

Spacecraft Maximum Allowable Concentrations for Airborne Contaminants

Human Health and Performance Directorate

Biomedical Research and Environmental Sciences Control Board
(BRESCB) Controlled

Revision C

DATE 6/13/2024

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National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas

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NASA APPROVAL SHEET

Spacecraft Maximum Allowable Concentrations for Airborne Contaminants

Human Health and Performance Directorate

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CHANGE HISTORY

Revision/P CN	Date	Authorization/ Originator/Phone	Description
Baseline	09/2017	CR# SA-00308 Valerie E. Ryder 281-483-4989	<p>NOTE: Previous versions of the document were baselined through the STIC Library and not "BASELINED" through a Board. Therefore, the versioning of the document will start at BASELINE for Configuration Management purposes.</p> <p>PREVIOUS INFORMATION FROM STIC BASELINE: <i>Errata</i></p> <p>Correct CAS numbers are below:</p> <ul style="list-style-type: none"> • 75-69-4 (Freon 11) • 111-30-8 (Glutaraldehyde) • 7647-01-0 (Hydrogen chloride) • 5989-27-5 (Limonene) <p>CURRENT UPDATES:</p> <p>Introductory page revised</p> <p>CAS number for Acrolein corrected to 107-02-8</p> <p>Compound names revised to match published NRC Vol. 5: 1-Butanol to n-Butanol; Unsymmetrical Dimethylhydrazine to Dimethylhydrazine</p> <p>C3-C8 Aliphatic Saturated Aldehydes 7-d, 30-d, 180-d, 1000-d values revised to match NRC Vol. 5 (5 ppm)</p> <p>Carbon dioxide (CO₂) SMACs have been deleted – CO₂ does not fit SMAC paradigm and is being managed based on expected performance and health decrements and the associated risks. NASA Standard 3001 is currently under revision to provide guidance on acceptable CO₂ levels.</p> <p>Linear Siloxanes group SMACs added</p> <p>Octamethyltrisiloxane SMACs deleted (replaced by Linear Siloxanes)</p>
Revision A	03/2020	CR# SA-02481 Valerie E. Ryder 281-483-4989	<p>Clarification of SMACs for small chain alkanes (C2-C4) versus longer chain alkanes (C5-C9)</p> <p>Revised SMACs for methanol</p> <p>New SMACs for manganese</p> <p>Updated MAPTIS access information</p>

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Revision B	11/30/2022	CR # SA-05524 Valerie E. Ryder 281-483-4989	Revised SMACs for propylene glycol New SMACs for n-hexane, hydrogen fluoride, and ethyl acetate
Revision C	6/13/2024	CR# SA-07170 Shannon D. Langford 281-483-2137	Update to acute benzene SMACs Added new SMACs for hydrogen sulfide Added notation that SMACs are set based on and applicable to ambient conditions (14.7 psi/25°C). Added clarification concerning the hierarchy of this document and specifying that this document is only a reprinting of data published and controlled in other sources.

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1.0 BACKGROUND

SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATIONS FOR AIRBORNE CONTAMINANTS

The enclosed table lists official Spacecraft Maximum Allowable Concentrations (SMACs) for selected airborne contaminants. They are based upon experiments conducted at standard pressure and oxygen environments and may or may not be applicable to altered atmospheres. The values listed in this summary document are applicable only to ambient conditions at standard temperature and oxygen (14.7 psi and 21% O₂ at 25°C). These are guideline values set by the National Aeronautics and Space Administration (NASA)/Johnson Space Center (JSC) Toxicology Group in cooperation with the National Research Council Committee on Toxicology (NRCCOT), through publication in the peer-reviewed scientific literature, or NASA Technical Memoranda. Based on documented guidance (NRC, 1992; NRC, 2016), NASA has established SMACs for 58 chemical compounds that are particularly relevant to atmospheric contamination of the International Space Station (ISS) and targets of Exploration. Some long-term limits (1000-days) have also been established to support manned deep-space exploration. Summaries of these SMACs are presented in tabular form as part of this publication. This document provides a tabular summary of values that have been previously established based on guidelines established by NASA and the National Research Council's Committee on Toxicology and vetted and published through the NRCCOT and/or non-NASA scientific literature and NASA Technical Memoranda. Complete documentation of the rationale used to establish the values summarized here is provided in the reference section below.

Short-term (1- and 24-hour) SMACs apply to off-nominal situations, such as accidental releases aboard a spacecraft. These limits permit risk of minor, reversible effects, such as mild mucosal irritation. In contrast, the long-term SMACs are set to fully protect healthy crewmembers from adverse effects resulting from continuous exposure to specific air pollutants for up to 1000 days. Because allergic reactions or chemical idiosyncrasy to certain airborne pollutants are very difficult to predict, crewmembers with allergies or unusual sensitivity to trace pollutants may not be afforded complete protection, even when long-term SMACs are not exceeded.

Conversely, exceedance of a SMAC does not mean that health impairment is certain (there are many other factors that influence ultimate health outcomes), although it does indicate that the crew may be subject to increased risks that must be closely evaluated. Environmental pollutant control to mitigate exposure will likely be triggered.

These values have been specifically established for human spaceflight and are not intended to apply to other situations, such as ground operations. The SMACs take into account a number of unique factors such as the effect of space-flight stress on human physiology, the uniform good health of the astronauts, and the absence of pregnant or very young individuals.

Crewmember exposures involve a mixture of contaminants, each at a specific concentration (C_n). These contaminants could interact to elicit symptoms of toxicity even though individual contaminants do not exceed their respective SMACs. We assume that the effects of a toxicologically similar group of compounds are additive. The air quality is therefore considered

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acceptable when the toxicity index (T_{grp}) for each toxicological group of compounds is less than 1, where T_{grp} is calculated as follows:

$$T_{grp} = C_1/SMAC_1 + C_2/SMAC_2 + \dots + C_n/SMAC_n$$

Toxicological groups are defined according to the target organ and the nature of the toxic response from exposure to the compounds in the group. As shown in the table of SMACs, the target organ and toxic effect can change depending on the duration of exposure.

In addition to official SMACs used for the evaluation of spacecraft air, the JSC Toxicology Group sets interim 7-day SMAC values that are posted to the “MAPTIS” database, which is used to evaluate materials and hardware off-gassing data. Following registration, these values can be accessed at: <https://maptis.nasa.gov/>. For help with registration or using MAPTIS, contact MAPTIS support at maptissupport@mail.nasa.gov.

2.0 PUBLISHED SMACS

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SMACs (Spacecraft Maximum Allowable Concentrations)

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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Acetaldehyde	10	(18)	6	(10)	2	(4)	2	(4)	2	(4)	Not Set	(Not Set)
<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>
CAS #: 75-07-0 REFERENCE: Wong, King Lit, (1994), Acetaldehyde, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants Vol 1: 19-38, National Academy Press, Washington, DC	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation Throat		

REMARKS: Carcinogen

Acetone	500	(1200)	200	(500)	22	(52)	22	(52)	22	(52)	Not Set	(Not Set)
<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>
CAS #: 67-64-1 REFERENCE: Garcia, Hector D. (2000), Acetone, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:17-41, National Academy Press, Washington, DC	CNS	Fatigue	CNS	Fatigue	CNS	Fatigue Headache	CNS	Fatigue Headache	CNS	Fatigue Headache		

REMARKS:

Acrolein	0.075	(0.17)	0.035	(0.08)	0.015	(0.03)	0.015	(0.03)	0.008	(0.02)	0.008	(0.02)
<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>	<u>Organ</u> <u>Effect</u>
CAS #: 107-02-8 REFERENCE: Langford, Shannon D. (2008), Acrolein, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:13-33, National Academy Press, Washington, DC	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation

REMARKS: Ceiling values

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d		
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
C3-C8 Aliphatic Saturated Aldehydes	45	(varies)	45	(varies)	5	(varies)	5	(varies)	5	(varies)	5	(varies)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
Mucosa	Irritation	Mucosa	Irritation	Nasal Cavity	Injury	Nasal Cavity	Injury	Nasal Cavity	Injury	Nasal Cavity	Injury	Nasal Cavity	Injury
CAS #: various REFERENCE: Langford, Shannon D. (2008), C3-C8 Aliphatic Saturated Aldehydes, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:34-47, National Academy Press, Washington, DC													

REMARKS: Includes propanal, butanal, pentanal, hexanal, heptanal, octanal
The mg/m3 value depends on the molecular weight of the particular aldehyde.

C5-C9 Alkanes	150	(varies)	80	(varies)	60	(varies)	20	(varies)	3	(varies)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Ototoxicity				
Eye	Irritation	Eye	Irritation				Ototoxicity						
Nose	Irritation	Nose	Irritation										
CAS #: various REFERENCE: McCoy, J. Torin. (2008), C2-C9 Alkanes, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:85-111, National Academy Press, Washington, DC													

REMARKS: Includes pentane, heptane, octane, and nonane and branched isomers
EXCLUDES n-hexane
The mg/m3 value depends on the molecular weight of the particular alkane.

Ammonia	30	(20)	20	(14)	3	(2)	3	(2)	3	(2)	3	(2)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation
CNS	Headache	CNS	Headache	CNS	Headache	CNS	Headache	CNS	Headache	CNS	Headache	CNS	Headache
CAS #: 7664-41-7 REFERENCE: Garcia, Hector D. (2008), Ammonia, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:48-61, National Academy Press, Washington, DC													

REMARKS:

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d		
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Benzene	40	(120)	6.7	(20)	0.5	(1.5)	0.1	(0.3)	0.07	(0.2)	0.013	(0.04)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 71-43-2 REFERENCE: Ryder VE, Williams ES. Revisions to acute/off-nominal limits for benzene in spacecraft air. <i>Aerosp Med Hum Perform.</i> 2023;94(7):544-545. Kahn-Mayberry, Noreen N. (2008). Benzene. <i>Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants</i> , Vol 5:62-72, National Academy Press, Washington, DC	CNS	Depression	CNS	Depression	Blood	Immunotoxicity	Blood	Immunotoxicity	Blood	Immunotoxicity	Blood	Hematological	
Remarks:													

REMARKS:

Bromotrifluoromethane	3500	(21000)	3500	(21000)	1800	(11000)	1800	(11000)	1800	(11000)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 75-63-8 REFERENCE: Lam, Chiu-Wing. (1996). Bromotrifluoromethane. <i>Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants</i> , Vol 3:21-52, National Academy Press, Washington, DC	Heart	Arrhythmia	Heart	Arrhythmia	CNS	Depression	CNS	Depression	CNS	Depression			
	CNS	Cognition	CNS	Cognition	Heart	Arrhythmia							

REMARKS:

n- Butanol	50	(150)	25	(80)	25	(80)	25	(80)	12	(40)	12	(40)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 71-36-3 REFERENCE: James, John T. (2008). n-Butanol. <i>Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants</i> , Vol 5:73-84, National Academy Press, Washington, DC	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	
	CNS	Depression				Systemic Injury		Systemic Injury		Systemic injury		Systemic injury	

REMARKS: The odor threshold and noxious odor concentrations are uncertain. These concentrations may not preclude odor detection by the crew.



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Chemical

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	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
tert- Butanol	50	(150)	50	(150)	50	(150)	50	(150)	40	(120)	Not Set	(Not Set)
CAS #: 75-65-0 REFERENCE: James, John T. (1996), tert-Butanol, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 3:78-104, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS	Depression	CNS	Depression	CNS	Depression	Kidney CNS	Nephrotoxicity Depression	Kidney CNS U. Blad	Nephrotoxicity Depression Injury		

REMARKS:

Carbon monoxide	425	(485)	100	(114)	55	(63)	15	(17)	15	(17)	15	(17)
CAS #: 630-08-0 REFERENCE: James, John T. (2008), Carbon Monoxide, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:125-143, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression
	CV	Arrhythmia	CV	Arrhythmia	CV	Arrhythmia	CV	Arrhythmia	CV	Arrhythmia	CV	Arrhythmia

REMARKS: Carboxyhemoglobin target

Chloroform	2	(10)	2	(10)	2	(10)	1	(5)	1	(5)	Not Set	(Not Set)
CAS #: 67-66-3 REFERENCE: Garcia, Hector D. (2000), Chloroform, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:284-306, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression		
	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Liver Kidney	Hepatotoxicity Nephrotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity		

REMARKS:

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



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Chemical

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	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Decamethylcyclopentasiloxane	Not Set	(Not Set)	Not Set	(Not Set)	7	(100)	5	(75)	1	(15)	Not Set	(Not Set)
CAS #: 541-02-6 REFERENCE: James, John T. (2000), Polydimethylcyclsiloxanes, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:151-174, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
					RspSys	Injury	RspSys	Injury	RspSys	Injury		
					Gonad	Toxicity	Gonad	Toxicity	Gonad	Toxicity		

REMARKS: Documented as a polydimethylcyclsiloxane

Diacetone alcohol	50	(250)	50	(250)	20	(100)	6	(30)	4	(20)	Not Set	(Not Set)
CAS #: 123-42-2 REFERENCE: James, John T. (1996), Diacetone alcohol, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 3:105-116, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Liver	Hepatomegaly		
	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression		

REMARKS:

Dichloroacetylene	0.6	(2.4)	0.04	(0.16)	0.03	(0.12)	0.025	(0.10)	0.015	(0.06)	Not Set	(Not Set)
CAS #: 7572-29-4 REFERENCE: James, John T. (1996), Dichloroacetylene, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 3:117-134, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression		
	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity		
	Liver	Hepatotoxicity	Liver	Hepatotoxicity								

REMARKS:

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



SMACs (Spacecraft Maximum Allowable Concentrations)



Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
1,2- Dichloroethane	0.4	(1.6)	0.4	(1.6)	0.4	(1.6)	0.4	(1.6)	0.4	(1.6)	0.4	(1.6)
CAS #: 107-06-2 REFERENCE: Ramanathan, Raghupathy (2008), 1,2-Dichloroethane, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:144-161, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	G.I.	GI Toxicity	G.I.	GI Toxicity	G.I.	GI Toxicity	G.I.	G.I. Toxicity	G.I.	G.I. Toxicity	G.I.	G.I. Toxicity
											Liver	Hepatotoxicity

REMARKS: Impairs host defenses against bacteria.

Chemical	3		0.12		0.03		0.017		0.003		Not Set	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Dimethylhydrazine	3	(7.5)	0.12	(0.3)	0.03	(0.075)	0.017	(0.0425)	0.003	(0.0075)	Not Set	(Not Set)
CAS #: 57-14-7 REFERENCE: Khan-Mayberry, Noreen N. (2008), Dimethylhydrazine, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:162-189, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS		CNS		Blood	Anemia	Blood	Anemia	Liver	Anemia		
									Liver	Hepatotoxicity		

REMARKS:

Chemical	5000		5000		1000		1000		1000		1000	
	ppm	(10000)	ppm	(10000)	ppm	(2000)	ppm	(2000)	ppm	(2000)	ppm	(2000)
Ethanol	5000	(10000)	5000	(10000)	1000	(2000)	1000	(2000)	1000	(2000)	1000	(2000)
CAS #: 64-17-5 REFERENCE: McCoy, J. Torin (2008), Ethanol, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:190-205, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation
	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation
	Skin	Flushing	Skin	Flushing	Skin	Flushing	Skin	Flushing	Skin	Flushing	Skin	Flushing
	CNS	Depression	CNS	Depression	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity

REMARKS:



SMACs (Spacecraft Maximum Allowable Concentrations)

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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d		
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
2- Ethoxyethanol	10	(40)	10	(40)	0.8	(3)	0.5	(2)	0.07	(0.3)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
Blood	Hematotoxicity	Blood	Hematotoxicity	Blood	Hematotoxicity	Blood	Hematotoxicity	Blood	Hematotoxicity	Blood	Hematotoxicity		
Mucosa	Irritation	Mucosa	Irritation	Testes	Toxicity	Testes	Toxicity	Testes	Toxicity	Testes	Toxicity		
CAS #: 110-80-5 REFERENCE: Wong, King Lit (1996), 2-Ethoxyethanol, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 2:189-212, National Academy Press, Washington, DC													

REMARKS:

Ethyl acetate	400	(1440)	400	(1440)	117	(421)	117	(421)	117	(421)	39	(140)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
Mucosa	Irritation	Mucosa	Irritation	Body Weight	Reduction	Body	Reduction	Body	Reduction	Body	Reduction	Body	Reduction
						Weight		Weight		Weight		Weight	
CAS #: 141-78-6 REFERENCE: Williams, E.S. and Ryder, V.E. Spacecraft maximum allowable concentrations for ethyl acetate. Aerosp Med Hum Perform. 2023; 94(1):1-9.													

REMARKS:

Ethylbenzene	180	(780)	60	(260)	30	(130)	30	(130)	12	(50)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Testes	Necrosis		
CNS	Depression	CNS	Depression	Testes	Necrosis	Testes	Necrosis	Testes	Necrosis				
CAS #: 100-41-4 REFERENCE: Garcia, Hector D. (1996), Ethylbenzene, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 3:208-231, National Academy Press, Washington, DC													

REMARKS:

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



SMACs (Spacecraft Maximum Allowable Concentrations)

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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Ethylene glycol	25	(64)	25	(64)	5	(13)	5	(13)	5	(13)	Not Set	(Not Set)
CAS #: 107-21-1 REFERENCE: Wong, King Lit (1996), Ethylene glycol, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 3:232-270, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation		
			CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression		
					Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity		

REMARKS:

Formaldehyde	0.8	(1.0)	0.5	(0.6)	0.1	(0.12)	0.1	(0.12)	0.1	(0.12)	0.1	(0.12)
CAS #: 50-00-0 REFERENCE: McCoy, J. Torin (2008), Formaldehyde, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:216-249, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation
											Nose	Cancer

REMARKS: Ceiling values, Carcinogen

Freon 11	140	(790)	140	(790)	140	(790)	140	(790)	140	(790)	Not Set	(Not Set)
CAS #: 75-69-4 REFERENCE: Garcia, Hector D. (2000), Trichlorofluoromethane (Freon 11), Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:211-226, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia		

REMARKS:

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



SMACs (Spacecraft Maximum Allowable Concentrations)

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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d		
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Freon 113	50	(400)	50	(400)	50	(400)	50	(400)	50	(400)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 76-13-1 REFERENCE: Garcia, Hector D. and James, John T. (1994), Freon 113, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 1:121-138, National Academy Press, Washington, DC	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia			

REMARKS:

Freon 12	540	(2600)	95	(470)	95	(470)	95	(470)	95	(470)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 75-71-8 REFERENCE: Garcia, Hector D. (2000), Dichlorodifluoromethane (Freon 12), Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:227-239, National Academy Press, Washington, DC	Heart	Tachycardia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia			

REMARKS:

Freon 21	50	(210)	50	(210)	15	(63)	12	(50)	2	(8)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 75-43-4 REFERENCE: Garcia, Hector D. (2000), Dichlorofluoromethane (Freon 21), Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:175-189, National Academy Press, Washington, DC	Heart	Tachycardia	Heart	Tachycardia	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity			

REMARKS:

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



SMACs (Spacecraft Maximum Allowable Concentrations)

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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Freon 22	1000	(3500)	1000	(3500)	1000	(3500)	1000	(3500)	1000	(3500)	Not Set	(Not Set)
	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
CAS #: 75-45-6 REFERENCE: Garcia, Hector D. (2000), Chlorodifluoromethane (Freon 22), Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:190-210, National Academy Press, Washington, DC	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression		
	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia		

REMARKS:

Furan	4	(11)	0.4	(1)	0.025	(0.07)	0.025	(0.07)	0.025	(0.07)	Not Set	(Not Set)
	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
CAS #: 110-00-9 REFERENCE: Garcia, Hector D. and James, John T. (2000), Furan, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:307-329, National Academy Press, Washington, DC	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Cancer	Liver	Cancer	Liver	Cancer		

REMARKS: Carcinogen

Glutaraldehyde	0.12	(0.50)	0.04	(0.08)	0.006	(0.025)	0.003	(0.012)	0.0006	(0.002)	Not Set	(Not Set)
	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
CAS #: 111-30-8 REFERENCE: Garcia, Hector D. (1996), Glutaraldehyde, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 3:271-291, National Academy Press, Washington, DC	Mucosa	Irritation	Mucosa	Irritation	RspSys	Lesions	RspSys	Lesions	RspSys	Lesions		
	CNS	Headache	CNS	Headache								

REMARKS:

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



SMACs (Spacecraft Maximum Allowable Concentrations)

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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Hexamethylcyclotrisiloxane	Not Set		Not Set		10	(90)	5	(45)	1	(9)	Not Set	(Not Set)
CAS #: 541-05-9 REFERENCE: James, John T. (2000), Polydimethylcyclotrisiloxanes, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:151-174, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
					RspSys	Injury	RspSys	Injury	RspSys	Injury		
					CNS	Depression	CNS	Depression				

REMARKS: Documented as a polydimethylcyclotrisiloxane

n- Hexane	200	(703)	30	(106)	2.4	(8.4)	2.4	(8.4)	2.4	(8.4)	2.4	(8.4)
CAS #: 110-54-3 REFERENCE: Garcia, H.D. Acceptable Limits for n-Hexane in Spacecraft Atmospheres. Aerospace Medicine and Human Performance. 2021;92(12);956-961.	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Mucosa	Irritation	Mucosa	Irritation	CNS	Neurotoxicity	CNS	Neurotoxicity	CNS	Neurotoxicity	CNS	Neurotoxicity

REMARKS:

Hydrazine	4	(5)	0.3	(0.4)	0.04	(0.05)	0.02	(0.03)	0.004	(0.005)	Not Set	(Not Set)
CAS #: 302-01-2 REFERENCE: Garcia, Hector D. and James, John T. (1996), Hydrazine, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 2:213-233, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
		Death	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity		
							Liver	Hyperplasia	Liver	Hyperplasia		
							Nose	Cancer	Nose	Cancer		

REMARKS: Carcinogen

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



SMACs (Spacecraft Maximum Allowable Concentrations)



Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Hydrogen chloride	5	(8)	2	(3)	1	(1.5)	1	(1.5)	1	(1.5)	Not Set	(Not Set)
CAS #: 7647-01-0 REFERENCE: Lam, Chiu-Wing and Wong, King Lit (2000), Hydrogen Chloride, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:60-88, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation		
	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation		

REMARKS:

Hydrogen cyanide	8	(9)	4	(4.5)	1	(1.1)	1	(1.1)	1	(1.1)	Not Set	(Not Set)
CAS #: 74-90-8 REFERENCE: Lam, Chiu-Wing and Wong, King Lit (2000), Hydrogen Cyanide, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:330-365, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression		
	CNS	Headache	CNS	Headache	CNS	Headache	CNS	Headache	CNS	Headache		
	CNS	Nausea	CNS	Nausea	CNS	Nausea	CNS	Nausea	CNS	Nausea		
					Testes	Testicular toxicity	Testes	Testicular toxicity	Testes	Testicular toxicity		
							Thyroid	Thyroid effects	Thyroid	Thyroid effects		

REMARKS:

Hydrogen fluoride	3	(2.5)	3	(2.5)	0.3	(0.25)	0.3	(0.25)	0.3	(0.25)	0.3	(0.25)
CAS #: 7664-39-3 REFERENCE: Lam, C-W and Ryder, V.E. Spacecraft Maximum Allowable Concentrations for Hydrogen Fluoride. Aerospace Medicine and Human Performance. 2022; 93(10):1-3.	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	RspSys	Irritation	RspSys	Irritation	RspSys	Irritation	RspSys	Irritation	RspSys	Irritation	RspSys	Irritation

REMARKS:



SMACs (Spacecraft Maximum Allowable Concentrations)



Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d		
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Hydrogen sulfide	5	(7)	1.3	(1.8)	1.3	(1.8)	1.3	(1.8)	0.3	(0.5)	Not Set		
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 7683-06-4 REFERENCE: Wimberly, AA and Ryder VE. Exposure Limits for Hydrogen Sulfide in Spaceflight. NASA/TM-2024000101, NASA Johnson Space Center, 2024.	Nasal Cavity	Odor Irritant*	Nasal Cavity	Lesions	Nasal Cavity	Injury	Nasal Cavity	Injury	Nasal Cavity	Injury			

REMARKS: *The endpoint includes increased anxiety directly related to odor irritation.

Indole	1.0	(5)	0.3	(1.5)	0.05	(0.25)	0.05	(0.25)	0.05	(0.25)	Not Set (Not Set)		
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 120-72-9 REFERENCE: Lam, Chiu-Wing and James, John T. (1996), Indole, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 2:235-249, National Academy Press, Washington, DC	CNS	Nausea	CNS	Nausea	CNS	Nausea	CNS	Nausea	CNS	Nausea	Blood	Hematotoxicity	Death

REMARKS: Normal turnover of indole was used to establish a lower bound of 0.05 ppm.

Isoprene	50	(140)	25	(70)	2	(6)	2	(6)	1	(3)	Not Set (Not Set)			
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	
CAS #: 78-79-5 REFERENCE: James, John T. (2000), Isoprene, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:89-118, National Academy Press, Washington, DC	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Lung	Injury	Blood	Anemia	CNS	Neurotoxicity

REMARKS:



SMACs (Spacecraft Maximum Allowable Concentrations)



Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Limonene	80	(450)	80	(450)	20	(115)	20	(115)	20	(115)	20	(115)
CAS #: 5989-27-5 REFERENCE: Lam, Chiu-Wing (2008), Limonene, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:250-274, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation	Eye	Irritation
	Lung	Irritation	Lung	Irritation	Lung	Irritation	Lung	Irritation	Lung	Irritation	Lung	Irritation

REMARKS:

Chemical	600		100		100		50		50		50	
	(varies)		(varies)		(varies)		(varies)		(varies)		(varies)	
Linear Siloxanes												
CAS #: various REFERENCE: Meyers, Valerie E., Hector D. Garcia, Tami S. McMullin, Joseph M. Tobin, and John T. James. Safe human exposure limits for airborne linear siloxanes during spaceflight. <i>Inhal Toxicol</i> , 2013; 25(13): 735-746.	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Lung	Hemorrhage	Lung	Hemorrhage	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity
	CNS	Neurotoxicity	CNS	Neurotoxicity								

REMARKS: Includes hexamethyldisiloxane, octamethyltrisiloxane, decamethyltetrasiloxane, dodecamethylpentasiloxane.
The mg/m³ value depends on the molecular weight of the particular linear siloxane.

Chemical	3		2		0.3		0.3		0.008		0.008	
Manganese												
CAS #: 7439-96-5 REFERENCE: Romoser AA, Ryder VE, McCoy JT. Spacecraft Maximum Allowable Concentrations for Manganese Compounds in Mars Dust. <i>Aerosp Med Hum Perform</i> . 2019; 90(8):709-719.	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Lung	Lesions	Lung	Lesions	Lung	Irritation	Lung	Irritation	CNS	Neurotoxicity	CNS	Neurotoxicity
					Nasal Cavity	Irritation	Nasal Cavity	Irritation				

REMARKS:



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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Mercury	0.01	(0.08)	0.002	(0.02)	0.001	(0.01)	0.001	(0.01)	0.001	(0.01)	Not Set	(Not Set)
CAS #: 7439-97-6 REFERENCE: James, John T. and Kaplan, Harold L. (1996), Mercury, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 2:251-276, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Lung	Irritation	Lung	Irritation	CNS Kidney	Neurotoxicity Nephrotoxicity	CNS Kidney	Neurotoxicity Nephrotoxicity	CNS Kidney	Neurotoxicity Nephrotoxicity		

REMARKS:

Methanol	70	(92)	70	(92)	20	(26)	20	(26)	20	(26)	10	(13)
CAS #: 67-56-1 REFERENCE: Scully RR, Garcia H, McCoy JT, Ryder VE. Revisions to Limits for Methanol in the Air of Spacecraft. Aerosp Med Hum Perform. 2019; 90(9):807-812.	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS	Neurotoxicity	CNS	Neurotoxicity	CNS	Neurotoxicity	CNS	Neurotoxicity	CNS	Neurotoxicity	CNS	Neurotoxicity

REMARKS:

Methyl ethyl ketone	50	(150)	50	(150)	10	(30)	10	(30)	10	(30)	Not Set	(Not Set)
CAS #: 78-93-3 REFERENCE: Wong, King Lit (1996), Methyl Ethyl Ketone, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 2:307-329, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation		

REMARKS: Ceiling values

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d		
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Methyl hydrazine	0.002	(0.004)	0.002	(0.004)	0.002	(0.004)	0.002	(0.004)	0.002	(0.004)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
Nose	Lesions	Nose	Lesions	Nose	Lesions	Nose	Lesions	Nose	Lesions	Nose	Lesions		
CAS #: 60-34-4 REFERENCE: Garcia, Hector D. (2000), Methylhydrazine, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:119-136, National Academy Press, Washington, DC													

REMARKS: Carcinogen

4- Methyl-2-pentanone	35	(140)	35	(140)	35	(140)	35	(140)	35	(140)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression		
Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation		
CAS #: 108-10-1 REFERENCE: Wong, King Lit (2000), 4-Methyl-2-Pentanone, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:240-263, National Academy Press, Washington, DC													

REMARKS:

Methylene chloride	100	(350)	35	(120)	14	(49)	7	(24)	3	(10)	1	(3.5)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CNS	Depression	CNS	Depression	CNS	Depression	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Kidney	Nephrotoxicity
CAS #: 75-09-2 REFERENCE: Ramanathan, Raghupathy (2008), Methylene Chloride, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:289-313, National Academy Press, Washington, DC													

REMARKS: CO formation, carcinogen

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
 LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d		
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Nitromethane	25	(65)	15	(40)	7	(18)	7	(18)	5	(13)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 75-52-5 REFERENCE: Wong, King Lit (1996), Nitromethane, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 2:331-350, National Academy Press, Washington, DC	Blood	Anemia	Blood	Anemia	Blood	Anemia	Blood	Anemia	Blood	Anemia			

REMARKS:

Octamethylcyclotetrasiloxane	Not Set	Not Set	23	(280)	5	(60)	1	(12)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 556-67-2 REFERENCE: James, John T. (2000), Polydimethylcyclosiloxanes, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:151-174, National Academy Press, Washington, DC			Gonads	Toxicity	Gonads	Toxicity	Gonad	Toxicity			
			CNS	Depression							

REMARKS: Documented as a polydimethylcyclosiloxane

Perfluoropropane and Other Aliphatic Perfluoroalkanes	11,000	(varies)	11,000	(varies)	11,000	(varies)	11,000	(varies)	11,000	(varies)	Not Set	(varies)
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	
CAS #: 76-19-7 REFERENCE: Lam, Chiu-Wing (2000), Perfluoropropane and Other Aliphatic Perfluoroalkanes, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 4:137-150, National Academy Press, Washington, DC	CNS	Symptoms	CNS	Symptoms	CNS	Symptoms	CNS	Symptoms	CNS	Symptoms		

REMARKS: EXCLUDES perfluorocycloalkanes.
The mg/m3 value depends on the molecular weight of the particular perfluoroalkane.

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
2- Propanol	400	(1000)	100	(240)	60	(150)	60	(150)	60	(150)	Not Set	(Not Set)
CAS #: 67-63-0 REFERENCE: James, John T. and Kaplan, Harold L. (1996), 2-Propanol, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 2:351-371, National Academy Press, Washington, DC	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression		
	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation		
			Liver	Hepatotoxicity	Liver	Hepatotoxicity	PNS	DCV	PNS	DCV		
							Liver	Hepatotoxicity	Liver	Hepatotoxicity		

REMARKS:

Propylene glycol	64	(200)	32	(100)	32	(100)	32	(100)	32	(100)	32	(100)
CAS #: 57-55-6 REFERENCE: Ryder, V.E. and Williams, E.S. Revisions to Limits for Propylene Glycol in Spacecraft Air. Aerospace Medicine and Human Performance. 2022; 93(5):467-469.	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Mucosa	Irritation	Mucosa	Irritation	Blood	Elevated hemoglobin	Blood	Elevated hemoglobin	Blood	Elevated hemoglobin	Blood	Elevated hemoglobin
	Eye	Irritation	Eye	Irritation		Body Weight Gain		Body Weight Gain		Body Weight Gain		Body Weight Gain
	CNS	Fatigue	CNS	Fatigue								
	CNS	Headache	CNS	Headache								

REMARKS: updated from 2008, NRC Vol 5

Toluene	40	(151)	40	(151)	40	(151)	40	(151)	4	(15)	4	(15)
CAS #: 108-88-3 REFERENCE: Tapia CM, Langford SD, Ryder VE. Revisions to Limits for Toluene in Spacecraft Air. Aerosp Med Hum Perform. 2024. Garcia, Hector D. (2008), Toluene, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:329-347, National Academy Press. Washinaton. DC.	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	Gonads	Hormone	Gonads	Hormone
					Ear	Ototoxicity	Ear	Ototoxicity				
					Eye	Ocular toxicity	Eye	Ocular toxicity				

REMARKS:

Abbreviations: CNS: Central Nervous System CV: Cardiovascular DCD: Decreased Color Discrimination DCV: Decreased Conduction Velocity GI: Gastrointestinal tract HA: Headache
LEL: Lower Explosive Limit PNS: Peripheral Nervous System ppm: parts per million RespSys: Respiratory System U.Blad: Urinary bladder



SMACs (Spacecraft Maximum Allowable Concentrations)



Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d		
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Trichloroethylene	50	(270)	11	(60)	9	(50)	4	(20)	2	(10)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 79-01-6 REFERENCE: James, John T., Kaplan, Harold L., and Coleman, Martin E. (1996), Trichloroethylene, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 3:292-320, National Academy Press, Washington, DC	CNS Heart	Depression Arrhythmia	CNS	Depression	Kidney Liver	Nephrotoxicity Hepatotoxicity	Kidney Liver	Nephrotoxicity Hepatotoxicity	Multi. Kidney Liver	Cancer Nephrotoxicity Hepatotoxicity			

REMARKS: See dichloroacetylene if alkali scrubber is present. Possible carcinogen.

Trimethylsilanol	15	(55)	2	(7)	1	(4)	1	(4)	1	(4)	1	(4)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 1066-40-6 REFERENCE: James, John T. (2008), Trimethylsilanol, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:348-355, National Academy Press, Washington, DC	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	

REMARKS:

Vinyl chloride	130	(330)	30	(77)	1	(2.6)	1	(2.6)	1	(2.6)	Not Set	(Not Set)	
<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>	<i>Organ</i>	<i>Effect</i>
CAS #: 75-01-4 REFERENCE: Wong, King Lit (1994), Vinyl Chloride, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 1:185-219, National Academy Press, Washington, DC	Liver CNS CNS	Hepatotoxicity Headache Depression	Liver CNS	Hepatotoxicity Depression	Testes	Necrosis	Testes	Necrosis	Testes	Necrosis			

REMARKS:



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Chemical

Chemical	1 hr		24 hr		7 d		30 d		180 d		1000 d	
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)
Xylenes	50	(215)	17	(73)	17	(73)	17	(73)	8.5	(37)	1.5	(6.5)
	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>	<u>Organ</u>	<u>Effect</u>
	Mucosa	Irritation	Mucosa	Irritation	CNS	Neurotoxicity	CNS	Neurotoxicity	Ear	Ototoxicity	Ear	Ototoxicity
	CNS	Headache	CNS	Headache								
	Eye	Irritation	Eye	Irritation								

CAS #: 1330-20-7 (mixed)

REFERENCE: Ramanathan, Raghupathy (2008), Xylenes, Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants, Vol 5:366-386, National Academy Press, Washington, DC

REMARKS: Applies to each individual xylene isomer and mixtures of xylene isomers.

Abbreviations: CNS: Central Nervous System
LEL: Lower Explosive Limit

CV: Cardiovascular
PNS: Peripheral Nervous System

DCD: Decreased Color Discrimination
ppm: parts per million

DCV: Decreased Conduction Velocity
RespSys: Respiratory System

GI: Gastrointestinal tract
U.Blad: Urinary bladder

HA: Headache

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APPENDIX A ACRONYMS AND ABBREVIATIONS

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CAS	Chemical Abstract Service
C _n	Specific Concentration
CNS	Central Nervous System
CV	Cardiovascular
DCD	Decreased Color Discrimination
DCV	Decreased Conduction Velocity
GI	Gastrointestinal
HA	Headache
ISS	International Space Station
JSC	Johnson Space Center
NASA	National Aeronautics and Space Administration
NRC	National Research Council
NRCCOT	National Research Council Committee on Toxicology
PNS	Peripheral Nervous System
ppm	Parts Per Million
RespSys	Respiratory System
SMACs	Spacecraft Maximum Allowable Concentrations
T _{grp}	Toxicity Index
U.Blad	Urinary Bladder

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