

SAFETY DESIGN for SPACE OPERATIONS



Edited by
Firooz A. Allahdadi
Isabelle Rongier
Paul D. Wilde

Editor-in-Chief
Tommaso Sgobba



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*

About the Editors and Contributors

Firooz A. ALLAHDADI, Ph.D.

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.

Isabelle RONGIER

Founding Associated Fellow Member of the International Association for the Advancement of Space Safety (IAASS), and member of the IAASS Board.

Isabelle Rongier is General Inspector, Director of General Inspection and Quality, of the French Centre National d'Etudes Spatiales (CNES) since April 2010, in charge of internal audit and risk assessment at agency level, and responsible for quality standards application in management processes and space projects. She's also responsible for certifying technical conformity to the French Space Operation Act before each space operation (launch operations and in-orbit operations) is authorized. This certificate is then sent to French Ministry of Space on behalf of the President of CNES.

Previously (2005–2010), Isabelle Rongier was the Technical Director of CNES Launcher Directorate, dealing with all technical domains of a launcher design (solid, liquid and cryogenic propulsion, system and environment, mechanics and avionics). She has worked on all launchers operated from the European spaceport in French Guyana: Ariane 4 and 5, VEGA and Soyuz. She has always been deeply involved in safety methods and studies for all those launchers.

From 1997 to 2005, Isabelle Rongier served as head of system department and senior expert on flight management, including trajectory optimization, GNC algorithms design and validation, on-board flight software design and qualification and transient phases analysis. All these skills are necessary assets for performing safety analyses.



Paul D. WILDE, Ph.D., P.E.

Founding Fellow Member of the International Association for the Advancement of Space Safety (IAASS).

Dr. Paul Wilde has 20 years of experience in space safety standards development, launch and re-entry safety evaluations, explosive safety analysis, and operations safety. He is currently a technical advisor for the Chief Engineer in Federal Aviation Administration's (FAA's) Office of Commercial Space Transportation and chairman of the Range Commander's Council Risk Committee. He has performed leading roles for multi-organization projects in several



high-profile situations. During the Columbia accident investigation, Dr. Paul Wilde was the principal investigator of public safety issues and provided technical oversight for the foam impact tests. He also performed key roles in the independent flight safety evaluations for the maiden flights of the ATV, Atlas V, Delta IV, Falcon 9-Dragon, Space Ship 1, and the Titan IVB.

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.

Tommaso SGOBBA

President and Founding Associated Fellow Member of the International Association for the Advancement of Space Safety (IAASS).

Until October 2012 Tommaso Sgobba has been responsible for flight safety at the European Space Agency (ESA), including human-rated systems, spacecraft re-entries, space debris, use of nuclear power sources, and planetary protection. He joined the European Space Agency in 1989, after 13 years in the aeronautical industry. Initially he supported the developments of the Ariane 5 launcher, several Earth observation and meteorological satellites, and the early phase of the Hermes spaceplane. Later he became product assurance and safety manager for all European manned missions on Shuttle, MIR station, and for the European research facilities for the International Space Station (ISS). For 10 years he chaired the ESA ISS Payload Safety Review Panel; he was also instrumental in setting up the ESA Re-entry Safety Review Panel.

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*



Regime for Aviation and Space, published by Springer in 2011. He is a member of the editorial board of the *Space Safety Magazine*.

Tommaso Sgobba received the NASA recognition for outstanding contribution to the International Space Station in 2004, and the prestigious NASA Space Flight Awareness (SFA) Award in 2007.

William AILOR, Ph.D.

Principal Engineer at the Center for Orbital and Re-entry Studies at The Aerospace Corporation in El Segundo, California. He has worked in the areas of space debris and re-entry hazard analyses for many years. He is Founding Fellow Member of the International Association for the Advancement of Space Safety (IAASS) and Chairman of the IAASS Space Hazards Technical Committee.

Fernand ALBY

Expert in space debris and responsible for space surveillance activities at the Centre National d'Etudes Spatiales (CNES), Toulouse Center. He is member of the Steering Group of the IADC (Inter Agency Space Debris Coordination Committee) and is technical support to the French delegation to the United Nations Committee on the Peaceful Uses of Outer Space (UN-COPUOS) Scientific and Technical Sub-Committee. Author of numerous publications and member of the International Academy of Astronautics.

John B. BACON, Ph.D.

Has worked at NASA in space systems integration for 23 years. Currently he integrates a variety of International Space Station environments issues, including orbital debris modeling and protection, ISS end-of-life disposal. He is a graduate of the California Institute of Technology (B.S. 1976) and of the University of Rochester (Ph.D. 1984)

Sayavur I. BAKHTIYAROV, Ph.D.

Senior technical advisor of Space Safety Division at US Air Force Safety Center HQ, he is a US Department of Defense Coordinator for the Interagency Nuclear Safety Review Panel (INSRP) and an Associate Professor at New Mexico Tech. He participated in the US nuclear-powered Mars Science Laboratory-2011 mission.

Christophe BONNAL

Senior systems expert in the Technical Directorate of the Launcher Directorate of Centre National d'Etudes Spatiales (CNES). Since 1984, he has been in charge of numerous technical and project activities dealing with all current and future

European launchers. Expert in space debris aspects, French delegate to the IADC (Inter Agency Space Debris Coordination Committee) and Chairman of the Space Debris Committee of the International Academy of Astronautics.

Curt D. BOTTS

Chief of Launch Safety of 45th Space Wing, US Air Force, examining anomalous event risks and developing criteria used to terminate flight of vehicles violating prescribed mission rules. As Interagency Nuclear Safety Review Panel (INSRP) Launch Abort Chairman he evaluates proposed launch of systems utilizing radio-isotope sources. He has a Master's degree in aeronautical engineering.

Bernard BRANDT

Assistant Director in charge of design and development of ground-based space facilities, he joined the Launcher Directorate of the Centre National d'Etudes Spatiales (CNES) 35 years ago. He has contributed to the development of the European spaceport in French Guiana, and in particular of the five launch pad complexes used for the Ariane 1 to 5, Soyuz and Vega launchers.

Kenneth BUTTON

Kenneth Button is a University Professor at George Mason University. He was formerly VSB Visiting Professor of Transport Economics and Policy at the Free University of Amsterdam, Professor of Applied Economics and Transport at Loughborough University, and Counsellor in the Secretary General's Advisory Unit of the Organisation for Economic Coordination and Development.

Estelle CHAMPESTING

CNES Safety Studies Engineer in Guiana Space Center Ground Safety Department since 2008. In charge of modeling and calculation of hazardous phenomena for spacecraft and launch activities. Graduated from the National Physics School of Strasburg with a specialization in microelectronics. She gained her first professional experience in Texas Instruments Inc. at Villeneuve-Loubet, as a Test and Product Engineer in the mobile phone field.

Jon CHROSTOWSKI

Specialist in explosion analysis, and effects of air blast and debris on buildings/windows as well as in determining the probability of occupant injury and fatality. He has developed fast-running explosion effects models for generic structures and windows that are being used by the United States Air Force, Navy, Defense Threat

Reduction Agency (DTRA) and Department of Defense Explosives Safety Board (DDESB) to determine the risk from launch vehicle accidents, accidental vapor cloud explosions at explosive storage facilities, and terrorist attacks.

Nathalie COSTEDOAT

Expert in solid propellants design and engineering, pyrotechnics safety management for launchers and operations facilities. She acquired her experience in mathematical modeling development at the French company Société Nationale des Poudres et des Explosifs (SNPE), and in the field launchers operations and quality at the Centre National d'Etudes Spatiales (CNES).

Robert DEMPSEY, Ph.D.

With a Ph.D. in astrophysics, he worked at the Max Planck Institute for Extra-terrestrial Physics in Munich, Germany, and at the Space Telescope Science Institute, Baltimore, MD. Since 1997 Dr. Dempsey has worked on the International Space Station (ISS) program with over 6000 hours of real-time console experience.

John DOLLBERG

He has over 37 years of experience as a system safety engineer and has worked for NASA Kennedy Space Center since 1985. He holds a BS in Electrical Engineering from Valparaiso University and an MS in Industrial Engineering from Wayne State University. He also completed the US Army safety engineering intern training program.

Melissa EMERY

She has provided software integration and/or software safety support to the Space Shuttle program, International Space Station program, and several US Army programs. She is currently employed by APT-Research and provides airworthiness software support to the US Army. Melissa Emery holds a BS in Mathematics from the University of Houston, Clear Lake.

Wigbert FEHSE, Ph.D.

He worked initially in industry in the development of gyroscopes and accelerometers, reaction and momentum wheels and control moment gyros. He joined the European Space Agency (ESA) in 1973, later becoming responsible for automated

rendezvous and docking systems. He retired in 2002. He holds a Master's degree in aeronautical engineering, and a degree of a Doktor-Ingenieur (Ph.D.) from the TU Berlin. He is the author of the textbook *Automated Rendezvous and Docking of Spacecraft*.

David FINKLEMAN, Ph.D.

Internationally recognized expert in space system technology and operation, he served nearly 20 years as Chief Technical for the United States Space Command. He chairs the Space Operations and Ground Support Working Group of the International Organization for Standardization (ISO).

Jean-François GOESTER

Head of the Orbital Maneuvers Office at Centre National d'Etudes Spatiales (CNES), and expert in atmospheric re-entries and flight dynamics for various projects (Hermes spaceplane, Atmospheric Reentry Demonstrator, Automated Transfer Vehicle). He participated in the development of the ELECTRA tool for computation of potential risks to the population due to spacecraft re-entry.

Charles GRAY

Works as an Aerospace Engineer at the NASA Johnson Space Center. Charles has worked in the International Space Station Program Office for five years, serving as primary expert on jettison policy and approval for three years and ISS altitude maintenance and propellant management for the past two years.

Jerry HABER

Leader in the development of mathematical models, performance of flight safety analyses, and in the development of risk acceptability standards for the US National Ranges over a period of more than 30 years. He was a key author of the Range Commanders Council Guidelines for debris risk analysis and risk acceptability.

Andrew HERD

Works at the European Space Agency (ESA) within the field of human spaceflight safety. He has some 15 years of space program experience, in which time he gained over 500 hours on-console, reviewed over 200 spaceflight systems (hardware and software), attended over 350 safety reviews, and, provided safety approval over 1000 flight rules and crew procedures.

Lark HOWORTH

Lead of the International Space Station Trajectory Operations Office in the Mission Operations Directorate at NASA/Johnson Space Center. He manages the group responsible for the protection of ISS from collisions with orbital debris, including conjunction risk assessments and the international coordination of debris avoidance manoeuvres. For over 15 years he has developed analytical and operational capabilities supporting collision avoidance for ISS, Space Shuttle, and other NASA programs.

Nicholas JOHNSON

As NASA Chief Scientist for Orbital Debris, he serves as the agency authority in the field of orbital debris, including all aspects of environment definition, present and future, and the operational and design implications of the environment to both manned and robotic space vehicles operating in Earth orbit. In July 2008 Nicolas Johnson was awarded the US Department of Defense Joint Meritorious Civilian Service Award.

Michael T. KEZIRIAN, Ph.D.

Associate Technical Fellow with The Boeing Company, is a safety design engineer on the NASA Commercial Crew Program. He has 25 years experience in design and flight operations of space vehicles including Shuttle, International Space Station and communication satellites. He is an expert in Composite Overwrapped Pressure Vessels. He is Adjunct Associate Professor at the University of Southern California, he teaches the graduate course, "Safety of Space Systems and Space Missions."

Paul KIRKPATRICK

Chairman of the International Space Station Program Ground Safety Review Panel at NASA Kennedy Space Center (KSC), he is responsible for the safety review and approval of ISS flight hardware processing through KSC. He also serves as the ground safety SME for the project Orion flight test management office.

Steven L. KOONTZ, Ph.D.

BS in chemistry from the University of California at Berkeley, and a Ph.D. in chemistry from the University of Arizona. He has worked 30 years at NASA in materials research and environmental effects. Since 2000 he is ISS System Manager for Space Environments: ionizing radiation effects, spacecraft charging and plasma

interactions, contamination/damage by visiting vehicle, out-gasing, and external surfaces degradation.

Georg KOPPENWALLNER, Ph.D. (1935–2012)

Late professor Koppenwallner worldwide recognized expert of aerothermodynamics and re-entries was owner and CEO of Hyperschall Technologie Göttingen (HTG). He taught courses on aerothermodynamics and satellite aerodynamics at TU Braunschweig for many years. He had close cooperation with the Institute of Fluid Mechanics in the areas of wind tunnel development and experimental methods. Without his bright ideas and initiatives, the hypersonic wind tunnel HLB and the icing wind tunnel of the Institute would not be there.

Leonard KRAMER, Ph.D.

Scientist at The Boeing Company supporting the International Space Station program. He is trained as a Space Physicist with a doctorate from Rice University and specializes in the theoretical aspects of plasma interactions with space vehicles. Leonard has developed circuit models that simulate electrical current exposure to the human body.

Udaya KUMAR, Ph.D.

Received Master's and Ph.D. degrees in high voltage engineering at Indian Institute of Science, India. Currently an associate professor in the same institute. His research interests cover electromagnetics, lightning modeling and protection, and high voltage engineering. He was involved in the analysis and design of lightning protection systems of Indian launch pads.

Erik LARSON Ph.D.

Received a Ph.D. in geophysics from Harvard University, and is now a senior scientist and program manager at ACTA, Inc, in Torrance, CA. He primarily supports the US Federal Aviation Administration and Department of Defense agencies in space vehicle risk software development and flight safety analysis.

Wim van LEEUWEN

Worked 32 years at European Space Agency (ESA) on different spacecraft projects, including Automated Transfer Vehicle and Columbus Module for ISS in the area of development checkout systems. He chaired the ESA manned projects Ground

Segment Control Board (GSCB) and of the Security Control Board (SCB). He represented ESA in the ISS Security Assessment and Report Team (SART).

Carine LEVEAU

Leads the technical department of the Launcher Directorate of Centre National d'Etudes Spatiales (CNES) in charge of guidance, navigation and control (GNC), trajectory and safety during flight. She joined CNES in 2002 working for 3 years at the European Spaceport in Kourou, French Guiana. She managed technical activities related to Ariane 5 and VEGA stages re-entry, and was also responsible for the latest Ariane 5 main stage observation campaign.

Eugene LEVIN, Ph.D.

Leading expert on space tether dynamics, the author of two books on the subject. He worked on various projects with NASA, and US Air Force and Navy. He is currently working with the US Naval Research Laboratory on the flight demonstration of electrodynamic propulsion.

Michael G. LUTOMSKI

Has worked for 27 years at NASA on Manned Spaceflight Programs. Currently he is risk manager for the International Space Station (ISS) program. He is responsible for defining and implementing the qualitative and quantitative risk management processes across the entire program to assist the ISS management in making risk-informed decisions.

Kelli MALONEY

Mechanical Design Engineer with NASA, Kennedy Space Center, Florida since 2002. Lead Design Engineer for the Constellation Program Ground Emergency Egress System and Crew Access Arm designs. Currently Lead Mechanical Designer for the new Space Launch System's Crew Access Arm and the Ground Emergency Egress design engineering representative.

Ronald R. MIKATARIAN

BS in aeronautical engineering from Rensselaer Polytechnic Institute and an MS in mechanical engineering/fluid mechanics from the University of Santa Clara. He has worked for over 50 years in the areas of fluid dynamics, plasma physics and chemistry and is a member of Boeing Research and Technology. He is at present the Boeing Space Environments Manager on the International Space Station.

D. F. Kip MIKULA

System safety engineer at The Boeing Company, he has over 30 years experience in aerospace program system safety. Received a Bachelor of Science degree in mechanical engineering from the University of Michigan-Dearborn, a Master in Business Administration project management degree from National University, and a dual Master of Science degree in aeronautical sciences/operations from Embry-Riddle Aeronautical University.

Erwin MOOIJ, Ph.D.

Received his M.Sc. and Ph.D. in Aerospace Engineering from Delft University of Technology, The Netherlands, in 1991 and 1998, respectively. From 1995 until mid 2007 he worked for the Dutch Space company on re-entry systems and real-time simulator development. Currently, he is an assistant professor in the Faculty of Aerospace Engineering, Delft University of Technology, working on launch and re-entry systems.

Randy NYMAN

Has 23 years of range safety experience and has supported toxic dispersion model development and analysis applications at the United States federal ranges. He contributed to the development of toxic hazard and risk screening methodologies adopted by the FAA for US commercial spaceport licensing applications.

Ron NOOMEN

Received his M.Sc. degree in 1983 with honors in aerospace engineering from Delft University of Technology, in The Netherlands. He analyzed satellite laser ranging data until 2006 and was the analysis coordinator of the International Laser Ranging Service from 1998 to 2006. Currently, he is an assistant professor at Delft University of Technology, coaching interplanetary optimization student projects.

Gary F. POLANSKI, Ph.D.

Has worked for over 30 years at Sandia National Laboratories in national security, nuclear energy, and environmental programs. He has made key contributions in aerospace systems, space nuclear power and propulsion, terrestrial nuclear power, and nuclear materials management. He received a Ph.D. from the University of Texas.

Sandrine RICHARD

Environmental expert since 2005 at CNES/French Guiana Space Centre. Manages the measurement campaign for launchers in flight, the launch range activities and industrial activities. She is in charge of sustaining ISO 14001 certification with an environmental management plan, and research activities for knowledge of impacts, projects of waste reductions and energy consumption mitigation. Ph.D. in chemistry and environmental science.

Karl U. SCHREIBER, Ph.D.

Received his Ph.D. in applied physics in Göttingen, Germany, in 1988. Since that time he has worked for the Technische Universität München in the field of Space Geodesy. His interests are in Satellite and Lunar Laser Ranging (SLR/LLR) and Sagnac Interferometry. He habilitated in 1999 and is Associate Professor at the Forschungseinrichtung Satellitengeodäsie. He is a member of the International Laser Ranging Service (ILRS).

Joseph A. SHOLTIS

LtCol, USAF (Ret) was system program manager (1970–93). Owner, Sholtis Engineering & Safety, 1993–Present. He managed SP-100 space reactor program (1983–87). Participated in every US nuclear-powered space mission since 1974: Viking I & II, Lincoln Experimental Satellites 8 & 9, Voyager I & II, Galileo, Ulysses, Mars Pathfinder, Cassini, Mars Exploration Rovers A & B, Pluto – New Horizons, and Mars Science Laboratory.

Carlos E. SOARES

BS in aerospace and ocean engineering from the Virginia Polytechnic Institute and State University, and an MS in aerospace and mechanical engineering from the University of Oklahoma. He has worked 22 years at Boeing Research and Technology in molecular contamination, plume effects and space environment effects. He is currently the Boeing Lead Engineer/Scientist for ISS External Contamination in the Space Environments Team.

Richard G. STERN

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

Northrop Aircraft. Mr. Stern is the author of numerous technical papers and the co-holder of a patent for a passive satellite attitude control system.

Marc TOUSSAINT

Joined the European Space Agency (ESA) in 1986, after several years spent in the Belgian industry. He has covered many functions and responsibilities on different ESA programs, including Columbus module for the International Space Station and Ariane 5 launcher. He was responsible for the Ariane 5GS version and is currently working on Ariane 5ME version.

Jean-Pierre TRINCHERO

Senior range safety expert of the Centre National d'Etudes Spatiales (CNES) at the Europe's spaceport in French Guiana in the fields of pyrotechnics and propulsion, chemical propellants and payloads preparation. He held operational responsibilities as payload safety officer, head of range safety (ground and flight) including operational responsibility for flight termination system (FTS). He has been also deeply involved in developing launchers safety policy in Europe.

Jérôme VILA

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.

Gregory D. WYSS, Ph.D.

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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About the editors

Tommaso Sgobba is President of the International Association for the Advancement of Space Safety (IAASS) and former Head of the Independent Safety Office at the European Space Agency (ESA), Noordwijk, Netherlands.

Firooz A. Allahdadi is former Director of the Space Safety Division of the United States Air Force (USAF), and a representative of the US Department of Defense in the Inter-Agency Nuclear Safety Review Panel, Albuquerque, New Mexico, United States of America.

Isabelle Rongier is Inspector General and Director of Inspection and Quality at the French Centre National d'Etudes Spatiales (CNES), Paris, France.

Paul D. Wilde is Technical Advisor at the US Federal Aviation Administration (FAA), Houston, Texas, United States of America.

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