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SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATIONS FOR AIRBORNE CONTAMINANTS

Toxicology Group
Medical Operations Branch
Medical Sciences Division
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SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATIONS FOR AIRBORNE CONTAMINANTS

The enclosed table lists official spacecraft maximum allowable concentrations (SMACs), which are guideline values set by the NASA/JSC Toxicology Group in cooperation with the National Research Council Committee on Toxicology (NRCCOT). These values should not be used for situations other than human space flight without careful consideration of the criteria used to set each value. 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. Documentation of the values is given in a 4 volume series of books entitled "Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants" published by the National Academy Press, Washington, D.C. These books can be viewed electronically at http://www.nap.edu/info/browse.htm by selecting "Space Science."

Short-term (1 and 24 hour) SMACs are set to manage accidental releases aboard a spacecraft and 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 180 days. Crewmembers with allergies or unusual sensitivity to trace pollutants may not be afforded complete protection, even when long-term SMACs are not exceeded.

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

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

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.

Previous editions of this document contained many SMACs "developed" before 1990 when the cooperative effort between NASA and the NRCCOT began. These values had been considered official; however, an effort to determine how these values were set revealed that there was not an adequate document trail to continue to consider these old values as official SMACs. These old values will continue to be posted in the "MAPTIS" database, which is used to evaluate materials and hardware offgassing data, but they have been deleted from the present edition of this document. Many unofficial SMACs for groups of compounds with structural similarities (e.g. aliphatic ethers, aliphatic ketones) have been set with limited documentation and no review by the NRCCOT. These unofficial group SMACs can be obtained from the JSC Toxicology Group.

Spacecraft Maximum Allowable Concentrations

Chemical Name	Potential Exposure Duration: 1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
Acetaldehyde	12	(22)	6	(10)	2	(4)	2	(4)	2	(4)	Carcinogen
Synonyms:	Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		
NRC Vol. #: 1 CAS #: 75-07-0											
Year SMAC was Set/ Reviewed: 1992											
Acetone	500	(1200)	200	(500)	22	(52)	22	(52)	22	(52)	
Synonyms: 2-Propanone	Organ: CNS; Effect: Depression		Organ: CNS; Effect: Depression		Organ: CNS; Effect: Depression		Organ: CNS; Effect: Depression		Organ: CNS; Effect: Depression		
NRC Vol. #: 4 CAS #: 67-64-1											
Year SMAC was Set/ Reviewed: 1994											
Acrolein	0.075	(0.2)	0.035	(0.08)	0.015	(0.03)	0.015	(0.03)	0.015	(0.03)	Ceiling values
Synonyms: Propenal	Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		
NRC Vol. #: 2 CAS #: 107-02-08											
Year SMAC was Set/ Reviewed: 1992											
C3-C8 Aliphatic Saturated Aldehydes	50	(125-250)	50	(125-250)	6	(15-30)	1.5	(4-8)	1.5	(4-8)	The range of values listed in mg/m3 is due to differences in the molecular weights of the various aldehydes.
Synonyms:	Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa, Liver; Effect: Irritation, Hepatotoxicity		Organ: Liver; Effect: Hepatotoxicity		Organ: Liver; Effect: Hepatotoxicity		
NRC Vol. #: 4 CAS #: various											
Year SMAC was Set/ Reviewed: 1998											
Ammonia	30	(20)	20	(14)	10	(7)	10	(7)	10	(7)	Ceiling values
Synonyms:	Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		
NRC Vol. #: 1 CAS #: 7664-41-7											
Year SMAC was Set/ Reviewed: 1991											

Spacecraft Maximum Allowable Concentrations

Chemical Name	Potential Exposure Duration: 1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
Benzene Synonyms: NRC Vol. #: 2 CAS #: 71-43-2 Year SMAC was Set/ Reviewed: 1993	10	(35)	3	(10)	0.5	(1.5)	0.1	(0.3)	0.07	(0.2)	Leukemogen
	Organ: Blood	Effect: Immunotoxicity	Organ: Blood	Effect: Immunotoxicity	Organ: Blood	Effect: Immunotoxicity	Organ: Blood	Effect: Immunotoxicity	Organ: Blood	Effect: Immunotoxicity	
									Organ: Blood	Effect: Leukemia	
Bromotrifluoromethane Synonyms: Halon 1301 NRC Vol. #: 3 CAS #: 75-63-8 Year SMAC was Set/ Reviewed: 1993	3500	(21000)	3500	(21000)	1800	(11000)	1800	(11000)	1800	(11000)	
	Organ: Heart	Effect: Arrhythmia	Organ: Heart	Effect: Arrhythmia	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	
1- Butanol Synonyms: NRC Vol. #: 3 CAS #: 71-36-3 Year SMAC was Set/ Reviewed: 1994	50	(150)	25	(80)	25	(80)	25	(80)	12	(40)	
	Organ: Eye	Effect: Irritation	Organ: Eye	Effect: Irritation	Organ: Eye	Effect: Irritation	Organ: Eye	Effect: Irritation		Effect: Systemic Injury	
	Organ: CNS	Effect: Depression				Effect: Systemic Injury		Effect: Systemic Injury			
tert- Butanol Synonyms: 2-Methyl-2-propanol NRC Vol. #: 3 CAS #: 75-65-0 Year SMAC was Set/ Reviewed: 1995	50	(150)	50	(150)	50	(150)	50	(150)	40	(120)	
	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	Organ: Kidney	Effect: Nephrotoxicity	Organ: Kidney	Effect: Nephrotoxicity	
							Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	
									Organ: U. Blad	Effect: Injury	
Carbon dioxide Synonyms: NRC Vol. #: 2 CAS #: 124-38-9 Year SMAC was Set/ Reviewed: 1992	13000	(23000)	13000	(23000)	7000	(13000)	7000	(13000)	7000	(13000)	
	Organ: CNS	Effect: Hyperventil'n	Organ: CNS	Effect: Hyperventil'n	Organ: CNS	Effect: Hyperventil'n	Organ: CNS	Effect: Hyperventil'n	Organ: CNS	Effect: Hyperventil'n	
	Organ: CNS	Effect: Visual	Organ: CNS	Effect: Visual							

Spacecraft Maximum Allowable Concentrations

Chemical Name	Potential Exposure Duration: 1 hr ppm (mg/m³)	24 hr ppm (mg/m³)	7 d ppm (mg/m³)	30 d ppm (mg/m³)	180 d ppm (mg/m³)	Remarks
Carbon monoxide Synonyms: NRC Vol. #: 1 CAS #: 630-08-0 Year SMAC was Set/ Reviewed: 1991	55 (63) Organ: CNS, Heart Effect: Depression, Arrhythmia	20 (23) Organ: CNS, Heart Effect: Depression, Arrhythmia	10 (11) Organ: CNS, Heart Effect: Depression, Arrhythmia	10 (11) Organ: CNS, Heart Effect: Depression, Arrhythmia	10 (11) Organ: CNS, Heart Effect: Depression, Arrhythmia	Carboxyhemoglobin target
Chloroform Synonyms: Trichloromethane NRC Vol. #: 4 CAS #: 67-66-3 Year SMAC was Set/ Reviewed: 1999	2 (10) Organ: CNS, Liver, Kidney Effect: Depression, Hepatotoxicity, Nephrotoxicity	2 (10) Organ: CNS, Liver, Kidney Effect: Depression, Hepatotoxicity, Nephrotoxicity	2 (10) Organ: CNS, Liver, Kidney Effect: Depression, Hepatotoxicity, Nephrotoxicity	1 (5) Organ: CNS, Liver, Kidney Effect: Depression, Hepatotoxicity, Nephrotoxicity	1 (5) Organ: CNS, Liver, Kidney Effect: Depression, Hepatotoxicity, Nephrotoxicity	
Decamethylcyclopentasiloxane Synonyms: NRC Vol. #: 4 CAS #: 541-02-6 Year SMAC was Set/ Reviewed: 1998	N.S. Organ: Effect:	N.S. Organ: Effect:	7 (100) Organ: RspSys, Gonad Effect: Injury, Toxicity	5 (75) Organ: RspSys, Gonad Effect: Injury, Toxicity	1 (15) Organ: RspSys, Gonad Effect: Injury, Toxicity	Documented as a polydimethylcyclosiloxane
Diacetone alcohol Synonyms: NRC Vol. #: 3 CAS #: 123-42-2 Year SMAC was Set/ Reviewed: 1995	50 (250) Organ: Mucosa, CNS Effect: Irritation, Depression	50 (250) Organ: Mucosa, CNS Effect: Irritation, Depression	20 (100) Organ: Mucosa, CNS Effect: Irritation, Depression	6 (30) Organ: Mucosa, CNS Effect: Irritation, Depression	4 (20) Organ: Liver, CNS Effect: Hepatomegaly, Depression	
Dichloroacetylene Synonyms: NRC Vol. #: 3 CAS #: 7572-29-4 Year SMAC was Set/ Reviewed: 1992	0.6 (2.4) Organ: CNS, Kidney, Liver Effect: Depression, Nephrotoxicity, Hepatotoxicity	0.04 (0.16) Organ: CNS, Kidney, Liver Effect: Depression, Nephrotoxicity, Hepatotoxicity	0.03 (0.12) Organ: CNS, Kidney Effect: Depression, Nephrotoxicity	0.025 (0.10) Organ: CNS, Kidney Effect: Depression, Nephrotoxicity	0.015 (0.06) Organ: CNS, Kidney Effect: Depression, Nephrotoxicity	

Spacecraft Maximum Allowable Concentrations

Chemical Name	1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
	POTENTIAL EXPOSURE DURATION										
1,2- Dichloroethane Synonyms: NRC Vol. #: 3 CAS #: 107-06-2 Year SMAC was Set/ Reviewed: 1992	0.4	(2)	0.4	(2)	0.4	(2)	0.4	(2)	0.2	(1)	Carcinogen; impairs host defenses against bacteria.
	Organ: G.I.	Effect: GI Toxicity, Immunotoxicity	Organ: G.I.	Effect: GI Toxicity, Immunotoxicity	Organ: G.I.	Effect: GI Toxicity, Immunotoxicity	Organ: G.I.	Effect: GI Toxicity, Immunotoxicity	Organ: Various	Effect: Cancer	
Ethanol Synonyms: Ethyl alcohol NRC Vol. #: 3 CAS #: 64-17-5 Year SMAC was Set/ Reviewed: 1994	2000	(4000)	2000	(4000)	1000	(2000)	1000	(2000)	1000	(2000)	Skin "flushing" is a cardiovascular effect.
	Organ: Eye, Mucosa, Skin	Effect: Irritation, Irritation, Flushing	Organ: Eye, Mucosa, Skin	Effect: Irritation, Irritation, Flushing	Organ: Eye, Mucosa, Skin, Liver	Effect: Irritation, Irritation, Flushing, Hepatotoxicity	Organ: Eye, Mucosa, Skin, Liver	Effect: Irritation, Irritation, Flushing, Hepatotoxicity	Organ: Eye, Mucosa, Skin, Liver	Effect: Irritation, Irritation, Flushing, Hepatotoxicity	
2- Ethoxyethanol Synonyms: NRC Vol. #: 2 CAS #: 110-80-5 Year SMAC was Set/ Reviewed: 1992	10	(40)	10	(40)	0.8	(3)	0.5	(2)	0.07	(0.3)	
	Organ: Blood, Mucosa	Effect: Hematotoxicity, Irritation	Organ: Blood, Mucosa	Effect: Hematotoxicity, Irritation	Organ: Blood	Effect: Hematotoxicity	Organ: Blood	Effect: Hematotoxicity	Organ: Blood	Effect: Hematotoxicity	
Ethylbenzene Synonyms: NRC Vol. #: 3 CAS #: 100-41-4 Year SMAC was Set/ Reviewed: 1993	180	(800)	60	(250)	30	(130)	30	(130)	12	(50)	
	Organ: Mucosa, CNS	Effect: Irritation, Depression	Organ: Mucosa, CNS	Effect: Irritation, Depression	Organ: Mucosa, Testes	Effect: Irritation, Necrosis	Organ: Mucosa, Testes	Effect: Irritation, Necrosis	Organ: Testes	Effect: Necrosis	
Ethylene glycol Synonyms: NRC Vol. #: 3 CAS #: 107-21-1 Year SMAC was Set/ Reviewed: 1993	25	(60)	25	(60)	5	(13)	5	(13)	5	(13)	
	Organ: Mucosa	Effect: Irritation	Organ: Mucosa, CNS	Effect: Irritation, Depression	Organ: Mucosa, CNS, Kidney	Effect: Irritation, Depression, Nephrotoxicity	Organ: Mucosa, CNS, Kidney	Effect: Irritation, Depression, Nephrotoxicity	Organ: Mucosa, CNS, Kidney	Effect: Irritation, Depression, Nephrotoxicity	

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Chemical Name	POTENTIAL EXPOSURE DURATION 1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
Formaldehyde	0.4	(0.5)	0.1	(0.12)	0.04	(0.05)	0.04	(0.05)	0.04	(0.05)	Ceiling values, Carcinogen
Synonyms:	Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		
NRC Vol. #: 1 CAS #: 50-00-0											
Year SMAC was Set/ Reviewed: 1991											
Freon 11	140	(790)	140	(790)	140	(790)	140	(790)	140	(790)	
Synonyms: Trichlorofluoromethane	Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		
NRC Vol. #: 4 CAS #: 75-69-6											
Year SMAC was Set/ Reviewed: 1998											
Freon 113	50	(400)	50	(400)	50	(400)	50	(400)	50	(400)	
Synonyms: 1,1,2-trichloro- 1,2,2-trifluoro-ethane	Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		
NRC Vol. #: 1 CAS #: 76-13-1											
Year SMAC was Set/ Reviewed: 1991											
Freon 12	540	(2600)	95	(470)	95	(470)	95	(470)	95	(470)	
Synonyms: Dichlorodifluoromethane	Organ: Heart; Effect: Tachycardia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		Organ: Heart; Effect: Arrhythmia		
NRC Vol. #: 4 CAS #: 75-71-8											
Year SMAC was Set/ Reviewed: 1998											
Freon 21	50	(210)	50	(210)	15	(63)	12	(50)	2	(8)	
Synonyms: Dichlorofluoromethane	Organ: Heart; Effect: Tachycardia		Organ: Heart; Effect: Tachycardia		Organ: Liver; Effect: Hepatotoxicity		Organ: Liver; Effect: Hepatotoxicity		Organ: Liver; Effect: Hepatotoxicity		
NRC Vol. #: 4 CAS #: 75-43-4											
Year SMAC was Set/ Reviewed: 1998											

Spacecraft Maximum Allowable Concentrations

Chemical Name	Potential Exposure Duration: 1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
Freon 22 Synonyms: Chlorodifluoromethane NRC Vol. #: 4 CAS #: 75-45-6 Year SMAC was Set/ Reviewed: 1998	1000	(3500)	1000	(3500)	1000	(3500)	1000	(3500)	1000	(3500)	
	Organ: CNS, Heart	Effect: Depression, Arrhythmia	Organ: CNS, Heart	Effect: Depression, Arrhythmia	Organ: CNS, Heart	Effect: Depression, Arrhythmia	Organ: CNS, Heart	Effect: Depression, Arrhythmia	Organ: CNS, Heart	Effect: Depression, Arrhythmia	
Furan Synonyms: 1,4-Epoxy-1,3-buladiene NRC Vol. #: 4 CAS #: 110-00-9 Year SMAC was Set/ Reviewed: 1998	4	(11)	0.36	(1)	0.025	(0.07)	0.025	(0.07)	0.025	(0.07)	
	Organ: Liver	Effect: Hepatotoxicity	Organ: Liver	Effect: Hepatotoxicity	Organ: Liver	Effect: Cancer	Organ: Liver	Effect: Cancer	Organ: Liver	Effect: Cancer	
Glutaraldehyde Synonyms: 1,5-Pentanedial NRC Vol. #: 3 CAS #: 111-308 Year SMAC was Set/ Reviewed: 1993	0.12	(0.50)	0.04	(0.08)	0.006	(0.025)	0.003	(0.012)	0.0006	(0.002)	
	Organ: Mucosa, CNS	Effect: Irritation, Headache	Organ: Mucosa, CNS	Effect: Irritation, Headache	Organ: RspSys	Effect: Lesions	Organ: RspSys	Effect: Lesions	Organ: RspSys	Effect: Lesions	
Hexamethylcyclotrisiloxane Synonyms: NRC Vol. #: 4 CAS #: 541-05-9 Year SMAC was Set/ Reviewed: 1998	N.S.		N.S.		10	(90)	5	(45)	1	(9)	Documented as a polydimethylcyclosiloxane
	Organ:	Effect:	Organ:	Effect:	Organ: RspSys, CNS	Effect: Injury, Depression	Organ: RspSys, CNS	Effect: Injury, Depression	Organ: RspSys	Effect: Injury	
Hydrazine Synonyms: Diamine NRC Vol. #: 2 CAS #: 302-01-2 Year SMAC was Set/ Reviewed: 1993	4	(5)	0.3	(0.4)	0.04	(0.05)	0.02	(0.03)	0.004	(0.005)	Carcinogen.
	Organ:	Effect: Death	Organ: Liver	Effect: Hepatotoxicity	Organ: Liver	Effect: Hepatotoxicity	Organ: Liver, Liver, Nose	Effect: Hepatotoxicity, Hyperplasia, Cancer	Organ: Liver, Nose	Effect: Hepatotoxicity, Cancer	

Spacecraft Maximum Allowable Concentrations

Chemical Name	Potential Exposure Duration: 1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
Hydrogen	4100	(340)	4100	(340)	4100	(340)	4100	(340)	4100	(340)	Ceiling values are 10% of the Lower Explosive Limit
Synonyms:	Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		
NRC Vol. #: 1 CAS #: 1333-74-0	Explosion		Explosion		Explosion		Explosion		Explosion		
Year SMAC was Set/ Reviewed: 1990											
Hydrogen chloride	5	(8)	2	(3)	1	(1.5)	1	(1.5)	1	(1.5)	
Synonyms:	Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		
NRC Vol. #: 4 CAS #: 7647-01-1	Eye / Irritation		Eye / Irritation		Eye / Irritation		Eye / Irritation		Eye / Irritation		
Year SMAC was Set/ Reviewed: 1998	Mucosa / Irritation		Mucosa / Irritation		Mucosa / Irritation		Mucosa / Irritation		Mucosa / Irritation		
Hydrogen cyanide	8	(9)	4	(4.5)	1	(1.1)	1	(1.1)	1	(1.1)	
Synonyms:	Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		
NRC Vol. #: 4 CAS #: 74-90-8	CNS / Depression		CNS / Depression		CNS / Depression		CNS / Depression		CNS / Depression		
Year SMAC was Set/ Reviewed: 1998	CNS / Headache		CNS / Headache		CNS / Headache		CNS / Headache		CNS / Headache		
	CNS / Nausea		CNS / Nausea		CNS / Nausea		CNS / Nausea		CNS / Nausea		
Indole	1.0	(5)	0.3	(1.5)	0.05	(0.25)	0.05	(0.25)	0.05	(0.25)	Normal turnover of indole was used to establish a lower bound of 0.05 ppm.
Synonyms:	Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		
NRC Vol. #: 2 CAS #: 120-72-9	CNS / Nausea		CNS / Nausea		CNS / Nausea		CNS / Nausea		CNS / Nausea		
Year SMAC was Set/ Reviewed: 1992			Blood / Hematotoxicity		Blood / Hematotoxicity		Blood / Hematotoxicity		Blood / Hematotoxicity		
Isoprene	50	(140)	25	(70)	2	(6)	2	(6)	1	(3)	
Synonyms: 2-Methyl-1,3-butadiene	Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		Organ / Effect		
NRC Vol. #: 4 CAS #: 78-79-5	Mucosa / Irritation		Mucosa / Irritation		Mucosa / Irritation		Mucosa / Irritation		Lung / Injury		
Year SMAC was Set/ Reviewed: 1998					Blood / Anemia		Blood / Anemia		Blood / Anemia		
									CNS / Neurotoxicity		

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Chemical Name	1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
	POTENTIAL EXPOSURE DURATION										
Mercury	0.01	(0.1)	0.002	(0.02)	0.001	(0.01)	0.001	(0.01)	0.001	(0.01)	
Synonyms:	Organ: Lung; Effect: Irritation		Organ: Lung; Effect: Irritation		Organ: CNS, Kidney; Effect: Neurotoxicity, Nephrotoxicity		Organ: CNS, Kidney; Effect: Neurotoxicity, Nephrotoxicity		Organ: CNS, Kidney; Effect: Neurotoxicity, Nephrotoxicity		
NRC Vol. #: 2 CAS #: 7439-97-6											
Year SMAC was Set/ Reviewed: 1992											
Methane	5300	(3800)	5300	(3800)	5300	(3800)	5300	(3800)	5300	(3800)	Ceiling values are 10% of the Lower Explosive Limit. Methane is a non-toxic simple asphyxiant.
Synonyms: Natural gas	Organ: ; Effect: Explosion		Organ: ; Effect: Explosion		Organ: ; Effect: Explosion		Organ: ; Effect: Explosion		Organ: ; Effect: Explosion		
NRC Vol. #: 1 CAS #: 74-82-8											
Year SMAC was Set/ Reviewed: 1990											
Methanol	30	(40)	10	(13)	7	(9)	7	(9)	7	(9)	
Synonyms:	Organ: Eye; Effect: Visual Disturbances		Organ: Eye; Effect: Visual Disturbances		Organ: Eye; Effect: Visual Disturbances		Organ: Eye; Effect: Visual Disturbances		Organ: Eye; Effect: Visual Disturbances		
NRC Vol. #: 1 CAS #: 67-56-1											
Year SMAC was Set/ Reviewed: 1992											
Methyl Ethyl Ketone	50	(150)	50	(150)	10	(30)	10	(30)	10	(30)	Ceiling values
Synonyms: 2-Butanone	Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		Organ: Mucosa; Effect: Irritation		
NRC Vol. #: 2 CAS #: 78-93-3											
Year SMAC was Set/ Reviewed: 1992											
Methyl hydrazine	0.002	(0.004)	0.002	(0.004)	0.002	(0.004)	0.002	(0.004)	0.002	(0.004)	Carcinogen
Synonyms: Monomethylhydrazine	Organ: Nose; Effect: Lesions		Organ: Nose; Effect: Lesions		Organ: Nose; Effect: Lesions		Organ: Nose; Effect: Lesions		Organ: Nose; Effect: Lesions		
NRC Vol. #: 4 CAS #: 60-34-4											
Year SMAC was Set/ Reviewed: 1991											

Spacecraft Maximum Allowable Concentrations

Chemical Name	Potential Exposure Duration: 1 hr ppm (mg/m³)	1 hr Organ	1 hr Effect	24 hr ppm (mg/m³)	24 hr Organ	24 hr Effect	7 d ppm (mg/m³)	7 d Organ	7 d Effect	30 d ppm (mg/m³)	30 d Organ	30 d Effect	180 d ppm (mg/m³)	180 d Organ	180 d Effect	Remarks
4- Methyl-2-pentanone Synonyms: Methyl isobutyketone, MIBK NRC Vol. #: 4 CAS #: 108-10-1 Year SMAC was Set/ Reviewed: 1994	35 (140)	CNS Mucosa	Depression Irritation	35 (140)	CNS Mucosa	Depression Irritation	35 (140)	CNS Mucosa	Depression Irritation	35 (140)	CNS Mucosa	Depression Irritation	35 (140)	CNS Mucosa	Depression Irritation	
Methylene chloride Synonyms: Dichloromethane NRC Vol. #: 2 CAS #: 75-09-2 Year SMAC was Set/ Reviewed: 1992	100 (350)	CNS	Depression	35 (120)	CNS	Depression	15 (50)	CNS	Depression	5 (20)	Liver	Hepatotoxicity	3[1] (10)	Liver	Hepatotoxicity	CO formation, Carcinogen
Nitromethane Synonyms: NRC Vol. #: 2 CAS #: 75-52-5 Year SMAC was Set/ Reviewed: 1992	25 (65)	Blood	Anemia	15 (40)	Blood	Anemia	7 (18)	Blood	Anemia	7 (18)	Blood	Anemia	5 (13)	Blood	Anemia	
Octamethylcyclotetrasiloxane Synonyms: NRC Vol. #: 4 CAS #: 556-67-2 Year SMAC was Set/ Reviewed: 1998	N.S.			N.S.			23 (280)	RspSys CNS Gonad	Injury Depression Toxicity	5 (60)	RspSys Gonad	Injury Toxicity	1 (12)	Gonad RspSys	Toxicity Injury	Documented as a polydimethylcyclosiloxane
Octamethyltrisiloxane Synonyms: MDM NRC Vol. #: 1 CAS #: 107-51-7 Year SMAC was Set/ Reviewed: 1992	400 (4000)		Death	200 (2000)	Liver Kidney	Death Hepatotoxicity Nephrotoxicity	100 (1000)	Liver Kidney	Hepatotoxicity Nephrotoxicity	20 (200)	Liver Kidney	Hepatotoxicity Nephrotoxicity	4 (40)	Liver Kidney	Hepatotoxicity Nephrotoxicity	Based on structure activity relationships

Spacecraft Maximum Allowable Concentrations

Chemical Name	Potential Exposure Duration: 1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
Perfluoropropane and Other Aliphatic Perfluoroalkanes Synonyms: Octafluoropropane NRC Vol. #: 4 CAS #: 76-19-7 Year SMAC was Set/ Reviewed: 1998	11,000	(85,000)	11,000	(85,000)	11,000	(85,000)	11,000	(85,000)	11,000	(85,000)	This group SMAC is not applicable to perfluorocycloalkanes.
	Organ: CNS	Effect: Symptoms	Organ: CNS	Effect: Symptoms	Organ: CNS	Effect: Symptoms	Organ: CNS	Effect: Symptoms	Organ: CNS	Effect: Symptoms	
2- Propanol Synonyms: Isopropanol NRC Vol. #: 2 CAS #: 67-63-0 Year SMAC was Set/ Reviewed: 1992	400	(1000)	100	(240)	60	(150)	60	(150)	60	(150)	
	Organ: CNS, Mucosa	Effect: Depression, Irritation	Organ: CNS, Mucosa, Liver	Effect: Depression, Irritation, Hepatotoxicity	Organ: CNS, Mucosa, Liver	Effect: Depression, Irritation, Hepatotoxicity	Organ: CNS, Mucosa, PNS	Effect: Depression, Irritation, Decr. cond'n. velocity	Organ: CNS, Mucosa	Effect: Depression, Irritation	
Toluene Synonyms: Methyl benzene NRC Vol. #: 2 CAS #: 108-88-3 Year SMAC was Set/ Reviewed: 1992	16	(60)	16	(60)	16	(60)	16	(60)	16	(60)	
	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	Organ: CNS, Mucosa	Effect: Depression, Irritation	Organ: CNS, Mucosa	Effect: Depression, Irritation	Organ: CNS, Mucosa	Effect: Depression, Irritation	
Trichloroethylene Synonyms: NRC Vol. #: 3 CAS #: 79-01-6 Year SMAC was Set/ Reviewed: 1992	50	(270)	11	(60)	9	(50)	4	(20)	2	(10)	See dichloroacetylene if alkali scrubber is present. Possible carcinogen.
	Organ: CNS, Heart	Effect: Depression, Arrhythmia	Organ: CNS	Effect: Depression	Organ: Kidney, Liver	Effect: Nephrotoxicity, Hepatotoxicity	Organ: Kidney, Liver	Effect: Nephrotoxicity, Hepatotoxicity	Organ: Multi., Kidney, Liver	Effect: Cancer, Nephrotoxicity, Hepatotoxicity	
Trimethylsilanol Synonyms: Trimethylhydroxysilane NRC Vol. #: 1 CAS #: 1066-40-6 Year SMAC was Set/ Reviewed: 1991	150	(550)	20	(74)	10	(37)	10	(37)	10	(37)	
	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	Organ: CNS	Effect: Depression	

Spacecraft Maximum Allowable Concentrations

Chemical Name	Potential Exposure Duration: 1 hr ppm	1 hr (mg/m³)	24 hr ppm	24 hr (mg/m³)	7 d ppm	7 d (mg/m³)	30 d ppm	30 d (mg/m³)	180 d ppm	180 d (mg/m³)	Remarks
Vinyl chloride Synonyms: Chloroethene; chloroethylene NRC Vol. #: 1 CAS #: 75-01-4 Year SMAC was Set/ Reviewed: 1992	130	(330)	30	(77)	1	(2.6)	1	(2.6)	1	(2.6)	Carcinogen
	Organ	*Effect*	*Organ*	*Effect*	*Organ*	*Effect*	*Organ*	*Effect*	*Organ*	*Effect*	
	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Testes	Necrosis	Testes	Necrosis	Testes	Necrosis	
	CNS	Headache	CNS	Headache	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Cancer	
	CNS	Depression	CNS	Depression							
Xylene Synonyms: Dimethylbenzene, xylol NRC Vol. #: 3 CAS #: 1330207 Year SMAC was Set/ Reviewed: 1992	100	(430)	100	(430)	50	(220)	50	(220)	50	(220)	Applies to each individual xylene isomer and mixtures of xylene isomers.
	Organ	*Effect*	*Organ*	*Effect*	*Organ*	*Effect*	*Organ*	*Effect*	*Organ*	*Effect*	
	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	
	CNS	Depression	CNS	Depression							

Abbreviations:

CNS - Central Nervous System
GI - Gastrointestinal System
NRC - National Research Council
N.S. - Not Set
PNS - Peripheral Nervous System
RBC - Red Blood Cells
RspSys - Respiratory System