

# **SUBMARINE EXPOSURE GUIDANCE LEVELS FOR SELECTED HYDROFLUORO- CARBONS**

**HFC-236fa, HFC-23, and HFC-404a**

Subcommittee on Exposure Guidance Levels for Selected  
Hydrofluorocarbons  
Committee on Toxicology  
Board on Environmental Studies and Toxicology  
Commission on Life Sciences  
National Research Council

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# Submarine Exposure Guidance Levels For Selected Hydrofluorocarbons Hfc 236fa

**National Research Council, Division on  
Earth and Life Studies, Board on  
Environmental Studies and  
Toxicology, Committee on Fluoride in  
Drinking Water**

## **Submarine Exposure Guidance Levels For Selected Hydrofluorocarbons Hfc 236fa:**

*Submarine Exposure Guidance Levels for Selected Hydrofluorocarbons* National Research Council, Commission on Life Sciences, Board on Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee on Exposure Guidance Levels for Selected Hydrofluorocarbons, 2000-06-01 As part of the effort to phase out the use of stratospheric ozone depleting substances such as chlorofluorocarbons CFCs the U S Navy is considering hydrofluorocarbons HFCs as replacements for the CFC refrigerants used aboard its submarines Before using the HFCs the Navy plans to set emergency exposure guidance levels EEGLs and continuous exposure guidance levels CEGs to protect submariners from health effects that could occur as a result of accidental releases or slow leaks In this report the Subcommittee on Exposure Guidance Levels for Selected Hydrofluorocarbons of the National Research Council's NRC's Committee on Toxicology independently reviews the scientific validity of the Navy's proposed 1 hr and 24 hr EEGLs and 90 day CEGs for two of the candidate refrigerants HFC 236fa and HFC 404a In addition the subcommittee reviews the EEGLs and CEG for HFC 23 one of the combustion products of HFC 236fa This NRC report is intended to aid the Navy in using HFCs safely

*Emergency and Continuous Exposure Guidance Levels for Selected Submarine Contaminants* National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Emergency and Continuous Exposure Guidance Levels for Selected Submarine Contaminants, 2008-06-09 U S Navy personnel who work on submarines are in an enclosed and isolated environment for days or weeks at a time when at sea To protect workers from potential adverse health effects due to those conditions the U S Navy has established exposure guidance levels for a number of contaminants In this latest report in a series the Navy asked the National Research Council NRC to review and develop when necessary exposure guidance levels for 11 contaminants The report recommends exposure levels for hydrogen that are lower than current Navy guidelines For all other contaminants except for two for which there are insufficient data recommended levels are similar to or slightly higher than those proposed by the Navy The report finds that overall there is very little exposure data available on the submarine environment and echoes recommendations from earlier NRC reports to expand exposure monitoring in submarines

Acute Exposure Guideline Levels for Selected Airborne Chemicals Committee on Acute Exposure Guideline Levels, Committee on Toxicology, Board on Environmental Studies and Toxicology, Division on Earth and Life Studies, National Research Council, 2013-10-10 Acute Exposure Guideline Levels for Selected Airborne Chemicals Volume 15 identifies reviews and interprets relevant toxicologic and other scientific data for ethyl mercaptan methyl mercaptan phenyl mercaptan tert octyl mercaptan lewisite methyl isothiocyanate and selected monoisocyanates in order to develop acute exposure guideline levels AEGLs for these high priority acutely toxic chemicals AEGLs represent threshold exposure limits exposure levels below which adverse health effects are not likely to occur for the general public and are applicable to emergency exposures ranging from 10 minutes min to 8 h Three level AEGL 1 AEGL 2 and AEGL 3 are developed for each of five exposure periods 10 min

30 min 1 h 4 h and 8 h and are distinguished by varying degrees of severity of toxic effects This report will inform planning response and prevention in the community the workplace transportation the military and the remediation of Superfund sites

**Acute Exposure Guideline Levels for Selected Airborne Chemicals** National Research Council, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Acute Exposure Guideline Levels, 2010-03-18 This book is the eighth volume in the series Acute Exposure Guideline Levels for Selected Airborne Chemicals and reviews AEGLs for acrolein carbon monoxide 1,2-dichloroethene ethylenimine fluorine hydrazine peracetic acid propylenimine and sulfur dioxide for scientific accuracy completeness and consistency with the NRC guideline reports

**Acute Exposure Guideline Levels for Selected Airborne Chemicals** National Academies of Sciences, Engineering, and Medicine, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Acute Exposure Guideline Levels, 2016-09-26 Extremely hazardous substances can be released accidentally as a result of chemical spills industrial explosions fires or accidents involving railroad cars and trucks transporting EHSs Workers and residents in communities surrounding industrial facilities where these substances are manufactured used or stored and in communities along the nation's railways and highways are potentially at risk of being exposed to airborne EHSs during accidental releases or intentional releases by terrorists Pursuant to the Superfund Amendments and Reauthorization Act of 1986 the U.S. Environmental Protection Agency EPA has identified approximately 400 EHSs on the basis of acute lethality data in rodents

**Acute Exposure Guideline Levels for Selected Airborne Chemicals** Volume 20 reviews and updates the technical support document on acute exposure guideline levels AEGLs for selected chloroformates This update focuses on establishing AEGL 3 values for n-propyl chloroformate and isopropyl chloroformate but will also consider whether any new data are available that would affect the proposed values for the other 10 chloroformates AEGLs represent threshold exposure limits exposure levels below which adverse health effects are not likely to occur for the general public and are applicable to emergency exposures ranging from 10 minutes min to 8 h Three levels AEGL 1 AEGL 2 and AEGL 3 are developed for each of five exposure periods 10 min 30 min 1 h 4 h and 8 h and are distinguished by varying degrees of severity of toxic effects This report will inform planning response and prevention in the community the workplace transportation the military and the remediation of Superfund sites

**Review of Submarine Escape Action Levels for Selected Chemicals** National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee on Submarine Escape Action Levels, 2002-02-04 On board fires can occur on submarines after events such as collision or explosion These fires expose crew members to toxic concentrations of combustion products such as ammonia carbon monoxide hydrogen chloride and hydrogen sulfide Exposure to these substances at high concentrations may cause toxic effects to the respiratory and central nervous system leading possibly to death To protect crew members on disabled submarines scientists at the U.S. Navy Health Research Center's Toxicology Detachment have proposed two

exposure levels called submarine escape action level SEAL 1 and SEAL 2 for each substance SEAL 1 is the maximum concentration of a gas in a disabled submarine below which healthy submariners can be exposed for up to 10 days without encountering irreversible health effects while SEAL 2 the maximum concentration of a gas in below which healthy submariners can be exposed for up to 24 hours without experiencing irreversible health effects SEAL 1 and SEAL 2 will not impair the functions of the respiratory system and central nervous system to the extent of impairing the ability of crew members in a disabled submarine to escape be rescued or perform specific tasks Hoping to better protect the safety of submariners the chief of the Bureau of Medicine and Surgery requested that the National Research Council NRC review the available toxicologic and epidemiologic data on eight gases that are likely to be produced in a disabled submarine and to evaluate independently the scientific validity of the Navy s proposed SEALs for those gases The NRC assigned the task to the Committee on Toxicology s COT s Subcommittee on Submarine Escape Action Levels The specific task of the subcommittee was to review the toxicologic epidemiologic and related data on ammonia carbon monoxide chlorine hydrogen chloride hydrogen cyanide hydrogen sulfide nitrogen dioxide and sulfur dioxide in order to validate the Navy s proposed SEALs The subcommittee also considered the implications of exposures at hyperbaric conditions and potential interactions between the eight gases Review of Submarine Escape Action Levels for Selected Chemicals presents the subcommittee s findings after evaluation human data from experimental occupational and epidemiologic studies data from accident reports and experimental animal data The evaluations focused primarily on high concentration inhalation exposure studies The subcommittee s recommended SEALs are based solely on scientific data relevant to health effects The report includes the recommendations for each gas as determined by the subcommittee as well as the Navy s original instructions for these substances

*Spacecraft Water Exposure Guidelines for Selected Contaminants* National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Spacecraft Exposure Guidelines, 2008-11-21 NASA maintains an active interest in the environmental conditions associated with living and working in spacecraft and identifying hazards that might adversely affect the health and well being of crew members Despite major engineering advances in controlling the spacecraft environment some water and air contamination is inevitable Several hundred chemical species are likely to be found in the closed environment of the spacecraft and as the frequency complexity and duration of human space flight increase identifying and understanding significant health hazards will become more complicated and more critical for the success of the missions To protect space crews from contaminants in potable and hygiene water NASA requested that the National Research Council NRC provide guidance on how to develop water exposure guidelines and subsequently review NASA s development of the exposure guidelines for specific chemicals This book presents spacecraft water exposure guidelines SWEGs for antimony benzene ethylene glycol methanol methyl ethyl ketone and propylene glycol

**Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants**

National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Spacecraft Exposure Guidelines, 2008-12-24 NASA is aware of the potential toxicologic hazards to crew that might be associated with prolonged spacecraft missions. Despite major engineering advances in controlling the atmosphere within spacecraft, some contamination of the air appears inevitable. NASA has measured numerous airborne contaminants during space missions. As the missions increase in duration and complexity, ensuring the health and well-being of astronauts traveling and working in this unique environment becomes increasingly difficult. As part of its efforts to promote safe conditions aboard spacecraft, NASA requested the National Research Council to develop guidelines for establishing spacecraft maximum allowable concentrations (SMACs) for contaminants and to review SMACs for various spacecraft contaminants to determine whether NASA's recommended exposure limits are consistent with the guidelines recommended by the committee. This book is the fifth volume in the series *Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants* and presents SMACs for acrolein, C3 to C8 aliphatic saturated aldehydes, C2 to C9 alkanes, ammonia, benzene, carbon dioxide, carbon monoxide, 1,2-dichloroethane, dimethylhydrazine, ethanol, formaldehyde, limonene, methanol, methylene dichloride, n-butanol, propylene glycol, toluene, trimethylsilanol, and xylenes. **Managing Health**

**Effects of Beryllium Exposure** National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Beryllium Alloy Exposures, 2008-09-29 Beryllium is a lightweight metal that is used for its exceptional strength and high heat-absorbing capability. Beryllium and its alloys can be found in many important technologies in the defense and aeronautics industries, such as nuclear devices, satellite systems, radar systems, and aircraft bushings and bearings. Pulmonary disease associated with exposure to beryllium has been recognized and studied since the early 1940s, and an occupational guideline for limiting exposure to beryllium has been in place since 1949. Over the last few decades, much has been learned about chronic beryllium disease and factors that contribute to its occurrence in exposed people. Despite reduced workplace exposure, chronic beryllium disease continues to occur. Those developments have led to debates about the adequacy of the long-standing occupational exposure limit for protecting worker health. This book, requested by the U.S. Air Force to help determine the steps necessary to protect its workforce from the effects of beryllium used in military aerospace applications, reviews the scientific literature on beryllium and outlines an exposure and disease management program for its protecting workers. Combined Exposures to Hydrogen Cyanide and Carbon Monoxide in Army Operations National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Combined Exposures to Hydrogen Cyanide and Carbon Monoxide in Army Operations, 2008-11-15 To determine whether the air quality inside armored vehicle cabins can meet exposure guidelines under deployment conditions, the Army assessed possible synergistic toxic effects from potentially harmful substances. This book, the final of two reports on the subject from the National Research Council,

addresses whether the approach discussed in the technical context section of the Army's proposed guidance is appropriate or whether an alternative assessment method should be developed. Combined Exposures to Hydrogen Cyanide and Carbon Monoxide in Army Operations provides several conclusions and recommendations including the use of alternative instrumentation for monitoring gas conducting experiments on human subjects and seeking advice from additional groups involved with personnel training and field deployment.

**Review of the Toxicologic and Radiologic Risks to Military Personnel from Exposures to Depleted Uranium During and After Combat** National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Toxicologic and Radiologic Effects from Exposure to Depleted Uranium During and After Combat, 2008-06-06. Since the 1980s the U.S. military has used depleted uranium in munitions and in protective armor on tanks. Depleted uranium is a toxic heavy metal and is weakly radioactive. Concerns have been raised about the adverse health effects from exposure to depleted uranium that is aerosolized during combat. Some think it may be responsible for illnesses in exposed veterans and civilians. These concerns led the Army to commission a book, *Depleted Uranium Aerosol Doses and Risks: Summary of U.S. Assessments*, referred to as the Capstone Report, that evaluates the health risks associated with depleted uranium exposure. This National Research Council book reviews the toxicologic, radiologic, epidemiologic, and toxicokinetic data on depleted uranium and assesses the Army's estimates of health risks to personnel exposed during and after combat. The book recommends that the Army re-evaluate the basis for some of its predictions about health outcomes at low levels of exposure, but overall the Capstone Report was judged to provide a reasonable characterization of the exposure and risks from depleted uranium.

*Fluoride in Drinking Water* National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Fluoride in Drinking Water, 2007-01-22. Most people associate fluoride with the practice of intentionally adding fluoride to public drinking water supplies for the prevention of tooth decay. However, fluoride can also enter public water systems from natural sources, including runoff from the weathering of fluoride-containing rocks and soils, and leaching from soil into groundwater. Fluoride pollution from various industrial emissions can also contaminate water supplies. In a few areas of the United States, fluoride concentrations in water are much higher than normal, mostly from natural sources. Fluoride is one of the drinking water contaminants regulated by the U.S. Environmental Protection Agency (EPA) because it can occur at these toxic levels. In 1986, the EPA established a maximum allowable concentration for fluoride in drinking water of 4 milligrams per liter, a guideline designed to prevent the public from being exposed to harmful levels of fluoride. *Fluoride in Drinking Water* reviews research on various health effects from exposure to fluoride, including studies conducted in the last 10 years.

**Review of the Department of Defense Research Program on Low-Level Exposures to Chemical Warfare Agents** National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Toxicologic Assessment of Low-Level Exposures to Chemical

Warfare Agents,2006-01-08 Research related to chemical warfare agents CWAs has historically focused on life threatening battlefield effects caused by high level exposures to the agents not effects associated with exposures to low concentrations of them In this report low level concentrations refers to exposures that may not have any immediate observed health effects but may produce delayed health effects months or years later Recently there has been increased concern about the potential health effects of exposures to CWAs at low concentrations This report reviews the Department of Defense s DOD Research Plan for obtaining toxicologic and other relevant data to assess risk to military personnel The CWAs of concern include the following nerve and vesicant agents tabun sarin soman cyclosarin VX and sulfur mustard The report discusses the health effects of exposure to low levels of these agents and provides guidance to DOD on appropriate risk assessment methods for assessing toxicologic risk to military personnel from low level exposures to CWAs The report concludes that DOD s Research Plan is well planned and many of the proposed research tasks are likely to provide valuable information to DOD in protecting military personnel

*Review of the Department of Defense Enhanced Particulate Matter Surveillance Program Report* National Research Council,Division on Earth and Life Studies,Board on Environmental Studies and Toxicology,Committee for Review of the DOD's Enhanced Particulate Matter Surveillance Program Report,2010-08-23 Soldiers deployed during the 1991 Persian Gulf War were exposed to high concentrations of particulate matter PM and other airborne pollutants Their exposures were largely the result of daily windblown dust dust storms and smoke from oil fires On returning from deployment many veterans complained of persistent respiratory symptoms With the renewed activity in the Middle East over the last few years deployed military personnel are again exposed to dust storms and daily windblown dust in addition to other types of PM such as diesel exhaust and particles from open pit burning On the basis of the high concentrations observed and concerns about the potential health effects DOD designed and implemented a study to characterize and quantify the PM in the ambient environment at 15 sites in the Middle East The endeavor is known as the DOD Enhanced Particulate Matter Surveillance Program EPMSP The U S Army asked the National Research Council to review the EPMSP report In response the present evaluation considers the potential acute and chronic health implications on the basis of information presented in the report It also considers epidemiologic and health surveillance data collected by the USACHPPM to assess potential health implications for deployed personnel and recommends methods for reducing or characterizing health risks

Standing Operating Procedures for Developing Acute Exposure Guideline Levels for Hazardous Chemicals National Research Council,Commission on Life Sciences,Board on Environmental Studies and Toxicology,Committee on Toxicology,Subcommittee on Acute Exposure Guideline Levels,2001-06-25 Standing Operating Procedures for Developing Acute Exposure Guideline Levels for Hazardous Chemicals contains a detailed and comprehensive methodology for developing acute exposure guideline levels AEGLs for toxic substances from inhalation exposures The book provides guidance on what documents and databases to use toxicity endpoints that need to be evaluated dosimetry corrections from



animal to human exposures selection of appropriate uncertainty factors to address the variability between animals and humans and within the human population selection of modifying factors to address data deficiencies time scaling and quantitative cancer risk assessment It also contains an example of a summary of a technical support document and an example of AEGL derivation This book will be useful to persons in the derivation of levels from other exposure routes both oral and dermal as well as risk assessors in the government academe and private industry Nineteenth Interim Report of the Committee on Acute Exposure Guideline Levels Committee on Acute Exposure Guideline Levels, Committee on Toxicology, National Research Council, 2011-01-27 The present report is the committee's 19th interim report It summarizes the committee's conclusions and recommendations for improving NAC's AEGL documents for the following chemicals and chemical classes acrylonitrile benzonitrile boron tribromide BZ 3 quinuclidinyl benzilate chloroarsenicals chloroformates bis chloromethylether chloromethylether chlorosilanes 26 selected compounds cyanogen ethyl mercaptan hexafluoroacetone lewisites mercury vapor nitric acid nitric oxide nitrogen dioxide nitrogen tetroxide oleum phenyl mercaptan propargyl alcohol selenium hexafluoride silane sulfur trioxide sulfuric acid tear gas tert octyl mercaptan tetramethoxy silane thionyl chloride trimethoxysilane trimethylbenzenes 1 2 4 1 2 5 and 1 3 5 TMB and vinyl chloride Review of the Army's Technical Guides on Assessing and Managing Chemical Hazards to Deployed Personnel National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee on the Toxicological Risks to Deployed Military Personnel, 2004-09-03 To guide mission planning military decision makers need information on the health risks of potential exposures to individual soldiers and their potential impact on mission operations To help with the assessment of chemical hazards the U S Army Center for Health Promotion and Preventive Medicine developed three technical guides for characterizing chemicals in terms of their risks to the mission and to the health of the force The report reviews these guides for their scientific validity and conformance with current risk assessment practices The report finds that the military exposure guidelines are appropriate with some modification for providing force health protection but that for assessing mission risk a new set of exposure guidelines is needed that predict concentrations at which health effects would degrade the performance of enough soldiers to hinder mission accomplishment **Iodotrifluoromethane** National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee on Iodotrifluoromethane, 2004-12-23 The U S military is considering using a compound called iodotrifluoromethane CF<sub>3</sub>I for fire suppression to replace previously used compounds halons that are being phased out because they deplete the ozone layer This report reviews available toxicological data on CF<sub>3</sub>I and evaluates the scientific basis of the U S Army's proposed exposure limit of 2 000 parts per million ppm The report recommends that CF<sub>3</sub>I be used for fire suppression in normally unoccupied spaces because of its potential to cause cardiac sensitization in test animals The report also recommends that further genotoxicity testing be conducted testing for changes in genetic material and that CF<sub>3</sub>I

be assessed for its potential to cause cancer Should the Army decide to use CF3I information should be collected and evaluated on how much of the chemical or any of its degradation products might be released and how often *Toxicologic Assessment of Jet-Propulsion Fuel 8* National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee on Jet-Propulsion Fuel 8, 2003-02-14 This report provides a critical review of toxicologic epidemiologic and other relevant data on jet propulsion fuel 8 a type of fuel in wide use by the U S Department of Defense DOD and an evaluation of the scientific basis of DOD s interim permissible exposure level of 350 mg m<sup>3</sup> Methods for Developing Spacecraft Water Exposure Guidelines National Research Council, Commission on Life Sciences, Board on Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee on Spacecraft Water Exposure Guidelines, 2000-10-18 The National Aeronautics and Space Administration NASA maintains an active interest in the environmental conditions associated with living and working in spacecraft and identifying hazards that might adversely affect the health and well being of crew members Despite major engineering advances in controlling the spacecraft environment some water and air contamination appears to be inevitable Several hundred chemical species are likely to be found in the closed environment of the spacecraft and as the frequency complexity and duration of human space flight increase identifying and understanding significant health hazards will become more complicated and more critical for the success of the missions NASA asked the National Research Council NRC Committee on Toxicology to develop guidelines similar to those developed by the NRC in 1992 for airborne substances for examining the likelihood of adverse effects from water contaminants on the health and performance of spacecraft crews In this report the Subcommittee on Spacecraft Water Exposure Guidelines SWEGs examines what is known about water contaminants in spacecraft the adequacy of current risk assessment methods and the toxicologic issues of greatest concern

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