

THE 1973 MARINE POLLUTION CONVENTION'S IMPACT ON SHIPS TRANSPORTING HAZARDOUS MATERIALS*

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Summary

In October 1973, 70 nations met under the auspices of the Inter-Governmental Maritime Consultative Organization (IMCO) and adopted the International Convention for the Prevention of Pollution from Ships, 1973. This new Convention will regulate discharges of oil, noxious chemicals, sewage, and garbage into the sea. The Convention also includes control provisions for ensuring that vessels comply with its provisions.

The transportation of chemicals in bulk impacts or threatens the marine environment in two ways: first, through the intentional discharge of tank washings; and second, through the accidental discharge of cargo following a casualty. Prior to the 1973 Convention there were no internationally accepted regulations controlling the *intentional* discharge; IMCO had, however, begun addressing the problem of minimizing *accidental* pollution by developing a recommended Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, (IMCO Resolution A. 212 (VII)). Annex II of the new Convention provides the international controls for limiting intentional discharges and requires that Contracting States implement the Code. Taken together these provisions substantially fulfill the objective of the 1973 Conference, *i.e.*, "... the achievement by 1975 if possible, but certainly by the end of the decade, the complete elimination of the willful and intentional pollution of the seas by oil and noxious substances other than oil, and the minimization of accidental spills ..." (IMCO Assembly Resolution A. 237 (VII)).

Introduction

In October 1973 the United States along with 70 other nations met in London, England, under the auspices of the Inter-Governmental Maritime Consultative Organization (IMCO), and adopted the International Convention for the Prevention of Pollution from Ships, 1973. When ratified, this new Convention will regulate discharge of oil, noxious chemicals, sewage, and garbage into the sea. While efforts to control oil pollution from ships internationally go back a very long way, the 1973 Convention is the first internationa

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effort to control the intentional and accidental pollution from ships that transport hazardous materials.

The main objective of the London Conference, at which the new Convention was negotiated was "... the achievement by 1975 if possible, but certainly by the end of the decade, of the complete elimination of the willful and intentional pollution of the seas by oil and noxious substances other than oil, and the minimization of accidental spills ..." (IMCO Assembly Resolution A. 237 (VII)). The 1973 Convention substantially fulfills this objective [1, 2, 3].

To put the 1973 Convention into perspective, it should be viewed as one of a series of international agreements concerning the protection of the marine environment which has been developed since 1969. These agreements include the 1969 Intervention Convention, the 1969 Civil Liability Convention, the 1971 Compensation Fund Convention, and the 1972 Ocean Dumping

TABLE 1

International Convention for the Prevention of Pollution from Ships, 1973

Preamble

Article	<ol style="list-style-type: none"> 1. General obligation under the Convention 2. Definitions 3. Application 4. Violation 5. Certificates and special rules on inspection of ships 6. Detection of violations and enforcement of the Convention 7. Undue delay of ships 8. Reports of incidents involving harmful substances 9. Other treaties and interpretation 10. Settlement of disputes 11. Communication of information 12. Casualties to ships 13. Signature, ratification, acceptance, approval and accession 14. Optional annexes 15. Entry into force 16. Amendments 17. Promotion of technical cooperation 18. Denunciation 19. Deposit and registration 20. Languages
Annex I	— Regulations for the prevention of pollution by oil
Annex II	— Regulations for the control of pollution by noxious substances in bulk
Annex III	— Regulations for the prevention of pollution by harmful substances carried by sea in packaged forms or in freight containers, portable tanks or road and rail tank wagons
Annex IV	— Regulations for the prevention of pollution by sewage from ships
Annex V	— Regulations for the prevention of pollution by garbage from ships

Convention, as well as the 1973 Protocol which extended the Intervention Convention to include hazardous materials.

The Convention contains two main sections; the first contains the Articles of the Convention, and the second contains five technical annexes. The outline of the Convention is shown in Table 1. As is noted in Table 1, the Articles contain the basic legal and administrative provisions of the Convention. The Annexes, on the other hand, contain the technical regulations for controlling pollution (discharge) from ships.

The Convention comes into force 12 months after 15 states representing at least 50% of the gross tonnage of the world's merchant shipping have become parties to it. Annexes I and II are mandatory annexes: they must be accepted by a state without reservation of any kind when it becomes a party to the Convention. Annexes III, IV, and V are known as "optional annexes".

A state, at the time of becoming a party to the Convention, may declare that it does not accept any one or all of Annexes III, IV, and V. An optional annex would come into force 12 months after the above-mentioned conditions have been fulfilled for that annex and would operate only between those nations accepting the annex.

Annex II

The transportation of hazardous materials in bulk impacts or threatens the marine environment in two ways: first, through the intentional discharge of tank washings and second, through the accidental discharge of cargo following a casualty. Prior to the 1973 Convention there were no internationally accepted regulations controlling the *intentional* discharge; IMCO had, however, begun addressing the problem of minimizing *accidental* pollution by developing a recommended Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, (IMCO Resolution A. 212 (VII)). It is the purpose of Annex II to provide the international regulations and controls needed to limit intentional discharges and to set minimum vessel standards that would limit accidental discharges.

Regarding controlling intentional pollution, the Annex follows a three-step process. First, the substances are evaluated and categorized according to their hazard; second, discharge regulations (limits) are prescribed depending upon the category; and third, control procedures to ensure compliance are provided.

Hazard evaluations and categorization

During the pre-conference preparations at IMCO, it was recognized that an internationally agreed hazard evaluation system would be essential if the desire to set international pollution control standards for noxious substances was to be successful. The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), a group sponsored by several United Nations' agencies, developed, at the request of IMCO, the needed hazard evaluation

system. This system [4] (a portion is reproduced as Appendix 1) evaluates substances in each of the following five areas:

- (1) bioaccumulation
- (2) damage to living resources
- (3) hazard to human health (oral intake)
- (4) hazard to human health (skin contact and inhalation)
- (5) reduction of amenities

The GESAMP system was used at the London Conference to evaluate and categorize the substances along the agreed guidelines shown in Table 2.

TABLE 2

Guidelines for the categorization of noxious liquid substances

<i>Category A:</i>	Substances which are bioaccumulated and liable to produce a hazard to aquatic life or human health; or which are highly toxic to aquatic life (as expressed by a Hazard Rating 4, defined by a TLM less than 1 ppm); and additionally certain substances which are moderately toxic to aquatic life (as expressed by a Hazard Rating 3, defined by a TLM of 1 or more, but less than 10 ppm) when particular weight is given to additional factors in the hazard profile or to special characteristics of the substance.
<i>Category B:</i>	Substances which are bioaccumulated with a short retention of the order of one week or less; or which are liable to produce tainting of the sea food; or which are moderately toxic to aquatic life (as expressed by a Hazard Rating 3, defined by a TLM of 1 ppm or more, but less than 10 ppm); and additionally certain substances which are slightly toxic to aquatic life (as expressed by a Hazard Rating 2, defined by a TLM of 10 ppm or more, but less than 100 ppm) when particular weight is given to additional factors in the hazard profile or to special characteristics of the substance.
<i>Category C:</i>	Substances which are slightly toxic to aquatic life (as expressed by a Hazard Rating 2, defined by a TLM of 10 or more, but less than 100 ppm); and additionally certain substances which are practically non-toxic to aquatic life (as expressed by a Hazard Rating 1, defined by a TLM of 100 ppm or more, but less than 1,000 ppm) when particular weight is given to additional factors in the hazard profile or to special characteristics of the substance.
<i>Category D:</i>	Substances which are practically non-toxic to aquatic life (as expressed by a Hazard Rating 1, defined by a TLM of 100 ppm or more, but less than 1,000 ppm); or causing deposits blanketing the seafloor with a high biochemical oxygen demand (BOD); or highly hazardous to human health, with an LD ₅₀ of less than 5 mg/kg; or produce moderate reduction of amenities because of persistency, smell or poisonous or irritant characteristics, possibly interfering with use of beaches; or moderately hazardous to human health, with an LD ₅₀ of 5 mg/kg or more, but less than 50 mg/kg and produce slight reduction of amenities.

The Hazard Rating used in the guidelines refers to the GESAMP hazard evaluation rating. Appendix 2 contains a listing of the substances contained in the Annex along with their appropriate category.

Discharge regulation

The discharge of the substances is controlled in the following manner:

Category A

The discharge of category A substances, or mixtures containing category A substances, is prohibited unless the following conditions are fulfilled.

(a) Tanks are washed, and the resulting diluted residue must be discharged to a reception facility until the concentration of the substance in the effluent has been reduced to a predetermined residual concentration. The tank must then be emptied as far as practical to the reception facility. The residual concentration is normally 0.1% by weight.

(b) If the tank is to be further washed, a quantity of water equal to at least 5% of the total tank volume must be added to any residue remaining from the tank washing and this mixture may then be discharged into the sea provided:

- (1) the ship is proceeding en route at a speed of at least 7 knots (4 knots for barges);
- (2) the discharge is made below the waterline; and
- (3) the discharge is at least 12 miles from the nearest land in a depth of water of at least 25 meters.

Category B

The discharge of category B substances, or mixtures containing category B substances, is prohibited unless all the following conditions are fulfilled.

(a) The ship is proceeding en route at a speed of at least 7 knots (4 knots for barges).

(b) The procedures and arrangements for discharge are approved by the Administration. Such procedures and arrangements must be based upon standards developed by IMCO and must ensure that the concentration and rate of discharge is such that the concentration of the substance in the wake astern of the ship does not exceed one part per million.

(c) The maximum quantity discharged does not exceed the greater of 1 m³ or 1/3000 of the tank capacity.

(d) The discharge is below the waterline.

(e) The discharge is made at least 12 miles from land and in a depth of water of at least 25 meters.

Category C

The regulations for discharging category C substances are the same as for category B except the concentration permitted in the wake is increased to ten parts per million and the maximum quantity increased to 3 m³ or 1/1000 of the tank volume.

Category D

For a category D substance, the ship must be en route at a speed of at least

7 knots, the discharge must occur at least 12 miles from the nearest land, and the mixture discharged must be of a concentration not greater than one part of the substance in ten parts of water. As an alternative to the discharge regulations the Annex recognizes a ventilation procedure for cleaning tanks.

For chemical tankers which operate in two recognized special areas, the Baltic or the Black Sea, the discharge regulations become more restrictive. For example, the residual concentration for category A substances in most locations is 0.1% by weight. Inside the special area the prescribed residual concentration is 0.05% by weight.

The regulations were developed to prohibit, insofar as is practical, the discharge of category A substances into the sea while recognizing that it is virtually impossible to remove all traces of a substance from a ship's cargo tank. Insofar as category B and C substances are concerned, the regulations were designed to severely restrict the amount of product that may be discharged into the sea and take advantage of the mixing action of a ship's screw to reduce the concentration of permitted discharges to well below the threshold level. The discharge regulations are supported by studies conducted in the United States [5], Norway [6], and the Netherlands [7].

Measures of control

The Annex includes a control mechanism to ensure compliance with the regulations by providing for the use of surveyors and requiring that a cargo record book be carried aboard the ships. As should be expected, the most severe control measures have been provided for category A substances.

For category A substances, the washing of the tank must be done in the presence of a surveyor. He must obtain samples and arrange for them to be analyzed. He must also certify in the cargo record book that the residual concentration has been attained before any discharge into the sea is permitted. Where it is impractical to measure the concentration in the effluent the surveyor must certify that a pre-arranged and approved tank cleaning process has been followed and the tank washings have been discharged to a reception facility. For category B and C substances, the receiving Administration determines the extent a surveyor is to be used. For example, some receiving Administrations may use surveyors to certify in the record book the quantity of slops remaining in a cargo tank prior to vessel departure.

In any event, the Master must maintain for all categories of substances an accurate record in the cargo record book of all operations connected with each cargo tank indicating loading, unloading, quantities remaining, location of discharges into the sea and other similar activities. Finally, this cargo record book must be available for inspection by all Administrations.

Minimizing accidental pollution

As mentioned previously, the regulations formalize the existing IMCO

recommendation on chemical tanker design, the IMCO Chemical Code [8], by requiring parties to the Convention to issue detailed regulations which contain as a minimum all of the Code's provisions. For ships other than chemical tankers similar regulations are envisioned.

The IMCO Chemical Code provides design, construction, and operation standards for the safe carriage by sea of dangerous chemicals in bulk. The Code was developed using a philosophy of prescribing minimum containment standards according to the hazards of the cargoes to be carried. At the heart of the Chemical Code is the chapter dealing with "ship types". Three degrees of "ship types" are provided which define the location of the cargo with respect to the ship's side and bottom and the extent to which a ship should be capable of remaining afloat after damage. The assignment of the ship types to the various cargoes takes into account the hazard of the product.

The highest standard, Ship Type I, is required for those substances considered to have the greatest hazard, *i.e.*, those products which on release would have wide-reaching effects beyond the immediate neighborhood of the vessel. Ship Type I requires the cargo tank to be located inboard from the side of the vessel a distance equal to one-fifth of the beam, and above the bottom a distance of one-fifteenth of the beam. The ship must also meet at least a two-compartment standard of subdivision and damage stability when subjected to certain prescribed damages. Ship Types II and III are required for products with lesser hazards.

As the IMCO Chemical Code was initially developed around "safety", it must now be reviewed and modified from the "pollution prevention" point of view. Preliminary work in IMCO indicates that more attention is needed to prevent accidental spillage during transfer operations. Further, it is expected that the ship type assignment for some cargoes may be more severe when the pollution hazard is taken into account.

Annex II of the 1973 Convention also contains many other important regulations but the above-mentioned portions deal with the main thrust of the Annex.

Annex III

Annex III contains regulations for the prevention of pollution by harmful substances carried on the sea in package and other similar forms. These regulations establish general requirements for packaging, marking and labeling, stowage, quantity limitations, and notification. Parties to the Convention must issue detailed requirements to supplement these provisions. Further, by Conference Resolution, IMCO is to continue working on this Annex, incorporating more detailed requirements, if warranted, into the Inter-Governmental Maritime Dangerous Goods Code.

It should be noted that at the Conference there was detailed discussion over whether or not there was sufficient information available on transportation of harmful substances in packages to warrant an annex at that time. Ultimately,

it was decided to include the general requirements mentioned above and call by resolution for the more needed detailed investigation to be done by IMCO.

Future work

The London Conference adopted 26 resolutions, many of which call for more detailed work to be done on hazardous materials.

(a) The impact of the transportation of solid hazardous materials must be studied; if warranted, a separate annex is to be developed.

(b) A code for the Design and Construction of Liquefied Gas Tankers is needed (work is presently underway within IMCO on such a code, and it should be completed later this year).

(c) Many more substances must be evaluated using the GESAMP system and incorporated in Annex II.

(d) Procedures for discharging chemicals in accordance with Annex II must be developed.

(e) The IMCO Chemical Code must be reviewed.

To accomplish the above, IMCO has created a new Marine Environment Protection Committee. All of the above items are on its "action" plan, and many of the items mentioned are already being considered. Within the United States the ratification process has been set into motion. The Annexes are being carefully studied and their implementation planned.

The impact

The principal impact on ships will result because of the necessity to change. Prior to the 1973 Convention the discharge of tank washing from chemical tankers was not controlled. From the studies done prior to the Conference it was determined that approximately 10,000 tons of hazardous material were discharged annually into the marine environment — often in the more ecologically sensitive areas close to shore. While the tonnage discharge may not change significantly, the regulations will severely limit the amount of the most hazardous substances that may be discharged into the sea and require that any permitted discharge occur well away from land and be in a manner to ensure the resulting concentration is below the threshold limit. Therefore, the major impact is expected to be on chemical tanker operation. The impact will also carry through to the shore as reception facilities must now be provided to take category A tank washings. Reception facilities will also be needed for the other categories, especially in ship repair ports and at other locations, to receive excessive amounts of product remaining in a cargo tank.

The impact of Annex II on our marine environment is aimed at lessening the threat of its continued deterioration. Annex II should represent the first step; we know that discharges from ships amount to only a fraction of the total amount of chemicals reaching the sea each day. However, it will be only a tiny step if it does not serve as the challenge for action in controlling other sources of chemical pollution.

References

- 1 The Honorable Russel E. Train, Statement before the United States Senate Committee on the Commerce, November 14, 1973, Report Serial No. 93-52.
- 2 Admiral Chester R. Bender, Statement before the United States Senate Committee on the Commerce, November 14, 1973, Report Serial No. 93-52.
- 3 William M. Benkert and Douglas H. Williams, Impact of the 1973 IMCO Convention on the maritime industry, *Marine Technology*, 11 (Jan. 1974) 1.
- 4 IMCO/FAO/UNESCO/WMO/WHO/IAIA/UN/Joint Group of Experts on the Scientific Aspects of Marine Pollution, Report GESAMP IV/19 Supp. 1, March 1973.
- 5 Stevens Institute of Technology Report, Model study of the dilution soluble liquids discharged from tankers (prepared for the U.S. Coast Guard, Contract DOT-CG-33148-A MOD. 1), September 1973.
- 6 Final report on pollution caused by the discharge of noxious liquids other than oil through normal operational procedures of ships engaged in bulk transportation (Norway), March 1973, (IMCO Report PCMP/2/7).
- 7 Delft University of Technology Report, Model test on discharge of fluid with neutral density in the boundary layer of a light ship (prepared for the Government of the Netherlands), October 1973, (IMCO Report MP/CONF/INF. 15/1).
- 8 Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (IMCO Resolution A. 212 (VII)).

See Appendixes pp. 122-128

APPENDIX 1

Hazard profile of selected substances

Substances	Bioaccu- mulation	Damage to living resources	Hazard to human health		Reduction of amenities	Remarks
			Oral intake	Skin contact and inhalation (solution)		
	A	B	C	D	E	
Acetaldehyde	0	2	1	0	x	
Acetone cyanohydrin	0	4	3	II	xx	
Acrylonitrile	0	3	3	II	xxx	
Benzene	0	2	1	0	x	
n-Butyl alcohol	0	0/BOD	1	0	0	
Calcium hydroxide (solution)	0	1	0	0	0	
Carbon disulphide	+	4	2	I	xxx	
Chlorine	0	4	NA	II	xx	
Cresols	T	3	2	I	xx	
Dichlorobenzenes	Z	4	1	0	x	
Ethyl acrylate	0	1	1	0	x	
Ethyl amyl ketone	0	(2)	1	0	x	
Hydrochloric acid	0	1	1	0	0	
Hydrofluoric acid (40% aqueous)	0	3	2	II	0	
Methyl alcohol	0	0/BOD	0	0	0	
Molasses	0	0/BOD	0	0	x	
Nonyl phenol	0	2	1	I	x	
Oleum	0	2	1	II	0	
Olive oil	0	0/BOD	0	0	x	
Phenol	T	2	2	I	xx	
Phosphorus (elemental)	+	4	4	II	xxx	
Propylene glycol	0	0/BOD	0	0	0	
Propylene oxide	0	0/BOD	0	0	0	Treated as propylene oxide
Sodium hydroxide	0	2	1	I	0	
Tetra ethyl lead	Z	3	3	II	xxx	
Toluene	0	2	0	0	x	
Xylene (mixed isomers)	0	2	1	0	x	

Legend to the hazard profiles: see opposite page

APPENDIX 1 (continued)

Column A — Bioaccumulation

+	Bioaccumulated and liable to produce a hazard to aquatic life or human health
0	Not known to be significantly bioaccumulated
Z	Short retention of the order of one week or less
T	Liable to produce tainting of seafood

Column B — Damage to living resources

Ratings		TLm
4	Highly toxic	1 ppm
3	Moderately toxic	1—10 ppm
2	Slightly toxic	10—100 ppm
1	Practically non-toxic	100—1000 ppm
0	Non-hazardous	1000 ppm
BOD	Problem caused primarily to high oxygen demand	
D	Deposits liable to blanket the seafloor	

Column C — Hazard to human health, oral intake

Ratings		LD ₅₀
4	Highly hazardous	5 mg/kg
3	Moderately hazardous	5—50 mg/kg
2	Slightly hazardous	50—500 mg/kg
1	Practically non-hazardous	500—5000 mg/kg
0	Non-hazardous	5000 mg/kg

Column D — Hazard to human health, skin contact and inhalation (solution)

II	Hazardous (solution)
I	Slightly hazardous (solution)
0	Non-hazardous (solution)

Column E — Reduction of amenities

Ratings	
xxx	Highly objectionable because of persistency, smell or poisonous or irritant characteristics; beaches liable to be closed
xx	Moderately objectionable because of the above characteristics, but short-term effects leading to temporary interference with use of beaches
x	Slightly objectionable, no interference with use of beaches
0	No problem

All Columns

Ratings in brackets, (), indicate insufficient data available to the Panel on specific substances, hence extrapolation was required.

APPENDIX 2

List of noxious liquid substances carried in bulk

Substance	UN Number	Pollution Category for operational discharge	Residual concentration (per cent by weight)		
			(Regulation 3 of Annex II)	(Regulation 5(1) of Annex II)	(Regulation 5(7) of Annex II)
			I	II	III Outside special areas
Acetaldehyde	1089	C			
Acetic acid	1842	C			
Acetic anhydride	1715	C			
Acetone	1090	D			
Acetone cyanohydrin	1541	A	0.1		0.05
Acetyl chloride	1717	C			
Acrolein	1092	A	0.1		0.05
Acrylic acid*	—	C			
Acrylonitrile	1093	B			
Adiponitrile	—	D			
Alkylbenzene sulfonate	—				
(straight chain)		C			
(branched chain)		B			
Allyl alcohol	1098	B			
Allyl chloride	1100	C			
Alum (15% solution)	—	D			
Aminoethyl- ethanolamine (hydroxyethyl- ethylenediamine)*	—	D			
Ammonia (28% aqueous)	1005	B			
iso-Amyl acetate	1104	C			
n-Amyl acetate	1104	C			
n-Amyl alcohol	—	D			
Aniline	1547	C			
Benzene	1114	C			
Benzyl alcohol	—	D			
Benzyl chloride	1738	B			
n-Butyl acetate	1123	D			
sec-Butyl acetate	1124	D			

* Asterisk indicates that the substance has been provisionally included in this list and that further data are necessary in order to complete the evaluation of its environmental hazards, particularly in relation to living resources.

APPENDIX 2 (continued)

Substance	I	II	III	IV
<i>n</i> -Butyl acrylate	—	D		
Butyl butyrate*	—	B		
Butylene glycol(s)	—	D		
Butyl methacrylate	—	D		
<i>n</i> -Butyraldehyde	1129	B		
Butyric acid	—	B		
Calcium hydroxide (solution)	—	D		
Camphor oil	1130	B		
Carbon disulphide	1131	A	0.01	0.005
Carbon tetrachloride	1846	B		
Caustic potash (potassium hydroxide)	1814	C		
Chloroacetic acid	1750	C		
Chloroform	1888	B		
Chlorohydrins (crude)*	—	D		
Chloroprene*	1991	C		
Chlorosulphonic acid	1754	C		
<i>para</i> -Chlorotoluene	—	B		
Citric acid (10–25%)	—	D		
Creosote	1334	A	0.1	0.05
Cresols	2076	A	0.1	0.05
Cresylic acid	2922	A	0.1	0.05
Crotonaldehyde	1143	B		
Cumene	1918	C		
Cyclohexane	1145	C		
Cyclohexanol	—	D		
Cyclohexanone	1915	D		
Cyclohexylamine*	—	D		
<i>para</i> -Cymene (isopropyltoluene)*	2046	D		
Decahydronaphthalene	1147	D		
Decane*	—	D		
Diacetone alcohol*	1148	D		
Dibenzyl ether*	—	C		
Dichlorobenzenes	1591	A	0.1	0.05
Dichloroethyl ether	1916	B		
Dichloropropene— dichloropropane mixture (D.D. soil fumigant)	2047	B		
Diethylamine	1154	C		
Diethylbenzene (mixed isomers)	2049	C		
Diethyl ether	1155	D		
Diethylenetriamine*	2079	C		
Diethylene glycol monoethyl ether	—	C		
Diethylketone (3-pentanone)	1156	D		

APPENDIX 2 (continued)

Substance	I	II	III	IV
Diisobutylene*	2050	D		
Diisobutyl ketone	1157	D		
Diisopropanolamine	—	C		
Diisopropylamine	1158	C		
Diisopropyl ether*	1159	D		
Dimethylamine (40% aqueous)	1160	C		
Dimethylethanolamine (2-dimethylamino- ethanol)*	2051	C		
Dimethylformamide	—	D		
1, 4-Dioxane*	1165	C		
Diphenyl-diphenyloxide mixtures*	—	D		
Dodecylbenzene	—	C		
Epichlorohydrin	2023	B		
2-Ethoxyethyl acetate*	1172	D		
Ethyl acetate	1173	D		
Ethyl acrylate	1917	D		
Ethyl amyl ketone*	—	C		
Ethylbenzene	1175	C		
Ethyl cyclohexane	—	D		
Ethylene chlorohydrin (2-chloro-ethanol)	1135	D		
Ethylene cyanohydrin*	—	D		
Ethylenediamine	1604	C		
Ethylene dibromide	1605	B		
Ethylene dichloride	1184	B		
Ethylene glycol monoethyl ether (methyl cellosolve)	1171	D		
2-Ethylhexyl acrylate*	—	D		
2-Ethylhexyl alcohol	—	C		
Ethyl lactate*	1192	D		
2-Ethyl 3-propylacrolein*	—	B		
Formaldehyde (37—50% solution)	1198	C		
Formic acid	1779	D		
Furfuryl alcohol	—	C		
Heptanoic acid*	—	D		
Hexamethylenedia- mine*	1783	C		
Hydrochloric acid	1789	D		
Hydrofluoric acid (40% aqueous)	1790	B		
Hydrogen peroxide (greater than 60%)	2015	C		
Isobutyl acrylate	—	D		
Isobutyl alcohol	1212	D		
Isobutyl methacrylate	—	D		

APPENDIX 2 (continued)

Substance	I	II	III	IV
Isobutyraldehyde	2045	C		
Isooctane*	—	D		
Isopentane	—	D		
Isophorone	—	D		
Isopropylamine	1221	C		
Isopropyl cyclohexane	—	D		
Isoprene	1218	D		
Lactic acid	—	D		
Mesityl oxide*	1229	C		
Methyl acetate	1231	D		
Methyl acrylate	1919	C		
Methylamyl alcohol	—	D		
Methylene chloride	1593	B		
2-Methyl-5-ethylpyridine*	—	B		
Methyl methacrylate	1247	D		
2-Methylpentene*	—	D		
<i>alpha</i> -Methylstyrene*	—	D		
Monochlorobenzene	1134	B		
Monoethanolamine	—	D		
Monoisopropanolamine	—	C		
Monomethyl ethanolamine	—	C		
Mononitrobenzene	—	C		
Monoisopropylamine	—	C		
Morpholine*	2054	C		
Naphthalene (molten)	1334	A	0.1	0.05
Naphthenic acids*	—	A	0.1	0.05
Nitric acid (90%)	2031/2032	C		
2-Nitropropane	—	D		
<i>ortho</i> -Nitrotoluene	1664	C		
Nonyl alcohol*	—	C		
Nonylphenol	—	C		
<i>n</i> -Octanol	—	C		
Oleum	1831	C		
Oxalic acid (10–25%)	—	D		
Pentachloroethane	1669	B		
<i>n</i> -Pentane	1265	C		
Perchloroethylene (tetrachloroethylene)	1897	B		
Phenol	1671	B		
Phosphoric acid	1805	D		
Phosphorus (elemental)	1338	A	0.01	0.005
Phthalic anhydride (molten)	—	C		
<i>beta</i> -propiolactone*	—	B		
Propionaldehyde	1275	D		
Propionic acid	1848	D		
Propionic anhydride	—	D		
<i>n</i> -Propyl acetate*	1276	C		
<i>n</i> -Propyl alcohol	1274	D		
<i>n</i> -Propylamine	1277	C		

APPENDIX 2 (continued)

Substance	I	II	III	IV
Pyridine	1282	B		
Silicon tetrachloride	1818	D		
Sodium bichromate (solution)	—	C		
Sodium hydroxide	1824	C		
Sodium pentachloro- phenate (solution)	—	A	0.1	0.05
Styrene monomer	2055	C		
Sulphuric acid	1830/1831/ 1832	C		
Tallow	—	D		
Tetraethyl lead	1649	A	0.1	0.05
Tetrahydrofuran	2056	D		
Tetrahydronaphthalene	1540	C		
Tetramethylbenzene	—	D		
Tetramethyl lead	1649	A	0.1	0.05
Titanium tetrachloride	1838	D		
Toluene	1294	C		
Toluene diisocyanate*	2078	B		
Trichloroethane	—	C		
Trichloroethylene	1710	B		
Triethanolamine	—	D		
Triethylamine	1296	C		
Trimethylbenzene*	—	C		
Tritolyl phosphate (tricresyl phosphate)*	—	B		
Turpentine (wood)	1299	B		
Vinyl acetate	1301	C		
Vinylidene chloride*	1303	B		
Xylenes (mixed isomers)	1307	C		