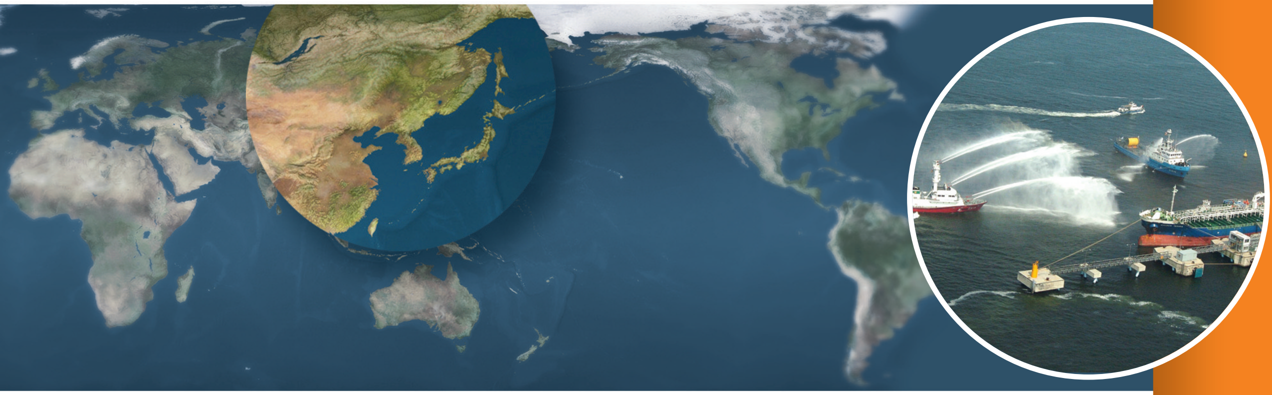
NOWPAP MERRAC

Northwest Pacific Action Plan
Marine Environmental Emergency Preparedness and Response
Regional Activity Centre
P.O. Box 23, Yuseong, Daejeon 305-600, Republic of Korea
(c/o MOERI/KORDI)
Tel: (+82-42) 866-3638, Fax: (+82-42) 866-3698
E-mail: nowpap@moeri.re.kr
Website: http://merrac.nowpap.org

UNEP IMO

HAZARDOUS & NOXIOUS SUBSTANCES (HNS) DATABASE IN THE NOWPAP REGION



MERRAC Technical Report No. 7

Regional Seas

NOWPAP MERRAC

Northwest Pacific Action Plan
Marine Environmental Emergency Preparedness and Response
Regional Activity Centre
P.O. Box 23, Yuseong, Daejeon 305-600, Republic of Korea
(c/o MOERI/KORDI)
Tel: (+82-42) 866-3638, Fax: (+82-42) 866-3698
E-mail: nowpap@moeri.re.kr
Website: http://merrac.nowpap.org

UNEP IMO

HAZARDOUS & NOXIOUS SUBSTANCES (HNS) DATABASE IN THE NOWPAP REGION

MERRAC Technical Report No. 7

Regional Seas

First published in 2009
by Marine Environmental Emergency Preparedness and Response
Regional Activity Centre
the Northwest Pacific Action Plan (NOWPAP MERRAC)
P.O.Box 23, Yuseong, Daejeon 305-600, Republic of Korea
(c/o MOERI/KORDI)

ISBN 978-89-93604-07-8

For bibliographical purposes, this document may be cited as:
MERRAC Technical Report No.7. Hazardous & Noxious Substances (HNS) Database in the NOWPAP Region, NOWPAP MERRAC, 2009.

Foreword

MERRAC, the Marine Environmental Emergency Preparedness and Response Regional Activity Centre, is one of four Regional Activity Centres of the Northwest Pacific Action Plan (NOWPAP) which was adopted in 1994 as a Regional Seas Programme of the United Nations Environment Programme (UNEP) by the People's Republic of China, Japan, Republic of Korea, and Russian Federation. MERRAC is responsible for regional co-operation on marine pollution preparedness and response in the region.

With technical support from the International Maritime Organization (IMO), MERRAC is currently functioning as secretariat for the NOWPAP MERRAC Focal Points Meeting, Expert Meeting, Competent National Authorities Meeting for NOWPAP Regional Oil Spill Contingency Plan (CNA meeting). The Centre also carries out other special activities including the management of a regional information system, organization of training and exercise, capacity building, co-ordination of research and development on the technical aspects of oil and Hazardous & Noxious Substances (HNS) spills.

As one of main outcomes of MERRAC activities, the NOWPAP Regional Oil and HNS Spill Contingency Plan (NOWPAP RCP) and its relevant Memorandum of Understanding (MoU) were developed and officially came into effect as being signed by all NOWPAP member states. The purpose of the NOWPAP RCP is to provide an operational mechanism for mutual assistance through which the member states will co-operate during major marine oil and HNS pollution incidents in the region

In order to provide practical and technical guidelines to promptly and effectively respond to major marine pollution accidents within the framework of the NOWPAP RCP, it was agreed to carry out the series of MERRAC Specific Projects related to oil spill prediction model, minimum level of preparedness for response to oil spill in the NOWPAP region, HNS response operation guidelines, HNS database in the NOWPAP region.

Through MERRAC Specific Projects, the technical report was developed by NOWPAP MERRAC based upon the decision of the 12th MERRAC Focal Points Meeting (June 2009). The Expert Group consisted of 4 experts who were nominated by MERRAC Focal Points as follow: Dr. Zhang Xiangshang

(China), Capt. Shin Ohnuki (Japan), Dr. Moonjin Lee (Korea, Leading Expert), Dr. Gennady Semanov (Russia), and contributed to developing the technical report. MERRAC staffs (Dr. Jeong-Hwan Oh, and Ms. Hyon-Jeong Noh) finalized and edited the report with technical support of MERRAC Focal Points, NOWPAP Regional Coordinating Unit (RCU), and IMO.

As Director of MERRAC, I would like to thank the MERRAC Focal Points and all experts of the Expert Group for their support and contributions to finalizing the MERRAC Technical Reports.

Seong-Gil Kang
Director of MERRAC

Tables of Contents

List of Tables

Chapter 1. Introduction

With growing international attention to HNS centering on IMO, the 10th NOWPAP Intergovernmental Meeting (IGM) adopted the regional NOWPAP cooperation on HNS responses as a new area of interest for MERRAC (UNEP/NOWPAPIG.10/10). Against this backdrop, details and ways of possible regional NOWPAP cooperation regarding HNS were discussed in the 9th NOWPAP MERRAC Focal Points Meeting (UNEP/IMO/NOWPAP/MERRAC/FPM 9/17), and member states explained how they are preparing themselves against potential HNS spills (UNEP/IMO/NOWPAP/MERRAC/FPM 9/19).

After the 9th NOWPAP MERRAC Focal Points Meeting, member countries agreed to produce national reports on their preparations against and responses to HNS spill accidents (UNEP/IMP/NOWPAP/MERRAC/FPM 9/20). They also decided to put together the national reports from each country and produce a regional report on preparations against and responses to HNS leakages in the NOWPAP region (UNEP/IMP/NOWPAP/MERRAC/FPM 10/24).

During the 10th NOWPAP MERRAC Focal Points Meeting, discussion occurred related to NOWPAP Regional Oil and HNS Spill Contingency Plan (Annex IV in UNEP/IMO/NOWPAP/ MERRAC) that was developed in 2006 NOWPAP MERRAC Expert Meeting (UNEP/IMO/NOWPAP/MERRAC/FPM 10/24). Also, research on development of an HNS database in the NOWPAP region was proposed as a specific project for NOWPAP MERRAC (UNEP/IMO/NOWPAP/ MERRAC/FPM 10/24).

As part of such measures to prepare against HNS in the NOWPAP region, this report looks into the HNS database for the region developed by Expert Group (Annex A).

Chapter 2. HNS Definition and Classification

2.1. HNS Definition

Article 1.5 of the HNS Convention defines hazardous and noxious substance (HNS) as:

(a) Any substances, materials, and articles carried on board a ship as cargo, referred to in (i) to (vii) below:

  (i) Oils carried in bulk listed in appendix I of Annex I from International Convention for the Prevention of Pollution from Ships, 1973 as amended by the Protocol of 1978 relating thereto (MARPOL 73/78), as amended.

  (ii) Noxious liquid substances carried in bulk referred to in appendix II of Annex II from MARPOL 73/78, as amended. And, substances and mixtures provisionally categorized and falling in pollution category A, B, C or D in accordance with regulation 3(4) of Annex II;

  (iii) Dangerous liquid substances carried in bulk listed in chapter 17 of the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk, 1983 (IBC Code) as amended, and the dangerous products, as prescribed in the preliminary stage, by the administration and port administrations involved in accordance with paragraph 1. 1.3 of the Code, as being in suitable conditions for transport.

  (iv) Dangerous, hazardous, and harmful substances as well as materials and articles in packaged form, covered by the International Maritime Dangerous Goods Code (IMDG Code), as amended.

  (v) Liquefied gases, as listed in chapter 19 of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, 1983 (IGC Code) as amended, and the products that were prescribed in the preliminary stage, by the Administration and port administrations involved in accordance with paragraph 1. 1.6 of the Code, as being in suitable conditions for transport.

(vi) Liquid substances carried in bulk with a flashpoint not exceeding 60°C (measured by a closed cup test).

(vii) Solid bulk materials possessing chemical hazards, covered by appendix B of the Code of Safe Practice for Solid Bulk Cargoes (BC Code) as amended, to the extent that these substances are also subject to the provisions of the IMDG Code when carried in a packaged form.

(b) Residues from the previous bulk carriage of substances referred to in the above section (a) (i) to (iii), and (v) to (vii).

The definition of HNS is largely based on the lists of individual substances which have been previously identified in a number of IMO Conventions and Codes, designed to ensure maritime safety and prevention of pollution. Many substances are covered under more than one section of the definition. There is considerable overlap between the three different definitions of liquid HNS, and some liquefied gases are also covered by the definition of dangerous liquid substances under the IBC Code.

HNS are quite varied and include both bulk cargoes and packaged goods. Bulk cargoes can be either solids or liquids, including oils or liquefied gases. The number of substances included is very large. The IMDG Code, for example, lists hundreds of materials which can be dangerous when shipped in packaged form. In practice, however, the number of HNS which are shipped in significant quantities is relatively small.

Bulk solids are included, if they are covered by appendix B of the BC Code, possess chemical hazards, and subject to the provisions of the IMDG Code when carried in packaged form. This means that many of the major bulk solids are excluded since they either do not possess chemical hazards (eg iron ore, grain, bauxite and alumina, phosphate rock, cement and fertilizers), or they are classified as materials hazardous only in bulk (MHB) (eg coal, reduced iron and woodchip). Bulk solids, which are covered, include fertilizers, sodium and potassium nitrates, sulfur, and certain types of fishmeal.

Bulk liquids are included if the pollution or explosion hazards are presented safely, and include organic chemicals (eg methanol, xylene and styrene), inorganic chemicals (eg sulfuric acid, phosphoric acid and caustic soda), and vegetable and animal oils & fats (eg palm oil, soybean oil and tallow). Both persistent and non-persistent oils of petroleum origin are also included, although persistent oil, according to the HNS Convention, does not cover the pollution damage. Bulk liquids, which are not covered, include potable alcohol and molasses.

All liquefied gases, which are transported in bulk, include liquefied natural gas (LNG), liquefied petroleum gas (LPG), ammonia, ethylene, butadiene, ethane and propylene.

Packaged goods are included if they are covered by the IMDG Code, which comprises a very wide range of chemicals, even though many of them are only carried in small quantities.

Table 1 provides an overview of the substances covered under the Convention.

Table 1. *HNS Substances*

Substances covered	Convention Codes	Reference
Bulk Oils	MARPOL 73/78	Annex I, Appendix I
Noxious Liquids Dangerous liquids Liquids with a flashpoint not exceeding 60C	MARPOL 73/78 IBC Code[18]	Annex II, Appendix II Chapter 17
Gases	IGC Code[19]	Chapter 19
Solids	BC Code[20]	Appendix B (if also covered by the IMDG Code in packaged form)
Packaged	IMDG Code	

2.2. Categorization of IBC Code

Transporting of chemicals, in bulk, is covered by regulations in SOLAS Chapter VII - Transportation of dangerous goods and MARPOL Annex II - Regulations, for the Control of Pollution by Noxious Liquid Substances in Bulk. Both Conventions require chemical tankers, built after July 1st, 1986, to comply with the International Bulk Chemical Code (IBC Code). This Code provides international standards for safe transport by sea, in bulk of liquid dangerous chemicals, by prescribing the design and the construction standards of ships involved in such transport. The Code also prescribes the equipments they should carry to minimize the risks to the ship, its crew, and to the environment, with regards to the nature of the products it's carrying.

MARPOL Annex II labels “noxious liquid substances carried in bulk” into four categories of A to D, according to the hazard they present to marine resources, human health, or amenities (see also revised categories from January 1st, 2007).

- Category A - Noxious liquid substances discharged into the sea, as a result of tank cleaning or deballasting operations, would present a major hazard to either marine resources or human health. This would also cause serious harm to amenities or other legitimate uses in the sea. Therefore, this justifies the application of stringent anti-pollution measures such as acetone cyanohydrin, carbon disulphide, cresols, naphthalene and tetraethyl lead.

- Category B - Noxious liquid substances discharged into the sea, as a result of tank cleaning or deballasting operations, would present a hazard to either marine resources or human health. This would also cause harm to amenities or other legitimate uses in the sea. Therefore, this justifies the application of special anti-pollution measures such as acrylonitrile, carbon tetrachloride, ethylene dichloride, and phenol.

- Category C - Noxious liquid substances discharged into the sea, as a result of tank cleaning or deballasting operations, would present a minor hazard to either marine resources or human health. This would also cause minor harm to amenities or other legitimate uses in the sea. Therefore this requires special operational measures such as styrene, toluene, and xylene.

- Category D - Noxious liquid substances discharged into the sea as a result of tank cleaning or deballasting operations would present a recognizable hazard to either marine resources or human health. This would also cause minimal harm to amenities or other legitimate uses in the sea. Therefore, this requires some attention in operational measures such as acetone, phosphoric acid and tallow.

The Annex also listed "other liquid substances" that fall outside categories A, B, C or D and therefore representing no harm when discharged into the sea, as a result of tank cleaning or ballasting operations. These substances include coconut oil, ethyl alcohol, molasses, olive oil, and wine. (see also revised categories from January 1st, 2007.)

The revised Annex II Regulations for the control of pollution, like noxious liquid substances in bulk, was adopted in October 2004. This also includes a new four-category categorization system for noxious and liquid substances. The revised annex is expected to enter into force on January 1st, 2007.
The new categories are:

- Category X: Noxious Liquid Substances discharged into the sea, as a result of tank cleaning or deballasting operations, are deemed to present a major hazard to either marine resources or human health. Therefore, it justifies the prohibition of the discharge into the marine environment.

- Category Y: Noxious Liquid Substances discharged into the sea, as a result of 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. Therefore, it justifies a limitation on the quality and quantity of the discharge into the marine environment.

- Category Z: Noxious Liquid Substances which discharged into the sea, as a result of tank cleaning or deballasting operations, are deemed to present a minor hazard to either marine resources or human health. Therefore, it justifies less stringent restrictions on the quality and quantity of the discharge into the marine environment.

- Category OS (Other Substances): Substances which have been evaluated and found to fall outside the categories X, Y, or Z because they are

> considered a non-threat to marine resources, human health, amenities, or other legitimate uses in the sea when discharged into the sea, as a result of the tank cleaning of deballasting operations. The discharge of bilge, ballast water, other residues, or mixtures containing these substances are not subject to any requirements of MARPOL Annex II.

The revised annex includes a number of other significant changes. Improvements in ship technology, such as efficient stripping techniques, has made possible significantly lower permitted discharge levels of certain products, that was incorporated into Annex II. For ships constructed on or after January 1st, 2007, the maximum permitted residue in the tank and its associated piping, left after the discharge, will be set at a maximum of 75 liters for products in categories X, Y and Z. Previous limits were set at a maximum of 100 or 300 liters, varying according to the product category.

Alongside the revision of Annex II, Evaluation of Hazardous has evaluated thousands of chemicals for marine pollution hazards. Substances Working Group, giving results from GESAMP2 Hazard Profile, indexes the substance according to its bio-accumulation, bio-degradation, acute toxicity, chronic toxicity, long-term health effects, and effects on marine wildlife and benthic habitats.

As a result of the hazard evaluation process and the new categorization system, vegetable oils, which were previously categorized as unrestricted, will now be required to be carried in chemical tankers. The revised Annex includes, under regulation 4 exemptions, provision for the administration to exempt certified ships from carrying individually identified vegetable oils, now subject to certain provisions relating, to the location of the cargo tanks carrying the specified vegetable oil.

Consequential amendments to the International Bulk Chemical Code (IBC Code) were also adopted in October 2004, reflecting the changes to the MARPOL Annex II. The amendments incorporate revisions to the categorization of certain products relating to their properties as potential marine pollutants, as well as revisions to ship type and carriage requirements, following their evaluation by the Evaluation of Hazardous Substances Working Group.

Ships constructed after 1986 carrying substances, identified in chapter 17 of the IBC Code, must follow the requirements for design, construction, equipment, and operation of ships contained in the Code.

2.3. IMDG Code Classes

The International Maritime Organization (IMO) is responsible for maintaining and updating the International Maritime Dangerous Goods Code (IMDG Code) which governs the vast majority of shipments of hazardous materials by water. The IMDG Code is intended to provide safe transportation of hazardous materials by vessels, protect crew members, and prevent marine pollution. The Code is based on the UN Model Regulations, but also includes additional requirements applicable to the transport of hazardous materials by sea (e.g., requirements for marine pollutants, freight container loading procedures, stowage and segregation, and other requirements applicable to shipboard safety and preservation of the marine environment) that are not covered by the UN Model Regulations. The IMDG Code is maintained and updated by IMO's DSC Sub-Committee. Implementation of the Code is mandatory in conjunction with the governments' obligations, under the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL). The U.S. is a signee to these two conventions. Today, at least 150 countries whose combined merchant fleets account for more than 98% of the world's gross tonnage use the IMDG Code as basis for regulating sea transport of hazardous materials. The U.S. Hazardous Materials Regulations authorize the use of IMDG Code as means of compliance with the HMR, when at least one segment of transport involves sea transport.

The IMDG Code is currently updated every two years. The latest revision, Amendment 33, became effective on January 1st, 2007. The IMO Marine Safety Committee has recommended a twelve month transitional period through December 31, 2007 to allow for users to become familiar with the new format. Amendment 33 is currently available from IMO as well as several commercial sources (see international transport publication link below).

The IMDG Code has been recommended to governments for adoption or for use as a base for the national regulations to promote harmonization of regulations concerning the transport of dangerous goods by sea.

The development of the IMDG Code dates back to 1960 Safety of Life at Sea Conference, which recommended that governments should adopt a uniform international code for the transport of dangerous goods by sea to supplement the regulations contained in the 1960 International Convention for the Safety of Life at Sea (SOLAS).

A resolution adopted by the 1960 Conference states that the proposed code should cover such matters as packing, container traffic, and stowage, with particular reference to the segregation of incompatible substances.

A working group of IMO's Maritime Safety Committee began preparing the Code in 1961, in close cooperation with the United Nations Committee of Experts on the Transport of Dangerous Goods, which in a 1956 report had established minimum requirements for the transport of dangerous goods by all modes of transport.

Since its adoption by the fourth IMO Assembly in 1965, the IMDG Code has undergone many changes, both in appearance and content to keep pace with the ever changing needs of the industry. Amendments which do not affect the principles, upon which the Code is based, may be adopted by the MSC, allowing IMO to respond to transport developments in reasonable time.

Amendments to the IMDG Code is derived from two sources, proposals submitted directly to IMO by Member States, and amendments required to take account of changes to the United Nations Recommendations on the Transport of Dangerous Goods that sets the basic requirements for all the transport modes.

Amendments to the provisions of the United Nations Recommendations are made on a two yearly cycle and approximately two years after their adoption. They are adopted by the authorities responsible for regulating the various transport modes. In that way, a basic set of requirements, applicable to all modes of transport, is established and implemented; thus, ensuring that difficulties are not encountered at inter-modal interfaces.

For the purpose of this Code, dangerous goods are classified in different classes to subdivide a number of these classes, and to define and describe characteristics and properties of the substances, materials, and articles which would fall within each class or division. General provisions for each class or division are given. Individual dangerous goods are listed in the Dangerous Goods list, with the class and specific requirements.

In accordance with the criteria for the selection of marine pollutants for the purposes of Annex III of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). A number of dangerous substances, in the various classes, have also been identified as substances harmful to the marine environment (MARINE POLLUTANTS).

Substances (including mixtures and solutions) and articles subject to the provisions of this Code are assigned to one of the classes 1-9, according to the hazard or the level of presence of predominant hazards. Some of these classes are subdivided into divisions. These classes or divisions are as listed below:

Class 1: Explosives

Division 1.1: Substances and articles which have a mass explosion hazard.

Division 1.2: Substances and articles which have a projection hazard but not a mass explosion hazard.

Division 1.3: Substances and articles which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.

Division 1.4: Substances and articles which present no significant hazard

Division 1.5: Very insensitive substances which have a mass explosion hazard

Division 1.6: Extremely insensitive articles that do not have a mass explosion hazard

Class 2: Gases

Class 2.1: Flammable gases

Class 2.2: Non-flammable, non-toxic gases

Class 2.3: Toxic gases

Class 3: Flammable liquids

Class 4: Flammable solids. Substances liable to spontaneous combustion. Substances which, in contact with water, emit flammable gases.

Class 4.1: Flammable solids. Self-reactive substances. Desensitized Explosives.

Class 4.2: Substances liable to have spontaneous combustion.

Class 4.3: Substances which, in contact with water, emit flammable gases.

Class 5: Oxidizing substances and organic peroxides.

Class 5.1: Oxidizing substances

Class 5.2: Organic peroxides

Class 6: Toxic and infectious substances

Class 6.1: Toxic substances

Class 6.2: Infectious substances

Class 7: Radioactive material

Class 8: Corrosive substances

Class 9: Miscellaneous and dangerous substances and articles

The numerical order of the classes and divisions is not an indication of a degree of danger.

Chapter 3. Review HNS Database

3.1. HNS Database of Japan

Japan designated 162 types of HNS based on transportation volumes by chemical tankers passing its waters, putting together the material properties of the selected HNSs into the database (Annex B-1). Material properties put into the database include UN No., CAS No., material name, IMDG Code, IMDG Class, molecular weight, flammable limits in Air (%), solubility in water, specific gravity, vapor specific gravity, boiling point, freezing point, flash point, ignition point, and steam pressure. Examples of what is stored in the database are shown in Table 2 (Marine Disaster Prevention Center of Japan, 2004).

In addition to this database on HNS material properties, Japan also established the Database for Marine HNS Spill Disaster Response, which was designed in the form of material safety data sheet (MSDS) to respond effectively to HNS spills. The information that this database contains is as follows (Japan Association of Marine Safety and Marine Disaster Prevention Center, 2004).

1) Hazard and Noxiousness
2) First Aid
3) The measure in case of afire
4) The measure at the time of the leak
5) Personal protective equipment and detector
6) The measure at the time of the leak at sea
7) The cautions on handling and transportation storage
8) The cautions on abandonment
9) Steam pressure curve
10) Limits of Detective Tube

Table 2. *Example of HNS database of Japan*

UN No.	CAS No.	Material Name	IMDG CODE	IMDG CLASS	Molecular Weight	Flammable Limits in Air(%)	Solubility in Water	Specific Gravity	Vapor Specific Gravity	Boiling Point (℃)	Freezing Point (℃)	Flash Point (℃)	Ignition Point (℃)	Steam Pressure (mmHg)
1307	1330-20-7	Xylene	3394	3.3	106.17	1.0~6.0	insoluble	0.880	3.66	144.4	-25.2	17	463	4.83
1114	71-43-2	Benzene	3185	3.2	78.12	1.3~7.1	insoluble	0.879	2.7	80.1	5.53	-11	498	95.18
2055	100-42-5	Styrene monomer	3381	3.3	104.15	0.9~6.8	insoluble	0.9075	3.6	145.2	-30.69	32	490	4.5
1230	67-56-1	Methacol	3251	3.2	32.04	6.0~36	easy soluble	0.7928	1.1	64.65	-93.9	11	385	100
1294	108-88-3	Toluene	3285	3.2	92.14	1.2~7.1	insoluble	0.8669	3.14	110.6	-95	4	480	24.3
1145	110-82-7	Cyclohexane	3114	3.1	84.18	1.3~8.3	insoluble	0.7786	2.9	80.7	6.47	-18	245	97.6
1093	107-13-1	Acrylonitrile	3173	3.2	83.06	3~17	easy soluble	0.806	1.83	77.3	-83.55	-6	480	83
1184	107-06-2	Ethylene dichloride	3224	3.2	98.96	6.2~16	insoluble	1.262	3.42	83.5	-35.3	13	440	61
1170	64-17-5	Ethanol	3219	3.2	46.07	3.3~19	easy soluble	0.7893	1.59	78.32	-114.5	13	363	44
1120	71-36-3	Butanol	3313	3.3	74.12	1.4~11.2	easy soluble	0.8096	2.55	117.3	-89.5	29	343	5.5
1090	67-64-1	Acetone	3102	3.1	58.08	2.5~12.8	easy soluble	0.791	2.0	56.3	-94.8	-20	558	181.7
1247	80-62-6	Methyl methacrylate	3259	3.2	100.1	1.7~8.2	insoluble	0.944	3.5	100.3	-48.2	10	421	31
1715	108-24-7	Acetic anhydride	8101	8	102.1	2.0~10.3	easy soluble	1.08	3.5	139.5	-73	49	315.5	10
1193	78-93-3	Methyl ethyl ketone	3226	3.2	72.11	1.7~11.4	easy soluble	0.8047	2.5	79.53	-87.3	-9	404	71.2

3.2. HNS Database of Republic of Korea

Based on transportation volumes of vessels passing through domestic waters, Korea selected 130 types of HNS applying the following three conditions below. It chose 68 of them for prioritized management (Annex B-2).

1) Liquid chemicals whose volumes of domestic marine transportation in 2007 are 100,000 m^3 or higher
2) Substances whose annual transportation volumes are below 100,000 m^3 but are included in the classification of hazardous liquid substance (X, Y and Z types 545)
3) Substances with history of marine contamination accident(s) since 1995

Though it has not established a database on material properties, regarding the selected HNSs, Korea did build an MSDS-type database on information for responding to spill accidents. The Korean HNS database includes the following information (Korea Coast Guard, 2005):

1) Material properties (UN No., CAS No., IMDG Code, Pollution Category, Molecular Weight, Formula, Appearance, Smell, Flammable Limits in Air, Solubility in Water, Specific Gravity, Vapor Specific Gravity, Boiling Point, Freezing Point, Flash Point, Steam Pressure, Viscosity etc.)
2) Hazard and Noxiousness
3) First Aid
4) Personal protective equipment and detector
5) The measure at the time of the leak
6) The measure in case of a fire
7) The measure at the time of the leak at sea
8) The cautions on handling and transportation storage
9) The cautions on abandonment

3.3. Emergency Response Guidebook 2008

As an example of an HNS database established and managed by a non-NOWPAP member state, the Emergency Response Guidebook 2008 (ERG2008) was examined (U.S. Department of Transportation and Transport Canada, 2008).

ERG2008 was developed jointly by Transport Canada (TC), the U.S. Department of Transportation (DOT), the Secretariat of Transport and Communications of Mexico (SCT), and with the collaboration of CIQUIME (Centro de Información Química para Emergencias) of Argentina, for use by fire fighters, police, and other emergency services personnel who may be the first to arrive at the scene of a transportation incident involving dangerous goods. It is primarily a guide to aid first responders in quickly identifying the specific or generic hazards of the material(s) involved in the incident, and protecting themselves and the general public during the initial response phase of the incident. For the purposes of this guidebook, the “initial response phase” is the period following the arrival at the scene of an incident. During which, the presence and/or identification of dangerous goods is confirmed, protective actions and area securement are initiated, and assistance of qualified personnel is requested. This is not intended to provide information on the physical or the chemical properties of dangerous goods.

ERG2008 incorporates dangerous goods lists from the most recent United Nations Recommendations as well as from other international and national regulations. Explosives are not listed individually by either proper shipping name or ID Number. They do, however, appear under the general heading “Explosives” on the first page of the ID Number index (yellow-bordered pages) and alphabetically in the Name of Material index (blue-bordered pages). Also, the letter “P,” following the guide number in the yellow-bordered and blue bordered pages, identifies those materials which present a polymerization hazard under certain conditions like Acrolein, stabilized 131P.

Based on the hazardousness grades of HNS substances, ERG2008 provides the following information for responses:

1) Potential Hazards
2) Public Safety
3) Emergency Response

Chapter 4. HNS Database of NOWPAP Region

4.1. Selection of Substances

In the NOWPAP regional oil and HNS spill contingency plan, HNS is defined as "noxious liquid substances carried in bulk, referred to in the newly revised MARPOL Annex II." Therefore, substances for establishing NOWPAP's HNS database were chosen among those meeting the definition of HNS in the NOWPAP regional oil and HNS spill contingency plan. In addition, it was based on the transportation volumes and accident records of member countries such as People's Republic of China, Japan, Republic of Korea, and Russian Federation, under the following criteria:

1) Substances with annual transportation volume of over 100,000 m^3
2) Substances with history of accident(s)

The transportation volume and accident records of member countries, which were used for selecting substances to be included in the NOWPAP HNS database, are shown in Annexes C and D.

4.2. NOWPAP HNS Database

A total of 25 substances have been selected for establishing the NOWPAP HNS database, which contains the following information:

1) UN No.
2) CAS No.
3) Material name
4) IMDG Code
5) IMDG Class
6) Molecular weight
7) Flammable limits in air
8) Solubility in water
9) Specific gravity
10) Vapor specific gravity
11) Boiling point
12) Freezing point

13) Flash point
14) Ignition point
15) Steam pressure

The database of HNS material properties for the NOWPAP region is explained in Table 3.

4.3. MSDS for HNS Spill Response in NOWPAP Region

Material Safety Data Sheets (MSDS) is designed to provide both workers and emergency personnel with the proper procedures for handling or working with a particular substance. MSDS's include information such as physical data (melting point, boiling point, flash point etc.), toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill/leak procedures. These are of particular use in case of a spill or other accidents.

Manufacturers of Hazardous and Noxious Substances typically provide MSDS which summarize the specific hazards associated with each substance. Over time, these will be replaced by Safety Data Sheets (SDS), under the UN Globally Harmonized System of Classification and Labeling of Chemicals (GHS). GHS classifies chemicals by the types of hazard they represent and proposes harmonized hazard communication by consistent labeling and safety data sheets. It aims at ensuring that information on physical hazards and toxicity from chemicals is available to enhance the protection of human health and the environment, during the handling, transport, and use of these chemicals. MSDS and SDS both follow the same format and provide the following information:

1) Identification
2) Hazard(s) identification
3) Composition/ingredients
4) First-aid measures
5) Fire-fighting measures
6) Accidental release measures
7) Handling &storage
8) Exposure controls/personal protection
9) Physical &chemical properties
10) Stability &reactivity

11) Toxicological information
12) Ecological information
13) Disposal considerations
14) Transport information
15) Regulatory information
16) Other information

Table 4 is drawn as an MSDS for responding effectively to HNS spills in the NOWPAP region. The table below is an example of MSDS. MSDS database, for all substances suggested in the database on material properties, is prepared in Annex E. The MSDS database is prepared as a standard draft and should be revised and improved through future discussions with experts from member countries.

Table 3. *HNS database of NOWPAP region*

UN No.	CAS No.	Material Name	IMDG CODE	IMDG CLASS	Molecular Weight	Flammable Limits in Air(%)	behavior in Water	Specific Gravity	Vapor Specific Gravity	Boiling Point (℃)	Freezing Point (℃)	Flash Point (℃)	Ignition Point (℃)	Steam Pressure (mmHg)
2672	1336-21-6	Ammonium Hydroxide	8111	8	35.05	16~25	easy soluble	0.877	0.6	-33.4	-77.7		651	0.01
1307	1330-20-7	Xylene	3394	3.3	106.17	1.0~6.0	insoluble	0.880	3.66	144.4	-25.2	17	463	4.83
2055	100-42-5	Styrene Monomer	3381	3.3	104.15	0.9~6.8	insoluble	0.9075	3.6	145.2	-30.69	32	490	4.5
1114	71-43-2	Benzene	3185	3.2	78.12	1.3~7.1	insoluble	0.879	2.7	80.1	5.53	-11	498	95.18
1230	67-56-1	Methanol	3251	3.2	32.04	6.0~36	easy soluble	0.7928	1.1	64.65	-93.9	11	385	100
	107-21-1	Ethylene glycol			62.07	3.2~	easy soluble	1.113	2.14	197.85	-12.6	111.1	398	1
1824	1310-73-2	Caustic Soda	8226	8	40		easy soluble	2.1		1390	318.4			1
1830	7664-93-9	Sulfuric acid	8230	8	98.1		easy soluble	1.834		340	10.36			5.9 204°C
1294	108-88-3	Toluene	3285	3.2	92.14	1.2~7.1	insoluble	0.8669	3.14	110.6	-95	4	480	24.3
1093	107-13-1	Acrylonitrile	3173	3.2	83.06	3~17	easy soluble	0.806	1.83	77.3	-83.55	-6	480	83
1184	107-06-2	Ethylene dichloride	3224	3.2	98.96	6.2~16	insoluble	1.262	3.42	83.5	-35.3	13	440	61
1145	110-82-7	Cyclohexane	3114	3.1	84.18	1.3~8.3	insoluble	0.7786	2.9	80.7	6.47	-18	245	97.6
2789 2790	64-19-7	Acetic acid	8100	8	60.05	5.4~16	insoluble	1.0492	2.1	117.8	16.635	39	463	0.35
1247	80-62-6	Methyl methacrylate	3259	3.2	100.1	1.7~8.2	insoluble	0.944	3.5	100.3	-48.2	10	421	31
2821	108-95-2	Phenol	6225	6.1	94.11	1.8~3.2	insoluble	1.0499	3.24	181.75	40.95	79	715	0.35
1593	75-09-2	Dichloroethane	6127	6.1	84.94	12~25	insoluble	1.3266	2.9	40.21	-96.8		556	200 6.85°C
1301	108-05-4	Vinyl acetate	3289	3.2	86.09	2.6~13.4	easy soluble	0.9342	3.0	73.1	-93.2	-8	402	83
2031	7697-37-2	Nitric acid	8195	8	63		easy soluble	1.5		86	-42			60 24.2°C
1193	78-93-3	Methyl ehtyl ketone	3226	3.2	72.11	1.7~11.4	easy soluble	0.8047	2.5	79.53	-87.3	-9	404	71.2
	111-87-5	Octanol	9028	9	130.23		insoluble	0.827		194	-17	81		0.2
1993	108-93-0	Cyclohexanol			100.16	1.1~8.1	easy soluble	0.96	3.5	161.1	25.15	68	300	10
2218	79-10-7	Acrylic acid	8102	8	72.1	2.4~8	insoluble	1.062	2.5	141.9	14	50	438	10
2348	141-32-2	Butyl acrylate	3315	3.3	128.17	1.7~9.9	insoluble	0.8998	4.45	147	-64.4	48.9	292	3.2
1888	67-66-3	Chloroform	6103	6.1	119.4		insoluble	1.4984	4.18	61.2	-63.5			200
1173	141-78-6	Ethyl acetate	3220	3.2	88.11	2.0~11.5	easy soluble	0.902	3.1	76.82	-83.6	-4	426	73

Table 4. *An example of MSDS for HNS spill response in NOWPAP region*

AMMONIUM HYDROXIDE

Identification

General Description

A colorless aqueous solution. Concentration of ammonia ranges up to approximately 30%. Ammonia vapors (which arise from the solution) irritate the eyes.

Identifiers

UN No.	CAS No.	IMDG CODE
2672	1336-21-6	Class8/P8111

Alternate Names

- AMMONIA WATER
- AMMONIA, AQUA
- AMMONIA, MONOHYDRATE
- AQUA AMMONIA

Physical Properties

Formula	NH_4OH	Molecular Weight	35.05	Flammable limits in Air (%)	16～25
Appearance	colorless			Solubility in Water	easily soluble
Specific Gravity	0.877	Vapor Specific Gravity	0.6	Boiling Point(℃)	-33.4
Freezing Point (℃)	-77.7	Flash Point (℃)		Ignition Point (℃)	651
Steam Pressure	0.01mmHg (20℃)	Corrosion	Human: yes Metal: yes	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air &Water Reactions

Water soluble. Generates a small amount of heat when diluted with water.

■ Fire Hazard

Non-combustible substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Some are oxidizers and may ignite combustibles (wood, paper, oil, clothing, etc.). Contact with metals may ignite flammable hydrogen gas. Containers may explode when heated.

■ Health Hazard

TOXIC; Inhalation, ingestion or skin contact with the material may cause severe injury or death. Contact with molten substance may cause severe burns to skin and eyes. Avoid any skin contact. Effects of contact or inhalation may be delayed. Fire may produce irritating, corrosive, and/or toxic gases. Runoff from fire control or dilution water may be corrosive and/or toxic, and cause pollution.

■ Reactivity Profile

AMMONIUM HYDROXIDE reacts exothermically with acids. It emits toxic gaseous ammonia with strong bases. It reacts extremely violently with dimethyl sulfate [NFPA 491M 1991]. It reacts with aqueous silver nitrate sodium hydroxide to give a black precipitate of silver nitride. Such a precipitate can explode when stirred [MCA Case History 1554 1968]. Aqueous ammonia and Hg react to form an explosive solid such as fulminate.

Response Information

■ Firefighting

- SMALL FIRE: Dry chemical, CO2 or water spray.
- LARGE FIRE: Dry chemical, CO2, alcohol-resistant foam or water spray. Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal. Do not scatter the material.

■ Spills and leakage response

ELIMINATE all ignition sources (no smoking, flares, sparks, or flames in immediate vicinity). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop the leak if you can do it without risk. Prevent entry into waterways, sewers, basements, or confined areas. Absorb or cover with dry earth, sand, or other non-combustible material, and transfer to containers. DO NOT GET WATER INSIDE CONTAINERS.

■ Response to spill at sea

Recovery is difficult because it dissolves at sea water in a very short time.

■ Protective clothing

Wear positive pressure, self-contained, breathing apparatus (SCBA). Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY. It is not effective in spill situations where direct contact with the substance is possible.

■ First Aid

Move the victim to an area of fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if the victim ingested or inhaled a substance. Give artificial respiration with the aid of a pocket mask, equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if the victim is having problems breathing. Remove and isolate contaminated clothing and shoes. In case of a contact with substance, immediately flush the skin or the eyes with running water for at least 20 minutes. For minor skin contact, careful not to spread the material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Chapter 5. Conclusion

This paper has discussed ways to establish a database on HNS substance information, in response to possible HNS spills in the NOWPAP region. With an aim to identify HNS material properties and criteria for classification, this paper has analyzed the definition of HNS in OPRC-HNS Conventions, classification standards such as MARPOL 73/78, IBC Code, and IMDG Code. Also, to formulate plans for establishing an HNS database, the current status of HNS databases, built and run by NOWPAP member states and elsewhere, have been examined.

The HNS database for NOWPAP has been structured around 25 substances that meet the HNS definition in the NOWPAP regional oil and HNS spill contingency plan. They are selected based on transportation volumes and accident records of NOWPAP member countries such as China, Japan, Russia, and Korea. This paper has also prepared MSDS on spill response information, as well as ways to build a database on how to respond to spill accidents by generating MSDSs on major HNS substances. MSDS database has prepared for all substances suggested in the database on material properties.

In this paper, 25 substances are suggested for HNS database in the NOWPAP region, under the reviews by experts from member countries. In the future, additional substances can be selected through agreement of NOWPAP member countries. Also, the format of MSDS database should be revised and improved through future discussions with experts from member countries. Along with this database, a management system of database should be developed for efficient application of this database. The management system can support the substance search in the database by using name, CAS Number, UN Number, etc. The management system can support managing databases like registration of substance, modification of substance, deleting of substance, etc.

Reference

Japan Association of Marine Safety and Marine Disaster Prevention Center of Japan, 2004. Report on Response of HNS Spill Incident in 2003.

Japan Association of Marine Safety and Marine Disaster Prevention Center of Japan, 2004. Database for Marine HNS Spill Disaster Response. NOAA, 2008. CAMEO (software).

Korea Coast Guard, 2005. Response Manual for HNS Spill Incident. 293pp.

U.S. Department of Transportation and Transport Canada, 2008. 2008 Emergency Response Guidebook. 372pp.

Annex A. List of Expert Group on HNS Database in the NOWPAP region

People’s Republic of China

Dr. Zhang Xiangshang
Shandong Maritime Safety Administration,
21 Wutangxia Road Qingdao, People’s Republic of China,
Tel: +86-532-8667-1126
Fax: +86-532-8667-1125
E-mail: msa12395@126.com

Japan

Capt. Shin Ohnuki
Principal Researcher
The Japan Association of MarineSafety(JAMS)
15-16, Toranomon 1-chome Minato-ku, Tokyo, Japan
Tel: +81-3-3502-3543
Fax: +81-3-3581-6136
E-mail: sohnuki@nikkaibo.or.jp

Republic of Korea: Leading Country

Dr. Moonjin Lee (Leading Expert)
Principal Research Scientist
Maritime and Ocean Engineering Research Institute / Korea Ocean
Research and Development Institute (MOERI/KORDI) Yuseong, P.O.Box23,
Daejeon, Republic of Korea
Tel: +82-42-868-7300
Fax: +82-42-868-7738
E-mail: Moonjin.Lee@moeri.re.kr

Russian Federation

Dr. Gennady Semanov
Head of Laboratory Environmental Safety of Maritime Transport
Central Marine Reseach & Design Institute (CNNIMF)
6, Kavalergardskaya Str., St.Petersburg, 191015, Russian Federation
Tel: +7-812-217-10-15
Fax: +7-812-274-38-64
E-mail: Semanov@cniimf.ru

Annex B. HNS Database of NOWPAP Member States

Table Annex B-1. *HNS Database of Japan*

UN No.	CAS No.	Material Name	IMDG CODE	IMDG CLASS	Molecular Weight	Flammable Limits in Air(%)	Solubility in Water	Specific Gravity	Vapor Specific Gravity	Boiling Point (℃)	Fr ezing Point (℃)	Flash Point (℃)	Ignition Point (℃)	Steam Pressure (mmHg)
1307	1330-20-7	Xylene	3394	3.3	106.17	1.0~6.0	insoluble	0.880	3.66	144.4	-25.2	17	463	4.83
1114	71-43-2	Benzene	3185	3.2	78.12	1.3~7.1	insoluble	0.879	2.7	80.1	5.53	-11	498	95.18
2055	100-42-5	Styrene monomer	3381	3.3	104.15	0.9~6.8	insoluble	0.9075	3.6	145.2	-30.69	32	490	4.5
1230	67-56-1	Methacol	3251	3.2	32.04	6.0~36	easy soluble	0.7928	1.1	64.65	-93.9	11	385	100
1294	108-88-3	Toluene	3285	3.2	92.14	1.2~7.1	insoluble	0.8669	3.14	110.6	-95	4	480	24.3
1145	110-82-7	Cyclohexane	3114	3.1	84.18	1.3~8.3	insoluble	0.7786	2.9	80.7	6.47	-18	245	97.6
1093	107-13-1	Acrylonitrile	3173	3.2	83.06	3~17	easy soluble	0.806	1.83	77.3	-83.55	-6	480	83
1184	107-06-2	Ethylene dichloride	3224	3.2	98.96	6.2~16	insoluble	1.262	3.42	83.5	-35.3	13	440	61
1170	64-17-5	Ehtanol	3219	3.2	46.07	3.3~19	easy soluble	0.7893	1.59	78.32	-114.5	13	363	44
1120	71-36-3	Butanol	3313	3.3	74.12	1.4~11.2	easy soluble	0.8096	2.55	117.3	-89.5	29	343	5.5
1090	67-64-1	Acetone	3102	3.1	58.08	2.5~12.8	easy soluble	0.791	2.0	56.3	-94.8	-20	558	181.7
1247	80-62-6	Methyl methacrylate	3259	3.2	100.1	1.7~8.2	insoluble	0.944	3.5	100.3	-48.2	10	421	31
1715	108-24-7	Acetic anhydride	8101	8	102.1	2.0~10.3	easy soluble	1.08	3.5	139.5	-73	49	315.5	10
1193	78-93-3	Methyl ehtyl ketone	3226	3.2	72.11	1.7~11.4	easy soluble	0.8047	2.5	79.53	-87.3	-9	404	71.2
1301	108-05-4	Vinyl acetate	3289	3.2	86.09	2.6~13.4	easy soluble	0.9342	3.0	73.1	-93.2	-8	402	83
2364	98-82-8	Propylbenzene	3357	3.3	120.19	0.9~6.5	insoluble	0.862	4.1	152.39	-96	36	424	0.02
2821	108-95-2	Phenol	6225	6.1	94.11	1.8~3.2	insoluble	1.0499	3.24	181.75	40.95	79	715	0.35
	107-21-1	Ethylene glycol			62.07	3.2~	easy soluble	1.113	2.14	197.85	-12.6	111.1	398	1
	108-93-0	Cyclohexanol			100.16	1.1~8.1	easy soluble	0.96	3.5	161.1	25.15	68	300	10
2348	141-32-2	Butyl acrylate	3315	3.3	128.17	1.7~9.9	insoluble	0.8998	4.45	147	-64.4	48.9	292	3.2
1173	141-78-6	Ethyl acetate	3220	3.2	88.11	2.0~11.5	easy soluble	0.902	3.1	76.82	-83.6	-4	426	73
1208	110-54-3	Hexane	3129	3.1	86.18	1.1~7.5	insoluble	0.659	3.0	68.7	-95.3	-22	223	155
1993	111-66-0	Octene	3230	3.2	112	0.8~6.5	insoluble	0.71	3.9	101.44	-106.4	-5	391	
2325	108-67-8	Alkylbenzene	3389-1	3.3	120.19	0.9~6.1	insoluble	0.862	4.2	164.7	-44.7	46	531	
1274	71-23-8	I-Propanol	3272-1	3.2	60.1	2.1~13.7	easy soluble	0.8	2.1	97.2	-126.5	23	412	20
1824	1310-73-2	Sodium hydroxide	8226	8	40		easy soluble	2.1		1390	318.4			1
1888	67-66-3	Chloroform	6103	6.1	119.4		insoluble	1.4984	4.18	61.2	-63.5			200
1547	62-53-3	Aniline	6068	6.1	93.13	1.3~11.0	easy soluble	1.022	3.22	184.55	-5.98	70	615	0.3
3295	124-11-8	Nonene	3352	3.3	126.23	0.7~3.9	insoluble	0.74	4.4	146.9	-81	25.6		5.34

UN No.	CAS No.	Material Name	IMDG CODE	IMDG CLASS	Molecular Weight	Flammable Limits in Air(%)	Solubility in Water	Specific Gravity	Vapor Specific Gravity	Boiling Point (℃)	Freezing Point (℃)	Flash Point (℃)	Ignition Point (℃)	Steam Pressure (mmHg)
2048		1,3-Cyclopentadiene dimer	3330	3.3			insoluble	1.012	4.6	170	33.6	32.2	503	
1593	75-09-2	Methylene chloride	6127	6.1	84.94	12~25	insoluble	1.3266	2.9	40.21	-96.8		556	200 (6.85°C)
2789 2790	64-19-7	Acetic acid	8100	8	60.05	5.4~16	insoluble	1.0492	2.1	117.8	16.635	39	463	0.35
1541	75-86-5	Acetone cyanohydrin	6051	6.1	85.11	2.2~12	insoluble	0.9267	3	81	-19	74	688	1
2218	79-10-7	Acrylic acid	8102	8	72.1	2.4~8	insoluble	1.062	2.5	141.9	14	50	438	10
1098	107-18-6	Allyl alcohol	6058	6.1	58.08	2.5~18.0	insoluble	0.854	2	96.9	-129	21	378	3.2
3082	143-08-8	Nonyl alcohol	9028	9	144.3	1.4~10.0	easy soluble	0.8274	5	213.5	-5.5	79	300	73
2265	68-12-2	Dimethylformamide	3335	3.3	73.1	2.2~15.2	insoluble	0.9445	2.5	153	-61	58	445	155
1175	100-41-4	Ethylbenzene	3222	3.2	106.2	1.0~6.7	easy soluble	0.8669	3.7	136.19	-94.98	21	432	
2050	11071-47-9	Diisobutylene	3210	3.2	112.22	0.8~4.8	easy soluble	0.715	3.9	101.44	-93.5	-6.6	415	
1710	79-01-6	Trichloroethylene	6273	6.1	131.4	8~10.5	easy soluble	1.4556	4.5	86.7	-88	32	420	20
1917	140-88-5	Ethyl acrylate	3220	3.2	100.1	1.4~14	easy soluble	0.9405	3.5	99.3	-71.2	10	372	1
1245	591-78-6	Methyl butyl ketone	3257	3.2	100.2	1.2~8.0	insoluble	0.8301	3.5	127.2	-56.9	35	423	200
2076	1319-77-3	Cresol	6114	6.1	108.1	1.4~	insoluble	1.0465	3.8	191	31	81	599	0.3
1100	107-05-1	Allyl chloride	3105-1	3.1	76.5	2.9~11.1	easy soluble	0.9397	2.6	45.1	-134.5	-32	485	5.34
2850		Propylene tetramer	3378	3.3		0.8~	insoluble	0.77	5.8	183~202	-35	60	255	
2831	71-55-6	1,1,1-Trichloroethane	6272-1	6.1	133.4	8~16	insoluble	1.3376	4.6	73.9	-32.96		500	60 (9.5°C)
1919	96-33-3	Methyl acrylate	3252	3.2	86.09	2.8~25.0	easy soluble	0.9561	3	79.6~80	-75	-2.8	468	100
2303	98-83-9	α-Methylstyrene	3357	3.3	118.2	0.9~6.6	insoluble	0.9134	4.1	163.5	-23.14	53.9	574.4	2.07
1206	142-82-5	Heptane	3235	3.2	100.21	1.1~6.7	insoluble	0.68378	3.5	98.427	-90.61	-4	204	
1123	123-86-4	Butyl acetate	3191	3.2	116.2	1.2~7.6	easy soluble	0.8826	4	126.3	-77	22	425	15
1993	9016-00-6	Polysiloxane	3230	3.2			insoluble	0.7636	5.6	99.5	-67	-9		
1578	88-73-3	o-Chloronitrobenzen	6106	6.1	157.56		insoluble	1.368	5.5	244.5	33	123		
1897	127-18-4	Tetrachloroethylene	6264	6.1	165.8		insoluble	1.60682	5.8	121.2	-22.18			14.3
2078	584-84-9	Toluene diisocyanate	6269	6.1	174.2	0.9~9.5	easy soluble	1.2244	6	251	19.5~21	132		0.01

UN No.	CAS No.	Material Name	IMDG CODE	IMDG CLASS	Molecular Weight	Flammable Limits in Air(%)	Solubility in Water	Specific Gravity	Vapor Specific Gravity	Boiling Point (℃)	Fr ezing Point (℃)	Flash Point (℃)	Ignition Point (℃)	Steam Pressure (mmHg)
	117-81-7	Diocthyl phthalate			390.56		insoluble	0.9861	13.6	385~390	-55	218	410	1.2 (200°C)
1198	50-00-0	Formalin	3347	3.3	30	7.0~73.0	easy soluble	1.085	1	96	-92	49	420	1.3
2261	1300-71-6	Xylenol	6280	6.1	122.17	1.4~	easy soluble	0.9680~ 1.036	4.2	203~225	26~76	94	599	
2584 2586	27176-87-0	Alkylbenzenesulfonic acid	8105	8	326.5		easy soluble							
1783	124-09-4	Hexamethylenediamine	8180	8	116.21	0.9~7.6	easy soluble	0.93	4	205	45	85	305	
1805	7664-38-2	Phosphoric acid	8204	8	98		easy soluble	1.8741		213	42.35			0.03
	50-70-4	Sorbitol			182.17		easy soluble	1.47			110~112			
3082	112-30-1	Decyl alcohol	9028	9	158.29		insoluble	0.83	5.5	229	-35	82.2	228	1(69.5°C)
2531	79-41-4	Methacrylic acid	8192	8	86	1.6~8.8	easy soluble	1.0128	3	161	16	77.2		1(25.5°C)
1814	1310-58-3	Potassium hydroxide	8214	8	56.1		easy soluble	2.05		1320	360.4			1(719°C)
2052	5989-54-8	Dipentene	3326	3.3	136.24	0.75~6.1	insoluble	0.8405	4.7	178	-95.5	45	237	
2949	1672-80-5	Sodium hydrogensulfite	8225	8	56.1		easy soluble	1.79			350			
2489	101-68-8	Diphenylmethane-4, 4-diisocyanate	6140	6.1	250.26		insoluble	1.19		194~199	37.2	202	232	
1662	98-95-3	Nitrobenzene	6208	6.1	123.1	1.8~40	insoluble	1.2037	4.3	211.03	5.85	88	482	1(44.4°C)
3082	84-74-2	Dibutyl phthalate	9028	9	278.35	0.5~2.5	insoluble	1.048	9.6	339	-35	187	402	1(148.2° C)
2491	102-71-6	Triethanolamine	8169	8	149.2	1.3~8.5	easy soluble	1.1242	5.2	206.7	17~19	179		1(159.5 6°C)
1594	64-67-5	Sulfuric acid diethyl ester	6130	6.1	154.18	4.1~	insoluble	1.1774	5.3	208	25.2	104	436.1	

UN No.	CAS No.	Material Name	IMDG CODE	IMDG CLASS	Molecular Weight	Flammable Limits in Air(%)	Solubility in Water	Specific Gravity	Vapor Specific Gravity	Boiling Point (℃)	Freezing Point (℃)	Flash Point (℃)	Ignition Point (℃)	Steam Pressure (mmHg)
2357	108-91-8	Cyclohexylamine	8156	8	99.18	1.5~9.4	easy soluble	0.8647	3.4	134.5	-17.7	31	293	30.5(15°C)
		Ehtyl-3-ethoxypropionate		3.3		1.05~	insoluble	0.949	5	170.1	-100	82.2	377	
2227	97-88-1	n-Butyl methacrylate	3316	3.3	142.2	2~8	insoluble	0.894	4.9	163	-60	52.2	294	2
2880	7778-54-3	Calcium oxychloride	5138	5.1	187.07		easy soluble	1.15						
2031	7697-37-2	Nitric acid	8195	8	63		easy soluble	1.5		86	-42			60(24.2°C)
3082	85-68-7	Butyl benzyl phthalate	9028	9	312.37		insoluble	1.117	10.8	370	-40	199		0.1(140°C)
1160	124-40-3	Dimethylamine	3118 3212	3.1 3.2	45.1	2.8~14.4	easy soluble	0.6804	1.6	6.88	-93	-17.8	400	1900
2491	141-43-5	Ethanolamine	8169	8	149.2	5.5~17	easy soluble	1.0117	2.1	171.1	10.5	85	410	
1760	111-42-2	Dietanolamine	8147	8	105.1	1.6~9.8	easy soluble	1.0881	3.6	271	28	138	662.2	1.09
1830	7664-93-9	Sulfuric acid	8230	8	98.1		easy soluble	1.834		340	10.36			5.9 (204°C)
1282	110-86-1	Pyridine	3277	3.2	79.1	1.8~12.4	easy soluble	0.977	2.7	115.5	-41.8	20	482	18
1604	107-15-3	Ethylenediamine	8170	8	60.1	2.7~16.6	easy soluble	0.8994	2.1	117	8.5	33.9	385	10(21.5°C)
	7783-20-2	Ammonium sulfate			132.13		easy soluble	1.76			513			
	111-55-9	Ethyleneglycol diacetate			146.1	1.6~8.4	easy soluble	1.1	5	191	-31	96		
1129	123-72-8	Butyraldehyde	3196	3.2	72.1	1.9~12.5	insoluble	0.8048		74.7	-99	-9		
	149-57-5	2-Ethylhexanoic acid(Octanoic acid)		8	144.22	0.8~6.0	insoluble	0.9077	5	226.9	-83	126.7	371	0.03
	9016-87-9	Polymethlene polyphenyl polyisocyanate						1.24	14	232		218		0.005
	9003-28-5	Polybutene			250~2500		insoluble	0.83~0.912			-50~20	115~230		
		Olefin mixtures(C5-C15)												
2074	79-06-1	Acrylamide	6054	6.1	71.08		easy soluble	1.122						
	70955-11-2	Heptanol			116.21	1.2~10.0	easy soluble	0.822	4.04	176.81	-34.03	74	300	0.9

UN No.	CAS No.	Material Name	IMDG CODE	IMDG CLASS	Molecular Weight	Flammable Limits in Air(%)	Solubility in Water	Specific Gravity	Vapor Specific Gravity	Boiling Point (℃)	Freezing Point (℃)	Flash Point (℃)	Ignition Point (℃)	Steam Pressure (mmHg)
		Palm oil fatty acid methyl ester						0.85		148		65		
3082	112-42-5	Undecyl alchol			172		insoluble	0.822	6	243	19	117		6~15
	78-59-1	Isophorone			138.21	0.8~3.8	insoluble	0.9229	4.8	215	-8.1	84	460	0.2
		Olefin mixtures(C5-C7)												
1993	108-65-6	Propylene glyeol monomethylether acetate	33454	3.3	132.1	1.5~7.0	easy soluble	0.97	4.6	146	-55	47.7		3.45
1172	111-15-9	Ethylglycol acetate	3341	3.3	132.2	1.7~12.7	easy soluble	0.9748	4.7	156.3	-61.7	52	379	1.2
	25265-71-8	Dipropylene glycol			134.2	2.9~12.6	easy soluble	1.02	4.63	231.8	-40	138	350	0.008
	2648-21-3	Diheptyl phthalate			362.51		insoluble	0.992	12.5	235~245	-46	193		
1171	110-80-5	2-Ethoxyethanol	3341	3.3	90.12	1.7~15.6	easy soluble	0.9275	3.1	135.1	-70	43	235	3.75
1299	8006-64-2	Turpentine oil	3391	3.3	136	0.8~	insoluble	0.860~ 0.875	4.8	150~170	-50~-60	35	253.3	10 (37.3°C)
2047	8003-19-8	1,3-Dichloropropene	3330	3.3	112.99	5.3~14.5	insoluble	1.224	3.9	112.2	-80	35	557	30
2079	111-40-0	Diethylenetriamine	8161	8	103.17	2~6.7	easy soluble	0.9586	3.6	207.1	-39	101.7	389	0.37
2672	1336-21-6	Aqueous ammonia	8111	8	35.05	16~25	easy soluble	0.877	0.6	-33.4	-77.7		651	0.01
	96-48-0	ϒ-Butyrolactone			86.1	0.3~16.0	easy soluble	1.1	3	204	-44	98	455	1.125
1148	123-42-2	Diacetone alcohol	3327	3.3	116.2	1.8~6.9	easy soluble	0.9306	4	167.9	-44	58	643	
2054	110-91-8	Morpholine	3367	3.3	87.12	2.0~11.2	easy soluble	1.007	3	128	-4.9	37.8	310	6.6
		Palm kernel acid oil					insoluble	0.8806		204				
	112-07-2	Ethylene glycol butyl ether acetate			160.2	0.9~8.5	easy soluble	0.94	5.5	192	-64	71	340	0.225~ 0.3

Table Annex B-2. *HNS Database of Republic of Korea*

Material Name	CAS No
1-OCTENE	111-66-0
1-HEXENE	592-41-6
2-ETHYLHEXYL ACRYLATE	103-11-7
(C8-10)ISO ALCOHOLS	68526-84-1
m-XYLENE	108-38-3
N,N-DIMETHYLFORMAMIDE	68-12-2
n-BUTYL ACETATE	123-86-4
n-BUTYL ACRYLATE	141-32-2
n-OCTYL ALCOHOL(OCTANOL)	111-87-5
o-XYLENE	02.
p-XYLENE	106-42-3
CAUSTIC SODA	1310-73-2
HYDROGEN PEROXIDE	7722-84-1
NAPHTHALENE	91-20-3
n-HEXANE	110-54-3
SOYBEAN OIL	8001-22-7
CATALYTIC CRACKED CLARIFIED OIL	64741-62-4
DIISOBUTYL KETONE	108-83-8
DIETHANOLAMINE	111-42-2
DIOCTYL PHTHALATE	117-84-0
DIISODECYL PHTHALATE	26761-40-0
METHYL METHACRYLATE	80-62-6
METHYL tert-BUTYL ETHER	1634-04-4
METHYL ACRYLATE	96-33-3
METHYL ALCOHOL	67-56-1
METHYL ETHYL KETONE	78-93-3
METHYL CHLOROFORM	71-55-6
ACETIC ANHYDRIDE	108-24-7
BENZENE	71-43-2
BUTADIENE	106-99-0
BUTYL BENZYL PHTHALATE	85-68-7
CYCLOHEXANONE	108-94-1
CYCLOHEXANE	110-82-7
PROPYLENE OXIDE	75-56-9
POTASSIUM HYDROXIDE	1310-58-3
TALLOW	61789-97-7
STYRENE	100-42-5
ANILINE	62-53-3

Material Name	CAS No
ACETONE	67-64-1
VINYL ACETATE	108-05-4
ETHYL ACETATE	141-78-6
ACETIC ACID	64-19-7
ISOBUTYL ALCOHOL	78-83-1
ACRYLONITRILE	107-13-1
AMMONIA,ANHYDROUS	7664-41-7
ETHANOLAMINE	141-43-5
ETHYL BENZENE	100-41-4
ETHYL ALCOHOL	64-17-5
ETHYLENE GLYCOL	107-21-1
ETHYLENE	74-85-1
EPICHLOROHYDRIN	106-89-8
CORN OIL	8001-30-7
ETHYLENE DICHLORIDE	107-06-2
PHOSPHORIC	7664-38-2
XYLENE	1330-20-7
NITRIC ACID	7697-37-2
CRESOL	1319-77-3
CHLOROFORM	67-66-3
TETRAHYDROFURAN	109-99-9
TOLUENE	108-88-3
TRICHLOROETHYLENE	79-01-6
TRIETHANOLAMINE	102-71-6
FATTY ACIDS, PALM-OIL, METHYL ESTERS	91051-34-2
PHENOL	108-95-2
PROPYLENE GLYCOL MONOMETHYL ETHER ACETATE	108-65-6
PROPYLENE	115-07-1
SULFUR	7704-34-9
SULFURIC ACID	7664-93-9

Annex C. Major List and Contents of Chemicals Transported in Bulk at Sea Area of NOWPAP Member States

Table Annex C-1. *Major list and contents of chemicals transported in bulk at sea area of People's Republic of China*

Rank in volume	Material Name	Volume of Traffic (tonnes)
1	Styrene	1,813,492
2	o-xylenes	1,485,805
3	p-xylenes	1,099,320
4	Benzenes	878,285
5	Sulfuric Acid	703,089
6	AClylonitrile	456,003
7	Toluene	368,538
8	Xylenes	359,572
9	Acetic acid	292,512
10	Ethylene glycol	284,354
11	Mixed benzenes	150,690
12	Methyl alcohol	127,297
13	Methanol	53,166
14	Chloroform	47,046
15	Tetrahydrofuram	22,830
16	Phenol	10,961

Table Annex C-2. *Major list and contents of chemicals transported in bulk at sea area of Japan*

Rank in volume	Material Name	Volume of traffic (tonnes)	UN No.
1	Xylene	2,805,279	1307
2	Benzene	1,779,155	1114
3	Styrene monomer	1,328,604	2055
4	Methanol	760,825	1230
5	Toluene	695,212	1294
6	Cyclohexane	466,084	1145
7	Acrylonitrile	370,367	1093
8	Butanol	302,484	1120
9	Methy1 methacrylate	274,474	1247
10	Acetic acid	263,329	2789
11	Ethanol	252,413	1170
12	Phenol	243,702	2821
13	Sodium hydroxide	241,855	1814
14	Acetone	216,907	1090
15	dichloroethane	214,454	1184
16	Ethylene glycol	207,494	
17	Vinyl acetate	190,342	1301
18	Propyl benzene	148,661	1918
19	Octanol	148,392	3082
20	Acetic ether	141,813	1173
21	Cyclohexanol	117,536	
22	Methyl ethyl ketone	106,230	1193
23	Acrylic acid	100,690	2218
24	Aniline	94,320	1547
25	1-Propanol	78,685	1274
26	Hexane	59,796	1208
27	Isobutyl acrylate	58,949	2527
28	Octene	58,750	1993
29	Latex	58,650	
30	Butyl acrylate	55,180	1123
31	Diphenylmethane diisocyanate	47,550	2489
32	Diisopropyl benzene	46,251	3082
33	Butylene glycol	46,238	
34	Alkyl benzene	42,651	2325
35	Dioctyl phthalate	41,619	
36	Methyl butyl ketone	41,299	1245
37	Acetic anhydride	40,947	1715
38	Molasses	40,777	
39	Epichlorohydrin	40,041	2023
40	Naphthalene	36,106	2304

Table Annex C-3. *Major list and contents of chemicals transported in bulk at sea area of Republic of Korea*

Rank in volume	Material Name	Volume of traffic (tonnes)	CAS No.
1	Aqueous ammonia	14,276	7664-41-7
2	Styrene	2,121	100-42-5
3	Benzene	2,021	71-43-2
4	Methyl alcohol	1,816	67-56-1
5	Xylene	1,758	1330-20-7
6	m-Xylene	1,173	108-38-3
7	p-Xylene	1,166	106-42-3
8	Ethylene glycol	916	107-21-1
9	Sodium Hydroxide	885	1310-73-2
10	Sulfuric acid	862	7664-93-9
11	Acrylonitrile	669	107-13-1
12	Ethylene dichloride	633	107-06-2
13	Toluene	313	108-88-3
14	Soybean Oil	246	8001-22-7
15	Acetic acid	229	64-19-7
16	Vinyl acetate	211	108-05-4
17	Nitric acid	210	7697-37-2
18	Methyl ethyl ketone	180	78-93-3
19	Ethylene	177	74-85-1
20	Ethyl alcohol	164	64-17-5
21	Propylene	159	115-07-1
22	Butadiene	135	106-99-0
23	Acetone	126	67-64-1
24	Catalytic cracked clarified Oil	125	64741-62-4
25	Propylene oxide	118	75-56-9
26	n-HEXANE	117	110-54-3
27	Cyclohexane	114	108-94-1
28	Fatty acids, Palm-oil, Methyl Esters	107	91051-34-2
29	Chloroform	92	67-66-3
30	Methyl tert-Butyl ether	92	1634-04-4
31	n-Octyl AlcoholALCOHOL(OCTANOL)	86	111-87-5
32	Normal Paraffin	82	64771-72-8
33	Calcium Lignosulfonate	74	8061-52-7
34	EPICHLOROHYDRIN	72	106-89-8
35	Methyl Methacrylate	70	80-62-6
36	Vinyl chloride	67	75-01-4
37	SULFUR	56	7704-34-9
38	Phenol	54	108-95-2
39	Ethyl acetate	48	141-78-6
40	Phosphoric	37	7664-38-2

Table Annex C-4. *Major list and contents of chemicals transported in bulk at sea area of Russian Federation*

Rank in volume	Material Name	Volume of traffic (tonnes)
1	coals	1,500,000
2	ferrochrom	39,000
3	ferrosilicon	31,000
4	ferrosilicon slag	3,400
5	ferrochrome silicon	1,500
6	microsilica	1,400

Annex D. Major List and Contents of Chemical Spill Submitted by NOWPAP Member States

Table Annex D-1. *List of HNS Spill incidents submitted by People's Republic of China*

Date	Location	Name of Vessel	Nationality	Type of vessel	Quantity (Tonnes)	HNS	Cause
1997.07.06	Yangzi River	Chuanliang 204, Chuanliang205	China	barge	330	Concentrated Sulphuric Acid	Sinking
1997.10.08	Yangzi River	GanfuzhouyouOO05	China	oil tanker	149	benzene	Grounding
1997.10.20	Yangzi River	NanxiOOl6	China	barge	220	Carbon Tetrachloride	Grounding
1998.06.02	Yangzi River	li angsu871	China	tugboat	108	Concentrated Sulphuric Acid	Grounding
2000.06.18	Yangzi River	llengshanj i 0018	China	chemical carrier	49	Organophosphorus Pesticide (methamidophos)	Sinking
2001.04.17	31°03'N, 122°46'E	DAE MYOUNG	Korea	bulk chemical carrier	639	Styrene	Collision
2001.09.04	Yangzi River	Chizhouhuo 178, ZongyanghuaOl7	China	bulk chemical carrier	203	Concentrated Sulphuric Acid	Collision
2001.09.05	Yangzi River	Yanduguan9848	China	bulk chemical carrier	150	Concentrated Sulphuric Acid	Collision

Date	Location	Name of Vessel	Nationality	Type of vessel	Quantity (Tonnes)	HNS	Cause
2002.07.11	Yangzi River	Ganjinghuo 0005	China	chemical carrier	240	30% Sodium Hydroxide solution Methyl Methacrylate	
2002.10.19	30049'N, 122°38'E	ACCORD	Korea	bulk chemical carrier	225	(MMA) & Propylene Glycol Methyl Ether Acetate (PGMEA)	Grounding
2003.02.10	Yangzi River	Dongfeng6	China	chemical carrier	300	Concentrated Sulphuric Acid	Grounding
2004.03.15	Yangzi River	Changrun	China	chemical carrier	10	Cyclohexanone	Collision
2004.04.06	22°00'N, 108°30'E	Cuiyun1519	China	chemical carrier	100	31% Hydrochloric acid	Grounding & Sinking
2004.09.11	36°43'N, 122°36'E	Jinda266	China	bulk chemical carrier	2000	32% Hydrochloric acid	Sinking

Table Annex D-2. *List of HNS Spill incidents submitted by Japan*

Date	Location	Name of Vessel	Nationality	Type of vessel	Quantity (Tonnes)	HNS	Cause
1994.02.14	Outside of the Osaka Port	Daisyo-maru	Japan	No record	116	Ethyl acetate	Collision
1995.09.06	2.4NM from Honmoku control signal center	HUSUM	Cyprus	Container vessel	Unknown	Sulfur dioxide	Chemical reaction
1996.02.10	Omaezaki	Dai 21 daiho-maru	Japan	Chemical tanker	400	Liquid phosphoric acid	Grounding Sinking
1996.02.09	33NM east-southeast from the Cheju, Korea	SUNNY BREEZE	Panama	Tanker	3,794 226	Gas oil Solvent	Explosion and Fire Sinking
1996.07.03	8NM from the Higashi izu town	Yusei-maru	Japan	Chemical tanker	Unknown	Butyl acrylate	Collision
1996.11.05	5,100m from the lifhhouse of the Daikoku dike, Yokohama city	FORMOSA-TWO	Liberia	Chemical tanker	26	Styrene monomer	Collision
1997.06.26	Tokyo-bay	Dai 2 takasago-maru	Japan	LPG tanker		Liquid propylene	Sinking
1997.10.09	Keihin-port, Tokyo-bay	BOW-PANTER	Noerway	Chemical tanker	20	Mixed xylene (o-xylene, m-xylene, p-xylene)	Damage of Hull

Date	Location	Name of Vessel	Nationality	Type of vessel	Quantity (Tonnes)	HNS	Cause
1997.12.12	Keihin-port, Tokyo Bay	LODESTAR-SPIRIT	Panama	Chemical tanker	Unknown	p-xylene	Collision
1998.10.19	Kimizu city, pref. ChibaOume cotainer pier, Tokyo-bay	UNI VITAL	Panama	Container vessel	Unknown		Unconnected electric power supply with cooling machine
2000.05.27	280NM North-west from Naha City	PRATIBHA YAMUNA	Unknown	Chemical tanker	Unknown	Naphtha	Explosion and Fire
2000.08.30	36NM from the Rishiri	Dai 8 Katu-maru	Japan	Fishing vessel	Unknown	Ammonia gas	Accident to a cooling machine
2000.09.17	1,300m from the Kushirozaki	PAO HSIANG No. 1	Taiwan	Fishing vessel	Unknown	Ammonia	Grounding
2002.10.05	102NM west-southwest from Irozaki lighthouse, Pref. Shizuoka	Eiwa-maru	Japan	Chemical Tanker	500	Xylene	Collision
2003.12.24	10.8NM from Hoziro lighthouse, Pref. Ymaguchi	SUN VENUS	Panama	Chemical Tanker	556	Ethanol	Explosion and Fire
2005.07.09	Outside of UBe port, Pref. Yamaguchi	Dainisyouturu-maru	Japan	LEG Tanker	32	Liquefied ethylene gas	Collision
2005.07.15	Offing of the Kumano city, Pref. Wakayama	Kyokuyo-maru	Japan	Chemical Tanker	300	Crude benzen	Collision

Table Annex D-3. *List of HNS Spill incidents submitted by Republic of Korea*

Date	Location	Name of Vessel	Nationality	Type of vessel	Quantity (Tonnes)	HNS	Cause
1996.12.26	Port Yeosu	LG Caltex		Land Facility	2.6	Toluene	-
1999.02.02	Ulsan (Front of Tae-Young Chemical Inc.)	Tae-Young Chemicals, Inc.		Land Facility	0.9	M-Xylene	Negligence
1999.11.11	SE 3.2Km, Bookhyeong Islands, Busan	Young-Chemi, Inc.	Belize	Chemicals Carrier	Bunker-C 69 Gasoline 177 Chloroform 988	Bunker-C Gasoline Chloroform	Submersion
2000.11.15	Quay Joongheung, port Kwangyang	Zinghaiting	China	Chemicals Carrier	2.5	Xylene	Negligence
2001.03.21	Front of Port Kohyeon, Sinhyeon-ub, Geoje	Shin-Ya III	Korea	Chemicals Carrier	1.2	Stylene Mannmer	Negligence
2001.09.17	Quay Nakpo, Industrial Complex, Yeosu	Hub Prince	Norway	Carrier for Miscellaneous	9.2	Ammonia Water	Breakage
2002.03.30	Quay Jangcheon 1, Jinhae, Tongyoung	Han-Yang	Panama	Chemicals Carrier	3.9	INA	Negligence
2002.05.13	SW 10 mile, Ucheong-do, Koonsan	Dae-San Pioneer	Korea	Chemicals Carrier	203.8	Xylene	Collision

Date	Location	Name of Vessel	Nationality	Type of vessel	Quantity (Tonnes)	HNS	Cause
2002.12.08	Quay Kiho Industry, Poseung-myeon, Pyeongtaek-shi	Chemibulk Singapore	Liberia	Chemicals Carrier	2.8	Beef tallow	Negligence
2003.02.03	Quay 4, Port North, Busan	99sa, 7521 Busan		Land Vehicle	2.8	Latex	Negligence
2004.12.24	Quay for Governmental Vessels, Busan	Jeong-il Stolt Heaven, Inc.		Land Store Facility	10	T-Xylene	Negligence
2006.08.24	Booan, Cheonbook	Vehicle (8303, 85sa, Cheonbuk)			8.0	Chloridized Aluminum	Breakage

Annex E. HNS MSDS Database in the NOWPAP region

Tables of Contents

AMMONIUM HYDROXIDE

Identification

General Description

A colorless aqueous solution. Concentration of ammonia ranges up to approximately 30%. Ammonia vapors (which arise from the solution) irritate the eyes.

Identifiers

UN No.	CAS No.	IMDG CODE
2672	1336-21-6	Class8/P8111

Alternate Names

- AMMONIA WATER
- AMMONIA, AQUA
- AMMONIA, MONOHYDRATE
- AQUA AMMONIA

Physical Properties

Formula	NH4OH	Molecurar Weight	35.05	Flammable limits in Air (%)	16~25
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	0.877	Vapor Specific Gravity	0.6	Boiling Point(℃)	-33.4
Freezing Point (℃)	-77.7	Flash Point (℃)		Ignition Point (℃)	651
Steam Pressure	0.01mmHg (20℃)	Corrosion	Human: yes Metal: yes	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air & Water Reactions

Water soluble. Generates a small amount of heat when diluted with water.

■ Fire Hazard

Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Some are oxidizers and may ignite combustibles (wood, paper, oil, clothing, etc.). Contact with metals may evolve flammable hydrogen gas. Containers may explode when heated.

■ Health Hazard

TOXIC; inhalation, ingestion or skin contact with material may cause severe injury or death. Contact with molten substance may cause severe burns to skin and eyes. Avoid any skin contact. Effects of contact or inhalation may be delayed. Fire may produce irritating, corrosive and/or toxic gases. Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution.

■ Reactivity Profile

AMMONIUM HYDROXIDE reacts exothermically with acids. Evolves toxic gaseous ammonia with strong bases. Reacts extremely violently with dimethyl sulfate [NFPA 491M 1991]. Reacts with aqueous silver nitrate sodium hydroxide to give a black precipitate of silver nitride. Such a precipitate can explode on stirring [MCA Case History 1554 1968]. Aqueous ammonia and Hg react to form an explosive solid, likely a fulminate.

Response Information

■ Firefighting

- SMALL FIRE: Dry chemical, CO2 or water spray.
- LARGE FIRE: Dry chemical, CO2, alcohol-resistant foam or water spray.

Move containers from fire area if you can do it without risk. Dike fire-control water for later disposal; do not scatter the material.

- **Spills and leakage response**
  ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. DO NOT GET WATER INSIDE CONTAINERS.

- **Response spill on the sea**
  Recovery is difficult in order to dissolve in sea water for a short time.

- **Protective clothing**
  Wear positive pressure self-contained breathing apparatus (SCBA). Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Structural firefighters' protective clothing provides limited protection in fire situations ONLY; it is not effective in spill situations where direct contact with the substance is possible.

- **First Aid**
  Move victim to fresh air. Call 911 or emergency medical service. Give artificial respiration if victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin or eyes with running water for at least 20 minutes. For minor skin contact, avoid spreading material on unaffected skin. Keep victim warm and quiet. Effects of exposure (inhalation, ingestion or skin contact) to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

XYLENE

Identification

■ General Description

A clear colorless liquid with a characteristic aromatic odor consisting of a mixture of the three isomers (ortho-, meta- and para-). The latter two predominate. Flash point 17℃. Less dense than water and insoluble in water. Hence floats on water. May be toxic by ingestion. Vapors heavier than air and may be narcotic in high concentrations. Used as a solvent for paints and adhesives, and to make other chemicals.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1307	1330-20-7	Class3.3/P3394

■ Alternate Names

- DILAN
- DIMETHYLBENZENE
- DIMETHYLBENZENES
- XYLENE
- XYLENE (MIXED ISOMERS)
- XYLENES
- XYLENES (ORTHO-XYLENE, META-XYLENE, PARA-XYLENE)
- XYLOL

Physical Properties

Formula	C8H10	Molecurar Weight	106.17	Flammable limits in Air (%)	1.0~6.0
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	0.88	Vapor Specific Gravity	3.66	Boiling Point (℃)	144.41
Freezing Point (℃)	-25.18	Flash Point (℃)	17	Ignition Point (℃)	463
Steam Pressure	0.64kPa/ 4.83 mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air & Water Reactions

Flammable. Insoluble in water.

■ Fire Hazard

HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Many liquids are lighter than water.

■ Health Hazard

May cause toxic effects if inhaled or absorbed through skin. Inhalation or contact with material may irritate or burn skin and eyes. Fire will produce irritating, corrosive and/or toxic gases. Vapors may cause dizziness or suffocation. Runoff from fire control or dilution water may cause pollution.

■ Reactivity Profile

XYLENE reacts exothermically with sulfuric acid, nitric acid, and strong oxidizing agents [Handling Chemicals Safely 1980. p. 962].

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may spread fire. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use foam, dry chemical, or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Apply "universal" gelling agent to immobilize spill. Apply approriate foam to diminish vapor and fire hazard. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Use surface active agent (e.g. detergent, soaps, alcohols), if approved by epa. Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms. If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

Avoid breathing vapors. Keep upwind. Wear appropriate chemical protective gloves, boots and goggles. Wear positive pressure self-contained breathing apparatus. Do not handle broken packages unless wearing appropriate personal protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. Avoid bodily contact with the material.

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

STYRENE MONOMER

Identification

■ General Description

A clear colorless to dark liquid with an aromatic odor. Flash point 32℃. Density 910.6 kg/m3. Vapors heavier than air and irritating to the eyes and mucous membranes. Subject to polymerization. If the polymerization takes place inside a closed container, the container may rupture violently. Less dense than water and insoluble in water. Used to make plastics, paints, and synthetic rubber.

■ Identifiers

UN No.	CAS No.	IMDG CODE
2055	100-42-5	Class3.3/P3381

■ Alternate Names

- CINNAMENE
- CINNAMENOL
- CINNAMOL
- DIAREX HF 77
- ETHENYL BENZENE
- ETHENYLBENZENE
- NCI-C02200
- PHENETHYLENE
- PHENYLETHENE
- PHENYLETHYLENE
- STYRENE
- STYRENE MONOMER
- STYRENE MONOMER, [INHIBITED]
- STYRENE, MONOMER, INHIBITED
- STYROL
- STYROLE
- STYROLENE

- STYRON
- STYROPOL
- STYROPOL SO
- STYROPOR
- UN 2055
- VINYL BENZENE
- VINYLBENZENE
- VINYLBENZOL

Physical Properties

Formula	C8H8	Molecurar Weight	104.15	Flammable limits in Air (%)	0.9~6.8
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	0.9	Vapor Specific Gravity	3.6	Boiling Point (℃)	145.2
Freezing Point (℃)	-30.69	Flash Point (℃)	32	Ignition Point (℃)	490
Steam Pressure	0.60kPa/ 4.5mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Highly Flammable
- Polymerizable
- Peroxidizable Compound

■ Air & Water Reactions

Highly flammable. Insoluble in water.

■ Fire Hazard

Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back. At elevated temperatures such as in fire conditions, polymerization may take place which may lead to container explosion.

■ Health Hazard

Moderate irritation of eyes and skin. High vapor concentrations cause dizziness, drunkeness, and anesthesia.

■ Reactivity Profile

STYRENE MONOMER is a colorless, oily liquid, moderately toxic, flammable. A storage hazard above 32°C, involved in several industrial explosions caused by violent, exothermic polymerization [Bond, J., Loss Prev. Bull., 1985, (065), p. 25]. Polymerization becomes self-sustaining above 95°C [MCA SD-37, 1971]. Presence of an inhibitor lessens but does not eliminate the possibility of unwanted polymerization. Violent polymerization leading to explosion may be initiated by peroxides (e.g., di-tert-butyl peroxide, dibenzoyl peroxide), butyllithium, azoisobutyronitrile. Reacts violently with strong acids (sulfuric acid, oleum, chlorosulfonic acid), strong oxidizing agents [Lewis, 3rd ed., 1993, p. 1185]. Reacts with oxygen above 40°C to form explosive peroxide [Barnes, C. E. et al., J. Amer. Chem. Soc., 1950, 72, p. 210]. Oxidizes readily in air to form unstable peroxides that may explode spontaneously [Bretherick 1979 p.151-154, 164]. Mixing styrene in equal molar portions with any of the following substances in a closed container caused the temperature and pressure to increase: chlorosulfonic acid, oleum, and sulfuric acid [NFPA 1991].

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may spread fire. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use foam, dry chemical, or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Apply "universal" gelling agent to immobilize spill. Apply approriate foam to diminish vapor and fire hazard. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Use surface active agent (e.g. detergent, soaps, alcohols), if approved by epa. Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms. If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.

■ First Aid

- EYES: First check the victim for contact lenses and remove if present.

Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. IMMEDIATELY call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.
- OTHER: Since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

BENZENE

Identification

■ General Description

A clear colorless liquid with a petroleum-like odor. Flash point less than 0℃. Less dense than water and slightly soluble in water. Hence floats on water. Vapors are heavier than air.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1114	71-43-2	Class3.2/P3185

■ Alternate Names

- (6)ANNULENE
- 1,3,5-CYCLOHEXATRIENE
- BENZIN
- BENZINE
- BENZOL
- BENZOLE
- BENZOLENE
- BICARBURET OF HYDROGEN
- CARBON OIL
- COAL NAPHTHA
- CYCLOHEXATRIENE
- MINERAL NAPHTHA
- MOTOR BENZOL
- NCI-C55276
- NITRATION BENZENE
- PHENE
- PHENYL HYDRIDE
- PYROBENZOL
- PYROBENZOLE
- RCRA WASTE NUMBER U019

- UN 1114
- [6]ANNULENE

Physical Properties

Formula	C6H6	Molecurar Weight	78.12	Flammable limits in Air (%)	1.3~7.1
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	0.88	Vapor Specific Gravity	2.73	Boiling Point (℃)	80.1
Freezing Point (℃)	5.53	Flash Point (℃)	-11	Ignition Point (℃)	498
Steam Pressure	12.69kPa/ 95.18mmHg (25℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Highly Flammable

■ Air & Water Reactions

Highly flammable. Slightly soluble in water.

■ Fire Hazard

Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.

■ Health Hazard

Dizziness, excitation, pallor, followed by flushing, weakness, headache, breathlessness, chest constriction, nausea, and vomiting. Coma and possible death.

■ Reactivity Profile

BENZENE reacts vigorously with allyl chloride or other alkyl halides even at minus 70°C in the presence of ethyl aluminum dichloride or ethyl aluminum sesquichloride. Explosions have been reported [NFPA 491M 1991]. Ignites in contact with powdered chromic anhydride [Mellor 11:235 1946-47]. Incompatible with oxidizing agents such as nitric acid. Mixtures with bromine trifluoride, bromine pentafluoride, iodine pentafluoride, iodine heptafluoride and other interhalogens can ignite upon heating [Bretherick 5th ed. 1995]. Benzene and cyanogen halides yield HCl as a byproduct (Hagedorn, F. H. Gelbke, and Federal Republic of Germany. 2002. Nitriles. In Ullman's Encyclopedia of Industrial Chemistry. Wiley-VCH Verlag GmbH &Co. KGaA.). The reaction of benzene and trichloroacetonitrile evolves toxic chloroform and HCl gasses. (Hagedorn, F., H.-P. Gelbke, and Federal Republic of Germany. 2002. Nitriles. In Ullman's Encyclopedia of Industrial Chemistry. Wiley-VCH Verlag GmbH &Co. KGaA.).

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may spread fire. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use foam, dry chemical, or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard (i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. IMMEDIATELY call a physician and be prepared to

transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.

- INGESTION: DO NOT INDUCE VOMITING. Volatile chemicals have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.
- OTHER: Since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

METHANOL

Identification

■ General Description

A colorless fairly volatile liquid with a faintly sweet pungent odor like that of ethyl alcohol. Completely mixes with water. The vapors are slightly heavier than air and may travel some distance to a source of ignition and flash back. Any accumulation of vapors in confined spaces, such as buildings or sewers, may explode if ignited. Used to make chemicals, to remove water from automotive and aviation fuels, as a solvent for paints and plastics, and as an ingredient in a wide variety of products.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1230	67-56-1	Class3.2/P3251

■ Alternate Names

- BIELESKI'S SOLUTION
- CARBINOL
- COLONIAL SPIRIT
- COLUMBIAN SPIRIT
- COLUMBIAN SPIRITS
- METHANOL CLUSTER
- METHANOL {METHYL ALCOHOL}
- METHYL ALCOHOL
- METHYL HYDROXIDE
- METHYLOL
- MONOHYDROXYMETHANE
- PYROLIGNEOUS SPIRIT
- PYROXYLIC SPIRIT
- RCRA WASTE NUMBER U154
- SOLUTIONS, BIELESKI'S
- WOOD ALCOHOL

- WOOD NAPHTHA
- WOOD SPIRIT

Physical Properties

Formula	CH3OH	Molecurar Weight	32.04	Flammable limits in Air (%)	6.0~36
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	0.79	Vapor Specific Gravity	1.1	Boiling Point (℃)	64.7
Freezing Point (℃)	-93.9	Flash Point (℃)	11	Ignition Point (℃)	385
Steam Pressure	100mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Highly Flammable

■ Air & Water Reactions

Highly flammable. Soluble in water in all proportions.

■ Fire Hazard

Behavior in Fire: Containers may explode.

■ Health Hazard

Exposure to excessive vapor causes eye irritation, head- ache, fatigue and drowsiness. High concentrations can produce central nervous system depression and optic nerve damage. 50,000 ppm will probably cause death in 1 to 2 hrs. Can be absorbed through skin. Swallowing may cause death or eye damage.

■ Reactivity Profile

METHANOL reacts violently with acetyl bromide [Merck 11th ed. 1989]. Mixtures with concentrated sulfuric acid and concentrated hydrogen peroxide can cause explosions. Reacts with hypochlorous acid either in water solution or mixed water/carbon tetrachloride solution to give methyl hypochlorite, which decomposes in the cold and may explode on exposure to sunlight or heat. Gives the same product with chlorine. Can react explosively with isocyanates under basic conditions. The presence of an inert solvent mitigates this reaction [Wischmeyer 1969]. A violent exothermic reaction occurred between methyl alcohol and bromine in a mixing cylinder [MCA Case History 1863. 1972]. A flask of anhydrous lead perchlorate dissolved in methanol exploded when it was disturbed [J. Am. Chem. Soc. 52:2391. 1930]. P4O6 reacts violently with methanol. (Thorpe, T. E. et al., J. Chem. Soc., 1890, 57, 569-573). Ethanol or methanol can ignite on contact with a platinum-black catalyst.

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, dry chemical or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to disperse vapors and dilute standing pools of liquid. Apply water spray or mist to knock down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Water spill: Allow to aerate. Use natural barriers or oil spill control booms to limit spill travel. Remove trapped material with suction hoses.

■ **Response spill on the sea**

Recovery is difficult in order to dissolve in sea water for a short time.

■ **Protective clothing**

Approved canister mask for high vapor concentrations; safety goggles; rubber gloves.

■ **First Aid**

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. Volatile chemicals have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

ETHYLENE GLYCOL

Identification

General Description

Ethylene glycol is a clear, colorless syrupy liquid. The primary hazard is the threat to the environment. Immediate steps should be taken to limit its spread to the environment. Since it is a liquid it can easily penetrate the soil and contaminate groundwater and nearby streams.

Identifiers

UN No.	CAS No.	IMDG CODE
none	107-21-1	none

Alternate Names

- 1,2-DIHYDROXYETHANE
- 1,2-ETHANDIOL
- 1,2-ETHANEDIOL
- 1,2-ETHYLENE GLYCOL
- 146AR
- 2-HYDROXYETHANOL
- DOWTHERM SR 1
- ETHANE-1,2-DIOL
- ETHYLENE ALCOHOL
- ETHYLENE DIHYDRATE
- FRIDEX
- GLYCOL
- GLYCOL ALCOHOL
- LUTROL-9
- M.E.G.
- MACROGOL 400 BPC
- MONOETHYLENE GLYCOL
- NCI-C00920
- NORKOOL

- RAMP
- TESCOL
- UCAR 17
- ZEREX

Physical Properties

Formula	$C_2H_6O_2$	Molecurar Weight	62.07	Flammable limits in Air (%)	3.2~
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	1.11	Vapor Specific Gravity	2.1	Boiling Point (℃)	197.85
Freezing Point (℃)	-12.6	Flash Point (℃)	111.1	Ignition Point (℃)	398
Steam Pressure	1mmHg (53℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air &Water Reactions

No rapid reaction with air. No rapid reaction with water.

■ Fire Hazard

This chemical is combustible.

■ Health Hazard

Inhalation of vapor is not hazardous. Ingestion causes stupor or coma, sometimes leading to fatal kidney injury.

■ Reactivity Profile

Mixing ETHYLENE GLYCOL in equal molar portions with any of the following substances in a closed container caused the temperature and pressure to increase: chlorosulfonic acid, oleum, sulfuric acid.

Response Information

■ Firefighting

Extinguish fire using agent suitable for type of surrounding fire. (Material itself does not burn or burns with difficulty.) Use "alcohol" foam, dry chemical or carbon dioxide. Keep run-off water out of sewers and water sources.

■ Spills and leakage response

Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Land spill: Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Water spill: Remove trapped material with suction hoses.

■ Response spill on the sea

Recovery is difficult in order to dissolve in sea water for a short time.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: Workers whose clothing may have become contaminated should change into uncontaminated clothing before leaving the work premise.

■ First Aid

- EYES: First check the victim for contact lenses and remove if present.

Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

CAUSTIC SODA, SOLUTION

Identification

General Description

A dark, thick liquid. More dense than water. Contact may severely irritate skin, eyes, and mucous membranes. Toxic by ingestion. Corrosive to metals and tissue. Density 1557.9kg/m3.

Identifiers

UN No.	CAS No.	IMDG CODE
1824	1310-73-2	Class8/P8226

Alternate Names

- AETZNATRON
- ASCARITE
- CAUSTIC SODA
- CAUSTIC SODA SOLUTION
- COLLO-GRILLREIN
- COLLO-TAPETTA
- LYE
- SODA LYE
- SODA, CAUSTIC
- SODIUM HYDRATE
- SODIUM HYDROXIDE
- SODIUM HYDROXIDE (LYE)
- SODIUM HYDROXIDE SOLUTION
- SODIUM HYDROXIDE, SOLUTION
- SODIUM HYDROXIDE, [LIQUID]
- WHITE CAUSTIC

Physical Properties

Formula	NaOH	Molecurar Weight	40	Flammable limits in Air (%)	
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	2.1	Vapor Specific Gravity		Boiling Point (℃)	1390
Freezing Point (℃)	318.4	Flash Point (℃)		Ignition Point (℃)	
Steam Pressure	1mmHg (767℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air & Water Reactions

Slowly absorbs carbon dioxide from the air to give solid products as crusts or precipitates. Water soluble. Dilution with water liberates heat, possibly enough to cause local boiling and spattering.

■ Fire Hazard

Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Some are oxidizers and may ignite combustibles (wood, paper, oil, clothing, etc.). Contact with metals may evolve flammable hydrogen gas. Containers may explode when heated.

■ Health Hazard

Causes severe burns of eyes, skin, and mucous membranes.

■ Reactivity Profile

CAUSTIC SODA, SOLUTION refers to an aqueous solution of sodium hydroxide. Strongly basic. Reacts rapidly and exothermically with organic and inorganic acids, with organic and inorganic acid anhydrides, including oxides of nonmetals such as sulfur dioxide, sulfur trioxide, phosphorus trioxide, phosphorus pentaoxide, and with organic and inorganic acid chlorides. May react explosively with maleic anhydride [MCA Case History 622 1960]. Attacks aluminum and zinc with evolution of hydrogen, a flammable gas. May initiate polymerization in polymerizable organic materials: a violent polymerization results if acetaldehyde contacts alkaline materials such as sodium hydroxide; an extremely violent polymerization results from contact of acrolein with alkaline materials such as sodium hydroxide [Chem. Safety Data Sheet SD-85 1961]. A violent explosion resulted when a quantity of pentol was accidentally brought in contact with a caustic cleaning solution chemically similar to aqueous sodium hydroxide [MCA Case History 363 1964]. Aqueous solutions of reducing sugars other than sucrose, when heated (above 84°C.), evolve toxic levels of carbon monoxide in the presence of alkalis or alkaline salts, such as sodium phosphate (also potassium hydroxide, sodium hydroxide, calcium hydroxide, etc.) [Bretherick 5th ed. 1995]. Hot and/or concentrated NaOH can cause hydroquinone to decompose exothermically at elevated temperature.

Response Information

■ Firefighting

Extinguish fire using agent suitable for type of surrounding fire. (Material itself does not burn or burns with difficulty.) Use water in flooding quantities as fog. Apply water from as far a distance as possible.

■ Spills and leakage response

Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Apply water spray or mist to knock down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash or cement powder. Neutralize with vinegar or other dilute acid. Water spill: Neutralize with dilute acid.

■ **Response spill on the sea**

Recovery is difficult in order to dissolve in sea water for a short time.

■ **Protective clothing**

Wide-brimmed hat; safety goggles with rubber side shields; tight-fitting cotton clothing; rubber gloves under shirt cuffs; rubber boots and apron.

■ **First Aid**

(Act quickly)

- EYES: flush with water at once for at least 15 min.
- SKIN: flush with water, then rinse with dilute vinegar (acetic acid).
- INGESTION: give water and milk. Do NOT induce vomiting. Call physician at once, even when injury seems to be slight.

SULFURIC ACID

Identification

■ General Description

Sulfuric acid is a colorless oily liquid. It is soluble in water with release of heat. It is corrosive to metals and tissue. It will char wood and most other organic matter on contact, but is unlikely to cause a fire. Density 1797.5kg/m3. Long term exposure to low concentrations or short term exposure to high concentrations can result in adverse health effects from inhalation. It is used to make fertilizers and other chemicals, in petroleum refining, in iron and steel production, and for many other uses.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1830	7664-93-9	Class8/P8230

■ Alternate Names

- BATTERY ACID
- BOV
- CHAMBER ACID
- CONTACT ACID
- DIHYDROGEN SULFATE
- DIPPING ACID
- FERTILIZER ACID
- HYDROGEN SULFATE
- MATTING ACID
- NORDHAUSEN ACID
- OIL OF VITRIOL
- SPENT SULFURIC ACID
- SPIRIT OF SULFUR
- SULFURIC ACID (AEROSOL FORMS ONLY)
- SULFURIC ACID (AQUEOUS)
- SULFURIC ACID, WITH MORE THAN 51% ACID

- SULPHURIC ACID
- SULPHURIC ACID, WITH MORE THAN 51% ACID
- VITRIOL BROWN OIL

Physical Properties

Formula	H2SO4	Molecurar Weight	98.1	Flammable limits in Air (%)	
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	1.834	Vapor Specific Gravity		Boiling Point (℃)	340
Freezing Point (℃)	10.36	Flash Point (℃)		Ignition Point (℃)	
Steam Pressure		Corrosion	Human: yes Metal: yse	Oxidation	yes

Hazards

■ Reactivity Alerts

- Strong Oxidizing Agent
- Water-Reactive

■ Air & Water Reactions

Reaction with water is negligible unless acid strength is above 80-90% then heat from hydrolysis is extreme, may cause severe burns [Merck, 11th ed. 1989]. During sulfonation of mononitrobenzene by fuming sulfuric acid, a leak from an internal cooling coil permitted water to enter the reaction tank. A violent eruption occurred due to the heat of solution [MCA Case History 944 1963].

■ Fire Hazard

It is highly reactive and capable of igniting finely-divided combustible materials on contact. When heated, it emits highly toxic fumes. Avoid heat; water and organic materials. Sulfuric acid is explosive or incompatible with an enormous array of substances. Can undergo violent chemical change at elevated temperatures and pressure. May react violently with water. When heated, it emits highly toxic fumes. Hazardous polymerization may not occur.

■ Health Hazard

Corrosive to all body tissues. Inhalation of vapor may cause serious lung damage. Contact with eyes may result in total loss of vision. Skin contact may produce severe necrosis. Fatal amount for adult: between 1 teaspoonful and one-half ounce of the concentrated chemical. Even a few drops may be fatal if the acid gains access to the trachea. Chronic exposure may cause tracheobronchitis, stomatitis, conjunctivitis, and gastritis. Gastric perforation and peritonitis may occur and may be followed by circulatory collapse. Circulatory shock is often the immediate cause of death. Those with chronic respiratory, gastrointestinal, or nervous diseases and any eye and skin diseases are at greater risk.

■ Reactivity Profile

SULFURIC ACID is strongly acidic. Reacts violently with bromine pentafluoride [Mellor 2 Supp. 1:172 1956]. Exploded with para-nitrotoluene at 80 °C [Chem. Eng. News 27:2504]. An explosion occurred when concentrated sulfuric acid was mixed with crystalline potassium permanganate in a vessel containing moisture. Manganese heptoxide was formed, which explodes at 70°C [Delhez 1967]. A mixture of acrylonitrile with concentrated sulfuric acid must be kept well chilled, otherwise a vigorous exothermic reaction occurs [Chem. Safety Data Sheet SD-31:8. 1949]. Mixing sulfuric acid (96%) in equal portions with any of the following substances in a closed container caused the temperature and pressure to increase: acetonitrile, acrolein, 2-aminoethanol, ammonium hydroxide (28%), aniline, n-butyraldehyde, chlorosulfonic acid, ethylene diamine, ethyleneimine, epichlorohydrin, ethylene cyanohydrin, hydrochloric acid (36%), hydrofluoric acid (48.7%), propiolactone, propylene oxide, sodium hydroxide, styrene monomer [NFPA 1991]. Sulfuric acid (concentrated) is extremely hazardous in contact with carbides, bromates, chlorates, fulminates, picrates, and powdered metals [Haz. Chem. Data 1966]. Allyl chloride may polymerize violently under conditions involving an acid catalyst, such as sulfuric acid [Ventrone 1971]. React exothermically with sodium hypochlorite to produce chlorine gas. Mixing chlorosulfuric acid and 98% sulfuric acid may evolve HCl [Subref: Anon, Loss Prev. Bull. 1977, (013), 2-3]. Zinc iodide reacts violently with H2SO4.

Response Information

■ Firefighting

Fight fire from safe distance or from protected location. Use care as water applied directly to this acid results in evolution of heat and causes spattering. Cool containers that are exposed to flames with streams of water until fire is out. Wear positive pressure breathing apparatus and special protective clothing. Not flammable. For small fires use dry chemical or carbon dioxide. Use water on combustibles burning in vicinity of this material. For large fires flood fire area with water from a distance. Do not get solid streams of water on material. Move container from area if you can do so without risk.

■ Spills and leakage response

Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Neutralize spilled material with crushed limestone, soda ash, or lime. Apply water spray or mist to knock down vapors. Vapor knockdown water is corrosive or toxic and should be diked for containment. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash or cement powder. Neutralize with agricultural lime (CaO), crushed limestone (CaCO3) or sodium bicarbonate (NaHCO3). Water spill: Neutralize with agricultural lime (CaO), crushed limestone (CaCO3), or sodium bicarbonate (NaHCO3).

■ Response spill on the sea

Recovery is difficult in order to dissolve in sea water for a short time.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.

- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided (when concentration is >1%) in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided (when concentration is >1%) within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- Caution: Sulfuric acid is extremely corrosive. Caution is advised.
- Signs and Symptoms of Acute Sulfuric Acid Exposure: Signs and symptoms of acute ingestion of sulfuric acid may be severe and include salivation, intense thirst, difficulty in swallowing, pain, and shock. Oral, esophageal, and stomach burns are common. Vomitus generally has a coffee-ground appearance. The potential for circulatory collapse is high following ingestion of sulfuric acid. Acute inhalation exposure may result in sneezing, hoarseness, choking, laryngitis, dyspnea (shortness of breath), respiratory tract irritation, and chest pain. Bleeding of nose and gums, ulceration of the nasal and oral mucosa, pulmonary edema, chronic bronchitis, and pneumonia may also occur. If the eyes have come in contact with sulfuric acid, irritation, pain, swelling, corneal erosion, and blindness may result. Dermal exposure may result in severe burns, pain, and dermatitis (red, inflamed skin).
- Emergency Life-Support Procedures: Acute exposure to sulfuric acid may require decontamination and life support for the victims. Emergency personnel should wear protective clothing appropriate to the type and

degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination.

- Inhalation Exposure:
    1. Move victims to fresh air. Emergency personnel should avoid self-exposure to sulfuric acid.
    2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
    3. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
    4. RUSH to a health care facility.
- Dermal/Eye Exposure:
    1. Remove victims from exposure. Emergency personnel should avoid self - exposure to sulfuric acid.
    2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
    3. Remove contaminated clothing as soon as possible.
    4. If eye exposure has occurred, eyes must be flushed with lukewarm water for at least 15 minutes.
    5. Wash exposed skin areas THOROUGHLY with soap and water.
    6. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
    7. RUSH to a health care facility.
- Ingestion Exposure:
    1. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
    2. Rinse mouth with large amounts of water. Instruct victims not to swallow the water.
    3. DO NOT induce vomiting or attempt to neutralize!
    4. Obtain authorization and/or further instructions from the local hospital

for administration of an antidote or performance of other invasive procedures.

5. Activated charcoal is of no value.
6. Give the victims water or milk: children up to 1 year old, 125 mL (4 oz or 1/2 cup); children 1 to 12 years old, 200 mL (6 oz or 3/4 cup); adults, 250 mL (8 oz or 1 cup). Water or milk should be given only if victims are conscious and alert.
7. RUSH to a health care facility.

TOLUENE

Identification

■ General Description

A clear colorless liquid with a characteristic aromatic odor. Flash point 4℃. Less dense than water (862.9kg/m^3) and insoluble in water. Hence floats on water. Vapors heavier than air. May be toxic by inhalation, ingestion or skin contact. Used in aviation and automotive fuels, as a solvent, and to make other chemicals.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1294	108-88-3	Class3.2/P3285

■ Alternate Names

- 1-METHYLBENZENE
- ANTISAL 1A
- BENZENE, METHYL-
- CP 25
- CP 25 (SOLVENT)
- METHACIDE
- METHANE, PHENYL-
- METHYL BENZENE
- METHYL BENZOL
- METHYLBENZENE
- METHYLBENZOL
- NCI-C07272
- PHENYL METHANE
- PHENYLMETHANE
- RCRA WASTE NUMBER U220
- TOLU-SOL
- TOLUOL
- UN 1294

Physical Properties

Formula	C7H8	Molecurar Weight	92.14	Flammable limits in Air (%)	1.2~7.1
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	0.87	Vapor Specific Gravity	3.1	Boiling Point (℃)	110.6
Freezing Point (℃)	-94.9	Flash Point (℃)	4	Ignition Point (℃)	480
Steam Pressure	24.31mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Highly Flammable

■ Air & Water Reactions

Highly flammable. Insoluble in water.

■ Fire Hazard

Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back.

■ Health Hazard

Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration.

■ Reactivity Profile

TOLUENE reacts vigorously with allyl chloride or other alkyl halides even at minus 70°C in the presence of ethyl aluminum dichloride or ethyl aluminum sesquichloride. Explosions have been reported [NFPA 491M 1991]. Incompatible with strong oxidizing agents. When added to a tank of sulfur dichloride, the tank over pressurized and ruptured in a reaction thought to be catalyzed by iron or iron(III) chloride [Chem. Eng. News, 1988, 66(32), 2].

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may spread fire. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use foam, dry chemical, or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Apply "universal" gelling agent to immobilize spill. Apply approriate foam to diminish vapor and fire hazard. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Use surface active agent (e.g. detergent, soaps, alcohols), if approved by epa. Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms. If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid.

When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and

IMMEDIATELY call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

ACRYLONITRILE

Identification

General Description

A clear colorless liquid with a strong pungent odor. Flash point -6℃. Prolonged exposure to the vapors or skin contact harmful. Density 802.9kg/m3. Vapors heavier than air. Combustion produces toxic oxides of nitrogen. Requires storage and handling in closed systems. Used in insecticides and to make plastics, fibers and other chemicals.

Identifiers

UN No.	CAS No.	IMDG CODE
1093	107-13-1	Class3.2/P3173

Alternate Names

- 2-PROPENENITRILE
- ACRITET
- ACRYLON
- ACRYLONITRILE
- ACRYLONITRILE MONOMER
- AN
- CARBACRYL
- CYANOETHENE
- CYANOETHYLENE
- ENT 54
- FUMIGRAIN
- MILLER'S FUMIGRAIN
- NCI-C50215
- PROPENENITRILE
- PROPENONITRILE
- RCRA WASTE NUMBER U009
- TL 314
- UN 1093

- VCN
- VENTOX
- VINYL CYANIDE

Physical Properties

Formula	H2CCHCN	Molecurar Weight	53.06	Flammable limits in Air (%)	3.0~17.0
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	0.8	Vapor Specific Gravity	1.8	Boiling Point (℃)	77.3
Freezing Point (℃)	-83.55	Flash Point (℃)	-6	Ignition Point (℃)	480
Steam Pressure	18.3kPa/ 137mmHG (30℃)	Corrosion	Human: no Metal: no	Oxidation	

Hazards

■ Reactivity Alerts

- Highly Flammable
- Polymerizable

■ Air & Water Reactions

Highly flammable. Soluble in water.

■ Fire Hazard

Materials are too dangerous to health to expose fire fighters. A few whiffs of vapor could cause death or vapor or liquid could be fatal on penetrating the fire fighter's normal full protective clothing. The normal full protective clothing and breathing apparatus available to the average fire department will not provide adequate protection against inhalation or skin contact with these materials. Explosion hazard is moderate. It is flammable and explosive at normal room temperatures. Can react violently with strong acids, amines, strong alkalis. Vapors may travel considerable distance to source of ignition and flash back. Dilute solutions are also hazardous (flash point of a solution of 2 percent in water is 70F). When heated or burned, toxic hydrogen cyanide gas and oxides of nitrogen are formed. Avoid strong acids, amines, alkalis. Incompatible with strong oxidizers (especially bromine) copper and copper alloys. Unstable, moderate hazard is possible when it is exposed to flames, strong acids, amines and alkalis. May polymerize spontaneously in the container, particularly in absence of oxygen or on exposure to visible light. If polymerization occurs in containers, there is a possibility of violent rupture.

■ Health Hazard

It is classified as very toxic. Probable oral lethal dose for human is 50-500 mg/kg (between 1 teaspoon and 1 oz.) for a 70 kg (150 lb.) person. Irritant skin dose – 500 mg. Toxic concentrations have been reported at 16 ppm/20 min. Acute toxicity is similar to that due to cyanide poisoning, and the level of cyanide ion in blood is related to the level of poisoning. Inhalation or ingestion results in collapse and death due to tissue anoxia (lack of oxygen) and cardiac arrest (heart failure).

■ Reactivity Profile

ACRYLONITRILE produces poisonous hydrogen cyanide gas on contact with strong acids or when heated to decomposition. Reacts violently with strong oxidizing agents (dibenzoyl peroxide, di-tert-butylperoxide, bromine) [Sax, 9th ed., p. 61]. Rapidly ignites in air and forms explosive mixtures with air. Polymerizes violently in the presence of strong bases or acids. Underwent a runaway reaction culminating in an explosion on contact with a small amount of bromine or solid silver nitrate [Bretherick, 5th ed., 1995, p. 404].

Response Information

■ Firefighting

In advanced or massive fires, fire fighting should be done from a safe distance or a protected location. Isolate for 1/2 mile in all directions if tank car or truck is involved in fire.

- Small fires: dry chemical, carbon dioxide, water spray or foam. Large fires: water spray, fog or foam. Stay away from ends of tanks. Do not get water inside container. Cool containers that are exposed to flames with water from the side until well after fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire.

■ **Spills and leakage response**

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to disperse vapors and dilute standing pools of liquid. Apply water spray or mist to knock down vapors. Combustion products include corrosive or toxic vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Apply "universal" gelling agent to immobilize spill. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Use surface active agent (e.g. detergent, soaps, alcohols), if approved by epa. Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms. Add calcium hypochlorite (Ca(ClO)2). If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ **Response spill on the sea**

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ **Protective clothing**

- Skin: Wear appropriate personal protective clothing to prevent skin contact.

- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

Warning: Effects, including skin reactions, may be delayed. Caution is advised. Vital signs should be monitored closely. Heart palpitation may begin within minutes after exposure.

- Note: Acrylonitrile is very readily absorbed through the skin.
- Signs and Symptoms of Acrylonitrile Exposure: Signs and symptoms of acute exposure to acrylonitrile may include hypertension (high blood pressure) and tachycardia (rapid heart rate), followed by hypotension (low blood pressure) and bradycardia (slow heart rate). Cherry-red mucous membranes and blood, cardiac arrhythmias, and other cardiac abnormalities are common. Cyanosis (blue tint to the skin and mucous membranes) is not a consistent finding. Tachypnea (rapid respiratory rate) may be followed by respiratory depression. Lung hemorrhage and pulmonary edema may also occur. Headache, vertigo (dizziness), agitation, and giddiness may be followed by combative behavior, convulsions, paralysis, protruding eyeballs, dilated and unreactive pupils, and coma. Acrylonitrile is irritating to the skin and mucous membranes. Lacrimation (tearing) and a burning sensation of the mouth and throat are common. Excessive salivation, nausea, and vomiting may also occur.

- Emergency Life-Support Procedures: Acute exposure to acrylonitrile may require decontamination and life support for the victims. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination.
- Inhalation Exposure:
    1. Move victims to fresh air. Emergency personnel should avoid self-exposure to acrylonitrile.
    2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. IMMEDIATELY begin administering 100% oxygen to all victims. Monitor victims for respiratory distress.Warning: To prevent self-poisoning, avoid mouth-to-mouth breathing; use a forced-oxygen mask. Direct oral contact with acrylonitrile-contaminated persons or their gastric contents may result in self-poisoning.
    3. RUSH to a health care facility!
    4. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
- Dermal/Eye Exposure
    1. Remove victims from exposure. Emergency personnel should avoid self-exposure to acrylonitrile.
    2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. IMMEDIATELY begin administering 100% oxygen to all victims. Monitor victims for respiratory distress.Warning: To prevent self-poisoning, avoid mouth-to-mouth breathing; use a forced-oxygen mask. Direct oral contact with acrylonitrile-contaminated persons or their gastric contents may result in self-poisoning.
    3. RUSH to a health care facility!
    4. Remove contaminated clothing as soon as possible.
    5. If eye exposure has occurred, eyes must be flushed with lukewarm water for at least 15 minutes.
    6. Wash exposed skin areas twice with soap and water.
    7. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.

- Ingestion Exposure:
  1. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. IMMEDIATELY begin administering 100% oxygen to all victims. Monitor victims for respiratory distress.Warning: To prevent self-poisoning, avoid mouth-to-mouth breathing; use a forced-oxygen mask. Direct oral contact with acrylonitrile-contaminated persons or their gastric contents may result in self-poisoning.
  2. RUSH to a health care facility!
  3. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
  4. DO NOT induce vomiting or attempt to neutralize!
  5. Activated charcoal may be administered if victims are conscious and alert. Use 15 to 30 g (1/2 to 1 oz) for children, 50 to 100 g (1-3/4 to 3-1/2 oz) for adults, with 125 to 250 mL (1/2 to 1 cup) of water.
  6. Give the victims water or milk: children up to 1 year old, 125 mL (4 oz or 1/2 cup); children 1 to 12 years old, 200 mL (6 oz or 3/4 cup); adults, 250 mL (8 oz or 1 cup). Water or milk should be given only if victims are conscious and alert.

ETHYLENE DICHLORIDE

Identification

■ General Description

A clear colorless liquid with a chloroform-like odor. Flash point 13℃. Denser than water and insoluble in water. Vapors are heavier than air. Density 1246.3kg/m^3.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1184	107-06-2	Class3.2/P3224

■ Alternate Names

- 1, 2-DICHLOROETHANE {ETHYLENE DICHLORIDE}
- 1,2-BICHLOROETHANE
- 1,2-DCE
- 1,2-DICHLORETHANE
- 1,2-DICHLOROETHANE
- 1,2-ETHYLENE DICHLORIDE
- ALPHA, BETA-DICHLOROETHANE
- BORER SOL
- BROCIDE
- DCE
- DESTRUXOL BORER-SOL
- DI-CHLOR-MULSION
- DICHLOR-MULSION
- DICHLOREMULSION
- DUTCH LIQUID
- DUTCH OIL
- EDC
- ENT 1,656
- ETHANE DICHLORIDE
- ETHYLENE CHLORIDE

- FREON 150
- GLYCOL DICHLORIDE
- HCC 150
- NCI-C00511
- NU-G00511
- RCRA WASTE NUMBER U077
- SYM-DICHLOROETHANE
- UN 1184

Physical Properties

Formula	C2H4Cl2	Molecurar Weight	98.96	Flammable limits in Air (%)	6.2~16.0
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	1.26	Vapor Specific Gravity	3.4	Boiling Point (℃)	83.5
Freezing Point (℃)	-35.3	Flash Point (℃)	13	Ignition Point (℃)	440
Steam Pressure	8.13kPa 61mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Highly Flammable

■ Air & Water Reactions

Highly flammable. Slightly water soluble.

■ Fire Hazard

- Special Hazards of Combustion Products: Toxic and irritating gases (hydrogen chloride, phosgene) are generated.

- Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.

■ Health Hazard

Inhalation of vapors causes nausea, drunkenness, depression. Contact of liquid with eyes may produce corneal injury. Prolonged contact with skin may cause a burn.

■ Reactivity Profile

Liquid ammonia and ETHYLENE DICHLORIDE can cause an explosion when mixed, NFPA 491M, 1991. A tank of dimethyl amino propyl amine exploded violently when it reacted with wet ethylene dichloride which had been the tank's previous contents [Doyle 1973]. Halogenated aliphatic compounds, such as ethylene dichloride, are moderately or very reactive. Reactivity generally decreases with increased degree of substitution of halogen for hydrogen atoms. Materials in this group are incompatible with strong oxidizing and reducing agents. Also, they are incompatible with many amines, nitrides, azo/diazo compounds, alkali metals, epoxides, aluminum

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may spread fire. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use foam, dry chemical, or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. Combustion products include corrosive or toxic vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Apply "universal" gelling agent to immobilize spill.

Apply approriate foam to diminish vapor and fire hazard. Water spill: Use natural deep water pockets, excavated lagoons, or sand bag barriers to trap material at bottom. If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. IMMEDIATELY call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. Volatile chemicals have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.
- OTHER: Since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

CYCLOHEXANE

Identification

General Description

A clear colorless liquid with a petroleum-like odor. Used to make nylon, as a solvent, paint remover, and to make other chemicals. Flash point -18℃. Density 778.9kg/m3 (less than water) and insoluble in water. Vapors heavier than air.

Identifiers

UN No.	CAS No.	IMDG CODE
1145	110-82-7	Class3.1/P3114

Alternate Names

- BENZENE HEXAHYDRIDE
- BENZENE, HEXAHYDRO-
- BENZENEHEXAHYDRIDE
- HEXAHYDROBENZENE
- HEXAMETHYLENE
- HEXANAPHTHENE

Physical Properties

Formula	C6H12	Molecurar Weight	84.18	Flammable limits in Air (%)	1.3~8.3
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	0.77	Vapor Specific Gravity	2.9	Boiling Point (℃)	80.74

Freezing Point (℃)	6.47	Flash Point (℃)	-18	Ignition Point (℃)	245
Steam Pressure	16.2kPa/ 121.6mmHg (30℃)	Corrosion	Human: no Metal: no	Oxidation	

Hazards

■ Reactivity Alerts

- Highly Flammable

■ Air & Water Reactions

Highly flammable. Insoluble in water.

■ Fire Hazard

Will be easily ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Many liquids are lighter than water. Substance may be transported hot.

■ Health Hazard

Dizziness, with nausea and vomiting. Concentrated vapor may cause unconsciousness and collapse.

■ Reactivity Profile

Liquid nitrogen dioxide was fed into a nitration column containing hot CYCLOHEXANE, due to an error. An explosion resulted. Incompatible with strong oxidizers.

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may spread fire. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use foam, dry chemical, or carbon dioxide.

■ **Spills and leakage response**

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Apply "universal" gelling agent to immobilize spill. Apply approriate foam to diminish vapor and fire hazard. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Use surface active agent (e.g. detergent, soaps, alcohols), if approved by epa. Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ **Response spill on the sea**

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ **Protective clothing**

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift. (NIOSH, 2003)

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. Volatile chemicals have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital. (NTP, 1992)

ACETIC ACID

Identification

General Description

A clear colorless liquid with a strong odor of vinegar. Flash point 39℃. Density 1054.6kg/m3. Corrosive to metals and tissue. Used to make other chemicals, as a food additive, and in petroleum production.

Identifiers

UN No.	CAS No.	IMDG CODE
2789, 2790	64-19-7	Class8/P8100

Alternate Names

- ACETIC ACID
- ACETIC ACID (AQUEOUS)
- ACETIC ACID, [GLACIAL]
- ACI-JEL
- ETHANOIC ACID
- ETHANOIC ACID MONOMER
- ETHYLIC ACID
- GLACIAL ACETIC ACID
- GLACIAL ACETIC ACID (PURE COMPOUND)
- METHANECARBOXYLIC ACID
- UN 2789
- UN 2790
- VINEGAR ACID

Physical Properties

Formula	C2H4O2	Molecurar Weight	60.05	Flammable limits in Air (%)	5.4~16
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	1.0492	Vapor Specific Gravity	2.1	Boiling Point (℃)	117.8
Freezing Point (℃)	16.6	Flash Point (℃)	39	Ignition Point (℃)	463
Steam Pressure		Corrosion	Human: yes Metal: yes	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air & Water Reactions

Flammable. Water soluble. Dissolution generates some heat.

■ Fire Hazard

Special Hazards of Combustion Products: Irritating vapor generated when heated.

■ Health Hazard

Breathing of vapors causes coughing, chest pain, and irritation of nose and throat; may cause nausea andvomiting. Contact with skin and eye causes burns.

■ Reactivity Profile

CMixing acetic acid in equal molar portions with any of the following substances in a closed container caused the temperature and pressure to increase: 2-Aminoethanol, chlorosulfonic acid, ethylene diamine, ethyleneimine [NFPA 1991]. Acetic acid or acetic anhydride can explode with nitric acid if not kept cold. Potassium hydroxide residue in a catalyst pot reacted violently when acetic acid was added [MCA Case History 920. 1963]. During the production of terephthalic acid, n-xylene is oxidized in the presence of acetic acid. During these processes, detonating mixtures may be produced. Addition of a small amount of water may largely eliminate the risk of explosion [NFPA 491M.1991.p. 7]. Acetaldehyde was put in drums previously pickled with acetic acid. The acid caused the acetaldehyde to polymerize and the drums got hot and vented [MCA Case History 1764. 1971]. A mixture of ammonium nitrate and acetic acid ignites when warmed, especially if concentrated [Von Schwartz 1918. p. 322]. Several laboratory explosions have been reported using acetic acid and phosphorus trichloride to form acetyl chloride. Poor heat control probably caused the formation of phosphine [J. Am. Chem. Soc. 60:488. 1938]. Acetic acid forms explosive mixtures with p-xylene and air (Shraer, B.I. 1970. Khim. Prom. 46(10):747-750.).

Response Information

■ Firefighting

Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, dry chemical or carbon dioxide. Use water spray to knock-down vapors.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Use water spray to knock-down vapors. Neutralize spilled material with crushed limestone, soda ash, or lime. Vapor knockdown water is corrosive or toxic and should be diked for containment. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash or cement powder. Neutralize with dilute caustic soda (NaOH) or soda ash (Na2CO3). Water spill: Add dilute caustic soda (NaOH).

■ Response spill on the sea

Recovery is difficult in order to dissolve in sea water for a short time.

■ Protective clothing

- Skin: If concentration is >10%, wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: If concentration is >10%, the worker should immediately wash the skin when it becomes contaminated.
- Remove: When concentration is >10% work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided (when concentration is >5%) in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided (when concentration is >50%) within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.] (NIOSH, 2003)

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation)

develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.

- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. Corrosive chemicals will destroy the membranes of the mouth, throat, and esophagus and, in addition, have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. Transport the victim IMMEDIATELY to a hospital.

METHYL METHACRYLATE

Identification

■ General Description

A clear colorless liquid. Slightly soluble in water and floats on water. Vapors heavier than air. Vapors irritate the eyes and respiratory system. Containers must be heavily insulated or shipped under refrigeration. An inhibitor such as hydroquinone, hydroquinone methyl ester and dimethyl t-butylphenol is added to keep the chemical from initiating polymerization. The chemical may polymerize exothermically if heated or contaminated with strong acid or base. If the polymerization takes place inside a container, the container may rupture violently. Used to make plastics.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1247	80-62-6	Class3.2/P3259

■ Alternate Names

- "MONOCITE" METHACRYLATE MONOMER
- 2-(METHOXYCARBONYL)-1-PROPENE
- 2-METHYL-2-PROPENOIC ACID METHYL ESTER
- 2-METHYLACRYLIC ACID METHYL ESTER
- 2-PROPENOIC ACID, 2-METHYL-, METHYL ESTER
- ACRYESTER M
- ACRYLIC ACID, 2-METHYL-, METHYL ESTER
- DIAKON
- METHACRYLATE MONOMER
- METHACRYLIC ACID METHYL ESTER
- METHACRYLIC ACID, METHYL ESTER
- METHYL 2-METHYL-2-PROPENOATE
- METHYL 2-METHYLACRYLATE
- METHYL A-METHYLACRYLATE
- METHYL ALPHA-METHYLACRYLATE

- METHYL ESTER OF METHACRYLIC ACID
- METHYL METHACRYLATE
- METHYL METHACRYLATE MONOMER, INHIBITED
- METHYL METHACRYLATE MONOMER, UNINHIBITED
- METHYL METHACRYLATE MONOMER, [INHIBITED]
- METHYL METHACRYLATE, MONOMER, INHIBITED
- METHYL METHYLACRYLATE
- METHYL-2-METHYL-2-PROPENOATE
- MMA
- MME
- NA 1247
- NCI-C50680
- PEGALAN
- RCRA WASTE NUMBER U162
- UN 1247

Physical Properties

Formula	C5H8O2	Molecurar Weight	100.1	Flammable limits in Air (%)	1.7~8.2
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	0.94	Vapor Specific Gravity	3.5	Boiling Point (℃)	100.3
Freezing Point (℃)	-48.2	Flash Point (℃)	10	Ignition Point (℃)	421
Steam Pressure	4.13kPa/ 31mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Highly Flammable
- Polymerizable
- Peroxidizable Compound

■ Air & Water Reactions

Highly flammable. Very slightly soluble in water.

■ Fire Hazard

Behavior in Fire: Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back. Containers may explode in fire or when heated because of polymerization.

■ Health Hazard

Irritation of eyes, nose, and throat. Nausea and vomiting. Liquid may cause skin irritation.

■ Reactivity Profile

METHYL METHACRYLATE MONOMER, may polymerize if contaminated or subjected to heat. If polymerization takes place in a container, the container is subject to violent rupture. Oxidizes readily in air to form unstable peroxides that may explode spontaneously [Bretherick 1979. p.151-154, 164]. Peroxides may also initiate exothermic polymierization of the bulk material [Bretherick 1979. p. 160]. Benzoyl peroxide was weighed into a beaker that had previously been rinsed with methyl methacrylate. The peroxide catalyzed polymerization of the methyl methacrylate and the build-up of heat ignited the remaining peroxide [MCA Case History 996. 1964].

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may spread fire. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use foam, dry chemical, or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Apply "universal" gelling agent to immobilize spill. Apply approriate foam to diminish vapor and fire hazard. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Use surface active agent (e.g. detergent, soaps, alcohols), if approved by epa. Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms. If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center.

Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.

- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. Corrosive chemicals will destroy the membranes of the mouth, throat, and esophagus and, in addition, have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. Transport the victim IMMEDIATELY to a hospital.

PHENOL

Identification

General Description

A colorless liquid when pure, otherwise pink or red. Combustible. Flash point 79℃. Must be heated before ignition may occur easily. Vapors are heavier than air. Corrosive to skin but because of anesthetic qualities will numb rather than burn. Upon contact skin may turn white. May be lethal by skin absorption. Does not react with water. Stable in normal transportation. Reactive with various chemicals and may be corrosive to lead, aluminum and its alloys, certain plastics, and rubber. Freezing point about 40.9℃. Density 1066.5kg/m3. Used to make plastics, adhesives and other chemicals.

Identifiers

UN No.	CAS No.	IMDG CODE
2821	108-95-2	Class6.1/P6225

Alternate Names

- BAKER'S P AND S LIQUID AND OINTMENT
- BENZENOL
- CARBOLIC ACID
- CARBOLIC OIL (MIXTURE)
- ENT 1814
- HYDROXYBENZENE
- LIQUEFIED PHENOL
- MIDDLE OIL
- MONOHYDROXYBENZENE
- MONOPHENOL
- NA 2821
- NCI-C50124
- OXYBENZENE
- PHENIC ACID

- PHENOL
- PHENOL (CARBOLIC ACID)
- PHENOL ALCOHOL
- PHENOL, MOLTEN
- PHENOL, [LIQUID]
- PHENYL ALCOHOL
- PHENYL HYDRATE
- PHENYL HYDROXIDE
- PHENYLIC ACID
- PHENYLIC ALCOHOL
- RCRA WASTE NUMBER U188
- UN 1671
- UN 2312
- UN 2821

Physical Properties

Formula	C6H6O	Molecurar Weight	94.11	Flammable limits in Air (%)	1.8~3.2
Appearance	light pink			Sollubility in Water	easily soluble
Specific Gravity	1.049	Vapor Specific Gravity	3.3	Boiling Point (℃)	181.75
Freezing Point (℃)	40.9	Flash Point (℃)	79	Ignition Point (℃)	715
Steam Pressure	0.05kPa/ 0.35mmHg (25℃)	Corrosion	Human: yes Metal: yes	Oxidation	no

Hazards

■ **Reactivity Alerts**

none

■ Air & Water Reactions

Soluble in water.

■ Fire Hazard

Special Hazards of Combustion Products: Unburned vapor is toxic

- Behavior in Fire: Yields flammable vapors when heated, which will form explosive mixtures with air

■ Health Hazard

Will burn eyes and skin. The analgesic action may cause loss of pain sensation. Readily absorbed through skin, causing increased heart rate, convulsions, and death.

■ Reactivity Profile

A liquid containing over 50% phenol. See Phenol (solid). Phenols do not behave as organic alcohols, as one might guess from the presence of a hydroxyl (-OH) group in their structure. Instead, they react as weak organic acids. Phenols and cresols are much weaker as acids than common carboxylic acids (phenol has Ka = 1.3 x 10^[-10]). These materials are incompatible with strong reducing substances such as hydrides, nitrides, alkali metals, and sulfides. Flammable gas (H2) is often generated, and the heat of the reaction may ignite the gas. Heat is also generated by the acid-base reaction between phenols and bases. Such heating may initiate polymerization of the organic compound. Phenols are sulfonated very readily (for example, by concentrated sulfuric acid at room temperature). The reactions generate heat. Phenols are also nitrated very rapidly, even by dilute nitric acid. Nitrated phenols often explode when heated. Many of them form metal salts that tend toward detonation by rather mild shock. Phenol may explode in contact with peroxodisulfuric acid (D’Ans, J. Ber., 1910, 43, 1880; Z. Anorg. Chem., 1911, 73, 1911.) or peroxomonosulfuric acid.

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, dry chemical or carbon dioxide. Keep run-off water out of sewers and water sources.

■ **Spills and leakage response**

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Neutralize spilled material with crushed limestone, soda ash, or lime. Apply water spray or mist to knock down vapors. Vapor knockdown water is corrosive or toxic and should be diked for containment. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash or cement powder. Water spill: If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ **Response spill on the sea**

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward.

■ **Protective clothing**

Fresh air mask for confined areas; rubber gloves; protective clothing; full face shield.

■ **First Aid**

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison

control center even if no symptoms (such as redness or irritation) develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.

- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. Phenols are very toxic poisons AND corrosive and irritating, so that inducing vomiting may make medical problems worse. IMMEDIATELY call a hospital or poison control center and locate activated charcoal, egg whites, or milk in case the medical advisor recommends administering one of them. If advice from a physician is not readily available and the victim is conscious and not convulsing, give the victim a glass of activated charcoal slurry in water or, if this is not available, a glass of milk, or beaten egg whites and IMMEDIATELY transport victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, assure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

DICHLOROETHANE

Identification

■ General Description

A colorless liquid with a sweet, penetrating, ether-like odor. Noncombustible by if exposed to high temperatures may emit toxic chloride fumes. Vapors are narcotic in high concentrations. Used as a solvent and paint remover.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1593	75-09-2	Class6.1/P6127

■ Alternate Names

- AEROTHENE MM
- DCM
- DICHLOROMETHANE {METHYLENE CHLORIDE}
- F 30
- F 30 (CHLOROCARBON)
- FREON 30
- HCC 30
- KHLADON 30
- METACLEN
- METHANE DICHLORIDE
- METHYLENE BICHLORIDE
- METHYLENE DICHLORIDE
- NARKOTIL
- NCI-C50102
- R 30
- R 30 (REFRIGERANT)
- RCRA WASTE NUMBER U080
- SOLAESTHIN
- SOLEANA VDA
- SOLMETHINE

- UN 1593

Physical Properties

Formula	CH2Cl2	Molecurar Weight	84.94	Flammable limits in Air (%)	12~25
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	1.3266	Vapor Specific Gravity	2.9	Boiling Point (℃)	40.21
Freezing Point (℃)	-96.8	Flash Point (℃)		Ignition Point (℃)	556
Steam Pressure		Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air & Water Reactions

Somewhat water soluble. Subject to slow hydrolysis which is accelerated by light.

■ Fire Hazard

Special Hazards of Combustion Products: Dissociation products generated in a fire may be irritating or toxic.

■ Health Hazard

- INHALATION: anesthetic effects, nausea and drunkenness.
- CONTACT WITH SKIN AND EYES: skin irritation, irritation of eyes and nose.

■ Reactivity Profile

DICHLOROMETHANE reacts vigorously with active metals such as lithium, sodium and potassium, and with strong bases such as potassium tert-butoxide. It is incompatible with strong oxidizers, strong caustics and chemically active metals such as aluminum or magnesium powders. The liquid will attack some forms of plastic, rubber and coatings. This compound reacts with sodium-potassium alloy, (potassium hydrogen + N-methyl-N-nitrosurea), nitrogen tetraoxide and liquid oxygen. It also reacts with titanium. On contact with water it corrodes iron, some stainless steels, copper and nickel. It is incompatible with alkali metals. It is incompatible with amines, zinc and alloys of aluminum, magnesium and zinc. This compound is liable to explode when mixed with dinitrogen pentaoxide or nitric acid. Mixtures of this compound in air with methanol vapor are flammable.

Response Information

■ Firefighting

Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Extinguish fire using agent suitable for type of surrounding fire. (Material itself does not burn or burns with difficulty.) Keep run-off water out of sewers and water sources.

■ Spills and leakage response

Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to knock-down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Water spill: Use natural deep water pockets, excavated lagoons, or sand bag barriers to trap material at bottom. Remove trapped material with suction hoses.

■ Response spill on the sea

Recovery is difficult in order to dissolve in sea water for a short time.

■ Protective clothing

● Skin: Wear appropriate personal protective clothing to prevent skin contact.

- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. IMMEDIATELY call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat,

or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.

- INGESTION: DO NOT INDUCE VOMITING. Volatile chemicals have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.
- OTHER: Since this chemical is a known or suspected carcinogen you should contact a physician for advice regarding the possible long term health effects and potential recommendation for medical monitoring. Recommendations from the physician will depend upon the specific compound, its chemical, physical and toxicity properties, the exposure level, length of exposure, and the route of exposure.

VINYL ACETATE

Identification

General Description

A clear colorless liquid. Flash point -8℃. Density 934.7kg/m3. Slightly soluble in water. Vapors are heavier than air. Vapors irritate the eyes and respiratory system. May polymerize if heated or contaminated. If polymerization occurs inside a container, the container may violently rupture. Used to make adhesives, paints, and plastics.

Identifiers

UN No.	CAS No.	IMDG CODE
1301	108-05-4	Class3.2/P3289

Alternate Names

- 1-ACETOXYETHYLENE
- ACETIC ACID ETHENYL ESTER
- ACETIC ACID VINYL ESTER
- ACETIC ACID, ETHENYL ESTER
- ACETIC ACID, VINYL ESTER
- ACETOXYETHENE
- ACETOXYETHYLENE
- ETHENYL ACETATE
- ETHENYL ETHANOATE
- PONAL
- RP 251
- RP 251 (ESTER)
- VAC
- VAM
- VINYL A MONOMER
- VINYL ACETATE HQ
- VINYL ACETATE MONOMER
- VINYL ACETATE, INHIBITED

- VINYL ETHANOATE
- VYAC
- ZESET T

Physical Properties

Formula	$C_4H_6O_2$	Molecurar Weight	86.09	Flammable limits in Air (%)	2.6~13.4
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	0.93	Vapor Specific Gravity	3	Boiling Point (℃)	73.1
Freezing Point (℃)	-93	Flash Point (℃)	-8	Ignition Point (℃)	402
Steam Pressure	11kPa/ 83mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

Reactivity Alerts

- Highly Flammable
- Polymerizable
- Strong Reducing Agent
- Peroxidizable Compound

Air & Water Reactions

Highly flammable. Slightly soluble in water.

Fire Hazard

When heated to decomposition, it burns and emits acrid fumes. Highly dangerous when exposed to heat, flames or oxidizers; explosion hazard with strong acids and strong oxidizers. Incompatible with alumina, oxidizing materials, 2-aminoethanol, chlorosulfonic acid; ethyleneimine; 36% hydrochloric acid; 48.7% hydrofluoric acid; 70% nitric acid; oleum; 96% sulfuric acid; ethylene diamine; peroxides and silica gel. Avoid light or any polymerizing initiator. Hazardous polymerization can be initiated by organic andinorganic peroxides; azo compounds; redox systems (including organometallic components); light; and high energy radiation.

■ Health Hazard

Vinyl acetate has been related to reproductive abnormalities. It is a skin and upper respiratory tract irritantand a central nervous system depressant. Exposure caused gradual deterioration of heart muscles.

■ Reactivity Profile

VINYL ACETATE may undergo spontaneous exothermic polymerization on exposure to light. Reacts with air or water to produces peroxides that initiate explosively violent polymerization. Reacts with hydrogen peroxide to form explosive peracetic acid. Reacts with oxygen to form explosive peroxides. Forms explosive vinyl acetate ozonide on contact with ozone. Undergoes violent or explosive reactions with 2-aminoethanol, chlorosulfonic acid, ethylenediamine, mineral acids (hydrochloric acid, hydrofluoric acid, nitric acid, sulfuric acid, oleum), and peroxides [Lewis, 3rd ed., 1993, p. 1311]. Polymerization initiated by dibenzoyl peroxide in ethyl acetate accelerated out of control, ignited and exploded [Vervalin, 1973, p. 81]. Polymerization in toluene solution has caused several large industrial explosions.

Response Information

■ Firefighting

Wear self-contained (positive pressure if available) breathing apparatus and full protective clothing. Spray cooling water on containers that are exposed to flames until well after the fire is out. For massive fire in cargo area, use unmanned hose holder or monitor nozzles; if this is impossible, withdraw from area and let fire burn. Withdraw immediately in case of rising sound from venting safety device or any discoloration of tank due to fire. Isolate for 1/2 mile in all directions if tank car or truck is involved in fire. Small fires: extinguish with dry chemical, carbon dioxide, water spray, fog, or alcohol foam. Large fires: water spray, fog, or alcohol foam.

■ **Spills and leakage response**

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to disperse vapors and dilute standing pools of liquid. Apply water spray or mist to knock down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Apply "universal" gelling agent to immobilize spill. Apply approriate foam to diminish vapor and fire hazard. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Use surface active agent (e.g. detergent, soaps, alcohols), if approved by epa. Inject "universal" gelling agent to solidify encircled spill and increase effectiveness of booms. If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Remove trapped material with suction hoses. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ **Response spill on the sea**

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ **Protective clothing**

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye

protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- Signs and Symptoms of Acute Vinyl Acetate Monomer Exposure: Vinyl acetate monomer may irritate the skin, eyes, and respiratory tract; blisters may form. Inhalation of vapors may result in dizziness or suffocation.
- Emergency Life-Support Procedures: Acute exposure to vinyl acetate monomer may require decontamination and life support for the victims. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air espiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination.
- Inhalation Exposure:
  1. Move victims to fresh air. Emergency personnel should avoid self-exposure to vinyl acetate monomer.
  2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
  3. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
  4. Transport to a health care facility.
- Dermal/Eye Exposure:
  1. Remove victims from exposure. Emergency personnel should avoid self - exposure to vinyl acetate monomer.
  2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.

3. Remove contaminated clothing as soon as possible.
4. If eye exposure has occurred, eyes must be flushed with lukewarm water for at least 15 minutes.
5. Wash exposed skin areas twice with soap and water.
6. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
7. Transport to a health care facility.

- Ingestion Exposure:

1. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
2. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
3. Vomiting may be induced with syrup of Ipecac. If elapsed time since ingestion of vinyl acetate monomer is unknown or suspected to be greater than 30 minutes, do not induce vomiting and proceed to Step
4. Ipecac should not be administered to children under 6 months of age.Warning: Syrup of Ipecac should be administered only if victims are alert, have an active gag-reflex, and show no signs of impending seizure or coma. If ANY uncertainty exists, proceed to Step
5. The following dosages of Ipecac are recommended: children up to 1 year old, 10 mL (1/3 oz); children 1 to 12 years old, 15 mL (1/2 oz); adults, 30 mL (1 oz). Ambulate (walk) the victims and give large quantities of water. If vomiting has not occurred after 15 minutes, Ipecac may be readministered. Continue to ambulate and give water to the victims. If vomiting has not occurred within 15 minutes after second administration of Ipecac, administer activated charcoal.
6. Activated charcoal may be administered if victims are conscious and alert. Use 15 to 30 g (1/2 to 1 oz) for children, 50 to 100 g (1-3/4 to 3-1/2 oz) for adults, with 125 to 250 mL (1/2 to 1 cup) of water.
7. Promote excretion by administering a saline cathartic or sorbitol to conscious and alert victims. Children require 15 to 30 g (1/2 to 1 oz) of cathartic; 50 to 100 g (1-3/4 to 3-1/2 oz) is recommended for adults.
8. Transport to a health care facility.

NITRIC ACID

Identification

General Description

A pale yellow to reddish brown liquid with reddish brown vapors and a suffocating odor. Very toxic by inhalation. Corrosive to metals or tissue. Accelerates the burning of combustible material and may cause ignition of combustible materials upon contact. Prolonged exposure to low concentrations or short term exposure to high concentrations may result in adverse health effects. Density 1438.0kg/m3.

Identifiers

UN No.	CAS No.	IMDG CODE
2031	7697-37-2	Class8/P8195

Alternate Names

none

Physical Properties

Formula	HNO3	Molecurar Weight	63	Flammable limits in Air (%)	
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	1.5	Vapor Specific Gravity		Boiling Point (℃)	86
Freezing Point (℃)	-42	Flash Point (℃)		Ignition Point (℃)	
Steam Pressure		Corrosion	Human: yes Metal: yes	Oxidation	yes

Hazards

■ Reactivity Alerts

- Strong Oxidizing Agent
- Water-Reactive
- Air-Reactive

■ Air & Water Reactions

Fumes in air. Fully soluble in water with the release of heat. Reacts violently with water with the production of heat, fumes, and spattering.

■ Fire Hazard

Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. Vapors may accumulate in confined areas (basement, tanks, hopper/tank cars etc.). Substance will react with water (some violently), releasing corrosive and/or toxic gases and runoff. Contact with metals may evolve flammable hydrogen gas. Containers may explode when heated or if contaminated with water.

■ Health Hazard

TOXIC; inhalation, ingestion or contact (skin, eyes) with vapors, dusts or substance may cause severe injury, burns or death. Reaction with water or moist air will release toxic, corrosive or flammable gases. Reaction with water may generate much heat that will increase the concentration of fumes in the air. Fire will produce irritating, corrosive and/or toxic gases. Runoff from fire control or dilution water may be corrosive and/or toxic and cause pollution.

■ Reactivity Profile

NITRIC ACID ignites upon contact with alcohols, amines, ammonia, beryllium alkyls, boranes, dicyanogen, hydrazines, hydrocarbons, hydrogen, nitroalkanes, powdered metals, silanes, or thiols [Bretherick 1979. p.174]. The reaction of finely divided antimony and nitric acid can be violent [Pascal 10:504. 1931-34]. Bromine pentafluoride reacts violently with strong nitric acid and strong sulfuric acid [Mellor 2, Supp. 1:172. 1956]. Fuming nitric acid reacts with hydrogen selenide with incandescence [Berichte 3:658]. Fuming nitric acid reacts with hydrogen sulfide with incandescence [Berichte 3:658]. A mixture of finely divided magnesium and nitric acid is explosive [Pieters 1957. p. 28]. Nitric acid oxidizes magnesium phosphide with incandescence [Mellor 8:842. 1946-47]. Experiments show that mixtures of over 50% nitric acid by weight in acetic anhydride may act as detonating explosives [BCISC 42:2. 1971]. An etching agent of equal portions of acetone, nitric acid, and 75% acetic acid exploded four hours after it was prepared and placed in a closed bottle. This is similar to a formulation for the preparation of tetranitromethane a sensitive explosive [Chem. Eng. News 38: 56. 1960]. Phosphine is violently decomposed by concentrated nitric acid, and flame is produced. Warm fuming nitric acid, dropped in a container of phosphine gas produces an explosion [Edin. Roy. Soc. 13:88. 1835]. An explosion occurs when nitric acid is brought into contact with phosphorus trichloride [Comp. Rend. 28:86]. The exothermic nitration of phthalic acid or phthalic anhydride by fuming nitric acid-sulfuric acid may give mixtures of the potentially explosive phthaloyl nitrates or nitrites or their nitro derivatives [Chem. &Ind. 20:790. 1972]. The reaction of sodium azide and strong nitric acid is energetic [Mellor 8, Supp 2:315. 1967]. Nitric acid can react with uranium with explosive violence [Katz and Rabinowitch 1951]. Reacts violently with water with the production of heat, fumes, and spattering.

Response Information

■ Firefighting

Note: Most foams will react with the material and release corrosive/toxic gases.

- SMALL FIRE: CO2 (except for Cyanides), dry chemical, dry sand, alcohol-resistant foam.
- LARGE FIRE: Water spray, fog or alcohol-resistant foam. Move containers from fire area if you can do it without risk. Use water spray or fog; do not use straight streams. Dike fire-control water for later disposal; do not scatter the material.
- FIRE INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Do not get water inside containers. Cool containers with flooding quantities of water until well after fire is out. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire.

■ **Spills and leakage response**

ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). All equipment used when handling the product must be grounded. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Stop leak if you can do it without risk. A vapor suppressing foam may be used to reduce vapors. DO NOT GET WATER INSIDE CONTAINERS. Use water spray to reduce vapors or divert vapor cloud drift. Avoid allowing water runoff to contact spilled material. Prevent entry into waterways, sewers, basements or confined areas.

- SMALL SPILL: Cover with DRY earth, DRY sand or other non-combustible material followed with plastic sheet to minimize spreading or contact with rain. Use clean non-sparking tools to collect material and place it into loosely covered plastic containers for later disposal.

■ **Response spill on the sea**

Recovery is difficult in order to dissolve in sea water for a short time.

■ **Protective clothing**

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided (when concentration is pH<2.5) in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided (when concentration is pH<2.5) within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available,

whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- Eye: If this chemical contacts the eyes, immediately wash the eyes with large amounts of water, occasionally lifting the lower and upper lids. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.
- Skin: If this chemical contacts the skin, immediately flush the contaminated skin with water. If this chemical penetrates the clothing, immediately remove the clothing and flush the skin with water. Get medical attention promptly.
- Breathing: If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform mouth-to-mouth resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- Swallow: If this chemical has been swallowed, get medical attention immediately.

METHYL EHTYL KETONE

Identification

■ General Description

Colorless fairly volatile liquid with a pleasant pungent odor. Flash point -9℃. Vapors heavier than air. Does not react with water or many common materials. Stable in normal transportation. Irritates the nose, eyes, and throat. Combustion may produce toxic materials. Density 802.9kg/m3. Used as a solvent, for making other chemicals, and for production of wax from petroleum.

■ Identifiers

UN No.	CAS No.	IMDG CODE
1193	78-93-3	Class3.2/P3226

■ Alternate Names

- 2-BUTANONE
- 3-BUTANONE
- BUTANONE
- ETHYL METHYL KETONE {METHYL ETHYL KETONE}
- KETONE, ETHYL METHYL
- MEETCO
- MEK
- METHYL ACETONE
- METHYL ETHYL KETONE
- METHYL ETHYL KETONE (MEK)
- RCRA WASTE NUMBER U159
- UN 1193
- UN 1232

Physical Properties

Formula	C4H8O	Molecurar Weight	72.11	Flammable limits in Air (%)	1.7~11.4
Appearance	light yellow			Sollubility in Water	easily soluble
Specific Gravity	0.8	Vapor Specific Gravity	2.5	Boiling Point (℃)	79.5
Freezing Point (℃)	-87	Flash Point (℃)	-9	Ignition Point (℃)	404
Steam Pressure	9.5kPa/ 71.2mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Highly Flammable

■ Air &Water Reactions

Highly flammable. Soluble in water.

■ Fire Hazard

HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Many liquids are lighter than water.

■ Health Hazard

Liquid causes eye burn. Vapor irritates eyes, nose, and throat; can cause headache, dizziness, nausea, weakness, and loss of consciousness.

Reactivity Profile

ETHYL METHYL KETONE is explosive in the form of vapor when exposed to heat, flame or sparks. Ignition on contact with potassium tert-butoxide. Reactive with strong oxidizing materials, and will dissolve or soften some plastics. Mixture with 2-propanol will form explosive peroxides during storage. Vigorous reaction with chloroform in the presence of alkali (sodium hydroxide, potassium hydroxide), chlorosulfonic acid, fuming sulfuric acid (oleum) [Lewis, 3rd ed., 1993, p. 855]. Reaction with hydrogen peroxide in the presence of nitric acid forms heat- and shock-sensitive explosive acetone peroxides. [Bjorklund, G. H. et al., Trans. R. Soc. Can, 1950, 44, p. 25]

Response Information

Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, dry chemical or carbon dioxide.

Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to disperse vapors and dilute standing pools of liquid. Apply water spray or mist to knock down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Remove trapped material with suction hoses.

Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. Volatile chemicals have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and

IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

OCTANOL

Identification

General Description

A clear colorless liquid with a penetrating aromatic odor. Insoluble in water and floats on water. Vapors heavier than air. Vapors may irritate the eyes, nose, and respiratory system.

Identifiers

UN No.	CAS No.	IMDG CODE
none	111-87-5	Class9/P9028

Alternate Names

- 1-HYDROXYOCTANE
- 1-OCTANOL
- ALCOHOL C-8
- ALFOL 8
- CAPRYLIC ALCOHOL
- HEPTYL CARBINOL
- HEPTYLCARBINOL
- N-OCTAN-1-OL
- N-OCTANOL
- N-OCTYL ALCOHOL
- OCTILIN
- OCTYL ALCOHOL
- OCTYL ALCOHOL (N)
- SIPOL L8

Physical Properties

Formula	C8H18O	Molecurar Weight	130.23	Flammable limits in Air (%)	
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	0.82	Vapor Specific Gravity	4.5	Boiling Point (℃)	178.5
Freezing Point (℃)	-38.6	Flash Point (℃)	60	Ignition Point (℃)	
Steam Pressure	0.2mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air & Water Reactions

Insoluble in water.

■ Fire Hazard

No information available.

■ Health Hazard

Irritates skin and eyes.

■ Reactivity Profile

Attacks plastics [Handling Chemicals Safely 1980. p. 236]. Acetyl bromide reacts violently with alcohols or water [Merck 11th ed. 1989]. Mixtures of alcohols with concentrated sulfuric acid and strong hydrogen peroxide can cause explosions. Example: an explosion will occur if dimethylbenzylcarbinol is added to 90% hydrogen peroxide then acidified with concentrated sulfuric acid. Mixtures of ethyl alcohol with concentrated hydrogen peroxide form powerful explosives. Mixtures of hydrogen peroxide and 1-phenyl-2-methyl propyl alcohol tend to explode if acidified with 70% sulfuric acid [Chem. Eng. News 45(43):73. 1967; J, Org. Chem. 28:1893. 1963]. Alkyl hypochlorites are violently explosive. They are readily obtained by reacting hypochlorous acid and alcohols either in aqueous solution or mixed aqueous-carbon tetrachloride solutions. Chlorine plus alcohols would similarly yield alkyl hypochlorites. They decompose in the cold and explode on exposure to sunlight or heat. Tertiary hypochlorites are less unstable than secondary or primary hypochlorites [NFPA 491 M. 1991]. Base-catalysed reactions of isocyanates with alcohols should be carried out in inert solvents. Such reactions in the absence of solvents often occur with explosive violence [Wischmeyer 1969].

Response Information

■ Firefighting

Fire Extinguishing Agents: Foam, carbon dioxide, or dry chemical.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Use water spray to knock-down vapors.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward.

■ Protective clothing

Avoid breathing vapors. Keep upwind. Wear appropriate chemical protective gloves, boots and goggles. Do not handle broken packages unless wearing appropriate personal protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water.

■ First Aid

Flush with copious amounts of water.

CYCLOHEXANOL

Identification

General Description

A colorless liquid with a camphor-like odor. Soluble in most organic liquids. Flash point 154°F. May be toxic by inhalation or skin exposure. Vapors are narcotic in high concentrations. Irritates skin, eyes and mucus membranes. Used in making soap, lacquers, and plastics.

Identifiers

UN No.	CAS No.	IMDG CODE
1993	108-93-0	none

Alternate Names

- 1-CYCLOHEXANOL
- ADRONAL
- ADRONOL
- ANOL
- CYCLOHEXYL ALCOHOL
- HEXAHYDROPHENOL
- HEXALIN
- HEXALIN (ALCOHOL)
- HYDRALIN
- HYDROPHENOL
- HYDROXYCYCLOHEXANE
- NAXOL
- PHENOL, HEXAHYDRO-

Physical Properties

Formula	C6H12O	Molecurar Weight	100.16	Flammable limits in Air (%)	1.1~8.1
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	0.96	Vapor Specific Gravity	3.5	Boiling Point (℃)	161.1
Freezing Point (℃)	25.15	Flash Point (℃)	68	Ignition Point (℃)	300
Steam Pressure	10mmHg (56℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ **Reactivity Alerts**

none

■ **Air & Water Reactions**

Less dense than water and slightly soluble in water.

■ **Fire Hazard**

HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Many liquids are lighter than water. Substance may be transported hot.

■ **Health Hazard**

Narcosis-depression of the central nervous system tending to produce sleep or unconsciousness.

■ Reactivity Profile

CYCLOHEXANOL is an alcohol. Flammable and/or toxic gases are generated by the combination of alcohols with alkali metals, nitrides, and strong reducing agents. They react with oxoacids and carboxylic acids to form esters plus water. Oxidizing agents convert them to aldehydes or ketones. Alcohols exhibit both weak acid and weak base behavior. They may initiate the polymerization of isocyanates and epoxides. Violent reaction with nitric acid. Incompatible with strong oxidizers (chromium trioxide, nitric acid, etc.).

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, dry chemical or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Apply water spray or mist to knock down vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash, cement powder, or commercial sorbents. Water spill: Use natural barriers or oil spill control booms to limit spill travel. Remove trapped material with suction hoses.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.

- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: Workers whose clothing may have become contaminated should change into uncontaminated clothing before leaving the work premise.

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital. (NTP, 1992)

ACRYLIC ACID

Identification

General Description

Acrylic acid is a colorless liquid with a distinctive acrid odor. Flash point 50℃. Boiling point 141.9℃. Freezing point 14℃. Corrosive to metals and tissue. Prolonged exposure to fire or heat can cause polymerization. If polymerization takes place in a closed container, violent rupture may occur. The inhibitor (usually hydroquinone) greatly reduces the tendency to polymerize.

Identifiers

UN No.	CAS No.	IMDG CODE
2218	79-10-7	Class8/P8102

Alternate Names

- 2-PROPENOIC ACID
- ACROLEIC ACID
- ACRYLIC ACID
- ACRYLIC ACID, GLACIAL
- AQUEOUS ACRYLIC ACID (TECHNICAL GRADE IS 94%)
- ETHYLENE CARBOXYLIC ACID
- ETHYLENECARBOXYLIC ACID
- GLACIAL ACRYLIC ACID
- GLACIAL ACRYLIC ACID (98% IN AQUEOUS SOLUTION)
- PROPENE ACID
- PROPENOIC ACID
- RCRA WASTE NUMBER U008
- UN 2218
- VINYL FORMIC ACID
- VINYLFORMIC ACID

Physical Properties

Formula	CH2CHCOO H	Molecurar Weight	72.1	Flammable limits in Air (%)	2.4~8
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	1.062	Vapor Specific Gravity	2.5	Boiling Point (℃)	141.9
Freezing Point (℃)	14	Flash Point (℃)	50	Ignition Point (℃)	438
Steam Pressure	3.1mmHg (20℃)	Corrosion	Human: yes Metal: yes	Oxidation	no

Hazards

■ Reactivity Alerts

- Polymerizable

■ Air & Water Reactions

Flammable. Soluble in water. The presence of water, due to different solubilities of the acid and inhibitor (partitioning one from the other), may initiate polymerization.

■ Fire Hazard

- Special Hazards of Combustion Products: Toxic vapors are generated when heated
- Behavior in Fire: May polymerize and explode

■ Health Hazard

May burn skin or eyes upon short contact. INHALATION: eye and nasal irritation and lacrimation. INGESTION: may cause severe damage to the gastrointestinal tract.

Reactivity Profile

ACRYLIC ACID may polymerize violently especially when the frozen acid is partially thawed (freezing point 12°C or 53°F). Frozen acid should be melted at room temperature and the process should be well stirred. Do not use heat during the melting process [Kirk-Othmer, 3rd ed., Vol. 1, 1978, p. 330]. Corrodes iron and steel and polymerization may occur on contact with iron salts. The uninhibited acid polymerizes exothermically at ambient temperature and explodes if confined. The inhibitor (usually hydroquinone) greatly reduces the tendency to polymerize. Explosive polymerization can also occur with strong bases, amines, ammonia, oleum, chlorosulfonic acid, and peroxides. Mixing with 2-aminoethanol, 28% ammonium hydroxide, ethylenediamine or ethyleneimine in a closed container causes an increase in temperature and pressure. Can react violently with oxidizing reagents and strong bases [Bretherick, 5th ed., 1995, p. 419].

Response Information

Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, dry chemical or carbon dioxide. Use water spray to knock-down vapors.

Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Use water spray to knock-down vapors. Neutralize spilled material with crushed limestone, soda ash, or lime.

Response spill on the sea

Recovery is difficult in order to dissolve in sea water for a short time.

Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.

- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. IMMEDIATELY call a hospital or poison control center even if no symptoms (such as redness or irritation) develop. IMMEDIATELY transport the victim to a hospital for treatment after washing the affected areas.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. IMMEDIATELY call a physician and be prepared to transport the victim to a hospital even if no symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained

Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.

- INGESTION: DO NOT INDUCE VOMITING. Corrosive chemicals will destroy the membranes of the mouth, throat, and esophagus and, in addition, have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. Transport the victim IMMEDIATELY to a hospital.

BUTYL ACRYLATE

Identification

General Description

A clear colorless liquid with a sharp characteristic odor. Very slightly soluble in water and somewhat less dense than water. Hence forms surface slick on water. Flash point 48.9℃. Density 898.8kg/m3. Used for making paints, coatings, caulks, sealants, adhesives.

Identifiers

UN No.	CAS No.	IMDG CODE
2348	141-32-2	Class3.3/P3315

Alternate Names

- 2-PROPENOIC ACID BUTYL ESTER
- 2-PROPENOIC ACID, BUTYL ESTER
- ACRILATO DE BUTILO (DOT SPANISH)
- ACRILATOS DE BUTILO, INHIBIDOS (DOT SPANISH)
- ACRYLATE DE BUTYLE (DOT FRENCH)
- ACRYLATES DE BUTYLE, STABILISÉS (DOT FRENCH)
- ACRYLIC ACID BUTYL ESTER
- ACRYLIC ACID N-BUTYL ESTER
- ACRYLIC ACID, BUTYL ESTER
- ACRYLIC ACID, N-BUTYL ESTER
- BUTYL 2-PROPENATE
- BUTYL 2-PROPENOATE
- BUTYL ACRYLATE, INHIBITED
- BUTYL ACRYLATES, INHIBITED
- BUTYL ESTER OF ACRYLIC ACID
- N-BUTYL 2-PROPENOATE
- N-BUTYL ACRYLATE

Physical Properties

Formula	C7H12O2	Molecurar Weight	128.17	Flammable limits in Air (%)	1.7~9.9
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	0.89	Vapor Specific Gravity	4.4	Boiling Point (℃)	147
Freezing Point (℃)	-64.4	Flash Point (℃)	48.9	Ignition Point (℃)	292
Steam Pressure	0.44kPa/ 3.2mmHg (20℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Polymerizable

■ Air & Water Reactions

Flammable. Very slightly soluble in water.

■ Fire Hazard

HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. May polymerize explosively when heated or involved in a fire. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Many liquids are lighter than water.

■ Health Hazard

Vapor is irritating when breathed at high concentrations. Contact with liquid causes irritation of skin and burning of eyes.

■ Reactivity Profile

BUTYL ACRYLATE reacts exothermically with acids to liberate heat along with alcohols and acids. Reacts with strong oxidizing agents, perhaps sufficiently exothermically to ignite the reaction products. Mixing with basic solutions generates heat. Generates flammable hydrogen with alkali metals and hydrides. Attacks many plastics [Handling Chemicals Safely 1980. p. 233]. Polymerizes readily, generating much heat in a reaction that is favored by heat and light [Handling Chemicals Safely 1980. p. 235].

Response Information

■ Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use foam, dry chemical, or carbon dioxide.

■ Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Use water spray to knock-down vapors.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it

becomes contaminated.

- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.

- INGESTION: DO NOT INDUCE VOMITING. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. Be prepared to transport the victim to a hospital if advised by a physician. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

CHLOROFORM

Identification

General Description

A clear colorless liquid with a characteristic odor. Denser (1473.9kg/m3) than water and slightly soluble in water. Hence sinks in water. Nonflammable under most conditions, but burns under extreme conditions. May cause illness by inhalation, skin absorption or ingestion. Used as a solvent, to make other chemicals, as a fumigant.

Identifiers

UN No.	CAS No.	IMDG CODE
1888	67-66-3	Class6.1/P6103

Alternate Names

- CHLOROFORME (DOT FRENCH)
- CLOROFORMO (DOT SPANISH)
- FORMYL TRICHLORIDE
- FREON 20
- HCC 20
- METHANE TRICHLORIDE
- METHANE, TRICHLORO-
- METHENYL CHLORIDE
- METHENYL TRICHLORIDE
- METHYL TRICHLORIDE
- NCI-C02686
- NCI-CO2686
- R 20
- R 20 (REFRIGERANT)
- R 20 (REFRIGERANT)
- R-20
- RCRA WASTE NUMBER U044
- TCM

- TRICHLOROFORM
- TRICHLOROMETHANE
- UN 1888

Physical Properties

Formula	CHCl3	Molecurar Weight	119.4	Flammable limits in Air (%)	
Appearance	colorless			Sollubility in Water	insoluble
Specific Gravity	1.5	Vapor Specific Gravity	4.1	Boiling Point (℃)	61.2
Freezing Point (℃)	-63.5	Flash Point (℃)		Ignition Point (℃)	
Steam Pressure	200mmHg (25.9℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

none

■ Air & Water Reactions

Slightly soluble in water. Dissolves in water to form a corrosive solution of hypochlorous acid which decomposes on standing to chlorine, oxygen, and chloric acid.

■ Fire Hazard

Container may explode in the heat of fire. When heated it liberates phosgene, hydrogen chloride, chlorine and toxic and corrosive oxides of carbon and chlorine. Chloroform explodes when in contact with aluminum powder or magnesium powder or with alkali metals (e.g., lithium, sodium, and potassium) and dinitrogen tetroxide. It reacts vigorously with acetone in the presence of potassium hydroxide or calcium hydroxide. It is oxidized by strong oxidizers such as chromic acid forming phosgene and chlorine. It reacts vigorously with triisopropylphosphine. It develops acidity from prolonged exposure to air and light.

■ Health Hazard

It is classified as moderately toxic. Probable oral lethal dose for humans is 0.5 to 5 g/kg (between 1 ounce and 1 pint) for a 150 lb. person. The mean lethal dose is probably near 1 fluid ounce (44 g). It is a human suspected carcinogen. Also, it is a central nervous system depressant and a gastrointestinal irritant. It has caused rapid death attributable to cardiac arrest and delayed death from liver and kidney damage.

■ Reactivity Profile

A mixture of acetone and CHLOROFORM in a residue bottle exploded. Since addition of acetone to chloroform in the presence of base will result in a highly exothermic reaction, it is thought that a base was in the bottle. [MCA Case History 1661(1970)]. Powdered aluminum and carbon tetrachloride(also methyl chloride and chloroform or mixtures of these chemicals) exploded when heated(to 153°C.) and by impact, [Chem. Eng. News 32:258(1954); UL Bull. Research 34(1945), ASESB Pot. Incid. 39(1968)]. An inadequately cooled addition of sodium to a chloroform-methanol mixture (sodium methoxide) caused a violent explosion, [MCA Case History No. 693]. It is incompatible with dinitrogen tetraoxide, fluorine, sodium metal and alcohols, nitromethane, and triisopropylphosphine.

Response Information

■ Firefighting

Wear self-contained breathing apparatus and special protective clothing. Move container from fire area. Fight fire from maximum distance. Dike fire control water for later disposal; do not scatter the material.
Extinguish with dry chemical, carbon dioxide, water spray, fog or foam.

■ Spills and leakage response

Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Combustion products include corrosive or toxic vapors. Land spill: Dig a pit, pond, lagoon, holding area to contain liquid or solid material. Dike surface flow using soil, sand bags, foamed polyurethane, or foamed concrete. Absorb bulk liquid with fly ash or cement powder. Apply "universal" gelling agent to immobilize spill. Water spill: Use natural deep water pockets, excavated lagoons, or sand bag barriers to trap material at bottom. Remove trapped material with suction hoses. If dissolved, in region of 10 ppm or greater concentration, apply activated carbon at ten times the spilled amount. Use mechanical dredges or lifts to remove immobilized masses of pollutants and precipitates.

■ Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet or significantly contaminated should be removed and replaced.
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.
- Provide: Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance; this is irrespective of the recommendation involving the wearing of eye protection. Facilities for quickly drenching the body should be provided within the immediate work area for emergency use where there is a possibility of exposure. [Note: It is intended that these facilities provide a sufficient quantity or flow of water to quickly remove the substance from any body areas likely to be exposed. The actual determination of what constitutes an adequate quick drench facility depends on the specific circumstances. In certain instances, a deluge shower should be readily

available, whereas in others, the availability of water from a sink or hose could be considered adequate.]

■ First Aid

- Signs and Symptoms of Chloroform Exposure: Signs and symptoms of acute exposure to chloroform vapor may include conjunctivitis and blepharospasm (twitching of the eyelid). Burning pain and corneal epithelium injury may occur from chloroform liquid splashed in the eye. Acute exposure may also lead to respiratory depression, chemical pneumonitis, pulmonary edema, metabolic acidosis, central nervous system depression, headache, fatigue, and dizziness. Gastrointestinal signs and symptoms include nausea, vomiting, salivation, anorexia, and gastrointestinal irritation. Cardiac arrhythmias and cardiac arrest have been reported.
- Emergency Life-Support Procedures: Acute exposure to chloroform may require decontamination and life support for the victims. Emergency personnel should wear protective clothing appropriate to the type and degree of contamination. Air-purifying or supplied-air respiratory equipment should also be worn, as necessary. Rescue vehicles should carry supplies such as plastic sheeting and disposable plastic bags to assist in preventing spread of contamination.
- Inhalation Exposure:
  1. Move victims to fresh air. Emergency personnel should avoid self-exposure to chloroform.
  2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
  3. Obtain authorization and/or further instructions from the local hospital for performance of invasive procedures.
  4. Transport to a health care facility.
- Dermal/Eye Exposure:
  1. Remove victims from exposure. Emergency personnel should avoid self-exposure to chloroform.
  2. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
  3. Remove and isolate contaminated clothing as soon as possible.

4. If eye exposure has occurred, eyes must be flushed with lukewarm water for at least 30 minutes.
5. Wash exposed skin areas thoroughly with water.
6. Obtain authorization and/or further instructions from the local hospital for performance of other invasive procedures.
7. Transport to a health care facility.

- Ingestion Exposure:
  1. Evaluate vital signs including pulse and respiratory rate, and note any trauma. If no pulse is detected, provide CPR. If not breathing, provide artificial respiration. If breathing is labored, administer oxygen or other respiratory support.
  2. DO NOT induce vomiting.
  3. Obtain authorization and/or further instructions from the local hospital for administration of an antidote or performance of other invasive procedures.
  4. Activated charcoal may be administered if victims are conscious and alert. Use 15 to 30 g (1/2 to 1 oz) for children, 50 to 100 g (1-3/4 to 3-1/2 oz) for adults, with 125 to 250 mL (1/2 to 1 cup) of water.
  5. Promote excretion by administering a saline cathartic or sorbitol to conscious and alert victims. Children require 15 to 30 g (1/2 to 1 oz) of cathartic; 50 to 100 g (1-3/4 to 3-1/2 oz) is recommended for adults.
  6. Transport to a health care facility.

ETHYL ACETATE

Identification

General Description

A clear colorless liquid with a fruity odor. Flash point -4℃. Less dense than water. Vapors heavier than air.

Identifiers

UN No.	CAS No.	IMDG CODE
1173	141-78-6	Class3.2/P3220

Alternate Names

- ACETIC ACID, ETHYL ESTER
- ACETIC ESTER
- ACETIC ETHER
- ACETIDIN
- ACETOXYETHANE
- ETHYL ACETIC ESTER
- ETHYL ESTER OF ACETIC ACID
- ETHYL ETHANOATE
- ETOAC
- RCRA WASTE NUMBER U112
- UN 1173
- VINEGAR NAPHTHA

Physical Properties

Formula	C4H8O2	Molecurar Weight	88.11	Flammable limits in Air (%)	2.0~11.5
Appearance	colorless			Sollubility in Water	easily soluble
Specific Gravity	0.9	Vapor Specific Gravity	3.1	Boiling Point (℃)	76.82
Freezing Point (℃)	-83.6	Flash Point (℃)	-4	Ignition Point (℃)	426
Steam Pressure	13.3kPa/ 100mmHg (27℃)	Corrosion	Human: no Metal: no	Oxidation	no

Hazards

■ Reactivity Alerts

- Highly Flammable
- Peroxidizable Compound

■ Air & Water Reactions

Highly flammable. Slightly soluble in water. This chemical is slowly hydrolyzed by moisture.

■ Fire Hazard

HIGHLY FLAMMABLE: Will be easily ignited by heat, sparks or flames. Vapors may form explosive mixtures with air. Vapors may travel to source of ignition and flash back. Most vapors are heavier than air. They will spread along ground and collect in low or confined areas (sewers, basements, tanks). Vapor explosion hazard indoors, outdoors or in sewers. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Many liquids are lighter than water.

Health Hazard

Headache, irritation of respiratory passages and eyes, dizziness and nausea, weakness, loss of consciousness.

Reactivity Profile

ETHYL ACETATE is also sensitive to heat. On prolonged storage, materials containing similar functional groups have formed explosive peroxides. This chemical may ignite or explode with lithium aluminum hydride. It may also ignite with potassium tert-butoxide. It is incompatible with nitrates, strong alkalis and strong acids. It will attack some forms of plastics, rubber and coatings. It is incompatible with oxidizers such as hydrogen peroxide, nitric acid, perchloric acid and chromium trioxide. Violent reactions occur with chlorosulfonic acid. (NTP, 1992). SOCl2 reacts with esters, such as ethyl acetate, forming toxic SO2 gas and water soluble/toxic acyl chlorides, catalyzed by Fe or Zn (Spagnuolo, C.J. et al. 1992. Chemical and Engineering News 70(22):2.).

Response Information

Firefighting

Do not extinguish fire unless flow can be stopped. Use water in flooding quantities as fog. Solid streams of water may be ineffective. Cool all affected containers with flooding quantities of water. Apply water from as far a distance as possible. Use "alcohol" foam, dry chemical or carbon dioxide.

Spills and leakage response

Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Build dikes to contain flow as necessary. Attempt to stop leak if without undue personnel hazard. Use water spray to disperse vapors and dilute standing pools of liquid.

Response spill on the sea

When there is no possibility that gas may affect the circumference, monitoring is performed and it waits for disappearance of gas and liquid. When evaporation of gas needs to be reduced, a sea surface is covered by foam from the windward. Absorbing polymer and a solidyfing agent are sprinkled from the windward, and it solidifies. After checking that generating of gas has been lost, it collects in a recovery net etc.

■ Protective clothing

- Skin: Wear appropriate personal protective clothing to prevent skin contact.
- Eyes: Wear appropriate eye protection to prevent eye contact.
- Wash skin: The worker should immediately wash the skin when it becomes contaminated.
- Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard(i.e. for liquids with flash point <100°F)
- Change: No recommendation is made specifying the need for the worker to change clothing after the work shift.

■ First Aid

- EYES: First check the victim for contact lenses and remove if present. Flush victim's eyes with water or normal saline solution for 20 to 30 minutes while simultaneously calling a hospital or poison control center. Do not put any ointments, oils, or medication in the victim's eyes without specific instructions from a physician. IMMEDIATELY transport the victim after flushing eyes to a hospital even if no symptoms (such as redness or irritation) develop.
- SKIN: IMMEDIATELY flood affected skin with water while removing and isolating all contaminated clothing. Gently wash all affected skin areas thoroughly with soap and water. If symptoms such as redness or irritation develop, IMMEDIATELY call a physician and be prepared to transport the victim to a hospital for treatment.
- INHALATION: IMMEDIATELY leave the contaminated area; take deep breaths of fresh air. If symptoms (such as wheezing, coughing, shortness of breath, or burning in the mouth, throat, or chest) develop, call a physician and be prepared to transport the victim to a hospital. Provide proper respiratory protection to rescuers entering an unknown atmosphere. Whenever possible, Self-Contained Breathing Apparatus (SCBA) should be used; if not available, use a level of protection greater than or equal to that advised under Protective Clothing.
- INGESTION: DO NOT INDUCE VOMITING. Volatile chemicals have a high risk of being aspirated into the victim's lungs during vomiting which increases the medical problems. If the victim is conscious and not convulsing, give 1 or 2 glasses of water to dilute the chemical and IMMEDIATELY call a hospital or poison control center. IMMEDIATELY

transport the victim to a hospital. If the victim is convulsing or unconscious, do not give anything by mouth, ensure that the victim's airway is open and lay the victim on his/her side with the head lower than the body. DO NOT INDUCE VOMITING. IMMEDIATELY transport the victim to a hospital.

NOWPAP MERRAC

Northwest Pacific Action Plan
Marine Environmental Emergency Preparedness and Response
Regional Activity Centre

P.O. Box 23, Yuseong, Daejeon 305-600, Republic of Korea
(c/o MOERI/KORDI)
Tel: (+82-42) 866-3638, Fax: (+82-42) 866-3698
E-mail: nowpap@moeri.re.kr
Website: http://merrac.nowpap.org

92550
9 788993 604078
ISBN 978-89-93604-07-8