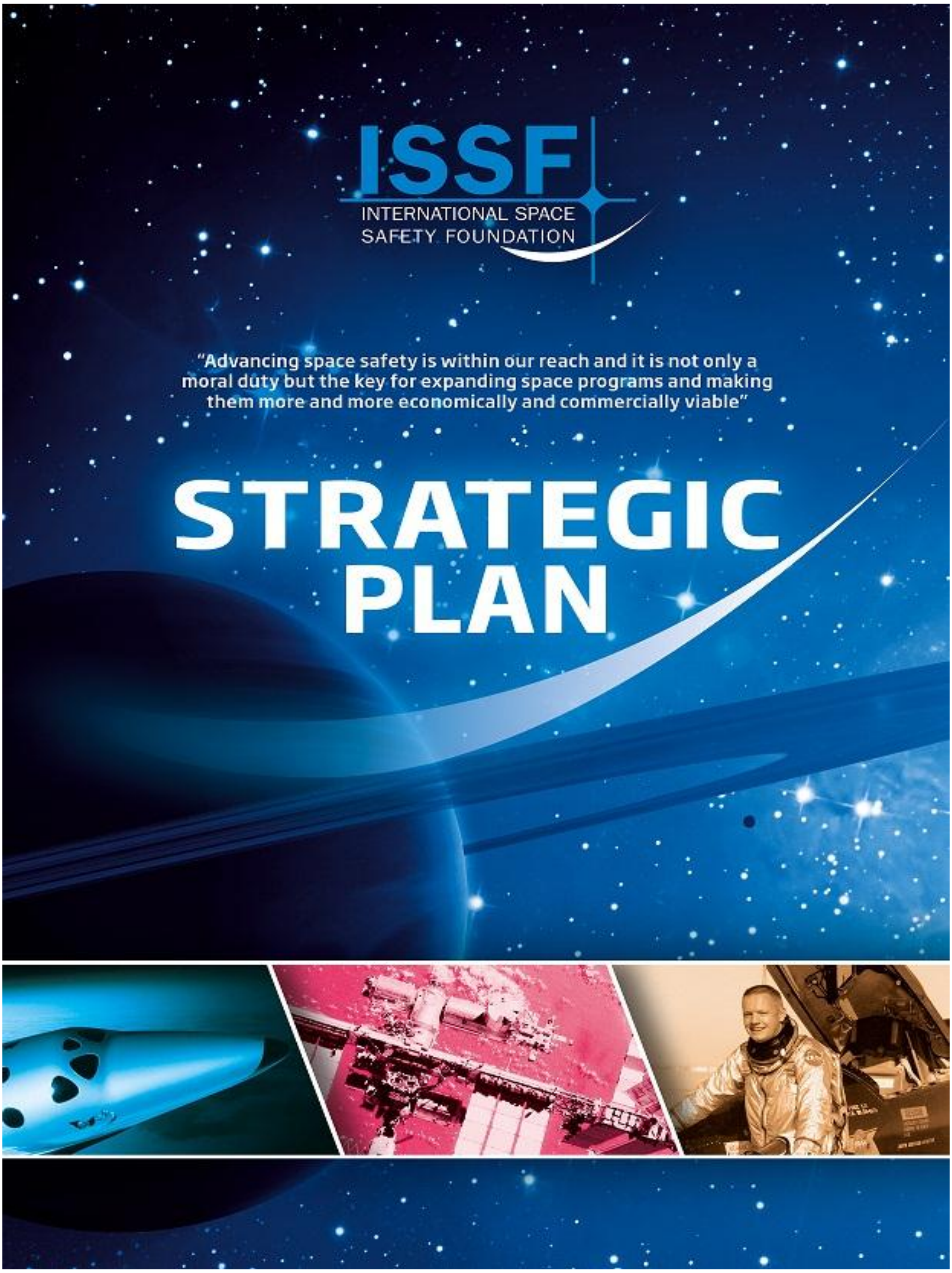
INTERNATIONAL SPACE SAFETY FOUNDATION
1440 Chapin Avenue, Suite 390 • Burlingame, California 94010 • 650/401-7100 • Fax: 650/401-7101 • www.issfoundation.org



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1.0 INTRODUCTION

Space safety is about manned as well as unmanned missions. It is not only about space vehicles design, but includes spaceports operations, space traffic management, ground, atmospheric and on-orbit pollution (space debris), and safety of uninvolved public (launch, re-entries). Space safety is also about specific technical legal, insurance and regulatory matters. Finally, it is a national as well as and international matter.

1.1 Foundation's origins

The International Space Safety Foundation (ISSF) was established in 2008 by T. Sgobba, President of the International Association for the Advancement of Space Safety (IAASS), and by Dr. Richard Stuart President and CEO of ARES Corporation, a California based company specialized in risk and project management with customers in 20 countries.

The basic rationale for establishing the ISSF was that significant progress in the field of space safety requires substantial financial resources for independent research and educations that are well beyond the reach of IAASS, an association of space safety professionals. In addition, a foundation was deemed better suited to solicit and manage funds than a professional association. Because orbital space activities have become predominantly commercial and as consequence the primary beneficiaries of space safety improvements are commercial space industries, the foundation's membership should be made of commercial space corporations which provide funds. It was also considered that because the IAASS and the Foundation share same goals and values and have complementary memberships, their respective activities should be coordinated to create valuable synergies and prevent waste by duplication.

The International Space Safety Foundation has been recognized by the US Internal Revenue Service (IRS) as 501(c)(3) tax-exempt organization, based in California. In the course of the application process clarifications were requested by IRS about the inter relationship with IAASS, which were found acceptable. Dr. Richard Stuart became the first President and CEO of the ISSF. For an initial period of 3 years the Foundation received administrative support as in-kind sponsorship by ARES Inc., concurrently the IAASS deposited on the Foundation bank account the sponsorships received from US companies in conjunction with conferences or as annual membership fee.

In the last months, the missions and goals of the Foundation have been further refined with the support of the Foundation's Advisory Council and are currently being re-directed towards the development, as first step, of the academic education and professional training program of the so-called International Institute for Space Safety (IISS), as explained later in this plan.

1.2 The IAASS

After losing radio contact with ground control, Space Shuttle Columbia re-entered the Earth's atmosphere disastrously in 2003. The shuttle burned up on re-entry and disintegrated over Texas, killing all seven crew members. Small and large bits of shuttle debris were spread over a wide area of Texas, including shuttle engines full of highly toxic chemicals. Fortunately, no others were harmed, but the risk of a fatal crash with air traffic was estimated by Federal Aviation Administration to be as high as 1/3 for the several airliners that were crossing that fatal day the curtain of falling debris.

The Columbia accident as well the disaster in August of the same year when the Brazilian VLS-1 rocket exploded on the Alcantara launch pad killing 21 people, spurred the establishment of the first association of space safety professionals, the International Association for the Advancement of Space Safety (IAASS).

The IAASS was the initiative of an international group of safety engineers and managers involved in the International Space Station (ISS) Program which decided to give finally voice to the otherwise "silent" space safety community. In the process the original group of founding members reached several other colleagues working in other space projects, like launchers and nuclear payloads, and learned that they were very much willing to establish a forum for the exchange of knowledge and experience. They found that around the common safety goals it was not only possible but also necessary to create an international vision of cooperation, because safety is a common interest and a unifying objective of the human space adventure. The IAASS is registered as a non-profit association in The Netherlands.

In 2004 the IAASS became a member of the International Astronautical Federation (IAF). In 2006 former US Senator John Glenn, first American to orbit, accepted to become Honorary Member of the IAASS. In 2010 IAASS was granted Observer status at the United Nations COPUOS (Committee on the Peaceful Uses of Space).

In accordance with the Association Charter, the IAASS membership is open to anyone having a professional interest in space safety: physical persons, corporations, agencies, universities, institutions, and other professional associations. However, to ensure independence only individual members of the association can vote to elect officers and representatives of the Association. Currently the Association counts about 250 members from 26 countries. The IAASS is governed by a President and a Board including regional representatives worldwide, both elected by the General Assembly. The IAASS activities are carried out by Standing and Technical Committees, and supported by a Management Team.

Because of the very specialized field of interest, the growth potential of the association in the foreseeable future is up to a maximum of about 400 individual members. This means that the IAASS is and will remain a numerically small group of professionals yet a unique think-tank with a great potential for shaping attitude and culture of the wider space programs community.

Being numerically small by definition, the IAASS is unable to financially support all its initiatives solely through the individual membership fees but it needs additional income and the support of sponsors and donors. Currently the IAASS sustains itself through the organization of conferences (every 18 months) and professional training activities. The relevant income covers internal administrative costs, including a part-time salaried Executive Director, events advertisement and expenses, the Space Safety Magazine, website, awards as well as the cost of travelling for IAASS representatives at official gatherings (e.g. United Nations COPUOS).

Because the IAASS goals go well beyond the current activities and funds, and include in particular the promotion of independent space safety research and specialized academic education, the IAASS decided to seek the involvement of high profile corporations, government organizations, and private donors, particularly in United States and Europe. In consideration of the fact that the IAASS legal seat is in Europe while the main support is both in United States and Europe (55% and 30% respectively of the total of individual members) a sister organization, the International Space Safety Foundation (ISSF), was established to create synergies, involve commercial space industries, and facilitate funds raising in United States due to advantageous tax-exempt legislation.

1.3 Donating for safety: the aviation precedent

In the beginning of the past century the Guggenheims were a wealthy family who had made the bulk of their money from the mining industry. They believed they had an obligation to return to society some of the benefits they had reaped, so in 1924 they established the Daniel and Florence Guggenheim Foundation to promote a variety of charitable and benevolent causes.

After World War I, aviation in the United States was in a depressed state. Not only had the surplus of planes from the war eliminated the market for new aircraft, but also the majority of the American public had little interest in flying, largely because of its risky nature. And it was extremely risky, plagued by accidents and fatalities. But there was no pool of trained aeronautical engineers to improve the design and construction of aircraft. Thus, the Guggenheims set out to establish schools and research centers at universities around the country. They also set about to make air travel safer by using their fund to pay directly for aviation research. This research contributed to the development of more reliable aircraft engines and instruments, and eventually, public acceptance of aviation as a safe and fast method of transportation.

In the early times of aviation improvements in instrumentation were needed. Airplane pilots all knew that weather greatly affected flight safety, particularly when it reduced visibility. Fog, which could reduce visibility to nothing, was probably the most serious condition that pilots faced. Pilots who encountered fog quickly became disoriented and often crashed into the ground. The Guggenheim foundation paid for studies of "fog flying" and improved navigation by means of better instruments that would give pilots the information they needed to fly safely even if they couldn't see where they were going.

The Guggenheims felt that aircraft could be made safer by improving their aerodynamic characteristics. In 1927, they announced the Safe Aircraft Competition, offering a $100,000 prize and five $10,000 secondary awards for the safest aircraft that could be built.

The Guggenheim fund also created a "Model Airway" between San Francisco and Los Angeles that was operated by Western Air Express. This demonstration helped convince the American public that commercial passenger service could be safe, dependable, and comfortable and could exist apart from the airmail business. The service began on May 26, 1928, flying a Fokker F-10 Super Trimotor that Guggenheim provided. The scheduled flights gradually became part of Western's regular service. The flights did not prove financially profitable, but they were heavily used and demonstrated that regular, safe passenger service was a reality.

The Foundation educational activities began in 1925 with a grant for the establishment of a school of aeronautical engineering at New York University. Over the next four years, the fund would make grants that established Guggenheim schools or research centers at the California Institute of Technology, Stanford University, the University of Michigan, the Massachusetts Institute of Technology, the University of Washington, Georgia School (later Institute) of Technology, Harvard University, Syracuse University, Northwestern University, and the University of Akron.

Between 1925 and 1930, the Guggenheim family invested more than $2.6 million in a series of aviation-related programs. In 1950 the Daniel and Florence Guggenheim Foundation created the Cornell-Guggenheim Aviation Safety Center at Cornell University, where research was carried out in collision avoidance, crash fire protection, human factors, instrumentation error prevention, prevention of in-flight explosions. Eventually the center was closed in 1967 when the original foundation goal was achieved of making transportation by air as safe as trains.

1.4 Safety risk of space missions

The space industry is expanding rapidly worldwide and with it the safety risk because of poor attention, lack of technical progress in the field, cumulative effects, and weak or non-existent international rules. Eventually the prospect for industry growth will be badly hurt if the necessary course of corrective actions is not undertaken in the short period.

Safety risk in space missions refers to the general public safety (on ground, on air and at sea) during launch and re-entry operations, safety of launch range personnel, and safety of humans on-board. Space safety is also generally defined in a wider sense as encompassing the safeguard of valuable facilities on ground (e.g. launch pads), of strategic and costly systems on orbit (i.e. telecommunication satellites, global navigation systems, space stations, etc.) as well as the safeguard of the space and ground environment.

As of today there have been nearly 200 people killed on ground by rocket explosions during processing, test, launch preparations and launch. The figure is probably well approximate by defect because of discrepancies between some official accounts and other sources. In the last 10 years there have been also at least 6 launches which have been terminated by explosion commanded by the launch range safety officer to prevent risk for the public. There were also several more cases of launchers which did not make to orbit and crushed back on Earth. Out of the 200 people killed on ground since the beginning of the space programs, 35 casualties were counted just at the beginning of this century. First the explosion in October 2002 of a Russian Soyuz which killed a young soldier and just by luck did not involve members of a large international support team on-site. Then the explosion in August 2003 of the Brazilian VLS-1 rocket at Alcantara Launch Range which claimed 21 lives, and the accident at the Indian solid rocket processing facility in Sriharikota in February 2004 with six people killed. Finally the nitrous oxide flow test explosion at Scaled Composites, at Mojave Spaceport in California, in July 2007, which claimed the lives of 3 and seriously injured other 3 co-workers of the leading space tourism company.

A total of 22 astronauts and cosmonauts have lost their lives since the beginning of human spaceflight. The first was the soviet cosmonaut trainee V. Bondarenko in March 1961 who died in a pressure chamber fire during training. Three American astronauts were also killed by a fire during training in January 1967 inside an Apollo capsule.
The re-entry accidents where three in total: Soyuz 1, in April 1967, Soyuz 11 in June 1971, and Shuttle Columbia in February 2003. In the latter case, in addition to the loss of the crew, the public on ground and the passengers traveling by air, within the continental-wide path of falling debris, were subjected to an unprecedented level of risk.

In a different category are the environmental accidents such as failures leading to dispersal of radioactive material. As of today there have been 10 such cases, including the plutonium payload on board Apollo 13 lunar module jettisoned at re-entry, which ended up in the Pacific Ocean close to the coast of New Zealand, or the 68 pounds of uranium-235 from the Russian Cosmos 954 which were spread over Canada's Northwest Territories in 1978. The most recent accident of this kind was in 1996, when the Russian MARS96 disintegrated over Chile releasing its plutonium payload which has never been found.

Finally the risk represented by orbital debris. Orbital debris generally refers to any human-made material on orbit which is no longer serving any useful function. There are many sources of debris. One source is discarded hardware such as upper stages of launch vehicles or satellites which have been abandoned at the end of their useful lives. Another source is spacecraft items released in the course of mission operations. Typically, these items include launch vehicle fairings, separation bolts, clamp bands, adapter shrouds, lens caps, momentum flywheels, and auxiliary motors. Various shapes and sizes of debris are also produced as a result of the degradation of hardware due to atomic oxygen, solar heating, and solar radiation, and also from combustion of solid rocket motors. Examples of such products are paint flakes, aluminum oxide exhaust particles, and motor-liner residuals.

Fifty years of spaceflight have cluttered the space around the Earth with an enormous quantity of human-made debris. Scientists assume that there are approximately 500,000 objects in orbit whose sizes are above 1 centimeter. Currently, about 21,000 objects at least 10 cm in diameter or larger are being tracked by the U.S. Space Surveillance Network (including about 800 objects representing functional satellites). Only the largest pieces of debris in orbit can be regularly tracked, mainly by using optical sensors. The minimum size objects that are regularly tracked are 30cm in the geosynchronous orbit and about 10cm in low Earth orbits. Among the tracked pieces of debris, there are about 200 satellites abandoned in geosynchronous orbits occupying or drifting through valuable orbital positions and posing a collision hazard for functional spacecraft. The survival time of the debris can be very long. Objects in 1,000 km perigee orbits can exist for hundreds of years. At 1,500 km, the lifetime can go up to thousands of years. Objects in geosynchronous orbit can presumably survive for a million years.

The amount of debris on orbit in the future will depend upon whether the creation or removal rate dominates. Currently, the only mechanism for removal of debris is orbital decay by drag, which ultimately leads to re-entry. This mechanism is only effective in a restricted range of low Earth orbits. At higher orbits, it takes hundreds to thousands of years for objects to re-enter the Earth's atmosphere. Historically, the creation rate of debris has outpaced the removal rate, leading to a net growth in the debris population in low Earth orbit at an average rate of approximately 5 percent per year. A major contributor to the current debris population has been fragment generation via explosions. As the debris mitigation measure of passivation (e.g., depletion of residual fuel) becomes more common, explosions will decrease in frequency. It may take a few decades for the practice of passivation to reduce the explosion rate, which currently stands at about four per year.

Several environment projection studies conducted in recent years indicate that, with various assumed future launch rates, the debris populations at some altitudes in low Earth orbit will become unstable. Collisions will take over as the dominant debris generation mechanism, and the debris generated will feed back into the environment and induce more collisions. The most active orbital region is between the altitudes of 900 and 1000 km and, even without any new launches, this region is highly unstable. It is projected that the debris population (i.e.: objects 10 cm and larger) in this “red zone” will approximately triple in the next 200 years, leading to an increase in collision probability by a factor of ten. In reality, the future debris environment is likely to be worse than as suggested, as satellites continue to be launched into space. To better limit the growth of future debris populations, active removal of objects from space needs to be considered. The debris population of interest for possible removal includes small (1-10 mm), medium (1-10 cm) and large (derelict spacecraft/expended rocket bodies) sized debris in low Earth orbit (LEO), as well as large sized debris in Geosynchronous Earth Orbit (GEO). Collision Risk with Orbital Debris

Orbital debris generally moves at very high speeds relative to operational satellites. In LEO (i.e., altitudes lower than 2,000 km), the average relative impact velocity is 10 km/sec (36,000 km/hr). In the geosynchronous orbit, the relative velocity is lower, approximately 2 km/s, because most objects move in an eastward direction orbit. At these hyper velocities, pieces of debris have a tremendous amount of kinetic energy. A 1 kg object at a speed of 10 km/s has the same amount of kinetic energy that a fully loaded truck, weighing 35,000 kg, has at 190 km/hr. A 1 cm sized aluminum sphere at orbital speed has the energy equivalent of an exploding hand grenade. A 10 cm fragment in geosynchronous orbit has roughly the same damage potential as a 1 cm fragment in low Earth orbit.

Pieces or particles of debris smaller than 1 mm in size do not generally pose a hazard to spacecraft functionality. Debris fragments from 1 mm to 1 cm in size may or may not penetrate a spacecraft, depending on the material composition of the debris and whether or not shielding is used by the spacecraft. Penetration through a critical component, such as the flight computer or propellant tank, can result in loss of the spacecraft. NASA considers pieces of debris 3 mm in size and above as potentially lethal to the Space Shuttle and the International Space Station. Debris fragments between 1 and 10 cm in size will penetrate and damage most spacecraft. If the spacecraft is impacted, satellite function will be terminated and, at the same time, a significant amount of small debris will be created. For example, if a 10 cm debris fragment weighing 1 kg collides with a typical 1,200 kg spacecraft, over one million fragments ranging in size from about 1 mm and larger could be created. Such collisions result in the formation of a debris cloud which poses a magnified impact risk to any other spacecraft in the orbital vicinity (e.g., other members of a constellation of satellites).

Certain regions of the debris cloud are constricted to one or two dimensions. Such constrictions do not move with the debris cloud around its orbit. They remain fixed in inertial space while the debris cloud repeatedly circulates through them. In many satellite constellations, there are multiple satellites in each orbital ring. If one of these satellites breaks up, the remaining satellites in the ring will all repeatedly fly through the constrictions. If many fragments are produced by the breakup, the risk of damaging another satellite in the ring may be significant. If satellites from two orbital rings collide, two debris clouds will be formed with one in each ring. The constrictions of each cloud will then pose a hazard to the remaining satellites in both rings.

The collision in 2009 of the Russian satellite, Cosmos 2251 with Iridium 33 was the worst space debris event since China intentionally destroyed in 2007one of its aging weather satellites during an anti-satellite weapon test. The Iridium satellite that was lost in the collision was part of a constellation of sixty-six low Earth orbiting satellites providing mobile voice and data communications services globally. As expected, the risk of collision of other Iridium satellites in the same plane dramatically increased with daily announcements of possible collisions (called conjunctions) with the debris from Iridium 33.

To reduce the space debris risk, satellites should be disposed at the end of their operational life by either de-orbiting (those in low orbits) or moving to “graveyard” orbits (those in geostationary orbits). De-orbiting space hardware means also the possibility of debris surviving re-entry and causing casualties on ground. Here it is not so much a matter of trading one hazard for another because natural de-orbiting would in any case takes place in due time due to the physics of the residual atmosphere in Low Earth Orbit (LEO). Currently there are no means to remove the re-entry risk but only guidelines to move it in the timeframe (the well known 25 years rule). Instead the use of “graveyard” orbits for satellites operating in geostationary orbits is more and more frequently complied with, but there is the unresolved issue of those satellites that are out of control, or failed to complete the removal, because of malfunctions.

1.5 Commercial human spaceflight: the emerging market

Unmanned suborbital flights have been routine since the beginning of the space age, with sounding rockets covering a wide range of apogees even higher than the altitude of the Shuttle and ISS orbits. Nowadays suborbital spaceflight is living a new season due to the emerging human spaceflight industry which is proposing crewed vehicle configurations substantially similar to early government programs.
The sub-orbital commercial vehicles currently in development follow one of two basic configurations with different risk levels: launcher-capsule and aircraft-type. The requirements for the launcher-capsule configuration have been in place for more than 50 years and have been successfully proven in manned orbital space flights. The aircraft-type, on the other hand, presents safety requirements that have a well-established technological basis in the aeronautical engineering field. Still, the requirements related to the most safety-critical parts of the flight, like inadvertent or untimely release from the carrier, are not reflected in any current civil aviation type regulation.

In 2004, the US private spaceflight industry welcomed the Commercial Space Launch Amendment Act (CSLAA) which postponed until December 23, 2012 or until an accident occurs, the ability by the Federal Aviation Administration (FAA) to issue safety standards and regulations except for aspects of public safety. The Congress has recently extended the original deadline to October 1, 2015.

The CSLAA requires that a prospective space tourist shall be pre-briefed about the risks of spaceflight and sign an informed consent agreement. It can be reasonably expected that the average space flight participant will not have the necessary background and technical experience to truly grasp the risk of space flight. Due to the fact that there is no such thing as “absolute safety,” and that the acceptable risk is generally the one defined by government standards and regulations, an operator would have a hard time defending his vehicle risk level and demonstrating the thoroughness of the information he passed to the customer in case of litigation following an accident. A set of well-defined safety regulations, and a certification of compliance with them, not only serves the interests of the customer, but also protects the industry from tort liability, by implicitly or explicitly defining the acceptable risk level at the current state-of-art.

An alternative to government regulation is self-regulation, which promotes a higher level of safety as a business case. Formula 1 car racing presents a good example in this respect. In the first three decades of the Formula 1 World Championship, inaugurated in 1950, a racing driver's life expectancy was about two seasons. Total risk was accepted by pilots, racing teams, and the public. The deaths of Roland Ratzenberger and Ayrton Senna on live TV during the Imola Grand Pix of 1994 forced the car racing industry to look seriously at safety, or risk being banned forever. In the days after the Imola crashes the Fédération Internationale de l'Automobile (FIA) established the Safety Advisory Expert Group to identify innovative technologies to improve car and circuit safety, and mandated their implementation and certification testing. Thanks to this effort, Formula 1 car racing evolved into a safe, self-regulated , multibillion dollar business funded by sponsorships and global television rights.

Nowadays the need for self-regulation is seen as a way of complementing government safety policies, rules and oversight. An example comes from the oil industry. The US Presidential Commission that investigated the Deepwater Horizon oil spill in the Gulf of Mexico of April 2010, which killed 11 workers and caused an environmental catastrophe, recommended the establishment of an independent safety agency within the Department of the Interior and that "*the gas and oil industry must move towards developing a notion of safety as a collective responsibility*." According to the report, "*Industry should establish a 'Safety Institute' [...] an-industry created, self-policing entity aimed at developing, adopting, and enforcing standards of excellence to ensure continuous improvement in safety and operational integrity offshore*."

The above self-regulation model should be applied to the human commercial spaceflight industry to overcome the drawbacks of the traditional approach of the early space industry.

2.0 A FOUNDATION TO ADVANCE SPACE SAFETY

Notoriously space missions are risky. Although such risks are in a number of cases related to the extreme of the space environment and to the technological limits, it is a fact that as of today <u>all</u> accidents in space missions happened because of design and manufacturing errors which were well within the knowledge and capability of the time to control and prevent.

Accidents happen because of failures, malfunctions, human errors or combinations thereof. In addition, lack or deficient escape systems may greatly contributes to a fatal outcome. The main causes of failures and malfunctions are design errors and manufacturing errors. Catastrophic design errors in space projects can be tracked essentially to a difficult balance between on one side the complexity of the space systems, and the relative ease by which failures or malfunction of highly energetic systems can propagate to catastrophic consequences, and on the other side the limited systems safety engineering culture of the design teams as a whole. Manufacturing errors result in product nonconformities which may go undetected thus causing all kinds of consequences. A study of four decades of major space systems failures concluded that manufacturing, production and assembly errors had been also an important cause of space systems failures (the root cause of the Apollo 13 liquid oxygen tank explosion was a missed design change during manufacturing).

The space systems complexity as well the complexity of the overall organization involved in their realization and operation, requires a substantial advancement of the science of spaceflight hazards mitigation and control, and of risk assessment techniques. Furthermore it is required that the project teams maintain a safety culture based on a widespread knowledge of key principles and techniques of design for safety, and on a multidisciplinary awareness of hazards and potential vulnerabilities in the design, manufacturing and operations. Unfortunately safety design methods and hazard analyses techniques are not currently taught in engineering schools. In the aerospace industry on the job training in systems safety is usually reserved to small specialized groups of safety engineers, which often lack the necessary in depth system knowledge to become integral part of the design teams.

The current safety risk level in space mission (manned and unmanned) is totally inadequate. Without a “quantum leap” in the safety area any further expansion of the space industry may become constrained, orbital human spaceflight may never become commercially viable and government missions may even risk extinction because of diminishing political support.

Advancing space safety is within our reach and it is not only a moral duty but the key for expanding space programs and making them more and more economically and commercially viable. To advance space safety, improved education, exchange of knowledge, and focused studies are needed. The primary goal of the International Space Safety Foundation is to promote such advancement by identifying related programs, raising funds from private donations, and making them available to qualified universities, colleges, researchers and professional organizations. Donors may chose to support the overall Foundation efforts, or one or more programs, or an even specific project.

The International Space Safety Foundation is a non-profit organization dedicated to furthering the policies of international cooperation and scientific progress in the field of space safety

Mission & Goals

Significantly advance the science and application of space safety to enhance safe access to space for the world and for future generations by:

- Undertaking independent research, education, standards development and certification activities that address all elements of space safety.

- Improving the dissemination of knowledge and cooperation between interested groups and individuals. Promoting free and unobstructed flow of safety related information .

- Improving the understanding and public awareness of the space safety issues.

- Promoting innovative international cooperation policies, including close cooperation between governments and industry.

- Advocating the establishment of rules, and regulatory/self-regulatory bodies at national, international and industrial levels for the civil use of space.

- Seeking to influence all segments of space programs management, decision and policy makers, and elements of engineering and operations towards innovating safety processes, rules, standards and methods, and to push the use of improved technologies and inherently safe systems solutions.

Values & Beliefs

Excellence – The Foundation seeks to become the primary organization worldwide in supporting focused space safety research and best education and training in the field.

Independence – The Foundation will maintain an absolute independent stance by never subscribing to those policies (of donors and non-donors) contrary to the prime mission of the Foundation and its beliefs.

Integrity – Integrity is the primary asset of the Foundation, on which to build a reputation as the world leading organization in space safety research and education.

Knowledge - The Foundation believes that knowledge advancement, and knowledge management are formidable tools for accident prevention and therefore strives to advance, disseminate and provide easy access to knowledge.

Accountability – The Foundation is fully accountable to its stakeholders and donors for accurate and appropriate use of resources to achieve the goals of the Foundation.

3.0 FOUNDATION MANAGEMENT AND PROGRAMS

3.1 Management and development

The International Space Safety Foundation (ISSF) is dedicated to the promotion of space safety, through funding of research and development activities, development of space safety standards and compliance certification services, promotion of academic and training programs, motivational campaigns including recognition of outstanding contributions to the space safety field, and assistance to young people and professionals to acquire or further develop the necessary knowledge. In order to achieve these goals the ISSF requires professional management.

3.2 Program of activities and funding allocation

The Foundation will undertake programs to promote space safety with special focus on international cooperation. The programs are defined in terms of strategic directions and generic areas of interest and therefore should remain valid in the long period. In any case the programs will be reassessed, modified or updated by the ISSF Board as the need arises. The programs are executed through the selection and completion of projects which are part of multi-year planning. The allocation of program funds to detailed projects will be performed in the course of the projects evaluation process.

3.2.1 Research and Development Program

Currently space agencies and their contractors invest very little in general space safety research and tend to focus activities on project specific issues. In any case they look to matters from a national program perspective even when international cooperation is involved. A global space safety research and development program aiming to support dedicated systems development, global risk management, and international cooperation is practically non-existent.

The ISSF research and development program will aim to initiate innovative research projects in the field of space safety and to pursue whenever possible those study topics which may benefit from an international cooperation. The ISSF research and development program will also aim to stimulate the expansion of government and contractors space safety research efforts by undertaking precursor studies and publishing results. The ISSF research initiatives will include sponsorship of general studies in support of global risk management, conceptual studies of innovative systems, development of dedicated safety equipment, as well as performance of detailed studies on specific topics. Particular attention will be paid to studies of space systems interoperability, which could pave the way for the definition of standard interfaces to allow mutual assistance in case of emergency.

The ISSF research program will place emphasis on the involvement of academia and on synergies with industry. The ISSF sponsored studies will also aim to develop an international space safety culture by encouraging the setting up whenever possible of international studies teams to compare, discuss and bridge differences.

The Foundation will seek the support of the Technical Committees of the International Association for the Advancement of Space Safety (IAASS) for establishing multi-years research and development plans.

3.2.2 Standardization and Independent Safety Certification Program

Space up to and including geostationary orbits has become as international sea waters and airspace another realm where it is in the interest of the global community to operate in accordance with common international safety standards instead of vague principles. Voluntary consensus space safety standards need to be agreed internationally by industrial and institutional stakeholders as reference for the design and operations of space systems.

The ISSF Foundation will promote the incremental development of international space safety standards in four main directions: a) public risk and protection of assets on orbit; b) development of minimum safety standards for commercial human spaceflight; c) easing of barriers that different national safety regulations may create to international commerce, while preventing distortion of commercial competition due to substandard safety practices; d) development of safe-and-rescue interoperability capabilities.

The ISSF will in particular seek to provide the financial means for the initial definition, organization and set up of an international space safety standards secretariat.

The ISSF will also seek to support the development and establishment of independent flight safety certification and testing commercial services on the model of well known successful experiences in other industry branches (e.g. Classification Societies for shipbuilding). The ISSF would support the costs of studying and developing the concept and of initiating such services until they can become self-sustained on a commercial basis. The ISSF will also fund studies about possible liabilities and how to protect independent certification services. The ISSF will also seek to enter in discussion with insurance companies for the purpose creating a synergetic link with the above certification services.

3.2.3 Education and Training Programs

High technology organizations make a clear distinction between education and training. Education is instruction and study focused on creative problem solving that does not provide predictable outcomes. Education encompasses a broader flow of information to the student and encourages exploration into unknown areas and creative problem solving. Training instead is instruction and study focused on a structured skill set to acquire consistent performance. Training has predictable outcomes and when outcomes do not meet expectations, further training is required. On the one hand, graduate level education requires more time to complete and often culminates with an original research project. Such an educational program prepares individuals for careers and includes practice in critical and creative thinking that will in many ways last throughout a career. On the other hand, training is much more short term and typically takes days to a week or two to complete.

Space safety training in the space community has been essentially on-the-job training while space safety education has been virtually non-existent. Engineers initially selected for performing safety tasks generally have a variety of background. They develop their knowledge through internal information exchanges, brain storming, discussions, short seminars etc. Experienced safety engineers teach the newcomers in a sort of master-to-apprentice relationship.

Space safety education is required not only for safety engineers, but also of systems engineers and program managers. Space safety design criteria, methods and hazard analyses techniques are not generally taught in depth in aerospace engineering schools since up to now they have not been considered as part of a specialized branch of space systems engineering but rather as aspects of various specialist field of engineering (e.g. in relation to pressure systems, avionics design, etc.). Both manned programs and unmanned programs clearly demand to form a new technical profile, the safety engineer, to support/execute the design safety certification processes. These engineers had to gain system knowledge as well as a broad understanding of multidisciplinary safety aspects such to be able to perform integrated analyses. In parallel the systems engineering community has become increasingly aware that safety had to be designed-in from the very beginning or risk costs escalation, a huge pile of (unjustifiable) waiver and ultimately devastating accidents.
There is also the need for safety education for those operating space systems, from launch safety, to on-orbit traffic management, and re-entry safety. They should acquire knowledge of rules and methods for on-orbit environment protection (space debris mitigation, remediation, etc.).

An additional consideration is that in future space and aviation will share more and more common operational interests. Due to emerging of hybrid systems (i.e. sub-orbital space-planes), and the operational use of space-based critical systems for air navigation, aviation communication and high resolution weather forecasts. In other words aviation operators need to have some amount of education in space safety matters and vice-versa.

The effective education of professionals in the space safety field depends on the availability of relevant and up-to-date academic courses and textbooks in all areas related to space safety. The IAASS has just completed the production of a comprehensive set of university text books covering safety design, operations, and standards. About 150 authors, among top experts worldwide have been involved in such effort that lasted five years. In the meantime the Foundation, working in cooperation with the IAASS, has surveyed University officials and professors and organized workshops to determine a plan of actions. It has been determined that the first steps should be the establishment of undergraduate courses and a Certificate program to be followed later by the development of a full Master degree program. The first undergraduate course was launched by the University of Southern California early in 2012.

The Foundation will also seek to endow fellowships, scholarship, study grants for students as well as endow professorships in the field of space safety.

Finally, the key to effective space safety is the availability of well-trained and current professionals in the space industry that have the right skills and current knowledge of the latest space and safety technologies. The ISSF Foundation has been working with the IAASS and those involved in space safety around the world to develop an initial set of training courses in the areas of launch safety and payloads safety.

Although on-site education and training with quality instructors is a key element of the programs, the Foundation is also seeking to develop effective and interactive on-line courses that can allow professionals worldwide to obtain just-in-time, affordable training and Internet based courses that meet their individual needs.

3.2.4 Cooperation with IAASS Program

The International Association for the Advancement of Space Safety (IAASS) is the premiere and sole professional association worldwide in the field of space safety, which performs a pivotal cultural action in establishing and propagating an international space safety culture. Because of the highly specialized field in which it operates the association membership is destined to be limited to few hundreds highly knowledgeable individuals. As a consequence of such limitation and in consideration of its worldwide scope, most of its operations and programs rely on voluntarism and sponsorships.

The ISSF will work on a cooperative basis with the International Association for the Advancement of Space Safety (IAASS) to further the cause of space safety in the U.S. and globally. The two organizations work on common goals and objectives, and cooperate to conduct research, promote training, education and relevant literature in the field and to support conferences, workshops and awards in the field of space safety.

3.2.5 Conferences and Workshops Program

Critical to the success of progress in space safety around the world is the collaboration and exchange of ideas among professionals and academic, governmental and industrial researchers in the field. Conferences and workshops developed to exchange ideas, question new findings, and learn of critical experience and new data in the field. The ISSF Foundation will play a key role in supporting and sponsoring the organization and conduct of such key conferences, workshops and seminars in the field of space safety.

3.2.6 Motivational Program

Another aspect of innovation and progress in the field of space safety is the recognition of outstanding contributions to the field that have moved the state of the art forward. There are a number of strategies as to how such progress can best be achieved. These include lifetime achievement awards, innovation awards, design challenges and prizes and awards for student researchers. The Foundation will seek to establishment endowments to support such awards, recognitions and challenges. These efforts will seek to ensure that these efforts are well distributed around the world and cover the work of space agencies, industry, commercial space initiatives and students.

3.2.7 Management Expenses (TBD)

3.3 International Institute for Space Safety

The Foundation plans to consolidate and integrate selected parts of the above Foundation's programs, in support of the commercial spaceflight industry, into an International Institute for Space Safety (IISS). In particular: a) research and development projects, involving in particular universities; b) education and professional training; c) development of voluntary standards and, d) independent certification. The space safety institute would closely cooperate with the commercial space industry, and represent their independent, self-policing entity aimed at developing, adopting, and enforcing standards of excellence to ensure continuous improvement in space safety.

The International Institute for Space Safety (IISS) will be organized as a framework program of ISSF implemented with the support and in close cooperation with IAASS. The ISSF primary role would be to collect/provide funds, and to be in charge of strategic direction and overall control of funds spending. The IAASS primary role would be to solicit and coordinate the provision of technical knowledge and skills by its members, and to provide detailed project management. The Institute would be focused for the initial period of three years on implementing academic education and professional training activities, while pursuing the other activities as funding opportunities arise.

It is envisaged to create within the Institute a Center for Commercial Spaceflight Safety (CCSS) which would become Affiliated Member of the FAA COE-CST (Center of Excellence for Commercial Space Transportation). It also currently proposed to create within the Institute, in cooperation with commercial space operators and space agencies, a Center for Prevention and Control of Space Debris (CPCSD). The center would

4.0 FUNDS RAISING AND SPENDING

4.1 Funds raising

Funds to ISSF are provided by *Exceptional Donors* and *Members*, which having recognized the importance of ISSF goals for the human progress in space are willing to financially contribute to their achievement on a philanthropic basis.

Exceptional Donors are individuals, institutions or corporations which make substantial grants to ISSF on extemporary basis once (endowments) or without pre-determination of amount and periodicity.

Members are corporations or institutions which volunteer to make annual donations, ISSF Members will belong to one of the following three categories:

a) *Benefactor*: $25,000 or more

b) *Patron*: $15,000-24,999
c) *Contributor*: $10,000-14,999
d) *Supporter*: $5,000-$9,999
e) *Basic Member*: $500-$4,999

Note: The lower amount generally applies to small-medium enterprises, the higher one to large companies.

Exceptional Donors and *Members* will be publicly recognized by ISSF for their dedication and tangible support in making space safer and sustainable place. *Patron* or *Benefactor* Members would qualify as ISSF Board Member.

4.2 Benefits of ISSF Membership

Space industries joining ISSF as members would give a tangible prove of willingness to accept space safety as their collective responsibility, and sine-qua-non condition for further growth of space business. Their identity as champions of safety would be clearly established. People would see that they care about safety!

Being an ISSF Member would allow substantive impact on new and positive development in space systems and operations, in particular through the space safety institute. ISSF Members would gain access to a community of safety experts and their expertise, and would be proactively involved in identifying research areas and launching specific projects.

ISSF Members would receive access and use of all ISSF studies results and “modulated” discounts for their employees’ attendance to conferences, seminars and training events organized by ISSF. Their logos would be displayed on ISSF and Space Safety Magazine websites. Members would receive printed and electronic copies of each issue of Space Safety Magazine for distribution within their organization. In addition, *Benefactors* and *Patrons* would be allocated respectively a free 1/2 page and 1/4 page advertisement on each Space Safety Magazine issue.

4.3 Funds spending

4.2.1 <u>R&D Studies Contracts</u>

The Foundation will assign R&D tasks to private or public bodies such as universities, research laboratories, firms, and experts. To that end it will conclude with these partners research contracts under which the contractors are bound to make available to the Foundation any resulting invention or technical data under free, non-exclusive and irrevocable license. In other words, inventions or technical data resulting from an ISSF research work are owned by the contractor, who may or may not protect them by registered patent, and exploit them. In exchange, the ISSF and its Members may use the inventions or information under free irrevocable and non-exclusive license.

The Foundation R&D program, together with standardization program and educational and training program, will be managed by an ISSF nominated committee of experts and it is collectively called International Institute for Space Safety (IISS). The Foundation R&D program has a yearly amount of resources allocated in the ISSF Budget. The R&D program is established and updated every year through a *Call for Ideas,* for the two following years, open to experts and scientists active in space safety and related fields.

The pre-selected proposed studies with relevant allocation of funds and justification of proposed type of procurement (open competitive tender, restricted competitive tender and non-competitive tender) and justification, will be submitted to the approval of the ISSF Adjudication Committee, which is the internal ISSF body responsible that proposed procurement actions for R&D studies are in line with the ISSF established rules and policies. The Adjudication Committee is composed by three individuals nominated by the ISSF Board. Following the deliberation of the Adjudication Committee, an Invitation to Tender will be issued for each selected study. The ISSF Tender Evaluation Board, which is nominated annually by the ISSF President, will supervise the preparation of the Invitation to Tender, evaluate the proposal submitted by prospective contractors, and make recommendations to the ISSF President for the approval/disapproval of the draft contract. Finally the ISSF President will sign the contract and authorize spending. The management of the study contract execution and the review and approval of all contractual deliverables at the scheduled progress milestones is responsibility of the International Institute for Space Safety.

As a variation to the above process, for expensive R&D tasks the ISSF may decide to provide only partial funds (co-funding). In such case the procurement process followed is the same as above except that instead of a contract a suitable formal agreement will be established between the funding parties.

4.2.2 Grants

The Foundation will make grants toward the objectives of its programs. The Foundation grants spending is managed by the ISSF Board Secretary in accordance with the annual amount of resources allocated in the ISSF Budget. Grants requests (external) and grants proposals (internal) are compiled and pre-selected by the ISSF Board Secretary on a quarterly basis. The candidate grants list will be submitted to the approval of the ISSF Grants Committee, which is the internal ISSF body chaired by the ISSF President responsible for ensuring that pre-selected grants requests and proposals are in line with the ISSF established rules and policies. The Grants Committee is composed by three individuals nominated by the ISSF Board. Following the deliberation of the Grants Committee, the ISSF Board Secretary will manage the release of funds via the ISSF Treasurer and will maintain the relevant official documentation required by the Government.