

SAFETY DESIGN for SPACE OPERATIONS



Edited by
Firooz A. Allahdadi
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Editor-in-Chief
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Safety Design for Space Operations

*This book is dedicated to the memory of Jon Collins
and Georg Koppenwallner*

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Editor-in-Chief

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Editors

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Preface

The adventure of space exploration has come to a new crossroads in its history. After several decades of ambitious space programs that entailed cooperation between different states and space agencies, the industry is moving in new directions such as commercial access to space and new missions to explore other bodies in the solar system. It is impossible to imagine any of these programs going ahead unless safety is granted absolute priority for all aspects of the mission. I should like to quote Albert Einstein, who wrote “*Concern for man and his fate must always form the chief interest of all technical endeavours.*” But good intentions alone will not suffice and, in view of the inherent dangers of the space environment and planetary exploration, risk mitigation is more critical than ever and must be supported with constant scientific and technical research.

There is consequently a need — but also an opportunity — to develop closer international cooperation both in terms of the players involved and the regulatory authorities, to guarantee the success of these new missions. In this field as in others, we must call on one of the most remarkable characteristics of space exploration, which has created a genuine international community prepared to share its experiences for the future benefit of all.

I see the publication of this book as a fine and promising example of the pooling of experience acquired in the safety issues surrounding space operations, for the benefit of public safety and the protection of the environment. I am certain that the relationships and the dynamic created during this project will contribute to future success in international scientific and technical cooperation in this field. It therefore gives me great pleasure to commend this work and I wish it the success it deserves.

*Yannick d'Escatha
CNES President*

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Founding Fellow Member of the International Association for the Advancement of Space Safety (IAASS), and chairman of the IAASS Award Committee.

Dr. Firooz Allahdadi served (1998–2011) at the United States of America HQ Air Force Safety Center in multiple capacities. He was the Center’s Senior Technical Advisor, Director of Space Safety Division and the Department of Defense (DoD) representative in the presidentially mandated Inter-Agency Nuclear Safety Review Panel.



In 1998 Dr. Allahdadi employed rigorous scientific analysis to revamp the Air Force’s conventional weapons operational safety and guidelines. This undertaking produced measurable operational efficiency and considerable real estate savings. He pioneered the Directed Energy Weapons (DEW) Safety initiative leading teams of experts to identify and quantify the entire DEW hazards spectrum. He authored the governing DEW operation safety policies, AFD 91-4, which has been benchmarked throughout US military.

As the DoD representative, Dr. Firooz Allahdadi oversaw special analysis, provided technical oversight and garnered Presidential Launch authorization for the two Martian launches “Spirit” and “Opportunity” in 2003, the “New Horizons Mission,” a journey to Pluto in 2005, and landing of the nuclear-powered Rover “Curiosity” on the surface of Mars in 2010.

He founded and directed the Space Kinetic Impact and Debris Division (1990–1998) at the Air Force Research Laboratory. He led teams of scientists and engineers to develop high-fidelity analytical tools to predict dynamics of the debris clouds created from any space engagements. This technology was employed to simulate specific space scenarios for national security planning.

Dr. Firooz Allahdadi lectured on transport phenomenon and conducted research on several nationally important programs as a faculty member at University of New Mexico. He is a member of the National Research Council, Chief Editor of the International Society for Optical Engineering and has authored over 75 scientific papers.

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Dr. Paul Wilde was a leader in the development of several major US regulations and standards on launch and re-entry risk management. For example, he was the lead author for five of the eleven chapters in the US national standard on range operations risk acceptability requirements, rationale, and implementation guidelines. Dr. Paul Wilde was co-chair of the Common Standards Working Group during the development of the FAA regulation on launch safety, and a principal author for the FAA's *Flight Safety Analysis Handbook*. He has published over 100 technical reports and papers. He received the NASA Exceptional Achievement Medal, Special Congressional Recognition, and several other awards. He is a licensed professional engineer in Texas, with degrees in Mechanical Engineering from the University of California.

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Tommaso Sgobba holds an M.S. in aeronautical engineering from the Polytechnic of Turin (Italy), where he was also professor of space system safety (1999–2001). He has published several articles and papers on space safety, and co-edited the textbook *Safety Design for Space Systems*, published in 2009 by Elsevier, that was also published later in Chinese. He co-edited the book entitled *The Need for an Integrated Regulatory*

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Mr. Richard G. Stern was Department Director of the Flight Mechanics Department at The Aerospace Corporation for 23 years. Mr. Stern joined The Aerospace Corporation after working at Space Technology Laboratories (Ramo Wooldridge) and

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Joined the Centre National d'Etudes Spatiales (CNES) Launcher Directorate in 1997. He covered different positions throughout Ariane 5 design and development phase, finally leading the overall project from 2005 to 2009. Since 2009, he has been Technical Officer for the Ariane 5 Midlife Evolution launcher. He holds a Master's degree in engineering from Ecole Centrale de Paris, France.

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Distinguished member of technical staff at Sandia National Laboratories. He led the Power Systems Working Group for the Mars Science Laboratory Interagency Nuclear Safety Review Panel, and was member for the Pluto New Horizons mission. He is Fellow of the International Association for the Advancement of Space Safety (IAASS).

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