XYLENES

EU Classification:

Flammable

Xn: Harmful

UN n°: 1307 (o-xylene, p-xylene)
3295 (mixed xylenes)

MARPOL classification: Y
SEBC classification: FE (floats and evaporates)

TOTAL PETROCHEMICALS

CHEMICAL RESPONSE GUIDE

XYLENES

PRATICAL 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 Total Petrochemicals.

Warning

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

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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.

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Objet du 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, in ports and in 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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What you need to know about xylene

Definition

Xylene is a colourless liquid which gives off a sweet-smelling odour, similar to that of benzene. It is flammable and harmful for humans and the environment.

Xylene, still sometimes called dimethyl benzene, exists in two forms:

- a mixture of isomers, composed of 3 xylene isomers: ortho-, meta- and para-xylene. There also exists a product of similar quality from which a large part of the ortho isomer has been removed, which is generally referred to as "low ortho content". Xylene isomers are also sold separately in the form of products of varying quality (research, pure, commercial and technical)
- mixed xylenes, composed of a mixture of 80-85% isomers and 15-20% ethylbenzene.

Uses

Xylene is manufactured from raw primary materials from petroleum. It is a solvent commonly used in the manufacture of paint, varnish, glue, printing ink, insecticides, dyes and in the rubber and pharmaceutical product industries. It is also used in histology laboratories and in microscopy.

Xylene is the primary material for the production of benzoic acid. The individual isomers are used in organic synthesis for the production of:

- phthalic acid (converted into plasticizers) from ortho-xylene
- isophtalic acid and acide terephtalic acid (used for polyesters) from meta-xylene and para-xylene.

Risks

- Fire: xylenes are flammable and their vapours can cover a large distance, reach a source of ignition and cause a flashback. In the heat of a fire, xylene can break down, giving off toxic, irritating fumes.
- Explosion: the heating of a container storing xylene leads to an increase in pressure with a risk of bursting and the possibility of explosion (BLEVE). Xylene vapours can form explosive mixtures upon contact with air at a high temperature. The vapours are invisible and heavier than air. They spread out at ground level and can enter sewer systems and the subsoil.
- Toxicity: inhalation of xylene vapours can cause headaches, drowsiness, lesions, nausea, irritation of the nose and throat as well as breathing difficulties. If the concentration is high, there is a danger of irritation of mucous membranes, depression of the central nervous system and even death. Contact of xylene with the epidermis can cause irritation, dryness, erythema and dermatitis. Contact with the eyes can cause irritation and can lead to reversible corneal lesions.

Behaviour in the environment

When spilt in water, almost all the xylene will evaporate. A small part will float, forming a slick which will spread out (density = 0.8) and vaporise. Xylene vapours are heavier than air and move around at ground level. A small part will dissolve and accumulate in aquatic organisms.

First line emergency data

First aid information

(CEFIC; ERICARD, 2005 - TP SDS, 2006)

Use breathing apparatus. The effects caused by exposure can be deferred.

In the event of a spill of xylenes, the risk of fire is very high. Responders must wear protective clothing designed for fire fighting.

Intoxication by inhalation

- Move the victim into the open air and lie them down.
- Give the victim air or oxygen intermittently if they have difficulty breathing.
- Apply artificial respiration if the victim has stopped breathing.
- Transfer to hospital immediately.

Skin contact

- Immediately remove all soiled or spotted clothes; do not remove clothing which is stuck to the skin.
- Clean the affected parts immediately and at length with soap and water.
- Transfer to hospital in the event of serious contamination.

Contact with eyes

- Rinse immediately and at length with plenty of water keeping the eyelids open.
- Consult an ophthalmologist if the irritation persists.

Intoxication by ingestion

- Do not make the victim drink any liquids and do not induce vomiting.
- Treat with activated carbon if large quantities have been ingested.

If you suspect aspiration into the lungs, during vomiting for instance, transport the victim to hospital immediately.

ID card[1]

Xylenes

Mixed xylenes	
Composed of a mixture of 80-85% isomers and 15-20% ethylbenzene	**o-xylene** (> 98.5 % by weight) **p-xylene** (> 99.7 % by weight)

Gross formula: C_8H_{10}

Developed formula: $C_6H_4\text{-}(CH_3)_2$

Synonyms

Xylene (isomers o, m, p), xylene (mixed isomers), dimethylbenzene (mixed isomers), methyltoluene, xylene, xylol.

EU Classification

Xn: Harmful
Flammable
R10: Flammable
R20/21: Harmful by inhalation and in contact with skin
R38: Irritating to skin
R65: Harmful: may cause lung damage if swallowed

S2: Keep out of reach of children
S16: Keep away from sources of ignition. No smoking
S25: Avoid contact with the eyes
S62: If swallowed, do not induce vomiting: seek medical advice immediately and show the container or label

mixed xylenes	CAS n°: 90989-38-1 EC N° (EINECS): 292-694-9 Index n°: 648-010-00-X Classification for transportation UN N°: 3295 Class: 3	
mixed isomers (o, m, p)	CAS n°: 1330-20-7 EC N° (EINECS): 215-535-7 Index n°: 648-010-00-X	Classification for transportation UN N°: 1307 Class: 3
o-xylene	CAS n°: 95-47-6 EC N° (EINECS): 202-422-2 Index n°: 601-022-00-9	
p-xylene	CAS n°: 106-42-3 EC N° (EINECS): 203-396-5 Index n°: 601-022-00-9	

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[1] Additional data and sources in Annex 1

Physical data

(TP SDS, 2006)

Conversion factor (air at 20°C):	1 ppm = 4.42 mg/m³ 1 mg/m³ = 0.23 ppm 1 atm = 1.013×10⁵ Pa

	mixed xylenes	o-xylene	p-xylene
Physical state	liquid		
Colour	colourless		
Odour	sweet-smelling		
Olfactory threshold		5.4 ppm (CSST, 2002)	0.7 ppm (CSST, 2000)
Molecular mass	106 g/mol		
Melting point	< - 35°C	around - 25°C	around 13°C
Initial boiling point	> 139°C	> 144.4°C	> 138°C
Final boiling point	< 141°C	-	-
Critical temperature	350°C at 3,600 kPa	357.4°C at 3,730 kPa	343.5°C at 3,510 kPa
Vapour pressure/ tension	8.9 hPa at 20°C 47 hPa at 50°C	8.9 hPa at 20°C	11.5 hPa at 20°C
Relative vapour density (air = 1)	3.7	3.7	3.7
Volumic mass at 15°C	860 to 880 kg/m³	882 to 885 kg/m³	860 to 880 kg/m³
Solubility in water at 20°C	175 to 200 mg/l	175 mg/l	200 mg/l
pH	N/A		
Viscosity at 20°C	< 0.9 mm²/s	< 0.9 mm²/s	< 0.62 mm²/s

Definitions in glossary
Sources in Annex 2

Flammability data

(TP SDS, 2006)

Xylenes are flammable when exposed to a source of ignition or in the presence of oxidizing agents. The vapours, which are heavier than air, can cover a considerable distance and reach a source of ignition, causing a flashback.
Xylenes can accumulate static charge when agitated or when running through pipes. This can cause their vapours to ignite.

	mixed xylenes	o-xylene	p-xylene
Flash point in closed cup	> 23°C	> 23°C	> 24°C
Self-ignition temperature	465 to 525°C	> 464°C	> 540°C
LEL (% of volume)	1	1	1
UEL (% of volume)	9	7	7
Combustion rate	5.8 mm/min (CHRIS, 1999)		

Dangerous products of decomposition

Complete combustion, in the presence of excess air, produces carbon dioxide and water. Incomplete combustion produces carbon monoxide, soot and cracking products (aldehydes, ketones).

Definitions in glossary

Toxicological data

Acute human toxicity

(TP SDS, 2006 – CEDRE, 1990)

- By inhalation: headaches, drowsiness, irritation of mucous membranes in nose and throat, breathing difficulties, dizziness, nausea, tremors, visual difficulties, loss of consciousness. In very high concentrations (> 10 000 ppm): pulmonary oedema, narcosis, coma, death.
- By contact with skin: drying out of the skin, irritation, erythema and dermatitis.
- By contact with eyes: irritation of the conjunctiva, development of corneal ulcers.
- By ingestion: digestive troubles (stomach pains, nausea, cramps, vomiting, diarrhoea), hepatic and renal lesions in the case of strong concentrations.

Dose-response relationship (CSST, 2000 - CEDRE, 1990)

Concentration in ppm in air for mixed isomers o-, m- and p-xylene	Probable effects
20	Olfactory detection threshold
100	Threshold Limit Value – Time Weighted Average (TLV-TWA) Headaches, drowsiness
150	Threshold Limit Value – Short Term Exposure Limit (TLV-STEL)
200	Irritation of mucous membranes in nose and throat, breathing difficulties, dizziness, nausea, tremors, visual difficulties
300 (4 hours)	No effect in certain psychophysiological tests
450 (4 hours)	Prolonged reaction time
600 (4 hours)	No effect on reaction time
900 (4 hours)	Slight effect on electroencephalogram, impairment of vestibular and visual functions, prolonged reaction time
1,300 (2 hours)	Impaired performance
3,000 (15 minutes)	Dizziness
3,000 (1 hour)	Dizziness, irritation
> 10,000	Pulmonary oedema, sometimes very rapid, accompanied by narcosis or a coma (concentrations of 10,000 to 30,000 ppm can be fatal in 1 minute)

Chronic human toxicity

(TP SDS, 2006 – INRS, 2004 – INERIS, 2005)

Exposure to mixed xylenes via the lungs and skin can lead to:
- irritation of the eyes
- breathing difficulties
- cardio-vascular problems
- stomach pains
- haematological and immunological effects
- hepatic and renal problems
- neurological problems headaches, dizziness, faintness, irritability, memory loss and lack of concentration.

Important note:
The interpretation of data gathered through epidemiological studies is difficult due to insufficient knowledge of: the concentrations and exposure times as well as the possibility of previous and/or simultaneous exposure to other solvents (in particular benzene).

Threshold toxicological values

(TP SDS, 2006 – INERIS, 2005 – NIOSH, 1995)

Occupational exposure values
MEV (France): 221 mg/m³ = 50 ppm
ELV (France): 442 mg/m³ = 100 ppm
TLV-TWA (ACGIH): 442 mg/m³ = 100 ppm

Risk management values for the population
IDLH (NIOSH): 3,980 mg/m³ = 900 ppm
TLV-STEL (ACGIH): 663 mg/m³ = 150 ppm
TEEL 0: 442 mg/m³ = 100 ppm
TEEL 1: 663 mg/m³ = 150 ppm
TEEL 2: 884 mg/m³ = 200 ppm
TEEL 3: 3,980 mg/m³ = 900 ppm

Specific effects

(TP SDS, 2006)

Effects on development:
no data available

Effects on reproduction :
no data available

Carcinogenic effects: group 3 (IARC) =
not classifiable as to carcinogenity to humans

AEGLs for xylenes (CAS n° 1330-20-7) (US EPA, 2006)

Duration	10 minutes	30 minutes	1 hour	4 hours	8 hours
AEGL-1 (ppm)	130	130	130	130	130
AEGL-2 (ppm)	2,500	1,300	920	500	400
AEGL-3 (ppm)	-	3,600	2,500	1,300	1,000

Ecotoxicological data

Acute ecotoxicity

Species	Impact criterion	mixed xylenes (mg/L)	p-xylene (mg/L)	o-xylene (mg/L)
Crustacean (*Daphnia magna*) fresh water	EC_{50} (48h)	xylene (mixed isomers): 3.2 to 9.6 (TP SDS, 2006)		
		ethylbenzene: 1.8 to 2.4 (TP SDS, 2006)	3.6 (INERIS, 2005)	1.0 (INERIS, 2005)
Crustacean (*Crangon franciscorum*) sea water	EC_{50} (96h)	-	1.7	1.3
Fish (*Oncorhynchus mykiss*) fresh water	EC_{50} (96h)	-	2.6	7.6
Algae (*Selenastrum capricornutum*) fresh water	EC_{50} (72h)	xylene (mixed isomers): 3.2 to 4.9 (TP SDS, 2006)		
		ethylbenzene: 3.6 (TP SDS, 2006)	3.2 (INERIS, 2005)	4.7 (INERIS, 2005)

Chronic ecotoxicity (INERIS, 2005)

Species	Impact criterion	p-xylene (mg/L)	o-xylene (mg/L)
Algae (*Selenastrum capricornutum*) fresh water	8 day NOEC	0.9	1.0

PNEC (Predicted No-Effect Concentration) (INERIS, 2005)
In the absence of long term results on fish and daphnia for the 3 isomers, the results of the acute ecotoxicity tests will be used to determine the $PNEC_{water}$. The European Commission can therefore apply an extrapolation factor of 1000 to the EC_{50} of the most sensitive species.
However, according to INERIS estimations, it is likely that the 3 isomers act by a non polar narcotic mechanism. An extrapolation factor of 100 therefore seems sufficient to calculate the $PNEC_{water}$.

p-xylene	$PNEC_{water}$: 26 µg/L
o-xylene	$PNEC_{water}$: 10 µg/L

Definitions in glossary

Persistence in the environment

Behaviour

The product evaporates into the atmosphere. Generally speaking, the vast majority (99.7%) of xylenes released in the environment end up in the atmosphere.

Evaporation	Half life (calculated)	
	River	Lake
Mixed xylenes	-	-
Xylene (mixed isomers)	3 h	99 h
Ethylbenzene	3.1 h	-

In soil and sediments, their adsorption is moderate (log Koc = 2.1/2.5). Xylenes tend to leach into deeper soils.

When spilt in water, xylenes will spread over the water surface, where a small fraction may dissolve.

Volatilisation

Xylenes evaporate from surface waters; the calculated half life of mixed isomers in the air is 16 to 28 hours and 1 day for ethylbenzene.

Biodegradation

In water, and in an aerobic environment (water treatment plant) m-xylenes are biodegradable, o-xylenes are less so. In an anaerobic environment, xylenes are biodegradable in denitrification conditions. Xylene isomers are easily broken down in the atmosphere, mainly by photo-oxidation. The phenomenon of atmospheric oxidation of xylenes is rapid, by reaction with free radicals and hydroxyl radicals. The BOD5/ThOD ratio is greater than 0.5 for mixed isomers.

Bioaccumulation

According to the Kow and BCF values, the bioaccumulation potential of xylenes in aquatic organisms is low to moderate.

Organic carbon/water partition coefficient: 2.1/2.5 (TP SDS, 2006)

Octanol/water partition coefficient: 3.12/3.2 (TP SDS, 2006)

Bioconcentration factor BCF: (INERIS, 2005)
For m-xylene:
Fish (*Anguilla japonica*): BCF = 23.6
Mollusc (*Tapes semidecussa*): BCF (2-8 days) = 6
For o-xylene:
Fish (*Anguilla japonica*): BCF = 21.4
Mollusc (*Tapes semidecussa*): BCF (2-8 days) = 7.25

The BCFs measured for these two species are low. Nevertheless, this data is not sufficient to extend this to all aquatic organisms. It therefore appears appropriate to estimate the bioaccumulation factors from the Kow value and from a (Q)SAR relationship (EC, 1996) as follows:
- for m-xylene: BCF = 106
- for o-xylene: BCF = 72
- for p-xylene: BCF = 94

Definitions in glossary

Classification

IBC classification (IMO, 2004):

- hazards: P (Pollution risk)
- ship type: 3 until 31/12/2006
  2 since 01/01/2007
- tank type: 2G (integral gravity tank)
- tank vents: Cont (controlled venting)
- electrical equipment:
  class i''': (flash point > 60°C): no
- gauging: R (restricted gauging)
- vapour detection: F (flammable vapours)
- fire protection: A: Alcohol-resistant foam (or multipurpose foam)
- emergency equipment: no (no special requirements under this Code)
- specific requirements for p-xylene tanks: cargo tanks should be fitted with a visual and audible high-level alarm which indicates when the liquid level in the cargo tank approaches the normal full condition. The cargo's melting point should be indicated in the shipping document
- MFAG n°: 310

SEBC Classification: FE (floats and evaporates)

MARPOL classification: Y (definition in annex 3)

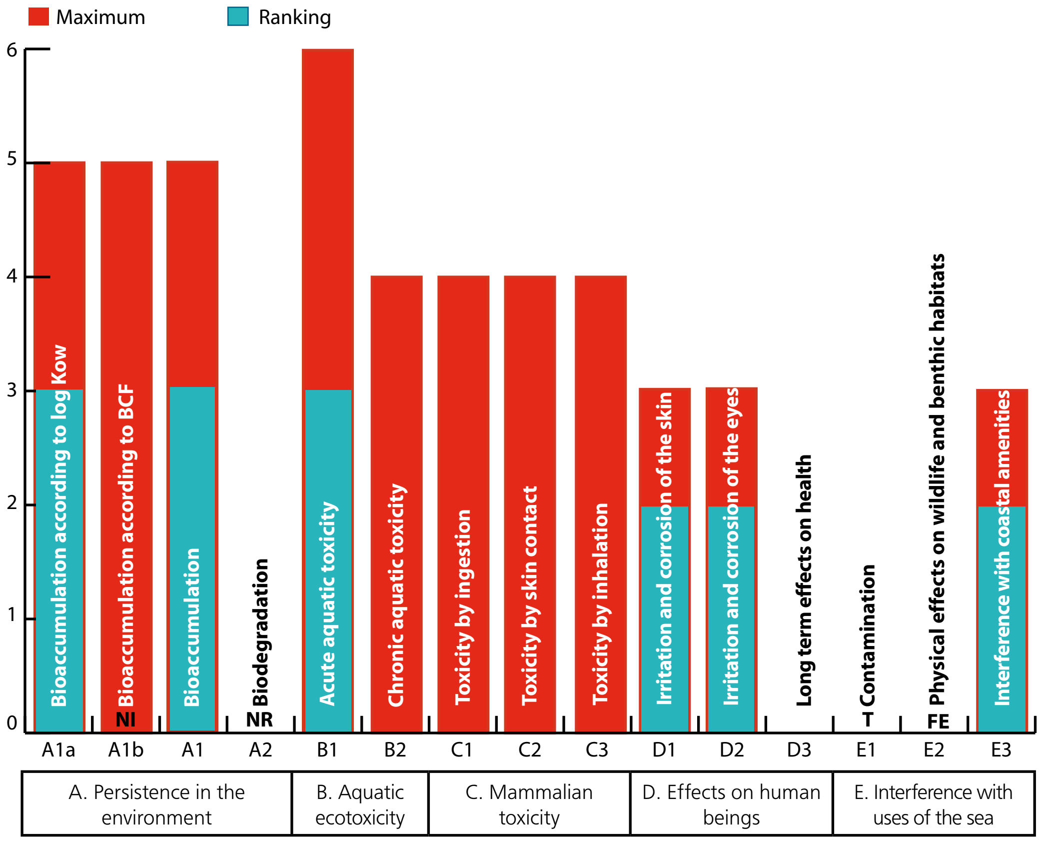
EU Classification:

Flammable

Xn: Harmful

R10	Flammable
R20/21	Harmful by inhalation and in contact with skin
R38	Irritating to skin
R65	Harmful: may cause lung damage if swallowed
S2	Keep out of reach of children
S16	Keep away from sources of ignition. No smoking.
S25	Avoid contact with the eyes
S62	If swallowed, do not induce vomiting. Seek medical advice immediately and show the container or label.

GESAMP classification for mixed xylenes (GESAMP, 2006)



A1a: moderate potential to bioaccumulate in aquatic organisms
A1b: NI: No Information
A1: moderate potential to bioaccumulate in aquatic organisms
A2: NR: Not Readily biodegradable

B1: moderate acute aquatic toxicity
B2: negligible chronic aquatic toxicity

C1: negligible toxicity when ingested by mammals
C2: negligible toxicity by skin contact with mammals
C3: negligible toxicity through inhalation by mammals

D1: irritating to the skin
D2: irritating to the eyes
D3: no long term effects on health

E1: according to the tests conducted, the substance taints the taste of fish when exposed to 1 mg/L for 24 hours (T: Tainting)
E2: floats/evaporates
E3: moderately objectionable, possible closure of amenities.

Particular risks

Polymerisation

N/A

Danger (ERICARD, 2003)

Fire: xylenes are highly flammable. Their vapours can cover a large distance as far as a source of ignition and produce flashback. In the heat of a fire, xylenes can break down, giving off toxic and irritating fumes.

Explosion: When a receptacle containing xylenes is heated, there is an increase in pressure leading to a risk of the container bursting and a possibility of explosion (BLEVE). Xylene vapours form explosive mixtures upon contact with air at high temperatures. The vapours are invisible and heavier than air. They spread out across the ground and can infiltrate drains and underground systems. Friction caused by the product flowing can create a charge of static electricity, which can lead to sparks resulting in ignition or explosion.

Stability and reactivity (TP SDS, 2006)

This product is stable in normal conditions of storage, handling and usage.

Conditions to be avoided: keep away from hot surfaces, flames, static electricity and sparks.

Substances to be avoided: avoid strong acids and oxidants, as well as certain rubbers and plastics (natural rubber, butyl, nitrile, polychloroprenes, polyethylene...).

Decomposition products:

- Complete combustion, in the presence of excess air, produces carbon dioxide and water vapour.
- Incomplete combustion produces substances including carbon monoxide, soot and cracking products such as aldehydes and ketones.

Behaviour when in contact with other products (ENVIRONMENT CANADA, 1985)

Violent reaction and explosion	concentrated acids (acetic acid, sulphuric acid, nitric acid) nitrating acid mixture (formation of nitroxylenes)
Fire	oxidants
Fire and explosion	heat, flames
Soluble in	ethanol, ethyl ether, acetone and benzene

Transportation, handling, storage

Transportation (TP SDS, 2006)

Transportation of mixed xylenes
Identification n° (UN): 3295

Transportation of o-xylene and p-xylene
Identification n° (UN): 1307

Land transportation:
RID (rail) /ADR (road)
Danger n°: 30
Class: 3
Packaging group: III
Classification code: F1
Labels: 3

Transportation via inland waterways:
ADN/ADNR
Class: 3
Packaging group: III
Classification code: F1
Labels: 3

Maritime transport: IMDG
Class: 3
Subsidiary risk: -
Packaging group: III
Marine pollutant (MP): No
Labels: 3

Air freight: IATA
Class: 3
Subsidiary risk: -
Packaging group: III
Labels: Class 3 - Flammable liquid

Handling (ENVIRONMENT CANADA, 1985 - TP SDS, 2006 - INRS, 2004)

- Keep xylenes in a well ventilated place.
- Store away from direct sunlight and other sources of radiation.
- Prevent the formation and spreading of vapours, fumes and aerosols in the atmosphere (in particular, during loading/unloading of the product).
- Avoid contact with the skin and eyes.
- Do not eat, drink or smoke during handling.
- In the event of possible exposure, use appropriate protective clothing, especially gloves.
- Store away from sources of heat, prevent accumulation of static electricity by grounding the equipment.
- Where possible, avoid using air for transferring the product.
- Transfer the chemical at a low speed (to prevent static electricity).
- Take specific precautions when the use or processing of the product is liable to produce stable emulsions with water.

Storage (ENVIRONMENT CANADA, 1985 - TP SDS, 2006 - INRS, 2004)

- Only use containers, joints, piping etc. which is resistant to aromatic hydrocarbons.
- Keep away from all sources of ignition. No smoking.
- Apply safety regulations for flammable liquids.
- Provide a retention tank.

Incompatible products: avoid strong acids and oxidants.

Packaging materials to be avoided: plastics.

Recommended packaging materials:
- Store xylenes in steel or stainless steel containers.
- Glass can also be used for small quantities: carboys should be protected with a more resistant, suitably adjusted metal cover.

Results of accident scenarios

Reminder of properties

Transportation

Xylenes are transported in liquid form in tanks at atmospheric pressure.

Vapour density and tension

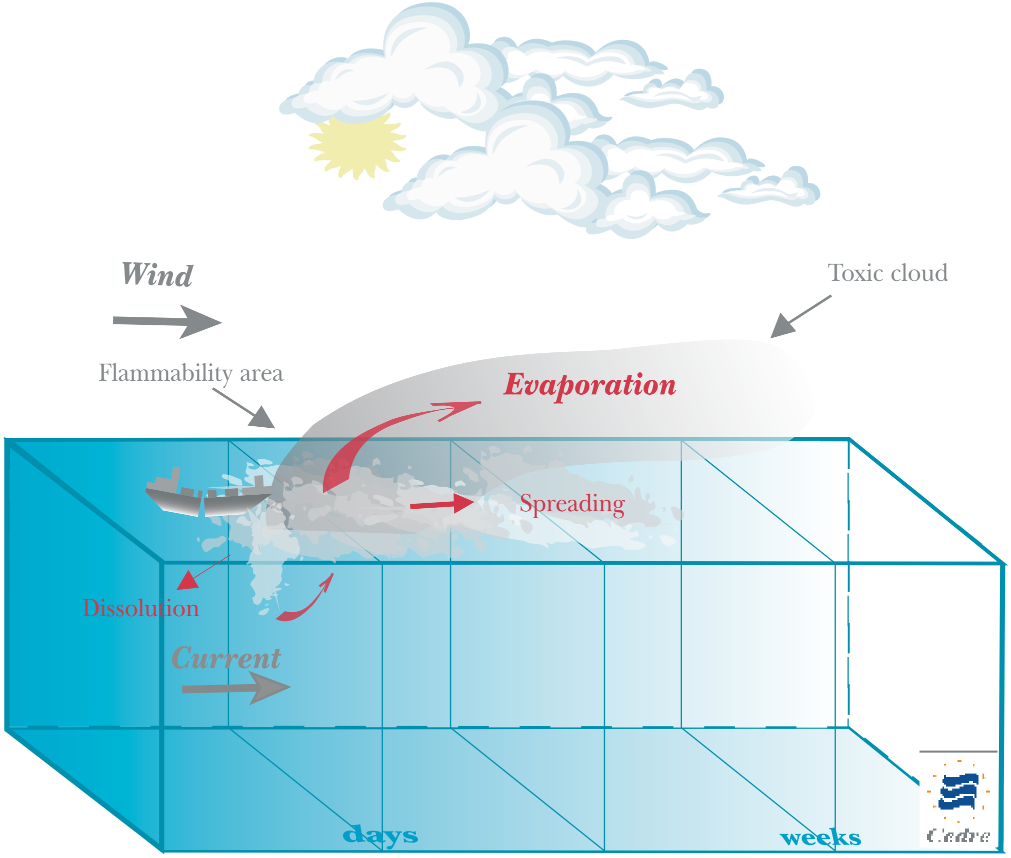
- Relative density: 0.88
- Vapour density: 3.7
- Vapour pressure/tension: 8.9 to 11.5 hPa at 20°C

Solubility

The solubility of xylenes in seawater is between 175 and 200 mg/L. The solubility and tension of xylene vapour cause this product to be classed as a **floater/evaporator (F/E).**

Behaviour in the environment

Xylenes are volatile liquids which form a slick that spreads over the surface of the water or ground. On land, they penetrate into the ground by absorption. Evaporation causes a continuous emission of flammable and irritating vapours, which are heavier than air. The vapour cloud will therefore tend to stay at the water surface or ground level. On water, the slick will tend to spread without causing a reaction.



Behaviour of xylenes when spilt at sea

Accident scenarios

The scenarios defined here are simply designed to give an indication of the possible behaviour of xylenes. 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.

The scenarios outlined in this guide were established based on average operational conditions:
- for maritime transport: nominal transfer rate of 300 t/h
- for river transport: nominal transfer rate of 150 t/h

For a leak caused by rupture to a transfer line, an accelerated scenario lasting 30 minutes is used in both cases.

The scenarios presented in this guide involve a mixture of o-, m- and p-xylene isomers being released one metre below the water surface (except for the “wreck” scenario).

Four xylene spill scenarios will be presented below, with the following spill rates:

- a high sea scenario (Channel): 1500 tonnes of xylene spilt over 5 hours, i.e. a spill rate of 300 t/h
- a port scenario (Cherbourg): 80 tonnes of xylene spilt over 30 minutes, i.e. a spill rate of 150 t/h
- a “wreck” scenario (Channel): 1500 tonnes of xylene spilt over 5 hours, i.e. a spill rate of 300 t/h
- a river scenario: 100 tonnes of xylene spilt over 30 minutes, i.e. a spill rate of 200 t/h

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
- Duration of spill: 5 hours

Port scenario
- Location: port of Cherbourg 49°39N 1°36W
- Air and water temperature: 10°C
- Two wind speeds: 3 and 10 m/s (NW)
- No currents
- Spill depth: 1 m
- Duration of spill: 30 minutes.

Wreck scenario
- Location 49°27N, 3°15W
- Air and water temperature: 10°C
- Two wind speeds: 0 and 10 m/s (NW)
- Channel currents
- Spill depth: 80 m
- Duration of spill: 5 hours

River scenario
- River depth: 4 to 5 m; width: 150 m
- Air and water temperature: 15°C
- Two wind speeds: 3 and 10 m/s (NW)
- Current speed: 0.12 m/s
- Spill depth: 1 m
- Duration of spill: 30 minutes.

Influence of ethylbenzene, making up 15-20% of mixed xylenes

Compared to a spill of mixed isomers, the concentrations in the air and water after a spill of mixed xylenes will tend to be:

- higher in the water column
- lower in the atmosphere.

Reminder of a few of xylenes' physicochemical properties

	Mixed isomers	**Mixed xylenes**
Vapour pressure/tension	0.01 atm = 11.15 hPa	0.0087 atm = 8.8 hPa
Dynamic viscosity	0.647 cP	0.77 cP
Solubility	198 ppm	200 ppm

Modelling

CHEMMAP software was used to model hypothetical spillages of xylenes 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 thirty minutes.

Results obtained after a spill of 180 tonnes of xylenes in the Channel

Figure 1

Location of the hypothetical spill in the Channel

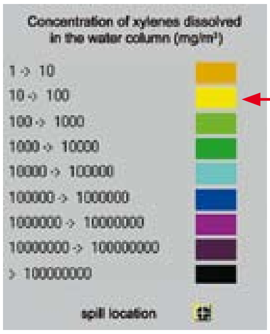
Figure 2

View of the dissolved part

⊕ Spill location

Key used in this guide

- for concentrations in the water column

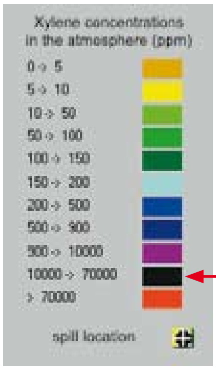


Concentration of xylenes dissolved in the water column (mg/m^3)

1 -> 10	🟧
10 -> 100	🟨
100 -> 1000	🟩
1000 -> 10000	🟩
10000 -> 100000	🟦
100000 -> 1000000	🟦
1000000 -> 10000000	🟪
10000000 -> 100000000	🟪
> 100000000	⬛
spill location	⊕

o-xylene PNEC (10 mg/m^3)

- for atmospheric concentrations



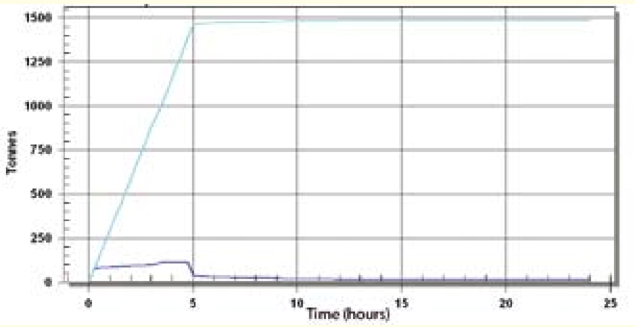
Xylene concentrations in the atmosphere (ppm)

0 -> 5	🟧
5 -> 10	🟨
10 -> 50	🟩
50 -> 100	🟩
100 -> 150	🟩
150 -> 200	🟦
200 -> 500	🟦
500 -> 900	🟦
900 -> 10000	🟪
10000 -> 70000	⬛
> 70000	🟥
spill location	⊕

LEL (10,000 ppm)

Results of the Channel scenario

Spill of 1500 t of xylenes over 5 hours (300 t/h) with a NW wind of 3 m/s.



Graph 1

— Quantity evaporated — Quantity dissolved

Whatever the wind speed, 3 or 10 m/s, almost all the xylenes spilt in the water are found in the atmosphere within 5 hours. A small part dissolves.

Behaviour of xylenes spilt in the Channel over 24 hours

Evolution of xylenes 24 hours after the spill with a 3 m/s NW wind

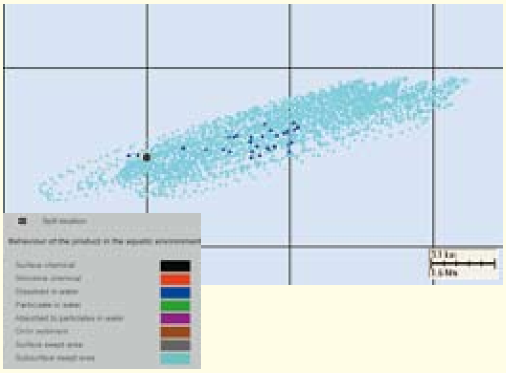


Figure 3

The surface liable to be affected by the xylenes extends over 21 km from east to west and 6 km from north to south.

Evolution of xylenes 24 hours after the spill with a 10 m/s NW wind

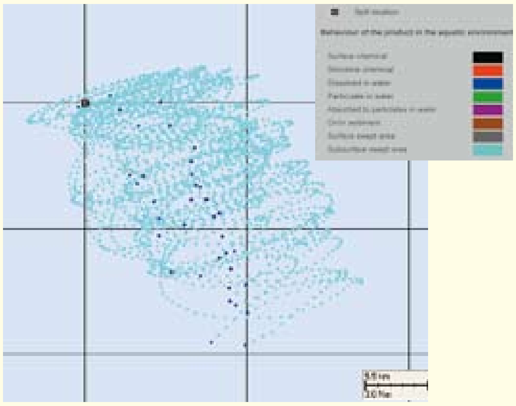
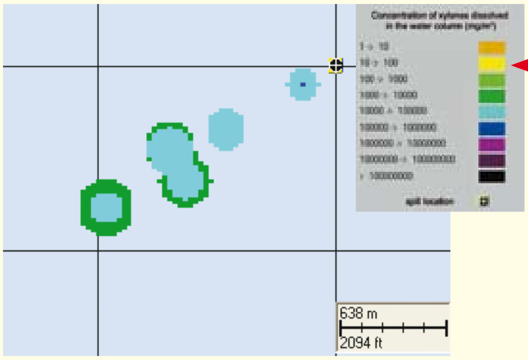


Figure 4

The surface liable to be affected by the xylenes extends over 26.5 km from east to west and 24 km from north to south.

Whatever the wind speed, the depth of the water column affected by the xylenes is between 0 and 10 metres below the surface.

Xylene concentrations in the water column, with a 3 m/s wind, one hour after the spill

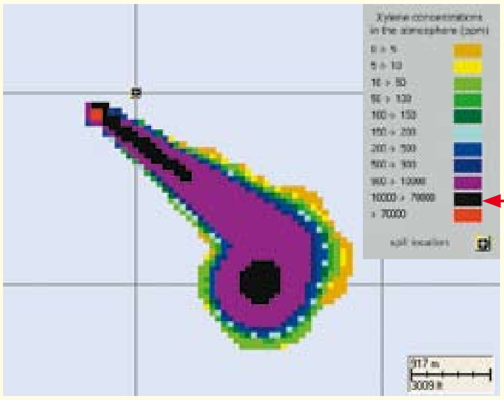


o-xylene PNEC
(10 mg/m^3)

Figure 5

The highest concentrations of dissolved xylenes detected are 100,000 mg/m^3 found up to 1.8 km south-west of the spill location.

Xylene concentrations in the atmosphere, with a 3 m/s wind, fifteen minutes after the spill



LEL
(10 000 ppm)

Figure 6

The atmospheric concentrations reach the lower explosive limit (10,000 ppm) up to 500 m south-east of the spill location.

Study of atmospheric concentrations: IDLH

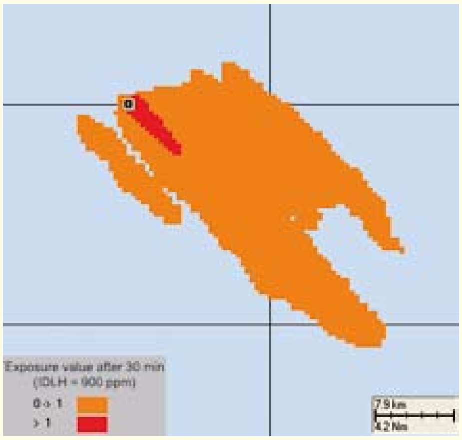


Figure 7

The IDLH level (900 ppm) is reached up to 8 km south-east of the spill location.

Safety distances for the toxic cloud of xylenes

Quantity spilt	NW Wind	Concentration (ppm)	Maximum distance reached	Time	Protection
1,500 T over 5 hours (300 T/h)	3 m/s	100 ppm (TLV-TWA)	10 km	5 h 15	A
		200 ppm (TEEL 2)	7 km	44 min	B
		900 ppm (IDLH)	5.5 km	31 min	C
		10,000 ppm (LEL)	1.7 km	9 min	D
		70,000 ppm (UEL)	0.75 km	3 min	D
	10 m/s	100 ppm (TLV-TWA)	8 km	14 min	A
		200 ppm (TEEL 2)	7 km	11 min	B
		900 ppm (IDLH)	5 km	7 min	C
		10,000 ppm (LEL)	2 km	2 min	D
		70,000 ppm (UEL)	0.8 km	1 min	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. 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 port scenario

Spill of 80 tonnes of xylene over 30 minutes (150 t/h) in the port of Cherbourg, with no current and a NW wind of 3 or 10 m/s

Behaviour of xylenes spilt in the port over 24 hours, with a 3 m/s wind

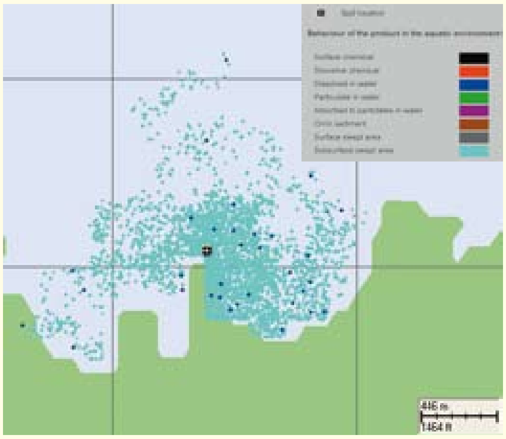
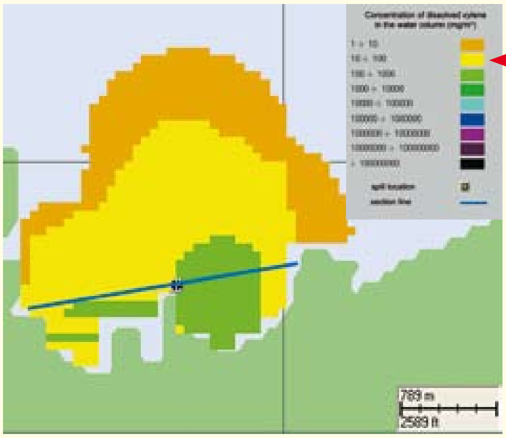


Figure 8

The xylenes spilt affect an area of 2 km in diameter around the spill location and a small part dissolves and is found throughout the entire depth of the water column (3 m).

Xylene concentrations in the water column, with a 3 m/s wind, one hour after the spill



o-xylene PNEC
(10 mg/m^3)

Figure 9

Vertical cross-section (in blue in figure 9)

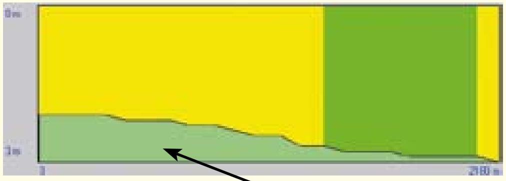


Figure 10

seabed

The highest concentrations of xylenes detected in the water column are 1,000 mg/m^3. The area detected covers a surface of 9 km^2 and the entire depth of the water column (3 m).

Xylene concentrations in the atmosphere, with a 3 m/s wind, thirty minutes after the spill

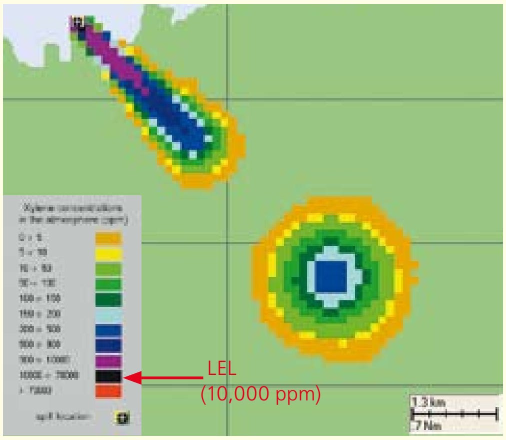


Figure 11

Thirty minutes after the spill, the xylenes reached maximum concentrations in the atmosphere of 70,000 ppm at around 200 metres south-east of the spill location. Concentrations to the order of 200 to 500 ppm reached a distance of around 6 km south-east of the spill location.

Xylene concentrations in the atmosphere, with a 3 m/s wind, one hour after the spill

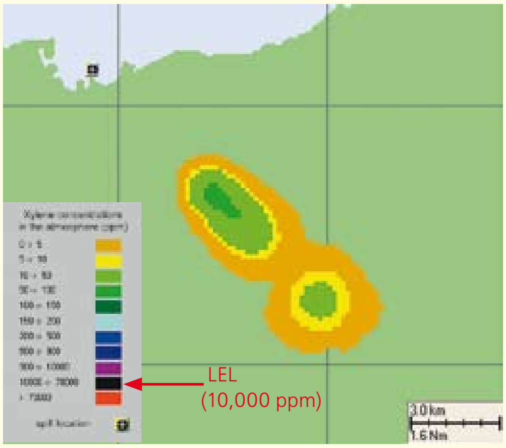


Figure 12

One hour after the spill, the xylenes reached maximum concentrations in the atmosphere of 100 ppm at around 7 km south-east of the spill location. The maximum distance affected is 13 km towards the south-east.

Study of atmospheric concentrations: IDLH

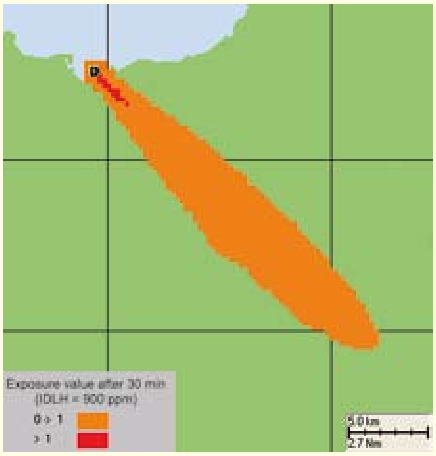


Figure 13

The IDLH level is reached up to 3 km south-east of the spill location.

Safety distances for the toxic cloud of xylenes

Quantity spilt	NW Wind	Concentration (ppm)	Maximum distance reached	Time	Protection
80 T over 30 minutes (150 T/h)	3 m/s	100 ppm (TLV-TWA)	11 km	55 min	A
		200 ppm (TEEL 2)	9 km	48 min	B
		900 ppm (IDLH)	6 km	32 min	C
		10,000 ppm (LEL)	2.6 km	13 min	D
		70,000 ppm (UEL)	1 km	5 min	D
	10 m/s	100 ppm (TLV-TWA)	11 km	17 min	A
		200 ppm (TEEL 2)	10 km	15 min	B
		900 ppm (IDLH)	6.5 km	10 min	C
		10,000 ppm (LEL)	3 km	4 min	D
		70,000 ppm (UEL)	1 km	1 min	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. 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 wreck scenario

A wreck is lying on the seabed 80 m below the surface not far from an inhabited coastline and begins to leak.
The leak leads to the **continuous release of 1500 tonnes of xylenes over 5 hours from the tanks of the wreck**.

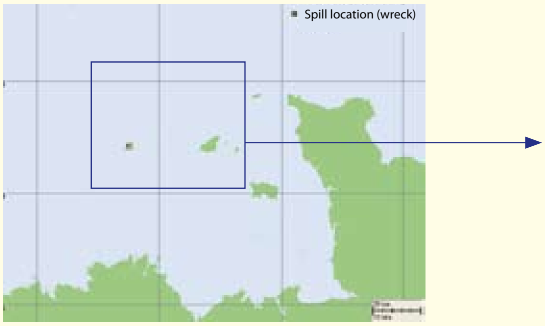


Figure 14

Location of the wreck

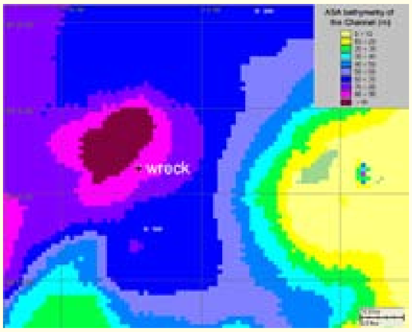
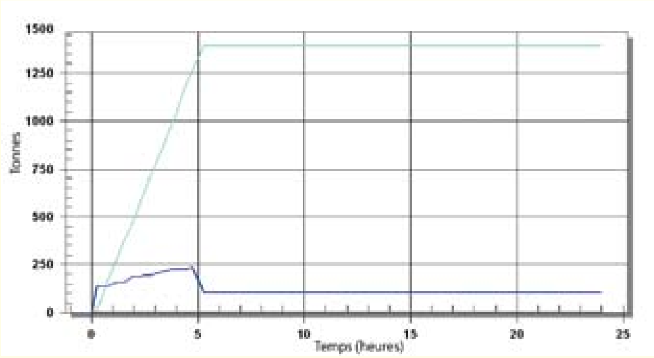


Figure 15

Bathymetry of the Channel

Spill of 1500 tonnes of xylenes over 5 hours in the Channel from a wreck lying at a depth of 80 metres.



Graph 2

— Quantity evaporated — Quantity dissolved

Almost all the xylenes spilt are found in the atmosphere within 5 hours after the spill. A small part dissolves.

Study over 24 hours of the behaviour of xylenes spilt 80 metres deep with no wind

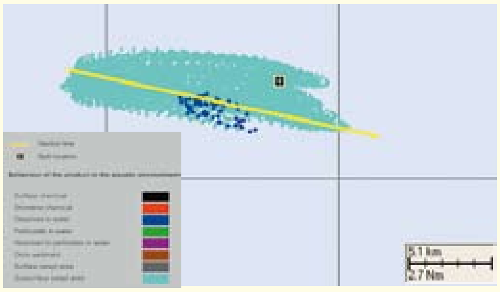


Figure 16

Vertical cross-section (in yellow in figure 16)

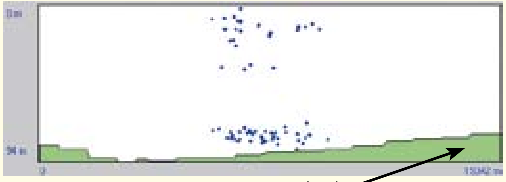


Figure 17

With no wind, the xylenes affect an area of 18 km from east to west and 4.5 km from north to south. The product spreads throughout the entire depth of the water column i.e. 80 metres.

Study over 24 hours of the behaviour of xylenes spilt 80 metres deep with a 10 m/s NW wind

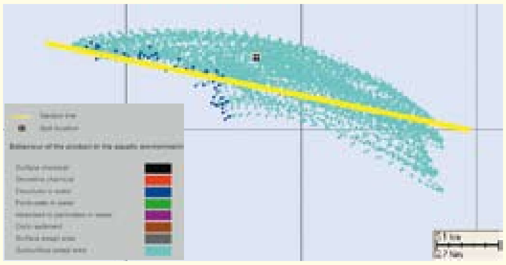


Figure 18

Vertical cross-section (in yellow in figure 18)

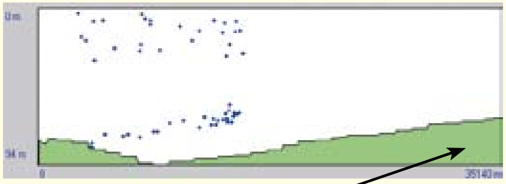


Figure 19

The surface area liable to be affected by the spill is around 140 km^2. The spill affects the entire depth of the water column.

Xylene concentrations in the water column, 30 minutes after the spill, with a 10 m/s wind

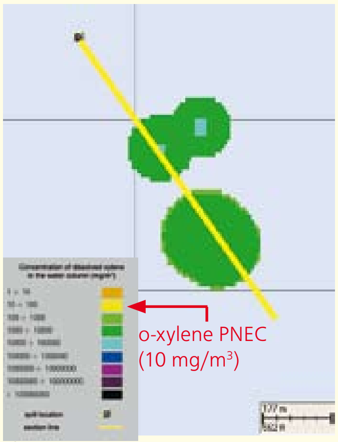


Figure 20

Vertical cross-section (in yellow in figure 20)

Figure 21

In the water, 30 minutes after the spill, the xylenes reach maximum concentrations of 100,000 g/m^3 up to 400 metres south-east of the spill location. The maximum distance is 780 metres, with concentrations of up to 10,000 mg/m^3.

Xylene concentrations in the water column, 2 hours after the spill, with a 10 m/s wind

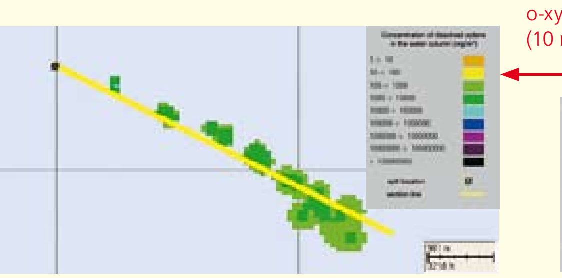


Figure 22

Vertical cross-section (in yellow in figure 22)

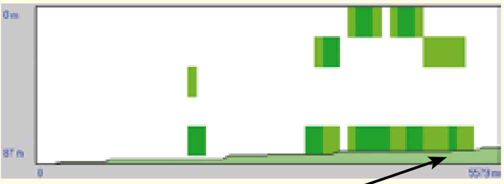


Figure 23

In the water, 2 hours after the spill, the xylenes reach maximum concentrations of 100,000 mg/m^3 up to 950 metres south-east of the spill location. The maximum distance is 5,500 metres, with concentrations of up to 1,000 mg/m^3.

Xylene concentrations in the atmosphere, 30 minutes after the spill, with a 10 m/s wind

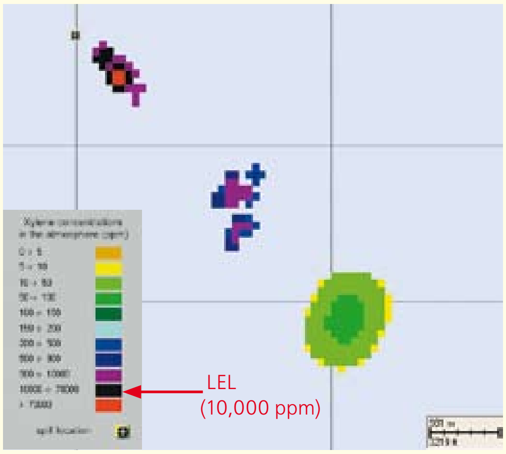


Figure 24

In the atmosphere, xylene concentrations reach the LEL up to 1000 metres south-east of the spill location. Xylenes are detected at concentrations of 100 ppm up to 6,500 metres from the spill location.

Xylene concentrations in the atmosphere, 2 hours after the spill, with a 10 m/s wind

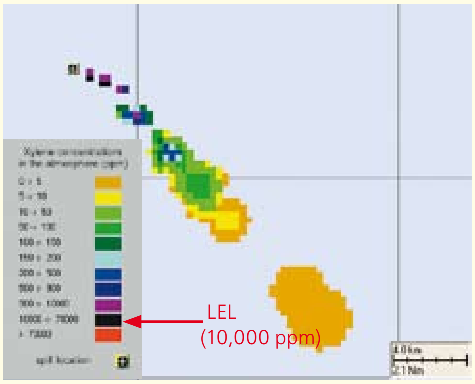


Figure 25

The LEL is reached up to 2 km south-east of the spill location. The maximum distance reached is 21 km.

24 hours after the spill, xylenes are no longer detected in the atmosphere.

Study of atmospheric concentrations: IDLH

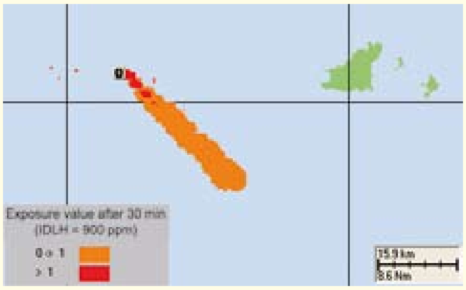
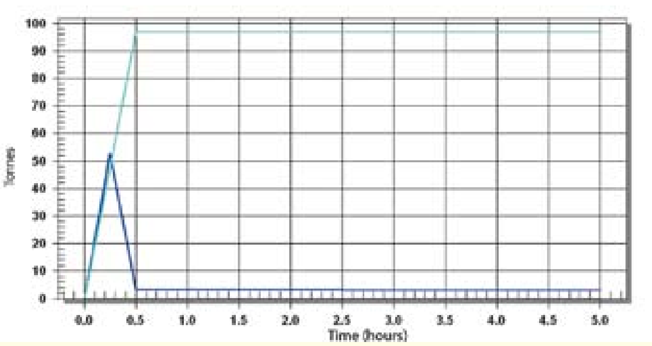


Figure 26

The IDLH level is reached up to 10 km south-east of the spill location.

Results of the river scenario

Spill of 100 tonnes of xylenes over 30 minutes, with a current speed of 0.12 m/s and a 3 m/s NW wind



Graph 3

Whatever the wind and current speed, all the xylenes (98%) spilt in the fresh water are found in the atmosphere in less than 30 minutes.

Study over 24 hours of the behaviour of xylenes spilt in a river

Behaviour of xylenes over 24 hours, with a current speed of 0.12 m/s and a 3 m/s NW wind

Figure 27

Vertical cross-section (in yellow in figure 27)

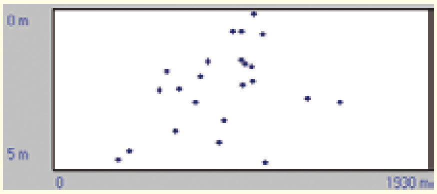
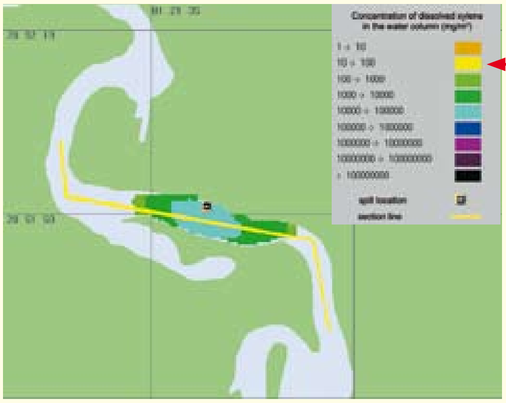


Figure 28

24 hours after the spill, the xylenes spilt in the river are found throughout the entire depth of the water column. Depending on the wind speed, the chemical spreads to different extents downstream, but also upstream: with a wind speed of 3 m/s, the chemical is found 1 km downstream and upstream of the spill location, whereas with a wind speed of 10 m/s, it is found up to 10 km downstream.

Xylene concentrations in the water column, 1 hour after the spill, with a 3 m/s NW wind



o-xylene PNEC (10 mg/m³)

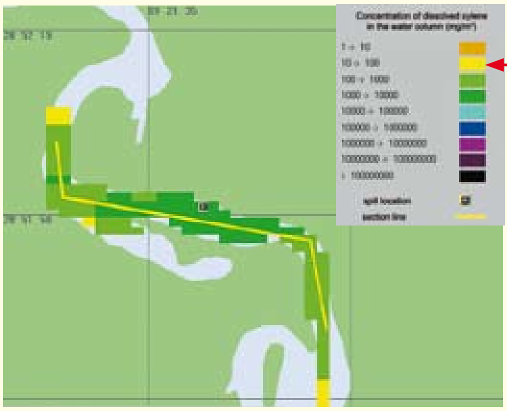
Figure 29

Vertical cross-section (in yellow in figure 29)

Figure 30

1 hour after the spill, the chemical affects the entire depth of the river (5 m) over a distance of 800 m around the spill location if the wind speed is 3 m/s. If the wind is stronger (10 m/s), concentrations can be detected up to 4 km downstream. The concentrations reach a maximum of 100,000 g/m³ whatever the wind speed.

Behaviour of xylenes in the water column, 24 hours after the spill, with a 3 m/s NW wind



o-xylene PNEC (10 mg/m³)

Figure 31

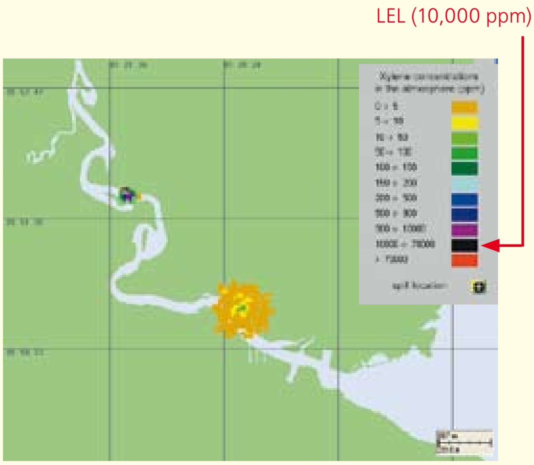
Vertical cross-section (in yellow in figure 31)

Figure 32

Xylene concentrations are detected in the water column over a distance of 2 km (upstream and downstream of the spill location) and throughout the entire depth of the water column. At the most, they reach concentrations to the order of 10,000 mg/m³.

If the wind is stronger, xylenes in the water can be detected up to 9 km downstream of the spill location and at maximum concentrations of 1,000 mg/m³.

Behaviour of xylene in the atmosphere, 15 minutes after the spill, with a 3 m/s NW wind

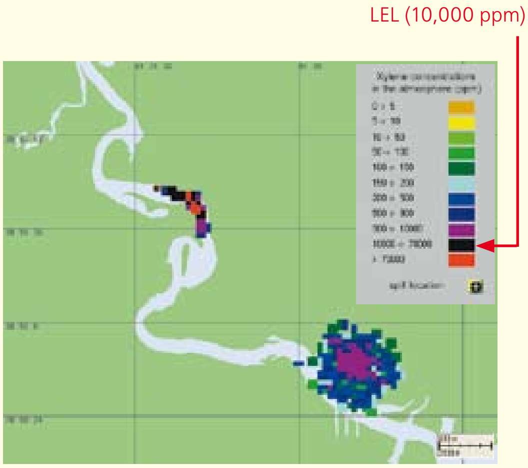


LEL (10,000 ppm)

Figure 33

15 minutes after the spill, atmospheric concentrations of xylenes of around 10,000 ppm are detected at the spill location; xylene concentrations of around 50 ppm are also observed 3 km downstream of the spill location.

Behaviour of xylene in the atmosphere, 15 minutes after the spill, with a 10 m/s NW wind



LEL (10,000 ppm)

Figure 34

15 minutes after the spill, xylene concentrations are near to the Upper Explosive Limit (UEL) up to 600 m downstream of the spill location (70,000 ppm). A cloud of the product is also detected 3 km downstream with maximum concentrations approaching 10,000 ppm.

Behaviour of xylene in the atmosphere, 30 minutes after the spill, with a 3 m/s NW wind

Figure 35

Xylenes are found in the atmosphere, 30 minutes after being spilt into the water, with maximum concentrations of 50 ppm 3 km downstream of the spill location and concentrations of 5 ppm up to 7 km downstream.

Behaviour of xylene in the atmosphere, 30 minutes after the spill, with a 10 m/s NW wind

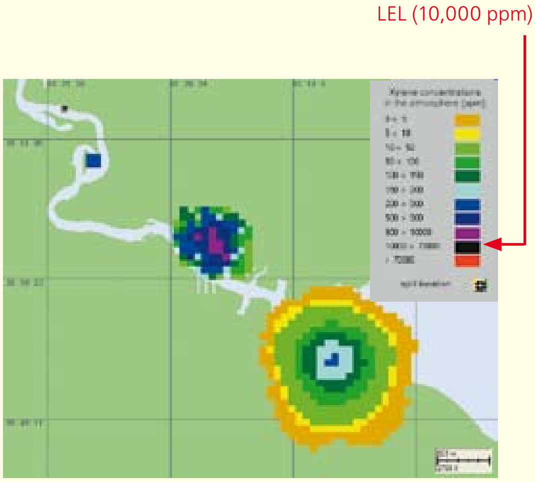


Figure 36

The atmospheric xylene concentrations are observed, 30 minutes after being spilt into the water, up to 4 km from the spill location at a maximum of 10,000 ppm and up to 6.5 m from the spill location at a concentration of 500 ppm.

Study of atmospheric concentrations: IDLH

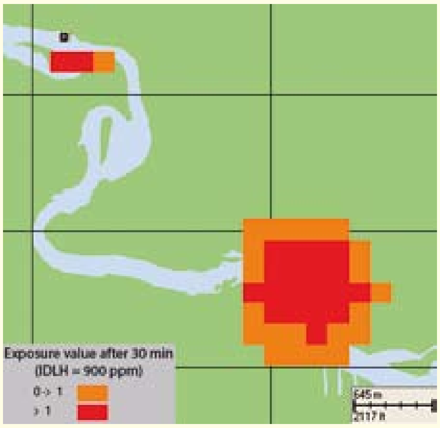


Figure 37

The IDLH level is reached up to 3 km southeast of the spill location.

Consumption scenarios

Due to the volatile nature of xylenes, their low solubility and their low potential to bioaccumulate along the food chain, it is unlikely that this chemical will exist in sufficiently large quantities to have an impact on humans who consume contaminated fish or seafood.

C3

Response

Examples of xylene spills

Grape One incident (Channel, 1993)

CEDRE, 2004

On 9 December 1993, the chemical tanker *Grape One* was sailing off the coast of Devon from the Tees to Haifa. She was loaded with 3,000 tonnes of xylene. The weather conditions were particularly bad that day. A ballast **tank ruptured** creating a 40 degree list. The 15 crew members were air-lifted to safety by helicopter. **The *Grape One* sank with her cargo**. No further response was implemented and **how much of the cargo was spilt remains unknown**.

Grounding of the *Ariadne* (Somalia, 1985)

TROCS, 2005

On 24 August 1985, the container ship *Ariadne* left the Port of Mogadishu in Somalia and **grounded on rocks about 100 metres from the shore**. The vessel was transporting a cargo of **118 containers** of hazardous chemicals, such as acetone, butyl acetate, tetraethyl lead, toluene, trichloroethylene and **xylene**.

As the ship began to list more and more, 14 containers fell into the sea. Attempts to salvage the ship began on 1st September, with the assistance of 2 salvage tugs and hydraulic pumps, but were unsuccessful. On 26 September, part of the deck collapsed and a fire started above one of the decks. Toxic fumes and chemical emissions drifted towards the city. The local authorities ordered the evacuation of a restricted number of inhabitants and companies in the port area. The following day, the vessel broke in two and large quantities of oil and cargo, including drums of chemicals, began to arrive on the shoreline. The Somali Government requested assistance. Five countries sent teams of experts specialised in areas such as salvage operations, fire fighting, spill response, chemistry, and environmental assessment, which arrived on 28 September. As of 29 September, 113 containers were able to be recovered, while heavy oil continued to be washed up on the coast. On 30 September, the rear part of the ship broke off further and began to list at a 90 degree angle.

On 2 October, despite the lack of protective clothing, a vast operation began to recover the cargo which had washed up on the shore. The merchandise collected was **transported to an area of the port for storage**. Leaking drums were plugged and chemicals were recovered by absorption using sand, both **without protective equipment**. Inspection of the storage area appeared rather casual and the personnel working in this area suffered from headaches, dizziness and nausea.

Response recommendations

All response actions must be carried out by trained personnel with the necessary equipment.

Is response possible?

Approach the accident area from upwind (wind behind you), and if possible upstream of the current, equipped with breathing apparatus and the appropriate protective equipment (cf. Personal Protective Equipment section). In the case of low current or a confined environment (e.g. harbour basin), take into account the spreading of the product.

Beware of leaks or spills of the product causing a major fire hazard or risk of explosion. The vapours are heavier than air and can spread across the ground: **the risk of explosion is very high at ground level.** Overflights should be prohibited during the first few hours following the spill. At sea, boats and other motor vehicles which may be a source of ignition should not approach the spill zone.

Response may be envisaged if the following precautions are taken:

1. Phase one: controlling the spill

- **Stop the spill or reduce the spill rate** if this is possible and not dangerous. The materials recommended for plugging a leak of xylene are polyester, polyester imide and epoxy resin resistant to seawater. If the spill occurs in a closed environment, ventilate before entering the area.
- **Remove all possible sources of ignition or heating. If possible, set up heat shields to prevent a fire from starting.**
- Set up water curtains to reduce the fire hazard and protect responders.
- **Reduce evaporation of the product by using a fluorocarbonated foaming agent to cover the surface, limit evaporation and thus reduce the xylene vapours.**
- Remove all sources of ignition, sparks or heating. Use fireproof material.
- Chemical spills can make surfaces slippery.

2. Phase two: vapour cloud + hot spot = fire/ explosion hazard

- Set up an exclusion zone around the area with a minimum radius of 1,000 metres. Xylene vapours can cover a large distance as far as a source of ignition and produce flashback. If a fire starts onboard a vessel and is too far on, all persons within a radius of 1,000 metres must be evacuated and the fire left to burn.
- Do not attempt to extinguish the flames before stopping the xylene spill or leak.
- Recommended fire extinguishers: carbon dioxide (CO_2), dry powder, foam. Water is not always effective but can be sprayed to reduce the combustion rate and cool the tanks.
- Fire extinguishers to be avoided: never use fire hoses (solid jet) as they may cause the flames to disperse further.
- Move the tanks of xylene away from the flames if it is possible and not dangerous. Otherwise, cool them with pressurised water to prevent an explosion, continuing to spray them after the flames have been extinguished.
- Keep away from the tank ends, and immediately evacuate if the safety valves begin to hiss, if the tank has such valves, or if the tank discolours due to heat.

Response techniques

Transshipment

- In the event of an emergency ship-to-ship transfer, prevent friction between the two hulls by taking the necessary precautions.
- The equipment used must be **fireproof**.
- **The lightering of a vessel** transporting xylene in bulk can be carried out by pumping. Lightering procedures should comply with the rules of good practice published by the OCIMF (Ship to Ship Transfer Guide – 2005 edition).
- The vapour pressure within the tank should be lowered by cooling or by releasing vapours at short intervals.
- The equipment needed will be: **steel pumps, unwelded alloy steel pipes and fittings** with chlorinated ether, polyvinylidene chloride or Viton seals. Flange joints are preferable to threaded fittings, which tend to cause leaks. Plastics are, however, **advised against**.
- It is also necessary to measure xylene concentrations using an explosimeter before beginning to pump.

Response

Depending on the circumstances surrounding the accident, the risk factor involved in leaving xylene to evaporate rather than attempting to recover in will vary.

At sea

Xylene is a colourless liquid; it is therefore **difficult to locate** a slick on water. Moreover, xylene slicks are **flammable and evaporate quickly**: recovery attempts therefore seem risky and ineffective, except in the case of a small spill in a port or harbour, for example, whereby the chemical can be **absorbed and recovered mechanically**.

In inland waters

- The slick can be, where technically possible, contained using **floating booms** positioned downstream to reduce the evaporation as well as the spreading of the xylene. The product can be recovered by **pumping** if action is taken before the product has completely evaporated.
- It is possible to use **skimmers** to remove the product, then apply **sorbents** to remove the final traces.

On land

- It is essential to prevent all polluted water from reaching the sewer system (risk of explosion) or any stream or river.
- **Pump off or absorb the liquid**. Do not cover the product with a tarpaulin (risk of creating an explosive atmosphere between the product and the tarpaulin); rather use foam or vermiculite.
- In the case of a shallow pool of xylene, use sand.
- Absorb the remaining chemical with sand, paper, sawdust, cloths or synthetic sorbent. In soil, the product is recovered using physical means (spades).
- The recovered product, as well as the polluted soil, should be **collected according to UN regulations** for disposal in a dangerous or special chemical waste plant.
- **Never use dispersants. Do not release this product into the environment.**

Choosing Personal Protective Equipment (PPE)

Ensure maximum protection. Xylenes produce flammable vapours at ambient temperatures.

Choosing breathing apparatus and protective clothing

The main risk is fire and vapours: use self-contained breathing apparatus (SCBA) as well as fireproof protective clothing.

Recommendations for use in the event of a spill (FINGAS, 2000)

- Self-contained breathing apparatus (SCBA) provides the best protection no matter what the product in question as the air supply is from an uncontaminated source. The user is independent of the surrounding atmosphere. Response personnel are normally trained to use SCBA; mask adjustment tests are recommended for new users and regular tests for other users in order to ensure optimal protection.
- Hose masks are suitable for static operations with a localised pollution risk; air line respirators are more suitable for mobile operations with diffuse or scattered pollution.
- Pressure demand and positive pressure, compressed air, open circuit (if the exhaled air is released into the atmosphere), self-contained breathing apparatus has a protection factor of around 10,000, i.e. it can ensure protection against up to 1,000,000 ppm of xylenes in the surrounding air (ELV = 100 ppm).
- Use SCBA to respond to an emergency situation:
  - if the oxygen concentration is, or is liable to become, less than 19%, or 21%, in volume
  - if the toxic concentration reaches or exceeds values greater than the threshold values or if it is unknown
  - in the event of a fire.
- The use of fireproof protection, as used by fire fighters, is recommended, with an F1 helmet to which the SCBA can be adapted.

Measures to take after using PPE in a spill situation

- Decontamination PPE used in response to an incident involving xylene is not possible.
- Used PPE should be collected together, put aside and treated appropriately as dangerous waste.

Permeation times through different materials (FORSBERG AND KEITH, 1995 - in FINGAS, 2005)

BETEX (butyl/neoprene): 10 min
Butyl: 30 min (variable)
Rubber: 2 min (variable)
Neoprene: 4 min (variable)
Nitrile: 60 min (variable)
Polyvinyl chloride: 1 min (variable)
Teflon: > 180 min
Viton: > 60 min

Chemical resistance (ANSELL)

Material	Breakdown	Permeation	Use
Nitrile	the liquid only induces slight breakdown	permeation time: 1.2 hour permeation rate: reasonable rate, < 900 µg/cm²/min (51 to 500 drops/hour pass through the glove)	suitable
Neoprene	it is inadvisable to expose this material to xylenes		unsuitable
Polyvinyl alcohol (PVA)	the liquid only induces minimal breakdown	no permeation detection during a 6 hour test permeation rate less than 0.9 µg/cm²/min (0 to ½ drop/hour passes through the glove)	very suitable
Polyvinyl chloride (PVC)	it is inadvisable to expose this material to xylenes		unsuitable
Natural rubber	it is inadvisable to expose this material to xylenes		unsuitable
Linear low density polyethylene (LLDPE)	no exposure test conducted for this product. However, the permeation time being > 8 hours, the breakdown ranking should be good or excellent.	permeation time: > 480 min permeation rate less than 0.9 µg/cm²/min (0 to ½ drop/hour passes through the glove)	very suitable

Note: this chemical resistance table is intended simply to give an indication of relative values. An assessment in the real conditions of usage should be carried out.

Measuring devices and waste treatment

Measuring devices (INRS, 2004)

Xylenes belong to the family of volatile organic compounds (VOCs) and more specifically that of monocyclic aromatic compounds (BTEX).

- Methods of detection and measurement in water:

- Sampling in water: with a sealed brown tube (penicillin tube), kept at 4°C until it is analysed.
- Extraction using an apolar solvent, using the "static headspace" method or the "purge and trap" method.
- Dosage by separating compounds by GPC and detection by FID, PID or MS.

Methods of detection and measurement in air:

- Dynamic or passive sampling on a tube of activated carbon.
- Chemical desorption of xylenes by carbon disulphide.
- Separation by GPC and detection by FID, PID or MS.

Waste treatment

Xylenes or waters polluted by xylenes should never be directly discharged into drains or surface waters; they should first be neutralised, either at the spill location or at a water treatment plant.

Examples of European suppliers of xylenes (ECB, 2005)

Total Petrochemicals, Exxon Chemical, Shell,...

Further information

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.

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_{50})
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_{50})
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.

pKa
The term pKa is the cologorithm of Ka, the acid dissociation constant to distinguish acids and bases.
$Ka = ([base] \times [H_3O^+])/[acid]$
$pH = pKa + \log [base]/[acid]$

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.

Source of ignition
Examples of sources of ignition: heat, sparks, flame, static electricity and friction. Sources of ignition should always be eliminated when handling flammable products or responding to an emergency in risky areas (use explosion proof pumps and VHF walky-talkies).

Surface roughness
Length of a transfer area between the atmospheric layer and a contact surface. This will depend on the average size of the roughness of the contact and atmospheric parameters near the water surface. When the sea is calm it is of the order of 0.02 to 0.06 cm.

Surface tension
A constant that expresses the force owing to molecular interaction exerted at the surface of a liquid when it comes into contact with another surface (liquid or solid) and that affects surface dispersion.

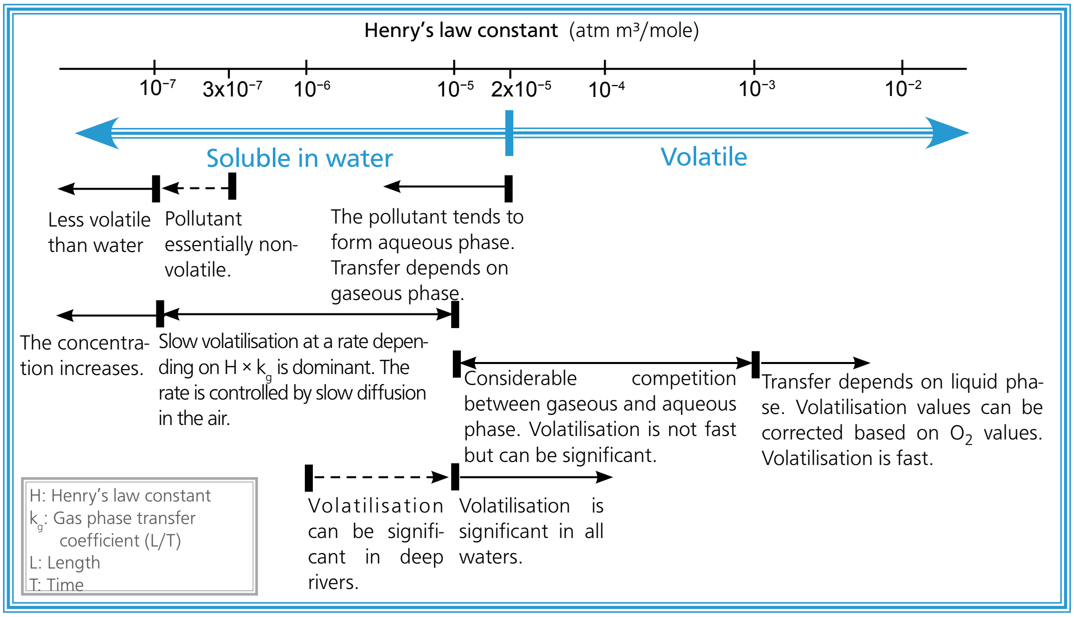
Temporary Emergency Exposure Limits (TEEL)
Exposure times when there is no ERPG.
TEEL 0 is the threshold concentration below which a large part of the population will experience no effect on health. TEEL 1 is equivalent to ERPG1, TEEL 2 is equivalent to ERPG2 and TEEL 3 is equivalent to ERPG3.

Threshold Limit Value (TLV)
Average limit value (weighted as a function of time) that people can be exposed to regularly at work 8 hours a day, 5 days a week without experiencing noxious effects. This value was defined and determined by ACGIH.
TLV-STEL: Mean weighted 15 minutes concentration that must never be exceeded at any time during the day.
TLV-TWA: Mean weighted values for an 8 hour period per day and 40 hours a week.
TLV-ceiling Ceiling values never to be exceeded not even for an instant.

Unconfined Vapour Cloud Explosion (UVCE)
Explosion of a gas cloud or slick of combustible vapours in an unconfined environment.

Upper Explosive Limit (UEL)
Maximum airborne concentration of a compound above which vapours will not ignite for lack of oxygen.

Vapour pressure or tension
Partial pressure of gas molecules in a state of equilibrium with the liquid phase for a given temperature.



Characteristics of volatilisation associated with different Henry's law constant values (*Lyman et al.*, 1990).

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
FID	Flame Ionisation Detector
GPC	Gas Phase Chromatography
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	Remote 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

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

European Chemicals Bureau
http://ecb.jrc.it

ICSC (International Chemical Safety Cards)
http://www.cdc.gov/niosh/ipcs/ipcscard.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.inchem.org/

NIOSH (US National Institute for Occupational Safety and Health)
http://www.cdc.gov/niosh/idlh/intridl4.html

NOAA (US National Oceanic and Atmospheric Administration), historical incident search page
http://www.noaa.gov/ocean.html

TP (Total Petrochemicals)
http://www.totalpetrochemicals.com/en/index.asp

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

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http://tis.eh.doe.gov/web/chem_safety/teel.html

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http://www.epa.gov

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http://www.reptox.csst.qc.ca/Produit.asp?no_produit=1206&nom=Xyl%E8ne+%28para%2D%29, and
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http://www.cdc.gov/niosh/ipcsneng/neng0084.html, and
http://www.cdc.gov/niosh/ipcsneng/neng0086.html.
(Pages visited in September 2006).

US EPA (US Environmental Protection Agency). *Acute Exposure Guideline Levels (AEGL) for xylenes.*
Available at:
http://www.epa.gov/oppt/aegl/pubs/results85.htm.
(Page visited in September 2006).

ANNEXES

Annex 1: summary and additional physical and toxicological data

Annex 2: fax format data card

Annex 3: classification of noxious liquid substances (valid since 01/01/2007)

Annex 4: behaviour graphs

- results of Channel scenario (1 page)
- results of wreck scenario (1 page)
- results of river scenario (1 page)

ANNEX 1: SUMMARY AND ADDITIONAL PHYSICAL AND TOXICOLOGICAL DATA

Classification

(CHRIS, 1999 AND INRS, 1997)

mixed xylenes	CAS n°: 90989-38-1 EC n° (EINECS): 292-694-9 Index n°: 648-010-00-X	Classification for transportation UN N°: 3295 Class: 3
mixed isomers (o, m, p)	CAS n°: 1330-20-1 EC n° (EINECS): 215-535-7 Index n°: 648-010-00-X	Classification for transportation UN N°: 1307 Class: 3
o-xylene	CAS n°: 95-47-6 EC n° (EINECS): 202-422-2 Index n°: 601-022-00-9	
p-xylene	CAS n°: 106-42-3 EC n° (EINECS): 203-396-5 Index n°: 601-022-00-9	

Physical data

(TP SDS, 2006)

	mixed xylenes	o-xylene	p-xylene
Physical state	liquid		
Colour	colourless		
Odour	sweet-smelling		
Olfactory threshold		5.4 ppm (CSST, 2002)	0.7 ppm (CSST, 2000)
Molecular mass	106 g/mol		
Melting point	< - 35°C	around - 25°C	around 13°C
Initial boiling point	> 139°C	> 144.4°C	> 138°C
Final boiling point	< 141°C	-	-
Critical temperature	350°C at 3 600 kPa	357.4°C at 3 730 kPa	343.5°C at 3 510 kPa
Vapour tension	8.9 hPa at 20°C 47 hPa at 50°C	8.9 hPa at 20°C	11.5 hPa at 20°C
Relative vapour density (air = 1)	3.7	3.7	3.7
Volumic mass at 15°C	860 to 880 kg/m^3	882 to 885 kg/m^3	860 to 880 kg/m^3
Solubility in water at 20°C	175 to 200 mg/l	175 mg/l	200 mg/l
pH	N/A		
Viscosity at 20°C	< 0.9 mm^2/s	< 0.9 mm^2/s	< 0.62 mm^2/s

Solubility in water for mixed isomers (CEDRE, 2005)	**25°C, 0‰**		**10°C, 34‰**	
	Average concentration (mg/L)	**Standard deviation**	**Average concentration (mg/L)**	**Standard deviation**
Maximum dispersion	3076.8	646.8	1134.23	10.99
Natural dispersion without filtration	767.7	163.9	407.5	11.26
Natural dispersion with filtration	144	11.8	104.26	3.02
Molecular diffusion	50.42	9.47	40.46	1.01

Toxicological data

Acute human toxicity

(TP SDS, 2005 - CEDRE, 2000)

- By inhalation: headaches, drowsiness, irritation of mucous membranes in the nose and throat, breathing difficulties, dizziness, nausea, tremors, visual difficulties, loss of consciousness. In very high concentrations (> 10,000 ppm): pulmonary oedema, narcosis, coma, death.
- By contact with skin: drying out of the skin, irritation, erythema and dermatitis.
- By contact with eyes: irritation of the conjunctiva, development of corneal ulcers.
- By ingestion: digestive troubles (stomach pains, nausea, cramps, vomiting, diarrhoea), hepatic and renal lesions in the case of high concentrations.

Chronic human toxicity

(TP SDS, 2006 - INRS, 2004 – INERIS, 2005)

Exposure to mixed xylenes via the lungs and skin can lead to:
- irritation of the eyes
- breathing difficulties
- cardio-vascular problems
- stomach pains
- haematological and immunological effects
- hepatic and renal problems
- neurological problems, headaches, dizziness, faintness, irritability, memory loss and lack of concentration.

Important note:
The interpretation of data gathered through epidemiological studies is difficult due to insufficient knowledge of concentrations and exposure times, as well as the possibility of previous and/or simultaneous exposure to other solvents (in particular benzene).

Threshold toxicological values

(TP SDS, 2006 – INERIS, 2005 – NIOSH, 1995)

Occupational exposure values
MEV (France): 221 mg/m^3 = 50 ppm
ELV (France): 442 mg/m^3 = 100 ppm
TLV-TWA (ACGIH): 442 mg/m^3 = 100 ppm

Risk management values for the population
IDLH (NIOSH): 3,980 mg/m^3 = 900 ppm
TLV-STEL (ACGIH): 663 mg/m^3 = 150 ppm
TEEL 0: 442 mg/m^3 = 100 ppm
TEEL 1: 663 mg/m^3 = 150 ppm
TEEL 2: 884 mg/m^3 = 200 ppm
TEEL 3: 3,980 mg/m^3 = 900 ppm

Specific effects

(TP SDS, 2006)

Effects on development: no data available
Effects on reproduction: no data available
Carcinogenic effects: group 3 (IARC) = not classifiable as to carcinogenity to humans

Toxicity indices

AEGLs for xylenes (CAS n° 1330-20-7) (US EPA, 2006)

Duration (minutes)	10	30	60	240	480
AEGL-1 (ppm)	130	130	130	130	130
AEGL-2 (ppm)	2,500	1,300	920	500	400
AEGL-3 (ppm)	-	3,600	2,500	1,300	1,000

Ecotoxicological data

Acute ecotoxicity (INERIS, 2005)

<table>
<tr><th>Species</th><th>Impact criterion</th><th>mixed xylenes (mg/L)</th><th>p-xylene (mg/L)</th><th>o-xylene (mg/L)</th></tr>
<tr><td rowspan="2">Crustacean
(<i>Daphnia magna</i>)
fresh water</td><td rowspan="2">EC_{50} (48h)</td><td colspan="3">xylene (mixed isomers): 3.2 to 9.6 TP SDS, 2006</td></tr>
<tr><td>ethylbenzene: 1.8 to 2.4
TP SDS, 2006</td><td>3.6
INERIS, 2005</td><td>1.0
INERIS, 2005</td></tr>
<tr><td>Crustacean
(<i>Crangon franciscorum</i>)
sea water</td><td>EC_{50} (96h)</td><td>-</td><td>1.7</td><td>1.3</td></tr>
<tr><td>Fish
(<i>Oncorhynchus mykiss</i>)
fresh water</td><td>EC_{50} (96h)</td><td>-</td><td>2.6</td><td>7.6</td></tr>
<tr><td rowspan="2">Algae
(<i>Selenastrum capricornutum</i>)
fresh water</td><td rowspan="2">EC_{50} (72h)</td><td colspan="3">xylene (mixed isomers): 3.2 to 4.9 TP SDS, 2006</td></tr>
<tr><td>ethylbenzene: 3.6
TP SDS, 2006</td><td>3.2
INERIS, 2005</td><td>4.7
INERIS, 2005</td></tr>
</table>

Chronic ecotoxicity (INERIS, 2005)

Species	Impact criterion	p-xylene (mg/L)	o-xylene (mg/L)
Algae (*Selenastrum capricornutum*) fresh water	8 day NOEC	0.9	1.0

PNEC (Predicted No-Effect Concentration): (INERIS, 2005)
In the absence of long term results on fish and daphnia for the 3 isomers, the results of the acute ecotoxicity tests will be used to determine the $PNEC_{water}$. The European Commission can therefore apply an extrapolation factor of 1,000 to the EC_{50} of the most sensitive species. However, according to INERIS' estimations, it is likely that the 3 isomers act by a non polar narcotic mechanism. An extrapolation factor of 100 therefore seems sufficient to calculate the $PNEC_{water}$.

p-xylene	$PNEC_{water}$: 26 µg/L
o-xylene	$PNEC_{water}$: 10 µg/L

ANNEX 2: FAX FORMAT DATA CARD

mixed xylenes	CAS n°: 90989-38-1 EC n° (EINECS): 292-694-9 Index n°: 648-010-00-X	Classification for transportation UN N°: 3295 Class: 3
mixed isomers (o, m, p)	CAS n°: 1330-20-1 EC n° (EINECS): 215-535-7 Index n°: 648-010-00-X	Classification for transportation UN N°: 1307 Class: 3
o-xylene	CAS n°: 95-47-6 EC n° (EINECS): 202-422-2 Index n°: 601-022-00-9	
p-xylene	CAS n°: 106-42-3 EC n° (EINECS): 203-396-5 Index n°: 601-022-00-9	

First aid information

Wear breathing apparatus. The effects caused by exposure can be deferred. In the event of a spill of xylenes, the risk of fire is very high. Responders must wear protective clothing designed for fire fighting.

Intoxication by inhalation
- Move the victim into the open air and lie them down.
- Give the victim air or oxygen intermittently if they have difficulty breathing.
- Apply artificial respiration if the victim has stopped breathing.
- Transfer to hospital immediately.

Skin contact
- Immediately remove all soiled or spotted clothes; do not remove clothing which is stuck to the skin.
- Clean the affected parts immediately and at length with soap and water.
- Transfer to hospital in the event of serious contamination.

Contact with eyes
- Rinse immediately and at length with plenty of water keeping the eyelids open.
- Consult an ophthalmologist if the irritation persists.

Intoxication by ingestion
- Do not make the victim drink any liquids and do not induce vomiting.
- Treat with activated carbon if large quantities have been ingested.

If you suspect aspiration into the lungs, during vomiting for instance, transport the victim to hospital immediately.

Physical data

	mixed xylenes	o-xylene	p-xylene
Physical state	liquid		
Colour	colourless		
Odour	sweet-smelling		
Olfactory threshold		5.4 ppm	0.7 ppm
Molecular mass	106 g/mol		
Melting point	< - 35°C	around - 25°C	around 13°C
Initial boiling point	> 139°C	> 144.4°C	> 138°C
Final boiling point	< 141°C	-	-
Critical temperature	350°C at 3,600 kPa	357.4°C at 3,730 kPa	343.5°C at 3,510 kPa
Vapour pressure/ tension	8.9 hPa at 20°C 47 hPa at 50°C	8.9 hPa at 20°C	11.5 hPa at 20°C
Relative vapour density (air = 1)	3.7	3.7	3.7
Volumic mass at 15°C	860 to 880 kg/m^3	882 to 885 kg/m^3	860 to 880 kg/m^3
Solubility in water at 20°C	175 to 200 mg/l	175 mg/l	200 mg/l
pH	N/A		
Viscosity at 20°C	< 0.9 mm^2/s	< 0.9 mm^2/s	< 0.62 mm^2/s

EU Classification:

Xn: Harmful

Flammable

R10: Flammable
R20/21/22: Harmful by inhalation and in contact with skin
R38: irritating to skin
R65: Harmful: may cause lung damage if swallowed
S2: Keep out of reach of children
S16: Keep away from sources of ignition. No smoking.
S25: Avoid contact with the eyes
S65: If swallowed, do not induce vomiting. Seek medical advice immediately and show the container or label.

Avril 2007

Toxicological data

Acute human toxicity

- By inhalation: headaches, drowsiness, irritation of mucous membranes in the nose and throat, breathing difficulties, dizziness, nausea, tremors, visual difficulties, loss of consciousness.

In very high concentrations (> 10 000 ppm): pulmonary oedema, narcosis, coma, death.

- By contact with skin: drying out of the skin, irritation, erythema and dermatitis.
- By contact with eyes: irritation of the conjunctiva, development of corneal ulcers.
- By ingestion: digestive troubles (stomach pains, nausea, cramps, vomiting, diarrhoea), hepatic and renal lesions in the case of strong concentrations.

Specific effects

Effects on development: no data available
Carcinogenic effects: group 3 (IARC) = not classifiable as to carcinogenity to humans
Effects on reproduction: no data available

Chronic human toxicity

Exposure to mixed xylenes via the lungs and skin can lead to:
- irritation of the eyes
- breathing difficulties
- cardio-vascular problems
- stomach pains
- haematological and immunological effects
- hepatic and renal problems
- neurological problems headaches, dizziness, faintness, irritability, memory loss and lack of concentration.

Threshold toxicological values

Occupational exposure values
MEV (France): 221 mg/m^3 = 50 ppm
ELV (France): 442 mg/m^3 = 100 ppm
TLV-TWA (ACGIH): 442 mg/m^3 = 100 ppm

Risk management values for the population
IDLH (NIOSH): 3,980 mg/m^3 = 900 ppm
TLV-STEL (ACGIH): 663 mg/m^3 = 150 ppm
TEEL 0: 442 mg/m^3 = 100 ppm
TEEL 1: 663 mg/m^3 = 150 ppm
TEEL 2: 884 mg/m^3 = 200 ppm
TEEL 3: 3,980 mg/m^3 = 900 ppm

AEGLs for xylenes

Duration	10 minutes	30 minutes	1 hour	4 hours	8 hours
AEGL-1 (ppm)	130	130	130	130	130
AEGL-2 (ppm)	2,500	1,300	920	500	400
AEGL-3 (ppm)	-	3,600	2,500	1,300	1,000

Ecotoxicological data

Acute ecotoxicity

Species	Impact criterion	mixed xylene (mg/L)	p-xylene (mg/L)	o-xylene (mg/L)
Crustacean (*Daphnia magna*) fresh water	EC$_{50}$ (48h)	xylene (mixed isomers): 3.2 to 9.6		
		ethylbenzene: 1.8 to 2.4	3.6	1.0
Crustacean (*Crangon franciscorum*) sea water	EC$_{50}$ (96h)	-	1.7	1.3
Fish (*Oncorhynchus mykiss*) fresh water	EC$_{50}$ (96h)	-	2.6	7.6
Algae (*Selenastrum capricornutum*) fresh water	EC$_{50}$ (72h)	xylene (mixed isomers): 3.2 to 4.9		
		ethylbenzene: 3.6	3.2	4.7

Chronic ecotoxicity

Species	Impact criterion	p-xylene (mg/L)	o-xylene (mg/L)
Algae *(Selenastrum capricornutum)* fresh water	NOEC 8d	0.9	1.0

PNEC (Predicted No-Effect Concentration)
In the absence of long term results on fish and daphnia for the 3 isomers, the results of the acute ecotoxicity tests will be used to determine the PNEC$_{water}$. The European Commission can therefore apply an extrapolation factor of 1,000 to the EC$_{50}$ of the most sensitive species.
However, according to INERIS estimations, it is likely that the 3 isomers act by a non polar narcotic mechanism. An extrapolation factor of 100 therefore seems sufficient to calculate the PNEC$_{water}$.

p-xylene	PNEC$_{water}$: 26 µg/L
o-xylene	PNEC$_{water}$: 10 µg/L

Persistence in the environment

- **Behaviour**

The product evaporates into the atmosphere.

Generally speaking, the vast majority (99.7%) of xylenes released in the environment end up in the atmosphere.

In soil and sediments, their adsorption is moderate (log Koc = 2.1/2.5); xylenes tend to leach into deeper soils.

When spilt in water, xylenes will spread over the water surface, where a small fraction may dissolve.

- **Volatilisation**

Xylenes evaporate from surface waters; the calculated half life of mixed isomers in the air is 16 to 28 hours and 1 day for ethylbenzene.

- **Biodegradation**

In water, and in an aerobic environment, xylenes are intrinsically biodegradable; in an anaerobic environment, they are biodegradable in denitrification conditions.

Xylene isomers are easily broken down in the atmosphere, mainly by photo-oxidation. The phenomenon of atmospheric oxidation of xylenes is rapid, by reaction with free radicals and hydroxyl radicals. The BOD5/ThOD ratio is greater than 0.5 for the mixed isomers.

- **Bioaccumulation**

According to the Kow and BCF values, the bioaccumulation potential of xylenes in aquatic organisms is low to moderate.

- **MARPOL classification:** C until 31/12/2006
  Y since 01/01/2007
- **SEBC classification:** FE (floats and evaporates)

Information on flammability

Xylenes are flammable when exposed to a source of ignition or in the presence of oxidizing agents. The vapours, which are heavier than air, can cover a considerable distance and reach a source of ignition, causing flashback.
Xylenes can accumulate static charge when agitated or when running through pipes. This can cause their vapours to ignite.

	mixed xylenes	o-xylene	p-xylene
Flash point in closed cup	> 23°C	> 23°C	> 24°C
Self-ignition temperature	465 to 525°C	> 464°C	> 540°C
LEL (% of volume)	1	1	1
UEL (% of volume)	9	7	7
Combustion rate	5.8 mm/min		

Particular risks

- **Polymerisation: N/A**
- **Danger**:
- Fire: Xylenes are very flammable and their vapours can cover a large distance as far as a source of ignition and produce flashback. In the heat of a fire, xylenes can break down, giving off toxic and irritating fumes.
- Explosion: When a receptacle containing xylenes is heated, there is an increase in pressure leading to a risk of the container bursting and a possibility of explosion (BLEVE). Xylene vapours form explosive mixtures upon contact with air at high temperatures.

The vapours are invisible and heavier than air. They spread out across the ground and can infiltrate drains and underground systems.

Friction caused by the product flowing can create a charge of static electricity, which can lead to sparks resulting in ignition or explosion.

- **Stability and reactivity**
- This product is stable in normal conditions of storage, handling and usage.
- Conditions to be avoided: keep away from hot surfaces, flames, static electricity and sparks.
- Substances to be avoided: avoid strong acids and oxidants, as well as certain rubbers and plastics (natural rubber, butyl, nitrile, polychloroprenes, polyethylene...).
- Decomposition products:

Complete combustion, in the presence of excess air, produces carbon dioxide (CO_2) and water vapour.
Incomplete combustion produces substances including carbon monoxide (CO), soot and cracking products such as aldehydes and ketones.

Transportation

Transportation of mixed xylenes
Identification n° (UN): 3295
Transportation of o-xylene and p-xylene
Identification n° (UN): 1307

Land transportation:
RID (rail) /ADR (road)
Danger n°: 30
Class: 3
Packaging group: III
Classification code: F1
Labels: 3

Transportation via inland waterways: ADN/ADNR
Class: 3
Packaging group: III
Classification code: F1
Labels: 3

Maritime transport: IMDG
Class: 3
Subsidiary risk: -
Packaging group: III
Marine pollutant (MP): No
Labels: 3

Air freight: IATA
Class: 3
Subsidiary risk: -
Packaging group: III
Labels: Class 3 - Flammable liquid

Handling

- Keep xylenes in a well ventilated place.
- Store away from direct sunlight and other sources of radiation.
- Prevent the formation and spreading of vapours, fumes and aerosols in the atmosphere (in particular, during loading/unloading of the product).
- Avoid contact with the skin and eyes
- Do not eat, drink or smoke during handling.
- In the event of possible exposure, use appropriate protective clothing, especially gloves.
- Store away from sources of heat, prevent accumulation of static electricity by grounding the equipment.
- Where possible, avoid using air for transferring the product.
- Transfer the chemical at a low speed (static electricity).
- Take specific precautions when the use or transformation of the product is liable to produce stable emulsions with water.

Storage

- Only use containers, joints, piping etc. which is resistant to aromatic hydrocarbons.
- Keep away from sources of ignition. Do not smoke.
- Apply safety regulations for flammable liquids.
- Provide a retention tank.

Incompatible products: avoid strong acids and oxidants.

Packaging materials to be avoided: plastics.

Recommended packaging materials:
- Store xylenes in steel or stainless steel containers.
- Glass can also be used for small quantities: carboys should be protected with a more resistant, suitable adjusted metal cover.

April 2007

ANNEX 3: CLASSIFICATION OF NOXIOUS LIQUID SUBSTANCES (valid since 01/01/07)

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

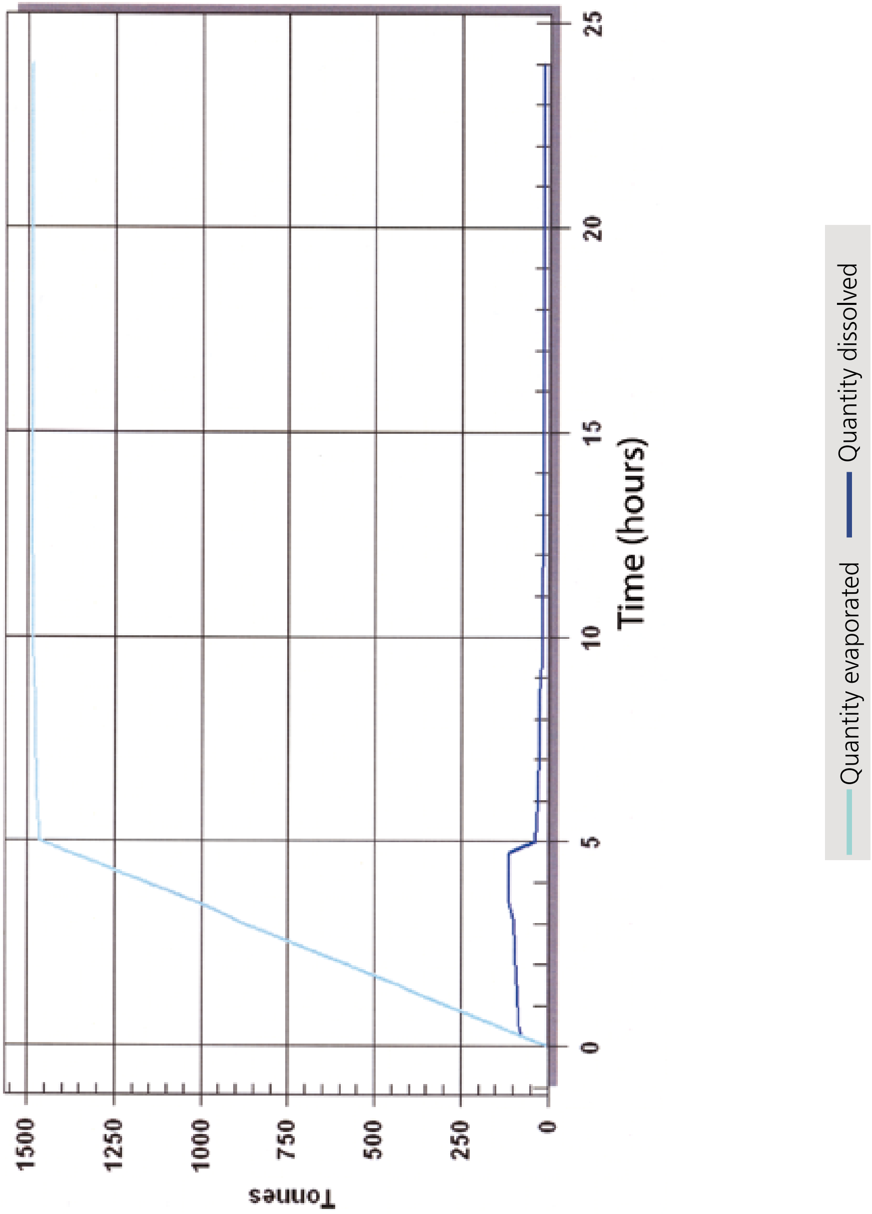
Other Substances: Substances which have been evaluated and found to fall outside Category X, Y or Z because they are considered to present no harm to marine resources, human health, amenities or other legitimate uses of the sea when discharged into the sea from tank cleaning of deballasting operations.

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.

ANNEX 4: BEHAVIOUR GRAPHS

Results of the Channel scenario

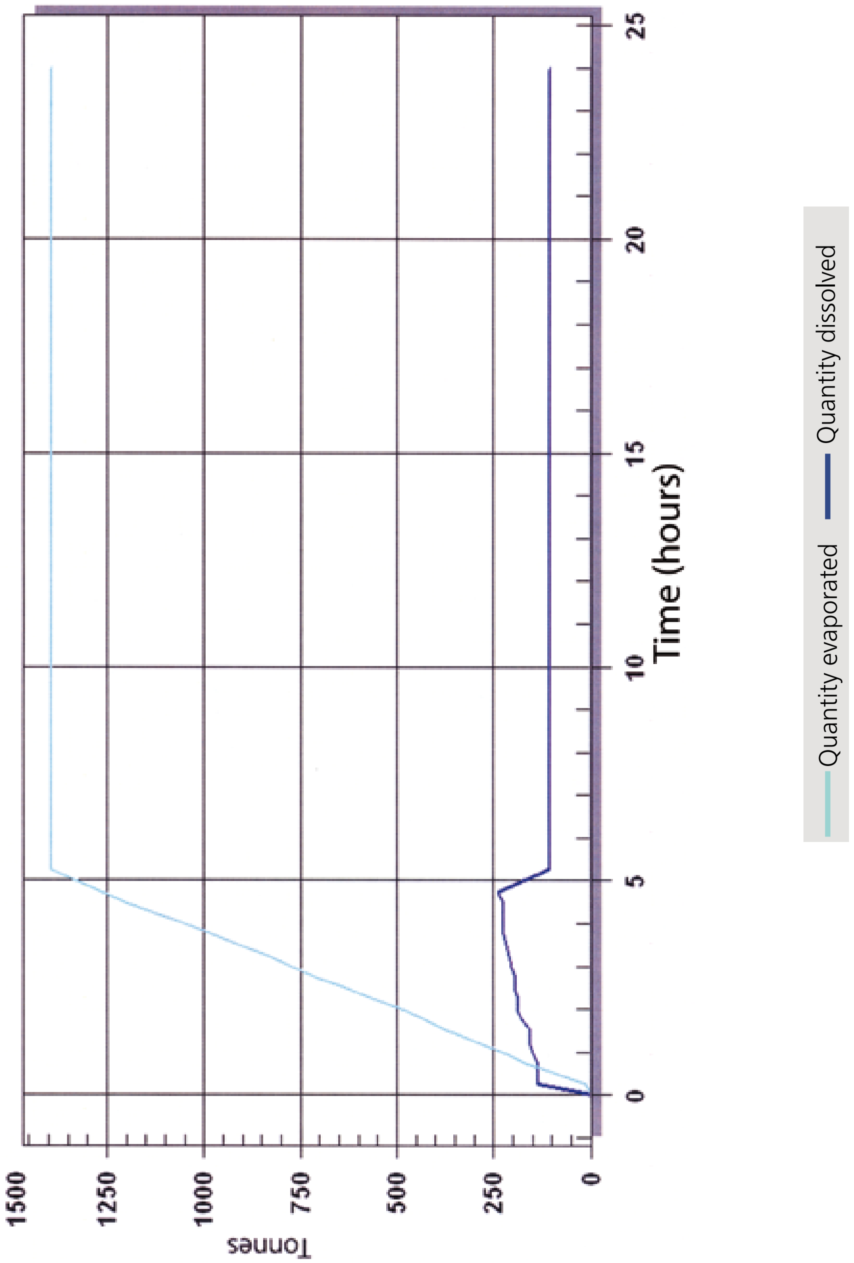
Spill of 1,500 t of xylenes over 5 hours (300 t/h) with a NW wind of 3 m/s.



Whatever the wind speed, 3 or 10 m/s, almost all the xylenes spilt in the water are found in the atmosphere within 5 hours. A small part dissolves.

Results of the wreck scenario

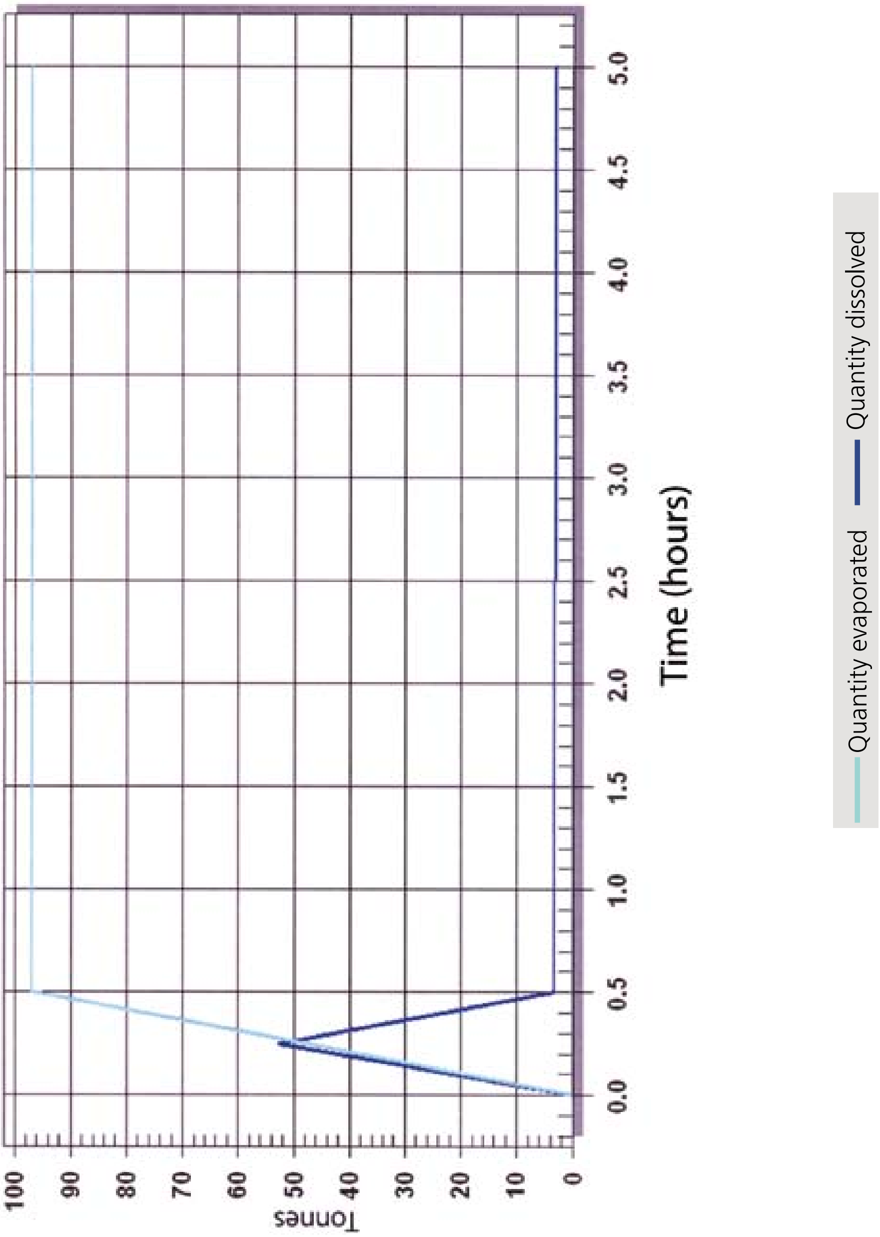
Spill of 1,500 tonnes of xylenes over 5 hours in the Channel from a wreck lying at a depth of 80 metres.



Almost all the xylenes spilt are found in the atmosphere within 5 hours after the spill. A small part dissolves.

Results of the river scenario

Spill of 100 tonnes of xylenes over 30 minutes, with a current speed of 0.12 m/s and a 3 m/s NW wind.



Whatever the wind and current speed, all the xylenes (98%) spilt in the fresh water are found in the atmosphere in less than 30 minutes.