** Noxious Liquid Substances which, if discharged into the sea from tank cleaning or deballasting operations, are deemed to present a minor hazard to either marine resources or human health and therefore justify less stringent restrictions on the quality and quantity of the discharge into the marine environment; and

**Other Substances:** substances which have been evaluated and found to fall outside Category X, Y or Z because they are considered to present no harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged into the sea from tank cleaning or deballasting operations.

The revision of this annex is based on the modification of other classifications such as the GESAMP classification and led to consequential amendments to the IBC Code.