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**SPACECRAFT MAXIMUM ALLOWABLE
CONCENTRATIONS FOR
AIRBORNE CONTAMINANTS**

**Toxicology Group
Medical Operations Branch
Medical Sciences Division
Space and Life Sciences Directorate**

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

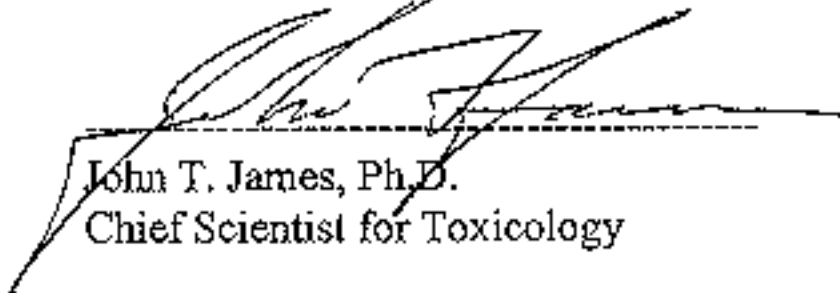
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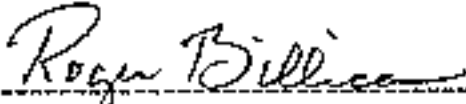
Toxicology Group
Medical Operations Branch
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NASA Johnson Space Center

Prepared by:

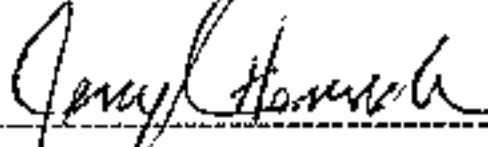


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SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATIONS FOR AIRBORNE CONTAMINANTS

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:

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

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.

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

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	1 hr		24 hr		7 d		30 d		180 d		Remarks
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Acetaldehyde Synonyms: NRC Vol. #: 1 CAS #: 75-07-0 Year SMAC was Self Reviewed: 1992	12	(22)	6	(10)	2	(4)	2	(4)	2	(4)	(4) Carcinogen
	<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		Mucosa Irritation
	Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		
Acetone Synonyms: 2-Propanone NRC Vol. #: 4 CAS #: 67-64-1 Year SMAC was Self Reviewed: 1994	500	(1200)	200	(500)	22	(52)	22	(52)	22	(52)	
	<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		
	CNS Depression		CNS Depression		CNS Depression		CNS Depression		CNS Depression		
Acrolein Synonyms: Propenal NRC Vol. #: 2 CAS #: 107-02-08 Year SMAC was Self Reviewed: 1992	0.075	(0.2)	0.035	(0.08)	0.015	(0.03)	0.015	(0.03)	0.015	(0.03)	Ceiling values
	<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		
	Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		
C3-C8 Aliphatic Saturated Aldehydes Synonyms: NRC Vol. #: 4 CAS #: various Year SMAC was Self Reviewed: 1998	50	(125-250)	50	(125-250)	6	(15-30)	1.5	(4-8)	1.5	(4-8)	The range of values listed in mg/m ³ is due to differences in the molecular weights of the various aldehydes.
	<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		
	Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		
					Liver Hepatotoxicity		Liver Hepatotoxicity		Liver Hepatotoxicity		
Ammonia Synonyms: NRC Vol. #: 1 CAS #: 7664-41-7 Year SMAC was Self Reviewed: 1991	30	(20)	20	(14)	10	(7)	10	(7)	10	(7)	Ceiling values
	<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		<u>Organ Effect</u>		
	Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		Mucosa Irritation		



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	P O T E N T I A L E X P O S U R E D U R A T I O N				Remarks	
	1 hr	24 hr	7 d	30 d		180 d
	ppm (mg/m ³)	ppm (mg/m ³)	ppm (mg/m ³)	ppm (mg/m ³)	ppm (mg/m ³)	
Benzene Synonyms: NRC Vol. #: 2 CAS #: 71-43-2 Year SMAC was Set/ Reviewed: 1993	10 (35) <u>Organ Effect</u> Blood Immunotoxicity	3 (10) <u>Organ Effect</u> Blood Immunotoxicity	0.5 (1.5) <u>Organ Effect</u> Blood Immunotoxicity	0.1 (0.3) <u>Organ Effect</u> Blood Immunotoxicity	0.07 (0.2) <u>Organ Effect</u> Blood Immunotoxicity Leukemia	Leukemogen
Bromotrifluoromethane Synonyms: Halon 1301 NRC Vol. #: 3 CAS #: 75-63-8 Year SMAC was Set/ Reviewed: 1993	3500 (21000) <u>Organ Effect</u> Heart Arrhythmia	3500 (21000) <u>Organ Effect</u> Heart Arrhythmia	1800 (11000) <u>Organ Effect</u> CNS Depression	1800 (11000) <u>Organ Effect</u> CNS Depression	1800 (11000) <u>Organ Effect</u> CNS Depression	(11000) Depression
1- Butanol Synonyms: NRC Vol. #: 3 CAS #: 71-36-3 Year SMAC was Set/ Reviewed: 1994	50 (150) <u>Organ Effect</u> Eye Irritation CNS Depression	25 (80) <u>Organ Effect</u> Eye Irritation	25 (80) <u>Organ Effect</u> Eye Irritation Systemic Injury	25 (80) <u>Organ Effect</u> Eye Irritation Systemic Injury	12 (40) <u>Organ Effect</u> Systemic Injury	
tert- Butanol Synonyms: 2-Methyl-2-propanol NRC Vol. #: 3 CAS #: 75-65-0 Year SMAC was Set/ Reviewed: 1995	50 (150) <u>Organ Effect</u> CNS Depression	50 (150) <u>Organ Effect</u> CNS Depression	50 (150) <u>Organ Effect</u> CNS Depression	50 (150) <u>Organ Effect</u> Kidney Nephrotoxicity CNS Depression	40 (120) <u>Organ Effect</u> Kidney Nephrotoxicity CNS Depression U. Blad Injury	
Carbon dioxide Synonyms: NRC Vol. #: 2 CAS #: 124-38-9 Year SMAC was Set/ Reviewed: 1992	13000 (23000) <u>Organ Effect</u> CNS Hyperventil'n CNS Visual	13000 (23000) <u>Organ Effect</u> CNS Hyperventil'n CNS Visual	7000 (13000) <u>Organ Effect</u> CNS Hyperventil'n CNS	7000 (13000) <u>Organ Effect</u> CNS Hyperventil'n CNS	7000 (13000) <u>Organ Effect</u> CNS Hyperventil'n CNS	(13000) Hyperventil'n



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	1 hr		24 hr		7 d		30 d		180 d		Remarks
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Carbon monoxide	55	(63)	20	(23)	10	(11)	10	(11)	10	(11)	Carboxyhemoglobin target
Synonyms:	<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>	
NRC Vol. #: 1	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
Year SMAC was Set/ Reviewed: 1991	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	Heart	Arrhythmia	
Chloroform	2	(10)	2	(10)	2	(10)	1	(5)	1	(5)	
Synonyms: Trichloromethane	<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>	
NRC Vol. #: 4	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
Year SMAC was Set/ Reviewed: 1999	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	
Decamethylcyclopentasiloxane	N.S.		N.S.		7	(100)	5	(75)	1	(15)	Documented as a polydimethylcyclosiloxane
Synonyms:	<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>	
NRC Vol. #: 4	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
Year SMAC was Set/ Reviewed: 1998	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	
Diacetone alcohol	50	(250)	50	(250)	20	(100)	6	(30)	4	(20)	
Synonyms:	<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>	
NRC Vol. #: 3	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Liver	Hepatomegaly	
Year SMAC was Set/ Reviewed: 1995	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
Dichloroacetylene	0.6	(2.4)	0.04	(0.16)	0.03	(0.12)	0.025	(0.10)	0.015	(0.06)	
Synonyms:	<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>	
NRC Vol. #: 3	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
Year SMAC was Set/ Reviewed: 1992	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	
	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	P O T E N T I A L E X P O S U R E D U R A T I O N				Remarks	
	1 hr ppm (mg/m ³)	24 hr ppm (mg/m ³)	7 d ppm (mg/m ³)	30 d ppm (mg/m ³)		180 d ppm (mg/m ³)
1,2-Dichloroethane Synonyms: NRC Vol. #: 3 CAS #: 107-06-2 Year SMAC was Self Reviewed: 1992	0.4 (2) <u>Organ Effect</u> G.I. GI Toxicity Immunotoxicity	0.4 (2) <u>Organ Effect</u> G.I. GI Toxicity Immunotoxicity	0.4 (2) <u>Organ Effect</u> G.I. GI Toxicity Immunotoxicity	0.4 (2) <u>Organ Effect</u> GI Toxicity Immunotoxicity	0.2 (1) <u>Organ Effect</u> Various Cancer	(1) Carcinogen; impairs host defenses against bacteria.
Ethanol Synonyms: Ethyl alcohol NRC Vol. #: 3 CAS #: 64-17-5 Year SMAC was Self Reviewed: 1984	2000 (4000) <u>Organ Effect</u> Eye Irritation Mucosa Irritation Skin Flushing	2000 (4000) <u>Organ Effect</u> Eye Irritation Mucosa Irritation Skin Flushing	1000 (2000) <u>Organ Effect</u> Eye Irritation Mucosa Irritation Skin Flushing Hepatotoxicity	1000 (2000) <u>Organ Effect</u> Eye Irritation Mucosa Irritation Skin Flushing Hepatotoxicity	1000 (2000) <u>Organ Effect</u> Eye Irritation Mucosa Irritation Skin Flushing Hepatotoxicity	Skin "flushing" is a cardiovascular effect.
2-Ethoxyethanol Synonyms: NRC Vol. #: 2 CAS #: 110-80-5 Year SMAC was Self Reviewed: 1992	10 (40) <u>Organ Effect</u> Blood Hematotoxicity Mucosa Irritation	10 (40) <u>Organ Effect</u> Blood Hematotoxicity Mucosa Irritation	0.8 (3) <u>Organ Effect</u> Blood Hematotoxicity	0.5 (2) <u>Organ Effect</u> Blood Hematotoxicity	0.07 (0.3) <u>Organ Effect</u> Blood Hematotoxicity	
Ethylbenzene Synonyms: NRC Vol. #: 3 CAS #: 100-41-4 Year SMAC was Self Reviewed: 1993	180 (800) <u>Organ Effect</u> Mucosa Irritation CNS Depression	60 (250) <u>Organ Effect</u> Mucosa Irritation CNS Depression	30 (130) <u>Organ Effect</u> Mucosa Irritation Testes Necrosis	30 (130) <u>Organ Effect</u> Mucosa Irritation Testes Necrosis	12 (50) <u>Organ Effect</u> Testes Necrosis	
Ethylene glycol Synonyms: NRC Vol. #: 3 CAS #: 107-21-1 Year SMAC was Self Reviewed: 1993	25 (60) <u>Organ Effect</u> Mucosa Irritation	25 (60) <u>Organ Effect</u> Mucosa Irritation CNS Depression	5 (13) <u>Organ Effect</u> Mucosa Irritation CNS Depression Kidney Nephrotoxicity	5 (13) <u>Organ Effect</u> Mucosa Irritation CNS Depression Kidney Nephrotoxicity	5 (13) <u>Organ Effect</u> Mucosa Irritation CNS Depression Kidney Nephrotoxicity	



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	1 hr		24 hr		7 d		30 d		180 d		Remarks
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Formaldehyde Synonyms: NRC Vol. #: 1 CAS #: 50-00-0 Year SMAC was Set/ Reviewed: 1991	0.4	(0.5)	0.1	(0.12)	0.04	(0.05)	0.04	(0.05)	0.04	(0.05)	Ceiling values, Carcinogen
Freon 11 Synonyms: Trichlorofluoromethane NRC Vol. #: 4 CAS #: 75-69-6 Year SMAC was Set/ Reviewed: 1998	140	(790)	140	(790)	140	(790)	140	(790)	140	(790)	Organ Effect Mucosa Irritation
Freon 113 Synonyms: 1,1,2-trichloro-1,2,2-trifluoroethane NRC Vol. #: 1 CAS #: 76-13-1 Year SMAC was Set/ Reviewed: 1991	50	(400)	50	(400)	50	(400)	50	(400)	50	(400)	Organ Effect Heart Arrhythmia
Freon 12 Synonyms: Dichlorodifluoromethane NRC Vol. #: 4 CAS #: 75-71-8 Year SMAC was Set/ Reviewed: 1998	540	(2600)	95	(470)	95	(470)	95	(470)	95	(470)	Organ Effect Heart Tachycardia
Freon 21 Synonyms: Dichlorofluoromethane NRC Vol. #: 4 CAS #: 75-43-4 Year SMAC was Set/ Reviewed: 1998	50	(210)	50	(210)	15	(63)	12	(50)	2	(8)	Organ Effect Heart Tachycardia Liver Hepatotoxicity



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

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



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	1 hr		24 hr		7 d		30 d		180 d		Remarks
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Hydrogen	4100	(340)	4100	(340)	4100	(340)	4100	(340)	4100	(340)	Ceiling values are 10% of the Lower Explosive Limit
Synonyms: NRC Vol. #: 1 CAS #: 1333-74-0 Year SMAC was Set/ Reviewed: 1990	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	<u>Organ Effect</u> Explosion	
Hydrogen chloride	5	(8)	2	(3)	1	(1.5)	1	(1.5)	1	(1.5)	
Synonyms: NRC Vol. #: 4 CAS #: 7647-01-1 Year SMAC was Set/ Reviewed: 1998	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	<u>Organ Effect</u> Eye Irritation Mucosa Irritation	
Hydrogen cyanide	8	(9)	4	(4.5)	1	(1.1)	1	(1.1)	1	(1.1)	
Synonyms: NRC Vol. #: 4 CAS #: 74-90-8 Year SMAC was Set/ Reviewed: 1998	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache CNS Nausea	<u>Organ Effect</u> CNS Depression CNS Headache 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: NRC Vol. #: 2 CAS #: 120-72-9 Year SMAC was Set/ Reviewed: 1992	<u>Organ Effect</u> CNS Nausea	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	<u>Organ Effect</u> CNS Nausea Blood Hematotoxicity	
Isoprene	50	(140)	25	(70)	2	(6)	2	(6)	1	(3)	
Synonyms: NRC Vol. #: 4 CAS #: 78-79-5 Year SMAC was Set/ Reviewed: 1998	<u>Organ Effect</u> Mucosa Irritation	<u>Organ Effect</u> Mucosa Irritation	<u>Organ Effect</u> Mucosa Irritation Blood Anemia	<u>Organ Effect</u> Mucosa Irritation Blood Anemia	<u>Organ Effect</u> Mucosa Irritation Blood Anemia	<u>Organ Effect</u> Mucosa Irritation Blood Anemia	<u>Organ Effect</u> Mucosa Irritation Blood Anemia	<u>Organ Effect</u> Mucosa Irritation Blood Anemia	<u>Organ Effect</u> Lung Injury Blood Anemia CNS Neurotoxicity	<u>Organ Effect</u> Lung Injury Blood Anemia CNS Neurotoxicity	



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	1 hr		24 hr		7 d		30 d		180 d		Remarks
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Mercury	0.01	(0.1)	0.002	(0.02)	0.001	(0.01)	0.001	(0.01)	0.001	(0.01)	
Synonyms:	<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>	
NRC Vol. #: 2	Lung	Irritation	Lung	Irritation	CNS	Neurotoxicity	CNS	Neurotoxicity	CNS	Neurotoxicity	
CAS #: 7439-97-6					Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	
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.
Synonyms: Natural gas	<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>	Methane is a non-toxic simple asphyxiant.
NRC Vol. #: 1	Explosion	Explosion	Explosion	Explosion	Explosion	Explosion	Explosion	Explosion	Explosion	Explosion	
CAS #: 74-82-8											
Year SMAC was Set/ Reviewed: 1990											
Methanol	30	(40)	10	(13)	7	(9)	7	(9)	7	(9)	
Synonyms:	<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>	
NRC Vol. #: 1	Eye	Visual Disturbances	Eye	Visual Disturbances	Eye	Visual Disturbances	Eye	Visual Disturbances	Eye	Visual Disturbances	
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	<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>	
NRC Vol. #: 2	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	
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	<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>	
NRC Vol. #: 4	Nose	Lesions	Nose	Lesions	Nose	Lesions	Nose	Lesions	Nose	Lesions	
CAS #: 60-34-4											
Year SMAC was Set/ Reviewed: 1991											



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

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



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	1 hr		24 hr		7 d		30 d		180 d		Remarks
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Perfluoropropane and Other Aliphatic Perfluoroalkanes	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.
Synonyms: Octafluoropropane	<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>	
NRC Vol. #: 4	CNS	Symptoms	CNS	Symptoms	CNS	Symptoms	CNS	Symptoms	CNS	Symptoms	
CAS #: 76-19-7											
Year SMAC was Self Reviewed: 1998											
2-Propanol	400	(1000)	100	(240)	60	(150)	60	(150)	60	(150)	
Synonyms: Isopropanol	<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>	
NRC Vol. #: 2	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
CAS #: 67-63-0	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	
Year SMAC was Self Reviewed: 1992	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	PNS	Decr. cond'n. velocity			
Toluene	16	(60)	16	(60)	16	(60)	16	(60)	16	(60)	
Synonyms: Methyl benzene	<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>	
NRC Vol. #: 2	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
CAS #: 108-88-3			Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	Mucosa	Irritation	
Year SMAC was Self Reviewed: 1992											
Trichloroethylene	50	(270)	11	(60)	9	(50)	4	(20)	2	(10)	See dichloroethylene if alkali scrubber is present. Possible carcinogen.
Synonyms:	<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>	
NRC Vol. #: 3	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
CAS #: 79-01-6	Heart	Arrhythmia	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Kidney	Nephrotoxicity	Mult.	Cancer	
Year SMAC was Self Reviewed: 1992			Liver	Hepatotoxicity	Liver	Hepatotoxicity	Liver	Hepatotoxicity	Kidney	Nephrotoxicity	
									Liver	Hepatotoxicity	
Trimethylsilanol	150	(550)	20	(74)	10	(37)	10	(37)	10	(37)	
Synonyms: Trimethylhydroxysilane	<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>	
NRC Vol. #: 1	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	CNS	Depression	
CAS #: 1066-40-6											
Year SMAC was Self Reviewed: 1991											



Spacecraft Maximum Allowable Concentrations

P O T E N T I A L E X P O S U R E D U R A T I O N

Chemical Name	1 hr		24 hr		7 d		30 d		180 d		Remarks
	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	ppm	(mg/m ³)	
Vinyl chloride Synonyms: Chloroethene; chloroethylene MRC Vol. #: 1 CAS #: 75-01-4 Year SMAC was Self Reviewed: 1992	130	(330)	30	(77)	1	(2.6)	1	(2.6)	1	(2.6)	Carcinogen
	<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>	
	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 MRC Vol. #: 3 CAS #: 1330207 Year SMAC was Self Reviewed: 1992	100	(430)	100	(430)	50	(220)	50	(220)	50	(220)	Applies to each individual xylene isomer and mixtures of xylene isomers.
	<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							

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