

# PROCEEDINGS

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## Spacecraft Contamination Environment

Carl R. Maag  
Chairman/Editor

*Cooperating Organization*  
Jet Propulsion Laboratory

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Arlington, Virginia

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1982

# Spacecraft Contamination Environment

**Mark A. Kahan**



## **Spacecraft Contamination Environment:**

*Spacecraft Contamination Environment*, 1982      **Spacecraft Contamination Environment** Carl R. Maag, Jet Propulsion Laboratory (U.S.), 1983      Spacecraft Water Exposure Guidelines for Selected Contaminants National Research Council, Division on Earth and Life Studies, Board on Environmental Studies and Toxicology, Committee on Toxicology, Committee on Spacecraft Exposure Guidelines, 2008-12-21 NASA maintains an active interest in the environmental conditions associated with living and working in spacecraft and identifying hazards that might adversely affect the health and well being of crew members Despite major engineering advances in controlling the spacecraft environment some water and air contamination is inevitable Several hundred chemical species are likely to be found in the closed environment of the spacecraft and as the frequency complexity and duration of human space flight increase identifying and understanding significant health hazards will become more complicated and more critical for the success of the missions To protect space crews from contaminants in potable and hygiene water NASA requested that the National Research Council NRC provide guidance on how to develop water exposure guidelines and subsequently review NASA's development of the exposure guidelines for specific chemicals This book presents spacecraft water exposure guidelines SWEGs for antimony benzene ethylene glycol methanol methyl ethyl ketone and propylene glycol      The Determination of the Spacecraft Contamination Environment, 1987 This report details our efforts in the determination of the on orbit environment surrounding spacecraft The research was performed for the Spacecraft Interactions Branch of the Space Physics Division of the Air Force Geophysics Laboratory This report includes contributions from our subcontractors EKTRON Applied Imaging and Miranda Laboratories The multilayer project consisted of three major tasks a literature survey preparation for the data of the Particle Analysis Cameras for Shuttle PACS and the analysis of the data to create a model of the orbital particulate environment During the literature search we discovered that many observations were presented with little or no insight provided Physical Sciences Inc PSI therefore undertook a critical review of the data in an attempt to reconcile seemingly contradictory observations and provide needed understanding of the variety of unexpected processes occurring above spacecraft surfaces in low earth orbit We were able to make contributions to the understanding of the neutral molecular contamination cloud the modifications of the ionic environment the optical contamination glow and the earlier observations of particulates Keywords Contamination Optical environment Low earth orbit Spacecraft glow particulates Space shuttle Chemiluminescence Space environments Manned spaceflight      **NASA/SDIO Space Environmental Effects on Materials Workshop, Part 1**, 1989 The National Aeronautics and Space Administration NASA and the Strategic Defense Initiative Organization SDIO cosponsored a workshop on Space Environmental Effects on Materials at the NASA Langley Research Center from June 28 to July 1 1988 The joint workshop was designed to inform participants of the present state of knowledge regarding space environmental effects on materials and to identify knowledge gaps that prevent informed decisions on the

best use of advanced materials in space for long duration NASA and SDIO missions Establishing priorities for future ground based and space based materials research was a major goal of the workshop The end product of the workshop was an assessment of the current state of the art in space environmental effects on materials in order to develop a national plan for spaceflight experiments The workshop was intended for participation by expert applied researchers systems technologists and program managers for spacecraft systems

*Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants* National Research Council, Commission on Life Sciences, Board on Environmental Studies and Toxicology, Committee on Toxicology, Subcommittee on Spacecraft Maximum Allowable Concentrations, 2000-04-02

The National Aeronautics and Space Administration NASA is aware of the potential toxicological hazards to crew members that might be associated with prolonged spacecraft missions Despite major engineering advances in controlling the atmosphere within spacecraft some contamination of the air appears inevitable NASA has measured numerous airborne contaminants during space missions As the missions increase in duration and complexity ensuring the health and well being of astronauts traveling and working in this unique environment becomes increasingly difficult As part of its efforts to promote safe conditions aboard spacecraft NASA requested the National Research Council NRC to develop guidelines for establishing spacecraft maximum allowable concentrations SMACs for contaminants and to review SMACs for various spacecraft contaminants to determine whether NASA s recommended exposure limits are consistent with the guidelines recommended by the subcommittee In response to this request the NRC first developed criteria and methods for preparing SMACs for spacecraft contaminants published in its 1992 report *Guidelines for Developing Spacecraft Maximum Allowable Concentrations for Space Station Contaminants* Since then the NRC s Subcommittee on Spacecraft Maximum Allowable Concentrations has been reviewing NASA s documentation of chemical specific SMACs This report is the fourth volume in the series *Spacecraft Maximum Allowable Concentrations for Space Station Contaminants* The first volume was published in 1994 and the second and third in 1996 *Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants* Volume 4 has been reviewed in draft form by individuals chosen for their technical expertise and diverse perspectives in accordance with procedures approved by the NRC s Report Review Committee for reviewing NRC and Institute of Medicine reports The purpose of that Independent review was to provide candid and critical comments to assist the NRC in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity evidence and responsiveness to the study charge The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process

**Self Contamination and Environment of an Orbiting Spacecraft** John J. Scialdone, 1972 The flux of molecules emitted by a spacecraft and subsequently reflected to its surface was investigated The reflection occurs upon collision of the outgassed molecules with ambient molecules Evaluation of the flux was based on a knowledge of the spacecraft outgassing rate the spacecraft dimensions and the orbit parameters Condensation rates and adsorption layers on

critical surfaces were calculated from the knowledge of this flux and the nature and temperature of the gas and the surface. Based on estimated and measured emission rates, calculation of these parameters was performed for a number of spacecraft. The relationships and graphs developed allow an estimate of several important parameters for an orbiting spacecraft to be made. The pressures and densities at various distances from the spacecraft as produced by the surrounding ambient molecules and by the spacecraft's own outgassing are presented. The pressure and density produced by the outgassing can be obtained as a function of time if the behavior of the outgassing with time is known. The number of desorbed molecules ionized by impact with ambient charged particles and the effect of the spacecraft's electric field on polarized desorbed molecules were considered.

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

**Scientific and Technical Aerospace Reports**, 1989. **Spacecraft Contamination Under Simulated Orbital Environment** Roger W. Phillips, Lucio U. Tolentino, Seymour Feuerstein, AEROSPACE CORP EL SEGUNDO CALIF CHEMISTRY AND PHYSICS LAB., 1977. Volatile condensable material (VCM) measurements on a number of spacecraft materials have indicated that contamination rates onto surfaces at subambient temperatures cannot be predicted from standard outgassing tests, particularly where long-term exposures are involved. Contamination rates may depend markedly on temperature differentials between source and collector, the collection temperature, the source geometry, and the exposure time. Contamination rates may also be influenced by solar irradiation. The results of this study were obtained on a new VCM facility that overcomes many deficiencies experienced in earlier designs and permits accurate simulation of space environmental conditions. Advantages of the present system include an oil-free high vacuum chamber (1 to 10 nanotorr), source temperatures from

ambient to 125 C collection temperatures from 140 to 125 C total mass loss measurements in situ VCM mass measurements with use of an internal temperature compensated quartz crystal microbalance in situ vacuum ultraviolet irradiation of either the specimen or of the collected VCM and infrared identification of the VCM by multiple internal reflection spectroscopy The system also features automated data acquisition and data processing

**Space Environmental Effects on Spacecraft**  
Edward Mark Silverman,1995 *Contamination Control Engineering Design Guidelines for the Aerospace Community* Alan C. Tribble,1996 **Optics in Adverse Environments** Mark A. Kahan,1980 **Space Station Systems** ,1990

**Technology for Large Space Systems** ,1989 **Space Environmental Effects on Spacecraft: LEO Materials Selection Guide, Part 1** ,1995 *A Study of Space Station Contamination Effects* Marsha R. Torr,James F. Spann,Tauna W. Moorehead,1988 Spacecraft Optical Contamination Environment S. B. Mende,LOCKHEED MISSILES AND SPACE CO

INC PALO ALTO CA.,1989 In the framework of this program the Lockheed Palo Alto Research Laboratories is performing a joint experiment with AFGL to make observations of shuttle induced emission effects such as shuttle glow and thruster induced effects In addition observations will be made of natural background phenomena such as the aurora and airglow At very high latitude when the shuttle transits the auroral regions we shall attempt to observe the direct effects of precipitation and precipitation induced discharges In this program the Air Force will be flying Lockheed instrumentation as secondary payload on the shuttle and the payload or mission specialists will make observations through the orbiter windows with the equipment The hardware is essentially a re flight of the Auroral Photography Experiment APE which was flown on mission 41 G augmented with the spectrometer and Fabry Perot The APE experiment will be reflown again in the near future with the expanded configuration Configuration B which includes the spectrometer and the Fabry Perot

Keywords Airglow Aurora Spacecraft glow Spacecraft interactions Rocket emissions Thruster firings Space environments kt **NASA/SDIO Space Environmental Effects on Materials Workshop** ,1989 **Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants** ,2000

The National Aeronautics and Space Administration NASA is aware of the potential toxicological hazards to crew members that might be associated with prolonged spacecraft missions Despite major engineering advances in controlling the atmosphere within spacecraft some contamination of the air appears inevitable NASA has measured numerous airborne contaminants during space missions As the missions increase in duration and complexity ensuring the health and well being of astronauts traveling and working in this unique environment becomes increasingly difficult As part of its efforts to promote safe conditions aboard spacecraft NASA requested the National Research Council NRC to develop guidelines for establishing spacecraft maximum allowable concentrations SMACs for contaminants and to review SMACs for various spacecraft contaminants to determine whether NASA s recommended exposure limits are consistent with the guidelines recommended by the subcommittee In response to this request the NRC first developed criteria and methods for preparing SMACs for spacecraft contaminants published in its 1992 report

Guidelines for Developing Spacecraft Maximum Allowable Concentrations for Space Station Contaminants Since then the NRC's Subcommittee on Spacecraft Maximum Allowable Concentrations has been reviewing NASA's documentation of chemical specific SMACs This report is the fourth volume in the series Spacecraft Maximum Allowable Concentrations for Space Station Contaminants The first volume was published in 1994 and the second and third in 1996 Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants Volume 4 has been reviewed in draft form by individuals chosen for their technical expertise and diverse perspectives in accordance with procedures approved by the NRC's Report Review Committee for reviewing NRC and Institute of Medicine reports The purpose of that Independent review was to provide candid and critical comments to assist the NRC in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity evidence and responsiveness to the study charge The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process

The Top Books of the Year Spacecraft Contamination Environment The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous captivating novels captivating the hearts of readers worldwide. Lets delve into the realm of popular books, exploring the fascinating narratives that have charmed audiences this year. The Must-Read : Colleen Hoover's "It Ends with Us" This touching tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover expertly weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can prevail. Uncover the Best : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids absorbing storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Discover the Magic : Delia Owens "Where the Crawdads Sing" This mesmerizing coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens weaves a tale of resilience, survival, and the transformative power of nature, entrancing readers with its evocative prose and mesmerizing setting. These popular novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of engaging stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a masterful and thrilling novel that will keep you speculating until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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