

PROJECT REVIEW MEETING

on

**STUDY TO IDENTIFY CHEMICAL AND
BIOLOGICAL HAZARDS TO U.S. NAVY
DIVERS AND SWIMMERS**

SwRI Project 18-2542-001

(Task funded under ARINC BOA)

Jerry Henkener

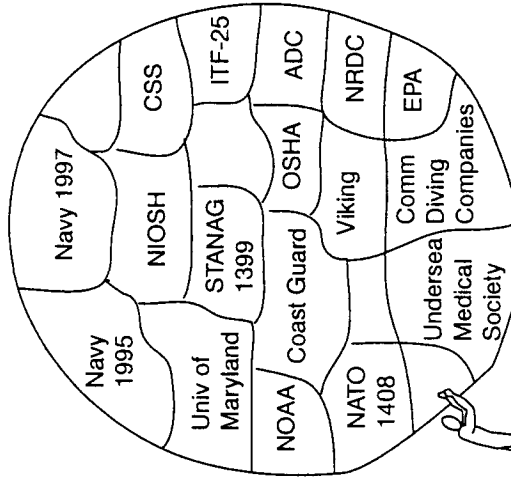
December 14, 1999

HAZARDS TO NAVY DIVERS

Task Objective:

The project objective is to develop a realistic list of chemical and biological contaminants that U.S. Navy divers and swimmers could encounter in the performance of their duties under non-warfare environmental conditions.

The overall NEDU objective is ultimately to develop and published an official procedure or guideline for “Diving in Contaminated Waters”. This SwRI task is the first step in this overall process.



HAZARDS TO NAVY DIVERS

Project Sub Tasks:

- **Step 1: - Interview key people and conduct literature/document search.**
- **Step 2: - Analyze the Information and Develop a Preliminary List of Potential Threats or Hazards.**
- **Step 3: - Navy Review and Inputs to the List**
- **Step 4: - Refine the list and Include Likelihood of Encounter and Severity of the Threat.**
- **Step 5: - Document Results in Summary Report**

BIBLIOGRAPHY REVIEW

of

Tables A through E

**CHEMICAL AND BIOLOGICAL
HAZARDS REVIEW**

of

Tables A through K

NIOSH Guide to Chemical Hazards

Acetic anhydride		CAS 108-24-7
(CH ₃ CO) ₂ O		RTECS AK1925000
Synonyms & Trade Names Acetic acid anhydride, Acetic oxide, Acetyl oxide, Ethanoic anhydride		DOT ID & Guide 1715 137
Exposure Limits NIOSH REL: C 5 ppm (20 mg/m ³) OSHA PEL: TWA 5 ppm (20 mg/m ³)		Conversion 1 ppm = 4.18 mg/m ³
IDLH 200 ppm See: 108247		
Physical Description Colorless liquid with a strong, pungent, vinegar-like odor.		
MW: 102.1	BP: 282°F	FRZ: 99°F
VP: 4 mmHg	TP: 10.00 eV	Sol: 12%
Fl.P: 120°F	UEL: 10.3%	Sp.Gr: 1.08
Class II Combustible Liquid; Fl.P. at or above 100°F and below 140°F.		
Incompatibilities & Reactivities Water, alcohols, strong oxidizers (especially chromic acid), amines, strong caustics [Note: Corrosive to iron, steel & other metals. Reacts with water to form acetic acid.]		
Measurement Method Bubbler, Reagent, Visible spectrophotometry. IV (#3506) See: NMAM INDEX		
See procedures immediately flush immediately Respiratory support Medical attention immediately		
flow mode ^f (APF = 25) Any powered, air-purifying and organic vapor cartridge(s) (APF = 50) Any air-purified organic vapor canister (APF = 50) Any cartridge(s) ^f (APF = 50) Any self-contained breathing apparatus (APF = 10,000) Any self-contained breathing apparatus pressure mode (APF = 10,000) Any supplied-air positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus		
Escape: (APF = 50) Any air-purifying, full-facepiece respirator (gas mask) with a chin-style, front- or back-mounted organic vapor canister/Any appropriate escape-type, self-contained breathing apparatus		
Exposure Routes inhalation, ingestion, skin and/or eye contact		
Symptoms conjunctivitis, lacrimation (discharge of tears), corneal edema, opacity, photophobia (abnormal visual intolerance to light); nasal, pharyngeal irritation; cough, dyspnea (breathing difficulty), bronchitis; skin burns, vesiculation, sensitization dermatitis		
Target Organs Eyes, skin, respiratory system		
See also: INTRODUCTION See ICSC CARD: 0209		

Available on the internet at <http://www.cdc.gov/niosh/npg/npgd0000.html>

HAZARDS TO NAVY DIVERS

- **Dividing Equipment**
 - EPA Refers to Diver Dress in Four Categories (Ref D-5,pg D-23)
 - Level A - highest level of protection
 - Level B - lesser skin protection than Level A
 - Level C - air purifying respirator but less than Level B
 - Level D - provides no protection against chemical hazards
 - Commercial Diving Companies generally use Viking Dry Suits and Superlite Helmets. Double exhaust valves are essential.
 - Commercial Diving Companies generally use Tyrek Suits over their Viking Dry Suits for Chafing Protection.
 - EPA Protocol refers to Draeger Suit, Mk-12, Superlite-17B Helmet, Helmax SS-20 and Desco Diving Hat.
 - CSS has tested US Navy Diving Equipment (Mk-12, etc)
 - ADS-2000 and ROVs

HAZARDS TO NAVY DIVERS

- FUTURE WORK
 - Up Date Chemical Spill Data to 1998-99.
 - Decide whether guidelines should be chemical specific or whether each dive should be treated on an individual basis.
 - If the decision is chemical-specific, then a list target chemicals needs to be expanded from one of the present lists. Navy equipment would need to be tested to cover the new list.
 - Navy identify specific areas in US and worldwide.
 - Use updated spill data and locations to establish “Likelihood of Encounter” for chemical hazards on the target list.
 - A draft guideline should be developed along the lines of Section 14 in the NOAA diving manual. The guideline should be exercised in a mock or real hazardous chemical environment to evolve its usefulness.
 - The guideline should take advantage of the internet and available databases and other sources (such as EPA) of technical information.

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TABLE A: BIBLIOGRAPHY - U.S. NAVY PROCEDURAL REFERENCE DOCUMENTS

AUTHOR	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
1 U.S. Navy, NAVSEA OOC	Section 19-8 entitled "Operational Hazards" from Chapter 19 entitled "Diving Disorders Not Requiring Recompression Therapy".	U.S. Navy Diving Manual, Volume No. 5	Arlington, VA	1999	This is the present section of the diving manual where hazards are discussed but chemical and biological hazards are not included.
2 U.S. Navy, NEDU	Diving in Polluted/Contaminated Waters Manual (DRAFT)	Naval Experimental Diving Unit (NEDU)	Panama City, Florida	1997	This draft document was obtained from LCDR Crepeau at NEDU. The document contains a general list of hazardous chemicals, a list of potential infections, and a list of nine known pathogens with their associated diseases.
3 U.S. Navy NAVSEA OOC	Diving in Polluted Water Guidelines and Standard operating Procedures (DRAFT)	Naval Sea Systems Command (NAVSEA OOC)	Arlington, VA	1995	This draft document was obtained from the file of LCDR Lewis at NAVSEA OOC. This draft document lists chemicals in four different categories and includes a table of nine known pathogens with their associated diseases.
4 U.S. Navy NAVSEA OOC	Contaminated Water Diving (Draft)	Naval Sea Systems Command (NAVSEA OOC)	Arlington, VA	1989	This draft document was obtained from the file of LCDR Lewis at NAVSEA OOC. The document appears to have been developed for potential inclusion in the latest revision to the Navy Diving Manual. No lists of hazards are included but a very good list of documents and organizations for use by response personnel is included.
5 U.S. Navy NAVSEA OOC	NAVSEA OOC comments on Draft STANAG 1399 UD	Naval Sea Systems Command (NAVSEA OOC)	Arlington, VA	1991	This memorandum contains lists of hazardous chemicals along with their respective hazard and toxicity info. U. S. spills from 1976 thru 1980 are also included.

TABLE B: BIBLIOGRAPHY - BIOLOGICAL HAZARDS REFERENCE DOCUMENTS

AUTHOR/SOURCE	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
Web Site for Diving Medicine Online - www.gulftel.com	Diving in Polluted Waters	<u>Diving Medicine Online</u>		1999	Two different five page articles on diving in polluted waters. Article includes a list of bacterial, viral and chemical hazards with related details.
Web Site for the Natural Resources Defense Council, Inc. (NRDC) - www.nrdc.org	A Guide to Water Quality at Vacation Beaches	<u>Testing the Waters - 1999</u> (annual report from NRDC survey of water quality monitoring)		1999	Five Chapter Report covering Sources, Health Risks, and Economic Impacts of Beachwater Pollution. Pathogens with their swimming associated illnesses are listed.
Burkholder, JoAnn M.	The Lurking Perils of Pfiesteria	<u>Scientific America</u>		1999	Article indicates that "Divers ... showing signs of Pfiesteria poisoning have described respiratory problems, headaches, extreme mood swings, aching joints and muscles, disorientation, and memory loss."
Virginia Water Control Board	Elizabeth River Toxics Initiative First Biennial Progress Report 1990	<u>Basic Data Bulletin</u> , No. 84	Chesapeake Bay, VA	1991	This report was used by Bert Marsh at NEDU in 1992 with inputs from NMRI to develop recommendations for a planned operation in the Elizabeth River by MDSU-2 divers.
Maryland Sea Grant College	The Hazards of Diving in Polluted Waters	<u>Proceedings of an International Symposium - Publication No. UM-SG-TS-92-02</u>	College Park, MD	1988	The Proceedings includes six papers on Microbiological Hazards and one paper on Chemical Hazards that lists hazardous chemicals in two categories.
Maryland Sea Grant College	Microbial Hazards of Diving In Polluted waters	<u>Symposium Proceedings - Publication No. UM-SG-TS-82-01</u>	College Park, MD	1985	Copy not yet in-hand. Has been ordered and expected to be received soon.

TABLE B: BIBLIOGRAPHY - BIOLOGICAL HAZARDS REFERENCE DOCUMENTS

AUTHOR/SOURCE	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
7 Naval Medical Research Institute	Scuba Disease Revisited	<u>NMRI 84-109</u>	Bethesda, MD	1984	U.S.Navy and Australian Navy have documented evidence that trainees have experienced a respiratory disease caused by the aspiration of organisms called <i>Pseudomonas</i> .
3 Goodman, Andrew K., et al.	Pathogenic Enteric Protozoa Associated with Scuba Diving in Sewage Contaminated Coastal Waters	<u>Bureau of Preventable Diseases</u>	New York, NY	1982	
9 Coolbaugh, James C., et al.	Bacterial Contamination of Divers During Training Exercises in Coastal Waters	<u>Marine Technology Society Journal</u> , Vol. 15, No. 2	Washington, DC	1981	Field testing was conducted to show that <i>Aeromonas</i> , a potential pathogen for causing wound infection and enteric disease, is prevalent in many harbor waters along with <i>Vibrio Parahaemolyticus</i> , <i>Escherichia Coli</i> , <i>Klebsiella</i> , and <i>Salmonella</i> .
0 Daily, Otis P., and Joseph, Sam W.	Infectious Diseases Hazards of Polluted Waters	<u>Naval Medical Research Institute</u>	Bethesda, MD		This is a copy of the manuscript that was later included as a lesson plan in the Diving Medical Officers Student Guide for course No. A-6A-0010 at NSD&S. A list of potentially pathogenic microorganisms and fifteen reference documents are included.
1 P. Brayton, D. Roszak, S.A. Huq, L.M. Palmer, D.J. Grimes and R.R. Colwell	Public Health Significance of Human Pathogens in the Ocean	<u>I.E.E. Oceans 84 Proceedings</u>	College Park, MD	1984	This paper points out the risk of waterborne E. coli, Vibrio cholera, Shigella, and Salmonella

TABLE B: BIBLIOGRAPHY - BIOLOGICAL HAZARDS REFERENCE DOCUMENTS

AUTHOR/SOURCE	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
2 A. Huq, M.A.R. Chowdhury, A. Felenstein, R.R. Colwell, R. Rahman, and K.M.B. Hossain	Biological Monitoring Environmental Pollution	<u>Proceedings of the Fourth IUBS International Symposium on Biomonitoring of the State of the Environment</u>	Tokyo, Japan	1987	This paper discusses the results of a study of <i>Vibrio cholerae</i> in Bangladesh.
3 R.R. Colwell	Chapter 13, Toxic Effects of Pollutants on Microorganisms	<u>Principles of Ecotoxicology</u>	College Park, MD	1979	This paper discusses the effect of chemical pollutants on the microbial population.

TABLE C: BIBLIOGRAPHY - CHEMICAL HAZARDS REFERENCE DOCUMENTS

AUTHOR	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
Cashman, John R.	Hazardous Materials Emergencies	<u>Technomic Publishing Co., Inc.</u>	Lancaster, PA	1995	Contains lists of US response teams and historical data of responses from 1993 thru 1994
NATO	Third Preliminary Draft Study 1408 Diving in Polluted Waters Guidelines	<u>NATO</u>	unknown	1994	Draft of the 1994 Study 1408 is in general terms with no reference to specific chemicals or pathogens.
NATO	Comments on Third Preliminary Draft Study 1408 - Diving in Polluted Waters Guidelines	<u>NATO</u>	unknown	1994	Comments get into details about hazards analysis and lists of chemical hazards in two categories and biological hazards are included.
NAVSEA OOC	Comments on Draft STANAG 1399 UD Potential Hazards to Divers called upon to Handle Toxic Substances	<u>NAVSEA OOC comments on Draft STANAG 1399 UD</u>	Washington, DC	1991	This memo contains a page of significant references and a list of chemicals to avoid in diving and salvage. Several enclosures are attached, one of which is a list of "frequently Spilled Waterborne Chemicals and Their Physical Properties".
Fire, Frank L.	The Common Sense Approach to Hazardous Materials	<u>Fire Engineering</u>	New York, NY	1986	Info for initial response to a hazardous material incident. Chemicals are listed in classes with information on characteristic human response & toxicity.
DePol, Dennis R., et al.	Emergency Response to Hazardous Materials Incidents	<u>Technomic Publishing Co., Inc.</u>	Lancaster, PA	1984	

TABLE C: BIBLIOGRAPHY - CHEMICAL HAZARDS REFERENCE DOCUMENTS

AUTHOR	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
Wells, J. Morgan Jr., et al	Protection of Divers in Water Containing Hazardous Chemicals, Pathogenic Organisms and Radioactive Material	CR 60(CW) 2-1-83	Bethesda, MD	1982	Extensive symposium with 28 papers related to diving in hazardous environments.
American Water Works Association	Committee on Materials Spills Hazardous to a Water Supply for the Resources Division AWWA	<u>Hazardous Materials Spills Emergency Handbook</u>	Denver, CO	1975	Contains procedures and phone numbers for use by municipal water utilities in responding to spills of hazardous material.
unknown	Hazardous Waterborne Chemicals	unknown	unknown	no date	Table is an eight page list of chemical including data showing basic data whether chemical sinks or floats.
Agency for Toxic Substances and Disease Registry	Minimal Risk Levels (MRLs) for Hazardous Substances	<u>U.S. Government</u>	Atlanta, GA	1999	MRL can be accessed on internet at http://www.atsdr.cdc.gov/mrls.html
Environmental Protection Agency (EPA)	Integrated Risk Information System (IRIS)	<u>U.S. Government</u>	unknown	1999	IRIS can be accessed on the internet at http://www.epa.gov/iris/subst/0020.htm

TABLE D: BIBLIOGRAPHY - ADDITIONAL RELATED REFERENCE DOCUMENTS

AUTHOR	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
Best Publishing Co.	Polluted Water Diving, Section 14	<u>NOAA Diving Manual</u> , latest edition to be available February 2000		1999	Received latest draft version which includes 14.1.1 Biological Pollutants and 14.1.2 Toxic Chemicals. Hazards are listed and protective equipment is discussed in the 15 page draft.
Troshinsky, Lisa	Navy Focuses on Countering NBC Terrorism In Next QDR	<u>Navy News and Undersea Technology</u>	Washington, DC	1999	Moved to other list
Barsky, Steven M.	Diving in High-Risk Environments	<u>Diving in High-Risk Environments</u>	Fort Collins, CO	1993	Appears to be excellent reference on the overall aspect of diving in contaminated water. Not all commercial people, however, think that it is valuable.
Traver, Richard P.	Interim Protocol for Diving Operations in Contaminated Water	<u>EPA/600/2-85/130</u>	Cincinnati, OH	1985	Extensis document on many aspects of contaminated water diving. Considerable information on hazardous chemicals.
Traver, Richard P.	Manual of Practice for Marine Safety Officers and On-Scene Coordinators Involved in Chemically and/or Biologically Contaminated Underwater Operations (Interim Protocol)	<u>Hazardous Waste Engineering Research Laboratory</u>	Cincinnati, OH	1984	This document appears to be the predecessor to Document D-5
Traver, Richard P.	Summary of On-Scene-Coordinator Protocol for Contaminated Underwater Operations	<u>EPA-600/D-84-040</u>	Edison, NJ	1984	A summary review of Documents D-5 and D-6.
					Duplicate document to Reference Document No. D-6.

TABLE D: BIBLIOGRAPHY - ADDITIONAL RELATED REFERENCE DOCUMENTS

AUTHOR	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
Webb, Paul	Hazards of Working Where Heat Loss is Restricted	<u>Protection of Divers in Water Containing Hazardous Chemicals, Pathogenic Organisms and Radioactive Material</u>	Bethesda, MD	1982	
Phoel, William C.	NOAA's Requirements and Capabilities for Diving in Polluted Waters	<u>Marine Technology Society Journal, Vol. 15, No. 2</u>	Washington, DC	1981	Brief discussion of diving equipment that NOAA was considering for diving in contaminated water in 1982.
NOAA	Diving in Polluted Water	<u>NOAA Diving Manual</u>		1979	Two pages on Diving in Polluted Water with very little details.
VIKING Scandinavian Diving Equipment	Diving in Contaminated Water	<u>Diving in Contaminated Water</u>		No Date	The Viking brochure list data from permeation and diffusion tests on Viking dry equipment and materials.
Stolt-Comex Seaway	Guidelines for Contaminated Water Diving Operations	<u>Commercial In-House</u>	New Iberia, LA	No Date	Commercial in-house guidelines of a general nature.

TABLE E: BIBLIOGRAPHY - EQUIPMENT REFERENCE DOCUMENTS

AUTHOR	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
1 U.S. Navy	Chemical Warfare Protection Dry Suit	<u>Technical Evaluation Report for Chemical Warfare Protection Dry Suit (CWPDS)</u>	Panama City, FL	1991	TECHEVAL Report from CSS on the Chemical Warfare Protective Dry Suit (CWPDS), EX 2 Mod 0. Includes list of test chemicals.
2 Naval Sea Systems Command (NAVSEA 06X)	Integrated Logistic Support Plan for Dry Suit, Chemical Warfare Protective EX 2 Mod 0	<u>NAVSEA ILSP NO. S1317-03-627-A-F-I</u>	Washington, DC	1990	
3 Texas Research Institute	Physical Performance and Chemical Compatibility of Materials Selected for the U.S. Navy Chemical Warfare Protective Dive Suit	<u>88245-016F:DFW</u>	Austin, TX	1989	Includes list if chemicals used to conduct permeation testing.
4 Texas Research Institute	Compatability of MK-12 System Components with Selected Hazardous Materials	<u>88245-014F:DFW</u>	Austin, TX	1989	Includes list if chemicals used to conduct permeation testing.
5 Texas Research Institute	Failure Modes, Effects and Criticality Analysis of the MK-12 Diving Helmet for Contaminated Water Diving Application	<u>86175-3:DFW</u>	Austin, TX	1987	
6 Wierimaa, Russell K.	Evaluation of Navy Diving Suits for use in Water Contaminated with Chemical Warfare Agent	<u>DPG-FR-85-302</u>	Dugway, UT	1985	
7 Texas Research Institute	Permeation of Environmental Pollutants through Diver's Air Hoses	<u>83131:DFW</u>	Austin, TX	1984	Includes list if chemicals used to conduct permeation testing.
8 Texas Research Institute	Chemical Compatibility Testing of Diving Related	<u>82112F:DEG</u>	Austin, TX	1983	Includes list if chemicals used to conduct permeation testing.

TABLE E: BIBLIOGRAPHY - EQUIPMENT REFERENCE DOCUMENTS

AUTHOR	TITLE	PUBLICATION	CITY/STATE	DATE	COMMENTS
9 Traver, Richard P.	Introduction to Personnel Safety Equipment and Decontamination Operations	<u>Undersea Medical Society</u>	Bethesda, MD	1982	
0 Evaluation Research Corporation	Results of the Diver's Hazardous Material Protection Device Literature Survey on Sampling and Analysis	<u>N60921-81-D-A001-0578-A001</u>	Arlington, VA	1982	
1 Walker, R. T.	State-of-the-Art Survey of Hardware Delivery and Damage Inspection Methods for Coast Guard Hazardous Chemical Spill Response	<u>CGR/DC-5/80</u>	Groton, CT	1980	

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**TABLE A: LIST OF PETROLEUM PRODUCT TYPES
THAT US NAVY DIVERS COULD ENCOUNTER**

CATEGORY	FACTOR
Crude Petroleum	May Sink or Float
Residual Fuel Oil	Volatile and Highly Dispersible
Gasoline	Disperse & Evaporate Prior to Diving
Distillate Fuel Oil Solvents (similar to gasoline)	Some Solvents are Reactive with other Chemicals, but Most are Soluble in Water.
Diesel Oil and Jet Fuel	Most Common in Marine Environment

TABLE B: LIST OF SHORT TERM EXPOSURE CHEMICAL HAZARDS

ST OF CHEMICAL POLLUTANTS IN WHICH A DIVER SHOULD ENTER THE WATER ONLY UNDER EMERGENCY CONDITIONS. EXPOSURES SHOULD BE LIMITED TO SHORT DURATION IF THE CONCENTRATIONS EXCEED 10 PPM.	1997 NEDU STUDY Ref A-2 Sect 2-3	1995 OOC STUDY Ref A-3 Sect 1-2 Sect 1-3	1994 NATO Study 1408 Ref C-4	1991 OOC Comments to STANAG 1399 Ref A-5	1999 NOAA Manual Ref D-1	1984 EPA Ref D-7	Barsky Ref D-4 Page 13	Testing
LIGHTLY SOLUBLE/INSOLUBLE SINKING COMPOUNDS								
Carbon Tetrachloride	X	X	X	X	X	X	XX	
Cresol (Phenols)	X	X	X	X	X	X	X	X
Dichloropropane	X	X	X	X	X	X	X	
Hydrogen Sulfide	X	X	X	X		X		
Methylene Chloride	X	X	X	X	X	X	XX	
Napthalene	X	X	X	X		X		
Perchloroethylene	X	X	X	X	X	X	X	
Polychlorinated Biphenyl (PCB's)	X	X	X	X		X	XXX	
Trichloroethylene	X	X	X	X	X	X	XX	X
Turpentine			X			X	XXX	
ISOLUBLE/SLIGHTLY SOLUBLE FLOATING COMPOUNDS								
Benzene	X	X	X	X			XXX	X
Ethylbenzene	X	X	X	X	X		X	
Methyl Methacrylate	X	X	X	X			XX	
Styrene	X	X	X	X	X		X	
Toluene	X	X	X	X				X
Xylene	X	X	X	X	X		XX	
Chromium Salts (A-3, Sect 1-2 & D-7)		X	X	X		X	X	
Glycol Salicylate (A-3, Sect 1-2 & D-7)		X	X	X		X	X	
Methyl Ethyl Ketone (A-3, Sect 1-2 & D-7)		X	X	X		X	X	*

TABLE C: LIST OF CHEMICAL HAZARDS THAT SHOULD BE AVOIDED

LIST OF CHEMICAL POLLUTANTS WHICH A DIVER SHOULD NOT ENTER THE WATER FOR ANY REASON IF THE CONCENTRATION EXCEEDS 10 PPM.	1997 NEDU STUDY Ref A-2 Sect 2-3	1995 OOC STUDY Ref A-3 Sect 1-2 Sect 1-3	1991 OOC Comments to STANAG 1399 Ref A-5	1994 NATO Study 1408 Ref C-4	1999 NOAA Manual Ref D-1	1984 EPA Ref D-7	Barsky Ref D-4 Page 13	Testing
SOLUBLY SOLUBLE/INSOLUBLE SINKING COMPOUNDS								
Acetic Anhydride	X	X	X	X	X	X	X	
Acrylonitrile	X	X	X	X		X	XX	X
Bromine	X	X	X	X		X		
Chordane	X	X	X	X	X	X	XX	
Epichlorohydrin	X	X	X	X	X	X	XX	
Methyl Parathion	X	X	X	X	X	X	X	
SOLUBLE/SLIGHTLY SOLUBLE FLOATING COMPOUNDS								
(none listed)								
XX -	Chemicals where the industrial source or normal use is indicated in the list on page 13 of Ref D-4							
XXX -	Chemicals included in the text but part of the list on page 13 of Ref D-4							
								*

TABLE D: LIST OF HAZARDOUS CHEMICALS THAT HAVE BEEN TESTED BY VIKING

CHEMICALS TESTED by Viking (Per ASTM F1001)	CHEMICAL CLASS	OTHER EXAMPLES	CHEMICALS LISTED IN ASTM S 1001
Acetone	Ketones	Methyl Isobutyl Ketone and Methyl Ethyl Ketone	X
Acetonitrile	Nitrile, Imides, and Amides	Acetamide	X
Ammonia Solutions	Ammonia Dissolved in Water at Different Concentrations		
Carbon Disulfide	Sulfur Compound		X
Dichloromethane	Chlorinated Hydrocarbons	Carbon Tetrachloride	X
Diethylamine	Amines	Ethyleneimine and Trimethylamine	X
Dimethylformamide	Amides	Formamide and Diethylformamide	X
Ethyl Acetate	Esters	Butyl Acetate, Amyl Acetate, and Methyl Acetate	X
Hexane	Aliphatic	Heptane and Octane	X
Methanol	Alcohols	Ethanol, Propanol, and Butanol	X
Sodium Hydroxide	Alkalies	Potassium Hydroxide and Calcium Hydroxide	X
Sulfuric Acid	Acids, Inorganic	Nitric Acid, Hydrochloric Acid, and Phosphoric Acid	X
Tetrachloroethylene	Chlorinated Hydrocarbons	Trichloroethylene and Perchloroethylene	X
Tetrahydrofuran	Ethers	Diethyl Ether, "Ether"	X
Toluene	Aromatic Hydrocarbons	Benzene and Xylene	X
Other Chemicals			
Nitrobenzene			X

Note: The chemicals tested by Viking are reported to be the most aggressive chemical within the particular class.

TABLE E: US Navy and NOAA Lists of Priority Hazardous Substances in Waterways

NAVY PRIORITY LIST		NOAA PRIORITY LIST	
1	Acetyl Chloride	1	Acetone
2	Acrylonitrile	2	Ammonia
3	Aqueous Film Forming Foam	3	Ammonium Nitrate
4	Benzene	4	Anhydrous Ammonia
5	1, 2-Butylene Oxide	5	Benzene
6	Chlorine	6	Butylhydrides
7	Carbon Disulfide	7	Dichloromethane (Methylene Dichloride)
8	Biethylether	8	Ethanol (Ethyl Alcohol)
9	DS-2	9	Hydrochloric Acid (Muriatic Acid)
10	Ethylamine	10	Isopropanol (Isopropyl Alcohol)
11	Ethylene Glycol	11	Methanol (Methyl Alcohol, Wood Alcohol)
12	Ethyl Mathacrylate	12	Methyl Ethyl Ketone (MEK)
13	Formaldehyde	13	Methyl Parathion
14	Formic Acid	14	Perchloroethylene (Tetrachloroethylene)
15	Hoxane	15	Phenol
16	Hydrochloric Acid	16	Phosphoric Acid
17	Methyl Ethyl Ketone	17	Propane (Liquified Propane Gas)
18	Witrobenzene	18	Sodium Hydroxide (Caustic Soda)
19	Oil, Gasoline	19	Styrene (Vinyl Benzene)
20	Oil, JP-4	20	Sulfuric Acid (Oleum, Oil of Vitriol)
21	Organo-Tin Paint	21	Tetraethyl Lead
22	Polychlorinated Biphenyls (50% Solution with Trichlorobenzene)	22	Toluene (Methyl Benzene)
23	Sulfuric Acid	23	Xylenes
24	Super Tropical Bleach		
25	Trichloroethylene		

Note: Both Lists are referenced to Table 6.6 in Ref D-5 and Table 3 in Ref D-7

TABLE F: LIST OF CHEMICALS USED IN MATERIAL AND DIVING EQUIPMENT EXPOSURE TESTS FOR CSS

Ref E-3 (1989) page 12 Comparable to ASTM F 1001	Ref E-3 (1989) page 13	Ref E-8 (1983) page 2	Ref E-7 (1984) page 5
Acetone	Acetic Acid	Hydrochloric Acid	Hydrochloric Acid
Acetonitrile	Acetyl Chloride	Sulfuric Acid	Formaldehyde
Carbon Disulfide	Acrylonitrile	Formaldehyde	Phenol
Dichloromethane	Aqueous Film Forming Foam	Phenol	Formic Acid
Diethylamine	Benzene	Benzene	Ethylamine
Dimethylformamide	1,2 Bulyene Oxide	Carbon Disulfide	Methyl Ethyl Ketone
Ethyl Acetate	Diethyl Ether	Nitrobenzene	Acrylonitrile
Hexane	Dimethyl Sulfoxide	Trichloroethylene	Ethylene Glycol
Methanol	Ethyl Amine	Formic Acid	Hexane
Nitrobenzene	Ethylene Glycol	Ethyl Amine	Gasoline
Sodium Hydroxide Solution	Ethyl Methacrylate	Ethyl Methacrylate	JP-4 Jet Fuel
Sulfuric Acid	Phenol	Acetyl Chloride	Super Tropical Bleach
Tetrachloroethylene	Formaldehyde	1,2-Butylene Oxide	DS-2
Tetrahydrofuram	Formic Acid	Methyl Ethyl Ketone	Aqueous Film Forming Foam
Toluene	Freon	Acrylonitrile	
DS2 Decontaminant	Unleaded Gasoline	Ethylene Glycol	
Deionized Water (control)	Hydrochloric Acid	PCB's	
	JP-4 Jet Fuel	Hexane	
	Methyl Ethyl Ketone	Diethyl Ether	
	Oleum	Gasoline	
	Tributyl Tin Oxide	JP-4 Jet Fuel	
	PCB's in Transformer Oil	Super Tropical Bleach	
	Sulfuric Acid	DS-2	
	Super Tropical Bleach	AFFF	
	Trichloroethylene		
Toluene			
Hexane			
Ethyl Amine			
Tetrahydrofuran			
Sodium Hydroxide			
Acetonitrile			
Methanol			

**TABLE G: LIST OF REPRESENTATIVE INFORMATION SOURCES
for
COMPLETION OF HAZARDOUS SUBSTANCE DATA SHEETS**

- 1 "Condensed Chemical Dictionary" by Gessner G. Hawley
- 2 "The Merck Index"
- 3 "Dangerous Properties of Industrial Materials" by N. Irving Sax
- 4 "NIOSH/OSHA Pocket Guide to Chemical Hazards"
- 5 "Documentation of the Threshold Limit Values (TLV)"
- 6 CHRIS, Volume 2
- 7 OHMTADS
- 8 Marine Safety Information System (MSIS) - Toxic Substance Data Base (1)

(1) MSIS is a Computer Data Base Available to Strike Teams

TABLE H: SHORT LIST OF BIOLOGICAL HAZARDS THEIR DISEASE CAUSING POTENTIAL
 from Reference Documents A-2 and A-3

PATHOGEN EXPOSURE	POTENTIAL RESULTING DISEASE
<i>Acanthamoeba Species</i>	Amebic Meningoencephalitis
<i>Echo Virus</i>	Associated with Aseptic Meningitis
<i>Hepatitis Virus</i>	Infectious Hepatitis
<i>Legionella Species</i>	Pneumonia
<i>Mycobacterium Tuberculosis</i>	Tuberculosis
<i>Pseudomonas Aeruginosa</i>	Urinary Tract Infections, Cellulitis
<i>Salmonella Species</i>	Typhoid Fever, Acute Gastroenteritis
<i>Schistosoma Mansoni</i>	Nematode Infection
<i>Vibrio Species</i>	Cholera, Septecimia

TABLE I: LONG LIST OF BIOLOGICAL HAZARDS AND THEIR DISEASE CAUSING POTENTIAL
 from Reference Document No. B-2 (NRDC) on US Swimming Areas

PATHOGENIC AGENT	POTENTIAL RESULTING DISEASE
BACTERIA	
<i>E. Coli</i>	Gastroenteritis
<i>Salmonella Typhi</i>	Typhoid Fever
Other <i>Salmonella</i> Species	Various Enteric Fevers (often called Paratyphoid), Gastroenteritis, Septicemia (generalized infections in which organisms multiply in the bloodstream)
<i>Shigella Dysenteria</i> and other species	Bacterial Dysentery
<i>Vibrio Cholera</i>	Cholera
VIRUSES	
<i>Rotavirus</i>	Gastroenteritis
<i>Norwalkvirus</i>	Gastroenteritis
<i>Poliovirus</i>	Polioyelitis
<i>Coxsackievirus</i> (some strains)	Various, including severe respiratory diseases, fevers, rashes, paralysis, aseptic meningitis, myocarditis
<i>Echovirus</i>	Various, similar to <i>Coxsackievirus</i> (evidence is not definite except in experimental animals)
<i>Adenovirus</i>	Respiratory and Gastrointestinal Infections
<i>Hepatitis</i>	Infectious <i>Hepatitis</i> (liver malfunction), also may affect Kidney and Spleen
PROTOZOA	
<i>Cryptosporidium</i>	Gastroenteritis
<i>Giardia Lambia</i>	Diarrhea (intestinal parasite)
<i>Entamoeba Histolytica</i>	Amoebic Dysentery, Infections of Other Organisms
<i>Isopora Belli and Isopora Hominus</i>	Intestinal Parasites, Gastrointestinal Infection
<i>Balantidium Coli</i>	Dysentery, Intestinal Ulcers

**TABLE J: BIOLOGICAL HAZARDS AS SUGGESTED OR DISCUSSED
IN REFERENCE DOCUMENTS AS NOTED**

PATHOGENIC AGENTS	NRDC Ref B-2 1999	Joseph Ref B-10 Table I	Barsky Ref D-4 pgs 6 & 7	NOAA MANUAL Ref D-1
BACTERIA (single Cell Creatures with characteristics common to plants & animals)				
<i>Aeromonas Hydrophilla</i>		X	X	X
<i>Escherichia Coli (E. Coli)</i>	X	X		X
<i>Klebsiella Pneumoniae</i>		X	X	
<i>Salmonella Typhi</i>	X	X		
<i>Other Salmonella Species</i>	X	X		
<i>Shigella Dysenteria</i> and other species	X			
<i>Vibrio Cholera</i>	X	X		
<i>Vibrio Vunificus</i>			X	X
<i>Legionella Oneumophila</i>		X		
VIRUSES (organisms that take over the chemistry of a host cell in living creatures to reproduce)				
<i>Rotavirus</i>	X			
<i>Norwalkvirus</i>	X			
<i>Poliovirus</i>	X			
<i>Coxsackievirus</i> (some strains)	X			
<i>Echovirus</i>	X			
<i>Adenovirus</i>	X	X		
<i>Hepatitis</i>	X	X	X	X
<i>Enteroviruses</i>		X		
<i>Reovirus</i>		X		
<i>Pfiesteria piscicida</i>				X
PROTOZOA (single celled animals)				
<i>Cryptosporidium</i>	X			
<i>Giardia Lamblia</i>	X	X	X	X
<i>Entamoeba Histolytica</i>	X	X	X	
<i>Isopora Belli and Isopora Hominus</i>	X			
<i>Balantidium Coli</i>	X			
<i>Naegleria Fowleri</i>		X	X	
<i>Ancanthamoeba</i>		X	X	X
<i>Hartmanella</i>		X		

TABLE K: LIST IF SUGGESTED ADDITIONAL PATHOGENS FROM DR. SAM JOSEPH

ADDITIONAL PATHOGENS	COMMENTS
<i>Calici Viruses</i>	Have been proven to be pathogenic to humans
<i>Salmonella Species (specific strains of concern)</i>	
<i>Phage Type 4</i>	
<i>Phage Type 8</i>	
<i>Typhimurium (or DT 104)</i>	Deadly
<i>E. Coli (six specific strains of concern)</i>	
<i>entero toxigenic ecoli</i>	
<i>entero pathogenic ecoli</i>	
<i>entero hemorrhag ecoli</i>	Type that's killing children in uncooked hamburger
<i>entero invasive ecoli</i>	
<i>entero agregative ecoli</i>	
<i>entero adherent ecoli</i>	