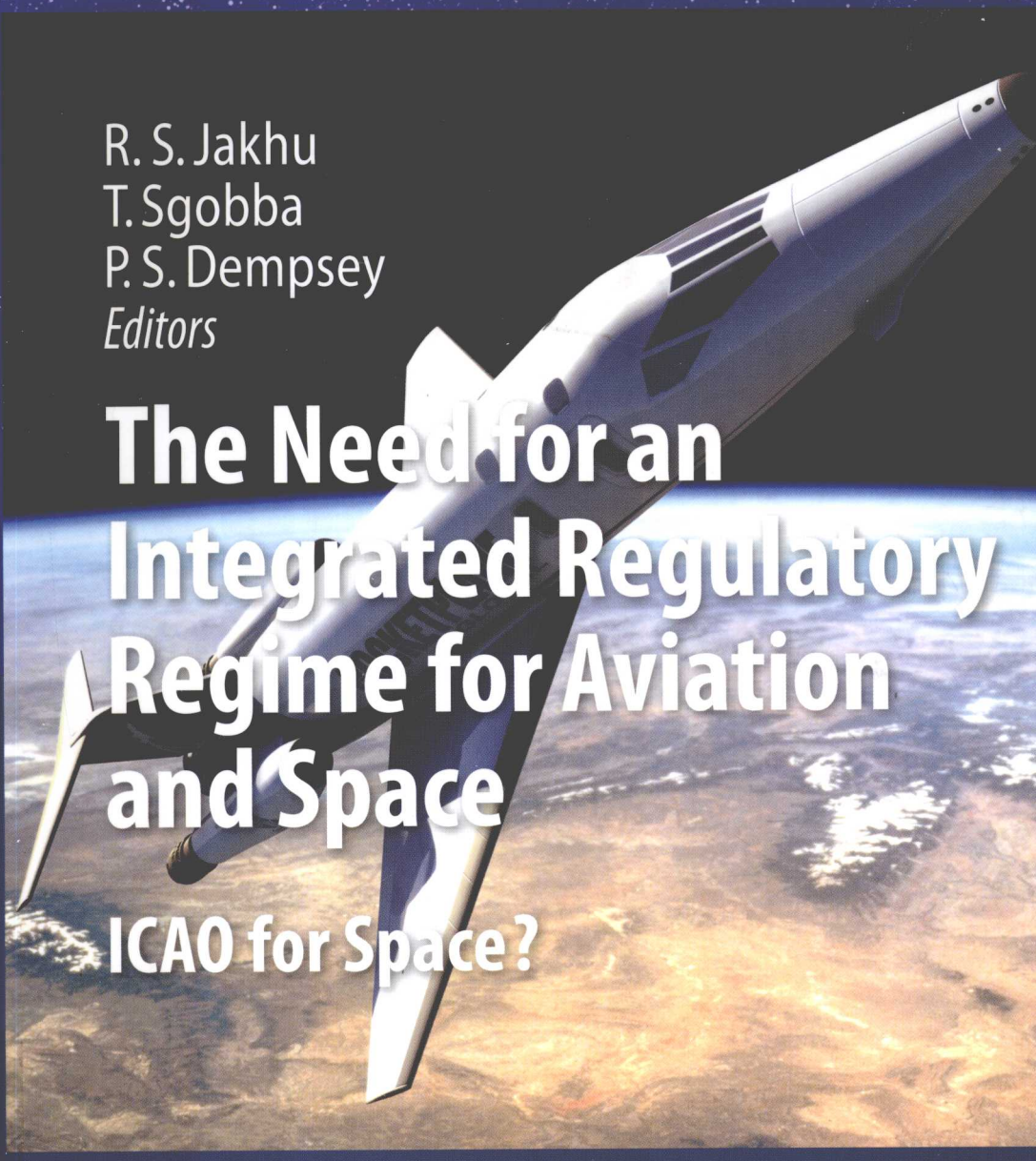
Studies in Space Policy



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The Need for an Integrated Regulatory Regime for Aviation and Space

ICAO for Space?

SpringerWienNewYork

ESPI
European Space Policy Institute

Ram S. Jakhu, Tommaso Sgobba,
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Foreword

I read with great interest the Study "ICAO for Space" and found it most interesting, well documented and well structured. I am providing in this Foreword some historical background and new perspectives regarding civil aviation.

At the invitation of the United States of America, 52 States met in Chicago and signed, on 7 December 1944, the Convention on International Civil Aviation, known as the "Chicago Convention", which is one of the most remarkable international legal documents of the 20th Century. I like to refer to it as the "*Magna Carta*" of global air transport for its breadth and scope, and for its enduring capacity to ensure the safe, secure and orderly development of what is today certainly the most efficient mode of mass transportation ever created.

This Convention has proven extraordinarily resilient for more than six decades, having been amended but twice in a substantive way, in areas which the visionary drafters of the Convention could not have foreseen (Article 3 bis dealt with the use of weapons against civil aircraft while Article 83 bis addressed the impact of globalization and wide spread economic liberalization of the air transport sector, emphasizing the spirit of the preamble to the Chicago Convention).

However, the 96 Articles of the Convention and its Annexes, which contain close to 10,000 Standards and Recommended Practices (SARPs), are much more complex in nature and relatively arduous to decipher and understand for those not involved in their application. Full and universal compliance with SARPs remains the first condition for maintaining and enhancing the safety of international civil aviation.

Safety, which is the top priority of the Convention, is another common concern we share. Indeed, there is no growth of air transport without safety. In spite of some accidents, air transport is fundamentally safe and remains the safest mode of mass transportation.

However, since this study is entitled "ICAO FOR SPACE", the first time that sub-orbital flights were mentioned in ICAO was at the 35th Session of the ICAO Assembly in 2004 when I said "100 years from now regular passenger flights in sub-orbital space and even outer space could be common place". To date we have no definition where the air space ends and where the outer space commences and, of course, no international treaty was established.

I am of the opinion that there is no need to establish a special international organization for future commercial civil sub-orbital flights, not even for space

flights. ICAO is very well structured to meet the necessary requirements for such development in the future by simply extending its mandate to cover this aspect of flights. Although there is no reference in the Chicago Convention to aviation security and environment, nevertheless these two items, together with safety, are top priority in the ICAO Programme and well integrated in ICAO activities. ICAO has developed two Annexes, one for the Environment (Annex 16) and the other for Security (Annex 17). New Annexes could be developed to cover sub-orbital flights and space flights. Should an amendment be needed to cover the sub-orbital and ultimately the outer space civil flights, of course this could be done but it may take a long time for the amendment to enter into force.

ICAO, which was created by the Chicago Convention, remains as relevant a global forum as ever, in promoting the safe and orderly development of international civil aviation. Today we find ourselves in a similar situation with respect to space. With the Chicago Convention we have a model at our disposal. We should not ignore this precious lesson of history by acting expeditiously. We can tackle issues before we are forced to do so.

I commend this Study for its in-depth analysis to all those who are interested in aviation, and wish to express my deepest appreciation to the authors of the study. Their vision will guide the policy of civil flights in space for the years to come.

Assad Kotaite
President Emeritus of the ICAO Council

Executive summary

The rise of the international commercial space sector from low Earth orbits to geosynchronous orbits is transforming the use of space. More actors have increased access for a greater number of activities in space. Yet their proliferation creates a commensurate amount of safety risks – for the general public (on the ground, in the air, and on the surface of the sea), spaceport personnel, space objects, human beings and property in orbit. Environmental accidents pose a threat, as does the ever-increasing amount of space debris and uncontrolled spacecraft re-entry.

There are significant differences between the regimes governing air navigation and space activities. A number of legal issues remain unresolved. Most notably, which regime controls a hybrid vehicle that behaves as an aircraft for one part of its mission and a spacecraft for the other? If a vehicle encounters a problem on the way to space but is still in airspace, to which regimes do those involved look for answers regarding liability? For that matter, where does space actually begin?

This Study addresses the question of whether the extension of the mandate of an existing intergovernmental aviation organization, the International Civil Aviation Organisation (ICAO), is the most appropriate means to initiate and manage regulatory and safety issues for civil and commercial spaceflight up to and including geosynchronous orbits, also considering the growing importance of space-based safety critical services (e.g. for navigation).

To best answer this inquiry, the Study employs the following methodology. First, it describes current regulations and standards bodies that either have developed, or are developing, with regard to space activities, providing an overview of these entities and their activities, be they domestic or international. Next, it assesses the (in)adequacy of the contemporary regime of regulatory protection and promotion of space safety. Further examination is extended to existing international regulatory frameworks in other similar international activities, such as the ITU (International Telecommunication Union) and the IMO (International Maritime Organization) for maritime shipping.

Subsequently, ICAO is analyzed thoroughly and carefully, as it is the entity responsible for promulgating the rules, regulations, procedures and standards that ensure a safe and viable aviation industry. The conflicts between the legal regimes for air and space are identified, including the ongoing functionalist/spatialist debate and the ambiguity regarding definition of an aircraft and a space object and boundary between air space and outer space. This detailed

scrutiny of ICAO includes a discussion of a transition to a new aerospace law, how to extend ICAO's current mandate to include jurisdiction over space activites, and the feasibility of expanding current aviation space traffic management to include suborbital flights.

Finally, in order to understand precisely what a new or extended regime would be regulating, safety issues pertinent to aerospace activities are described in great detail, from launch site processing and ground safety to the launch itself. Ground, orbital, and suborbital risks are addressed, including collision, debris, and traffic management.

The Study led to the following main Findings and Conclusions.

Findings

1. At present, there are no common safety standards and procedures for space operations, thus the public worldwide is not equally protected from the risks posed by launching, over-flying and re-entering space vehicles.
2. Current activities in space are unsustainable in the long term without uniformly implemented debris mitigation measures, well coordinated debris remediation operations, and global space traffic management (STM).
3. The focus of the regulatory regime should be on enhancing the safe and efficient use of space by all actors and the long-term sustainability of Earth orbit without imposing undue restrictions that stifle innovation and commercial development. It should not be so onerous that it undoes benefits for Earth by limiting potential for use.
4. There is no territorial sovereignty or national control in international common spaces such as outer space, the high seas, and international airspace, but only outer space is left without any form of international safety coordination. Furthermore no mutual aid provisions exists for space missions emergencies.
5. It is necessary to traverse airspace to get to outer space. Often this is the international airspace because, many launches occur from locations that are contiguous to the oceans for safety reasons.
6. ICAO already provides ATM, thorough its SARPs, to aircraft in airspace over the high seas (i.e. 72% of the airspace).
7. The prevailing functionality of a vehicle, safety of people on the ground, accumulated knowledge, and best practices in the most closely related fields should drive efforts to classify vehicles.
8. There is a current trend to operate aero-spacecraft from dual-use (airport/spaceport) ground infrastructure.

Conclusions

1. ICAO is a fully experienced and operational legislative and implementing intergovernmental body ideally suited for taking up the issues identified in this Study in relation to aerospace activities.
2. ICAO has in place detailed rules, regulations, guidelines, and operational procedures for aviation that could be gradually extended to space with the necessary modifications.
3. Initially relevant ICAO Annexes should be amended and/or new Annexes should be adopted by ICAO Council in order to address issues such as, *inter alia*, licensing of spaceports, human space flight, space traffic management, safety of personnel and astronauts, and security.
4. Eventually, as the need arises, the Chicago Convention should be appropriately amended to fully establish ICAO's jurisdiction over relevant space activities.
5. It is better to address these issues proactively than retroactively before threats and hazards to public safety become intolerable; now is the appropriate time.
6. A proposed STM regime, to prevent collision between space objects and of space objects with space debris, must be based on a technologically advanced and globally shared space situational awareness system. Such a regime must have its roots in existing international space law, particularly equal rights to space and freedom of use.
7. An international STM organization must be established primarily for the civil and commercial use of outer space and not appended to, or negotiated with, space arms control or disarmament.
8. ICAO's system is sufficiently sophisticated to effectively process these various STM regulatory needs. It is necessary to appropriately classify suborbital (aerospacecraft) vehicles before they begin flying commercially, though yet difficult to do so because of a lack of standard definitions.

Based upon these Findings and Conclusions, a regulatory model is proposed at the end of this Study, outlining the structure of an ICAO for Space organization and how best it should eventually be established and implemented.

To facilitate extension of ICAO's mandate, the following actions would be helpful:

1. A study of the experience gained by those countries which have already established a national licensing system for commercial space operations should be undertaken.
2. Exploration of methods of linking/merging the ITU information/notification system with an improved UN registration system, with the goal of a unified international notification/information system.

3. Further inquiry into the interests and expectations of private actors and costs and benefits of a global STM system into commercial activities is necessary.
4. A study should be made of the latest trends in technical international organizations regarding the adoption of safety technical regulations/standards, to provide more flexibility than the traditional system of negotiation and ratification.
5. Exploration of policy and regulatory initiatives to achieve and maintain common safety standards and avoid "flags of convenience".

Commencement of these actions would also facilitate timely and smooth introduction of emerging human suborbital and orbital spaceflight international services and eventual implementation of the overall model regulatory regime as suggested by this Study.

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The contents of this Study are developed with the intention of initiating international discussion on the subject and do not necessarily reflect the

personal views or opinions of the members of the ICAO for Space? Working Group, the editors, researchers and reviewers of this Study. Neither do they represent the official views of any organizations with which they may be associated or affiliated.

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List of acronyms

A
ADS: Automatic Dependent Surveillance system
ADS-B: Automatic Dependent Surveillance-Broadcast
AIAA: American Institute of Aeronautics and Astronautics
ATM: Air Traffic Management

C
CAIB: Columbia Accident Investigation Board
CEOS: Committee on Earth Observation Satellites
CINA: *Commission Internationale de la Navigation Aérienne*
CoC: Code of Conduct
COPUOS: United Nations Committee on the Peaceful Uses of Outer Space
COTS: Commercial-Off-The-Shelf
CNES: *Centre National d'Études Spatiales* (French Space Agency)
CSG: *Centre Spatial Guyanais* (Guyana Space Centre)

D
DARPA: Defence Advanced Research Projects Agency of the U.S.
DOD: Department of Defence of the U.S.
DSTs: Decision Support Tools

E
EEZ: Exclusive Economic Zone
ELV: Expendable Launch Vehicle
ESA: European Space Agency
EU: European Union
EVA: Extra-Vehicular Activity

F
FAA: Federal Aviation Administration of the U.S.
FAA-AST: Office of Commercial Space Transportation of the U.S. FAA
FSOA: French Space Operations Act of 2008

G
GALILEO: Satellite Navigation System of the EU and ESA
GEO: Geosynchronous (Geostationary) Earth Orbit
GLONASS: Satellite Navigation System of Russia
GNSS: Global Navigation Satellite System

GPS: Global Positioning Systems of the U.S.
GSE: Ground Support Equipment

I

IAA: International Academy of Astronautics
IAASS: International Association for the Advancement of Space Safety
IADC: Inter-Agency Space Debris Coordination Committee
ICAO: International Civil Aviation Organization
ICAN: International Commission for Air Navigation
ISFO: International Space Flight Organization
IMO: International Maritime Organization
ISO: International Organization for Standardization
ISS: International Space Station
ITU: International Telecommunication Union

L

LAAS: Local Area Augmentation System
LEO: Low Earth Orbit

M

MOL: Manned Orbiting Laboratory

N

NAS: National Airspace System
NASA: National Aeronautics and Space Administration of the U.S.
NRC: National Research Council of the U.S.

R

RFI: Request for Information
RCC: Range Commanders Council of the U.S.
RLV: Reusable Launch Vehicle
RORSATs: Radar Reconnaissance Satellites of the Soviet Union
RTS: Radio Thermal Generator

S

SMS: Safety Management System
SAR: Search and Rescue
SARPs: Standards and Recommended Practices adopted by the ICAO Council as Annexes to the Chicago Convention
SATMS: Space and Air Traffic Management System of the U.S. FAA
Space Shuttle: Space Transportation System of the U.S.
SSA: Space Situational Awareness
STM: Space Traffic Management

W

WAAS: Wide Area Augmentation System

Introduction

The human adventure in space is now more than half a century old. Approximately 6000 lift-offs have taken place and some 500 people have flown into space. Early space programmes were conducted almost exclusively by a few governments for military and civil purposes with little involvement by the private sector. Gradually, commercial uses of space began to develop and now represent the largest share of space activities. The international space community, including the IAASS, has identified the rapid international commercialization of space, particularly in the fields of telecommunication, navigation, Earth observation, and launch services, as an important and positive step for continual global and national economic growth. Recent interest and actions of the private sector in the field of commercial human suborbital spaceflight illustrates the widening range of financial commitments, and business risks the private sector is willing to take in space, especially with SpaceShipOne's aerospace vehicle winning the coveted Ansari X Prize in 2004 by launching up to an altitude of 100 km two suborbital flights carrying weight equivalent to that of three human beings and returning them to Earth two weeks apart. In addition, several governments and business communities around the world are cooperating to help fund the building of civil spaceports. Corporations like United Kingdom-based Virgin Galactic have made firm commitments in pursuing a new suborbital space tourism market and have shown interest in its possible extension to point-to-point international hypersonic travel. At the same time, the Russian and U.S. governments are promoting early steps towards commercial orbital human spaceflight. The Russians flew the first paying orbital space tourist to the International Space Station (ISS) in 2001 and have continued to do so regularly since then. In the meantime, NASA has launched an important initiative to procure commercial transportation services to the ISS.

However, the Shuttle Columbia accident of 2003, a sequence of accidents on ground, (in particular the disaster at the Brazilian Alcantara spaceport in the same year), and various spectacular launch failures have demonstrated the fact that the business of space is still fraught with risks, not only for the crew on board and ground personnel, but also for the public on ground, at sea or travelling by air. Furthermore, the space and ground environments are at risk. Currently, there are millions of objects of various sizes, which pose a direct potential threat to manned and unmanned orbiting space assets, and an indirect threat to space-based terrestrial safety-critical services. There are also important atmospheric effects

from chemical rocket propulsion and environmental impacts on ground because of dropping stages and launch failure. For example, in September 2007, the explosion of a Russian Proton M rocket (with toxic fuel weighing about 200 metric tons) contaminated a vast swath of agricultural land in Kazakhstan.

Though the commercial potential of space provides great promise for the global economy, and despite the fact that safety risks are very real and growing, there is no international cooperative effort to protect and enhance global commercial and public interests in space with internationally agreed-upon and enforceable safety risk mitigation standards. Because of this, the IAASS Legal and Regulatory Committee established the *ICAO for Space* Working Group (WG), an independent group of international space safety experts, to study the matter. The mandate of the WG was to prepare this Study and to document and initiate public debate on the need for international space safety standards and a regulatory regime and body for commercial space activities. In addition, the WG deemed it worthwhile to discuss what that body would look like if it is to be built on the model of existing international organizations such as ICAO. This Study is the result of the cooperative efforts of the various members of this Working Group, the reviewers, and others.

The Study discusses the various legal and regulatory instruments, organizations, and standards that currently impact commercial space safety. It notes that the International Standards Organization (ISO) is the only international body that has, thus far, attempted to develop space safety standards for global use. In any case, those standards are unstructured, sparse, generic, and not endorsed by the majority of national regulatory bodies that deal with space activities. Furthermore, they are meant for voluntary use, which defeats the key purposes of achieving an even level of risk mitigation worldwide and preventing unfair competition as a result of the use of substandard safety practices. However, some national and multinational space bodies have developed their own space safety standards. These are the natural reference for any international harmonization effort. In addition, commercial space activities are formally regulated only in a few countries. The U.S., through its Federal Aviation Administration Office of Commercial Space Transportation, is one such example.

Examining international regulatory regimes in analogous industries provides important insights into how such an international space safety regulatory framework might look. For example, the International Telecommunication Union (ITU) regulates radio frequencies and orbital positions. The telecommunications industry found that an international body that can regulate and manage the radio spectrum and orbits was necessary to help the industry grow in a sustainable way. Important search and rescue frequencies are reserved to ensure that they are not negatively impacted by telecoms' spectrum use and growth. The International

Maritime Organization is another example. Again, to support orderly growth of the international maritime industry and the goods and services it provides, it was paramount to establish international safety regulations.

Probably the best analogy is to the International Civil Aviation Organization (ICAO) which was created towards the end of World War II. Countries quickly realized that the global commercial civil aviation industry could not achieve and maintain sustainable growth without an international regulatory framework to ensure that civil aircraft could take off, fly, and land safely anywhere in the world. The adoption and implementation of common international safety standards has made civil aviation one of the most successful and safest modes of transportation. For this reason, and because of the commonality of interests, most notably the sharing of a crowded airspace, this Study focuses particular attention on ICAO as a model, and possibly as a seat (following the example of the Space Transportation Office at the U.S. FAA) for a future international commercial space safety regulatory body. This is why the study is titled "*ICAO for Space*"?

A review of the variety of, and interrelationships between, safety risks that space organizations are facing is important to fully comprehend the challenges envisaged in the effort to create an international space safety regulatory framework. Launch hazards are real and they impact not only those communities contiguous to the launch ranges but also the countries overflown. Orbital and suborbital flights face safety risks from orbital debris as well as the lack of spacecraft traffic management. Spacecraft are exposed to additional risks during their atmospheric re-entry phase.

This Study underlines two points which are discussed in detail and from various perspectives, and which seek to link ICAO to space. The first point finds expression in the thesis that the ICAO organizational model provides a good starting basis for drafting an international civil space regulatory framework. The second is that any international civil space regulatory organization will necessarily share close interfaces with ICAO, in particular for the integrated management of aviation and space traffic through the airspace, and for the safeguarding of future safety-critical aviation systems which will operate in space. Furthermore, a number of hybrid aircraft/spacecraft vehicles may eventually emerge, which would dictate a certain amount of technical and procedural coordination.

This Study is divided into five separate but interconnected parts:

Part A, Background, discusses the general history of spaceflight and the commercialization of space and examines why the international community should consider an organization like ICAO for space.

Part B, Legal and Regulatory Regimes, details the various national and international treaties, organizations, and standards that may impact space safety.

In addition, it analyzes the efficiency of the current regimes (particularly in the aviation and space fields) in place and whether they are suitable to handle the plethora of safety issues related to space activities.

Part C, Safety Issues, details the myriad of safety challenges envisaged during the entire lifecycle of a commercial space vehicle – from launch, through on-orbit operations, to re-entry or disposal. In addition, specific safety issues that need international safety standards are addressed.

Part D, Need for International Space Safety Regulations, makes the case for immediate and expedient international space safety regulations and the need for an appropriate regulatory body to manage them. In particular, space traffic management, orbital debris, and space tourism are discussed. This part also explains how an international set of regulations can help ensure robust space safety programmes for commercial space operations.

Finally, **Part E, Proposal for a New Regulatory Regime**, discusses the governance and operational construct of an international space safety body. In addition, a suggested regulatory operating model, based on expanding the current ICAO mandate to cover "near space", is described and recommended.