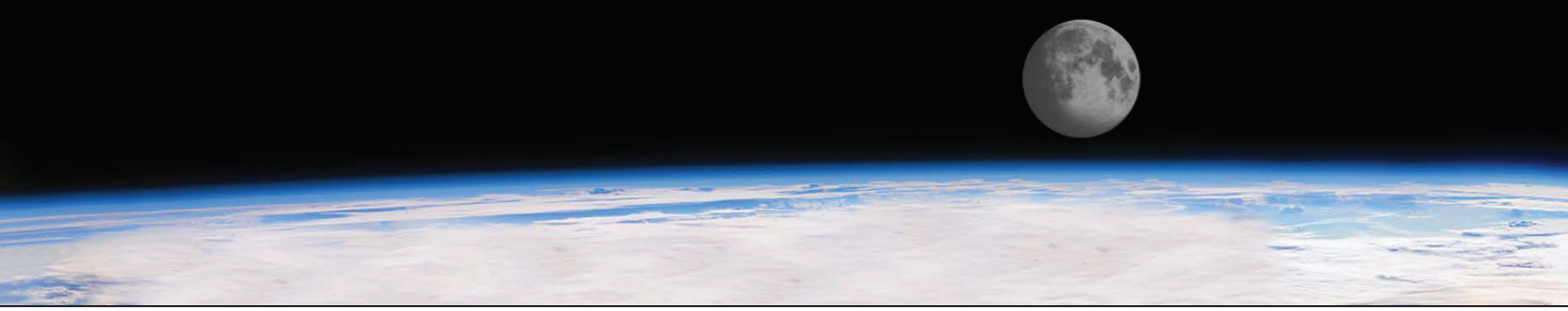

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Center for Space Policy and Strategy

Policy Paper

International Commercial Spaceflight Regulation: Assessing the Options

James A. Vedda
The Aerospace Corporation

Jim Vedda is a senior policy analyst performing policy research and evaluation for various government agencies. He is the author of Becoming Spacefarers: Rescuing America's Space Program *and* Choice, Not Fate: Shaping a Sustainable Future in the Space Age*. He holds a Ph.D. in political science from the University of Florida and an M.A. in science, technology, and public policy from George Washington University.*

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Foreword

Analysts in the U.S. and elsewhere have begun to address commercial spaceflight regulation issues, asking questions such as: Does this emerging industry need something akin to the International Civil Aviation Organization (ICAO)? If so, how soon is it needed, what would the organization look like, and what aspects of the spaceflight enterprise should be within its jurisdiction? This paper explores these questions and analyzes options for addressing the issue.

Seeking a Suitable Model

ICAO[1] has been identified as a model for a future international standards and practices organization for spaceflight. Some have suggested that ICAO itself should expand its mandate to include space, allowing a global spaceflight industry to develop more quickly and effectively in cooperation with an existing, proven organization. Assessing the validity of this suggestion requires consideration of the similarities and differences in the early development of commercial aviation (and ICAO's role in it) and the more recent emergence of commercial spaceflight.

ICAO is primarily "a technical organization with a central role in establishing international standards and practices, collecting statistics, and overseeing all the non-economic aspects of international commercial aviation."[2] In its early years, the organization endured a series of unsuccessful efforts to create a multilateral convention that would include economic regulations covering issues such as routes, landing rights, and ticket pricing. There was even some interest in creating an international airline to be operated by ICAO. It quickly became obvious that this was a bridge too far, as economic disagreements remained unresolved and an assortment of bilateral agreements quickly emerged from the extraordinary growth momentum of post-World War II civil aviation.[3] Decades later, in the years that followed U.S. airline deregulation, ICAO began to revisit multilateral approaches, culminating in a 1994 conference that once again failed to unseat the dominant bilateral system.[4] Technical and operational issues, in contrast, have proven much easier to resolve and are the backbone of the organization's work.

It has been argued that reentry vehicles are covered under the definition of "aircraft" and therefore reusable launch vehicles would fall under the jurisdiction of ICAO.[5] The argument stems from the fact that some reusable aerospace vehicles, including recent commercial concepts, behave like gliders upon reentry into the Earth's atmosphere. Other analysts do not accept that a space vehicle fits the definition of an "aircraft" even if it does glide in Earth's atmosphere.[6] This very discussion was held decades ago with regard to NASA's now-retired space shuttle, when it was determined that by virtue of the nature and intent of the vehicle to enter and travel in space, the shuttle was not an aircraft, and therefore not subject to the general jurisdiction and rules of aviation.[7]

In considering international regulatory alternatives and the relevance of the ICAO experience, it is important to remember that ICAO was born at the end of World War II, when the U.S. held unquestioned superiority in every aspect of air power, including the number of airplanes, pilots, aircraft factories, and likely customers for postwar air service. The nation's aeronautical research infrastructure and ongoing investment promised to sustain it as the world's top air power for a long time to come, as it has for the past several decades. That dominant position guaranteed the U.S. would drive the development of the international regulatory regime that would emerge under ICAO, thus ensuring its interests in the emerging aviation industry.

Although the U.S. is the world's top space power today, its dominance is not comparable to that of post-war aviation. Expertise in the technological, manufacturing, entrepreneurial, legal, and regulatory aspects of spaceflight is found in many countries. While it is possible that the U.S. will dominate commercial spaceflight in the years to come, this outcome is far from certain. Operational mishaps and financial setbacks routinely remind observers how difficult it is for any spaceflight enterprise to become commercially successful, or for any nation to attain and maintain space dominance. As a result, the U.S. will not be able to steer the development of an international regulatory regime for spaceflight as decisively as it did for aviation. This should not cause the U.S. to shrink from participation in the gestation of such a regime—that would be counterproductive, likely prompting other nations to proceed without U.S. input.

Atmospheric flight has long been recognized as an inherently international activity, and this characteristic applies to spaceflight as well. Its evolution is proceeding far more slowly than the post-war growth of aviation, but space-related commerce will experience expansion of the number of nations and businesses involved and the variety of services offered that will drive the need for a global system of technical standards and safety regulations. Among the assortment of issues to be considered are payload interfaces for commercial satellites, space traffic management, debris mitigation, and agreements on technical safeguards.

Commercial spaceflight has not yet reached the point where global coordination resembling that of commercial aviation is necessary. The world's airlines have tens of thousands of flights *per day,* carrying millions of passengers between locations worldwide; so far, commercial launches of large spacecraft to orbit number only about two dozen per year (none of which carry passengers yet), taking off from about a half-dozen locations, and the payload generally does not return to Earth.[8] Currently, bilateral agreements (in addition to general behavioral norms established in the multilateral space treaties, principles, and guidelines) are sufficient to address this level of traffic. As aviation has demonstrated, bilateral agreements are likely to continue their usefulness in an assortment of probable future scenarios, but the question is how long the exclusive use of bilateral arrangements will be adequate to the needs of a high-tech global industry that faces considerable safety risk.

The commercial human spaceflight regulatory regimes that emerge in other parts of the world are likely to differ from the U.S. approach, even though U.S. laws and regulations are being used as models. For example, use of U.S.-built vehicles outside of U.S. jurisdiction will raise issues of licensing, liability, and taxation that could impact the global development of the industry. This is already evident across the Atlantic, where the European Aviation Safety Agency (EASA), established by the European Union in 2002, has discussed plans to certify space vehicles that employ aerodynamic flight, and has pursued a path toward specific safety protection for passengers. This evolution may proceed at a different pace and in a different direction than what is envisioned in the United States. Another concern is that EASA is focusing on aerodynamic craft and not rockets, making it unclear how the latter will be addressed. At some point, cross-border harmonization of regulatory approaches with Europe and other active regions may aid the global expansion of the industry.[9]

As the commercial spaceflight industry transitions to common carrier status, existing international organizations may or may not be adequate to fulfill its needs. If they are, they will still need to adapt their expertise to encompass space activities. If they are not, it's not too early to think about what a dedicated international spaceflight regulatory regime might look like, and when it might be needed. The following sections discuss advantages and disadvantages of some likely options.

Option 1: Build Experience with Bilateral Agreements

As the aviation and shipping industries recognized, a system that relies on a patchwork of conflicting regulations and case-by-case arrangements can significantly hinder an industry's global development. But multilateral agreements that attempt to cover business plans (e.g., routes, flight frequencies, fares) and politics (e.g., landing rights, competition with state-owned domestic airlines) fail to garner widespread support, limiting or undermining their ability to promote a global industry and enable its safe operation. In contrast, agreements focused on technical standards and safety issues have proven successful as technologies and markets have matured. Bilateral agreements—for example, hundreds of

them in international aviation—have continued to be the instrument of choice for economic and politically sensitive issues.

Advantages. The number of countries involved in commercial spaceflight is small and will grow slowly, allowing bilateral agreements to be established with a far smaller number of parties than has been required for aviation. This provides a clean interface between the handful of countries that may consider launch capability to be an element of national prestige, and almost certainly consider its linkage to military missile systems to be a national security concern. The sensitive nature of launch capabilities and the small number of participating countries may make it quicker and easier to enact an array of bilateral agreements than to negotiate a multilateral accord able to attract a meaningful group of adherents.

Negotiation and implementation of bilateral agreements would provide international commercial launch participants with ample experience in addressing both technical and economic issues of spaceflight. This would benefit future efforts to craft a multilateral convention at an appropriate time, when the economic and political environment would find it useful and feasible.

Disadvantages. Proponents of commercial spaceflight hope to reach traffic levels of hundreds of flights per year (including both orbital and suborbital) within the next few years. If the market develops this quickly, includes a substantial number of human spaceflights, and involves services transiting international airspace, a strictly bilateral system would be cumbersome to establish and maintain if it tried to handle both technical and economic issues. A multilateral means of addressing technical issues would be essential to the safety, reliability, and consumer confidence needed to keep the industry moving forward.

To become a successful global industry in the not-too-distant future, commercial launch and reentry services within the next decade or two will need to go beyond ascents into space that last a few minutes and land at or near the launch site. Trips to orbit will need to have multiple (i.e., multinational, globe-spanning) options for returning to Earth. For suborbital point-to-point services, international transit is the primary objective, just as it is for international aviation. In either case, adequate facilities at the landing site will be required to safely receive the spacecraft and turn it around for launch to its next destination—which would be economically preferable to sending it back to its original launch site empty, riding in a ship's cargo hold. Coupled with appropriate bilateral accords, multinational technical arrangements would facilitate economical operations more efficiently than bilateral agreements alone in an active global market.

Option 2: Expand ICAO Responsibilities to Include Space

Some analysts believe that the most efficient and effective way of accommodating an emerging international regulatory regime for commercial spaceflight is to add space responsibilities to ICAO's portfolio. Why invent a new organization when a well-established one already exists? Among those taking this position over the past several years has been the International Association for the Advancement of Space Safety: "It would be difficult to justify replication of the able and detailed work already done by the ICAO on issues such as safety, navigation, security, and liability, at least with respect to flights in the Earth's atmosphere."[10] As noted earlier, it has been argued that ICAO already has jurisdiction over the portion of a spaceflight that takes place within the atmosphere if it is operating within ICAO's definition of an aircraft (i.e., utilizing aerodynamic lift, as does a reusable winged launch vehicle during reentry and landing).

A working paper presented to the ICAO Council in May 2005[11] specifically addressed the applicability of Standards and Recommended Practices (SARPs)[12] to suborbital spaceflight engaged in international flight. The paper did not provide a definitive answer, noting the lack of an accepted definition of where space begins and air regulations cease to be applicable. However, the paper found that "it might be argued from a functionalist viewpoint that air law would prevail since airspace would be the main centre of activities of sub-orbital vehicles in the course of an earth-to-earth transportation, any crossing of outer space being brief and only incidental to the flight." (Spaceflight entrepreneurs undoubtedly would disagree that transit through space is "only incidental," since that is the primary objective of suborbital tourism flights.) The ICAO paper deferred resolution of the issue, but made it clear that this will be reconsidered when commercial suborbital flights seek to cross international borders.

Under the Chicago Convention of 1944, ICAO was granted authority in three areas of global civil aviation: safety, research, and development of air navigation facilities. The organization's objectives as outlined in the Convention are to ensure the safe and orderly development of civil aviation, to establish equal opportunity for international air transportation, and to establish sound and economical aviation operations.

ICAO, which today has 191 members,[13] is made up of an Assembly—in which all member states set policy and budgets—a Council, and a Secretariat. The Council is the key governing body, so its operation is critical to any attempt to incorporate spaceflight regulation. It is composed of 36 states elected by the Assembly for a three-year term. The Assembly chooses the Council member states based on 1) their importance in air transport, 2) their provision of facilities for air navigation, and 3) their geographic dispersion, ensuring that all major areas of the world are represented. The Council adopts SARPs by a two-thirds majority and then distributes them to the member states. They enter into force three months (or another specified time period) after distribution unless a majority of member states register their disapproval within that period.[14]

There is a history of smaller players seeking to increase their influence and prevent the dominance of larger, more developed countries…

Advantages. ICAO is a mature organization representing most of the nations in the world, with decades of experience in flight safety, navigation, and liability. It has a full-time multinational staff at its Montreal headquarters and at regional offices, and manages a proven mechanism for initiating and updating standards and procedures and for interacting with other international entities in related fields.

Broadening ICAO's mandate to include space traffic seems to be driven by the same logic that resulted in communications satellites being added to the International Telecommunication Union (ITU) portfolio: "Thus, technically, using the mechanism of the [Chicago Convention] Annexes, the scope of application of the Convention could be widened to include 'aerospace vehicles' ... All that would be required is the development and adoption of a new and/or additional set of SARPs or Annexes to the Convention specifically designed to cater for the peculiar characteristics of such aerospace vehicles."[15]

Disadvantages. Bringing space into ICAO may be far more challenging and time-consuming than advocates have imagined. An organization made up of 191 countries that has been around since the 1940s may not be the right place for the emerging spaceflight industry. In fact, the character of this organization, with its entrenched membership, would need to be remade to assure adequate treatment of space-related issues. An overwhelming majority of the members are not space launch-capable states and may not want the resources they are investing in ICAO diverted to space-related matters, or have their annual assessments increased to accommodate new space-related responsibilities. ICAO's history has demonstrated that members tend to jealously guard the organization's resources.

The work program of ICAO, including the adoption of SARPs, is driven by its 36-member Council, made up of delegates who speak on behalf of their individual nations. The basis for choosing Council members, outlined above, is entirely aviation-driven and may prove unhelpful, even detrimental, to the interests of space. If these selection parameters remain unchanged, space will be relegated to the bottom of ICAO's priorities. For the foreseeable future, commercial spaceflight will be relevant to a very small subset of the ICAO membership, with the remainder likely to view it as a distraction from the organization's primary mission and a drain on its resources. It cannot be assumed that the selection criteria for Council members will be amended in ways that would be helpful to space interests. The group dynamics are well-established, and as in other international organizations, there is a history of smaller players seeking to increase their influence and prevent the dominance of larger, more developed countries—which include spacefaring nations.[16]

ICAO has no embedded space expertise beyond the use of space navigation systems in air transportation. The

Secretariat would need to be staffed up with a space-savvy cadre before work could begin on the many new and amended SARPs that would be required. Once this work is started, it cannot be expected to always go smoothly and quickly. ICAO's mechanisms for formulation and adoption of SARPs have been successful overall, but the time required for execution varies substantially, and can extend to several years. The non-spacefaring majority, which may be indifferent or hostile to the introduction of space to ICAO, could slow or block meaningful action on space issues that they may not find relevant to their nations' interests.

Despite being primarily a technical (rather than political or economic) organization, by the end of the 1950s ICAO experienced a shift in the character of its personnel, increasingly filling its ranks with "civil servants and government officials rather than the aviation professionals of the early years."[17] This may not be a problem for the much more mature aviation community, but may be inappropriate for the emerging commercial spaceflight sector, which would benefit from professional attention akin to that available in the first decade of ICAO. For example, in those early years "ICAO introduced a broad research program to study technical issues and then collect, analyze, and publish its research findings and statistics, including the many bilateral air agreements entered into by member governments."[18] Such an effort would be warranted for the space sector, but it is questionable whether ICAO would be willing to devote sufficient personnel and resources to ambitious projects that serve only a small fraction of its membership.

Introducing space to ICAO may raise security concerns. While aviation technology is ubiquitous and used across most of the world every day, the same is not true for space technology. The missile proliferation issues associated with launch technology would be a particular concern. ICAO may need to sequester information relevant to its spacefaring membership, which would incur new information handling expenses and possibly the resentment of the non-spacefaring majority of the members.

The expansion of ICAO responsibilities to include spaceflight would be a far more difficult task than the integration of satellite communications into the ITU. In the case of ITU, the global communications industry had achieved a high level of maturity—in laws, regulations, manufacturing capability, and infrastructure (both public- and private-sector-operated)—that allowed it to plug satellites into the mix with relative ease, essentially treating them as extremely tall microwave towers. The cultivation of new expertise was required, but the goal was simply to prevent frequency interference. ITU was not called upon to "certify" satellite designs, specify engineering "best practices" for satellite launches, collect and analyze performance statistics for satellite models, or determine safety requirements and oversee their implementation for users and uninvolved third parties. In contrast, an international organization responsible for technical standards and practices related to launch, reentry, and ultimately in-space operations would have a broad mandate that could not simply "plug in" to existing ICAO activities due to the need for substantial expertise and community relationships that are not present in ICAO.

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Option 3: Create New Standalone International Organization

Given the considerations discussed so far, it is possible that creation of a new, dedicated space organization may be quicker, more effective, and no more expensive than grafting space responsibilities onto an existing organization like ICAO. The structure and procedures of the new organization could be built on lessons learned from ICAO and others such as the International Maritime Organization and the Inter-Agency Space Debris Coordination Committee (IADC).

Lessons from ICAO and international organizations in general indicate that global space commerce would be best served if membership were restricted to those

nations that have a clear stake in the outcome, and are willing to commit their technical experts to serve the goals of the organization. Initially, this would create a group of manageable size, far smaller than ICAO was when it began in the 1940s. (IADC, which was formed in 1993, currently has 13 members consisting of national civil space agencies and the European Space Agency.[19]) Nations or regional space alliances eligible for membership would include those with one or more of the following:

- Operational orbital or suborbital launch capabilities
- On-orbit human spaceflight programs (including all participants in the International Space Station)
- Major facilities that support space launch, spaceflight navigation, and/or spacecraft reentry and landing
- An active space hardware manufacturing sector

The organization may start with 20 or fewer members, obviating the need for a separate council that is a subset of member states. A council made up of the lead delegates from each of the members could function similarly to the ICAO Council. In a group this size, there will be no need to choose council members based on their "importance in space transport, contribution to the provision of facilities for space navigation, and ability to ensure that all major areas of the world are represented," to paraphrase the ICAO Council parameters.

As noted earlier, ICAO adopts SARPs by a two-thirds majority in the Council and then distributes them to the member states. They enter into force after a specified time period (generally three months) unless a majority of member states register their disapproval within that period. Similarly, IMO uses a "tacit acceptance" procedure for amendments. Governments take action only if they object to an amendment. Rejection of an amendment occurs only if objections are received within a specified period (typically two years) from at least one-third of member nations whose combined merchant fleets represent not less than 50 percent of world gross tonnage. Otherwise, the amendment goes into effect on a date specified at its adoption by the IMO.[20] The space organization should adopt a similar procedure for enacting "space-SARPs" to ensure timely implementation of standards, practices, and their updates.

A new space organization can have regular interactions with other relevant international organizations, which would include ICAO, ITU, the World Meteorological Organization, and others as needed. Space weather and orbital debris would be important crossover issues.

Advantages. The functions discussed here will require the establishment of a cadre of space experts regardless of whether the activity is based in a new or existing organization. A new group would have the advantage of building its organizational structure and initiating its substantive efforts without the burdens of working within an existing bureaucracy designed to do something different and serve a different community. There would be no need to jockey for position, priority, and resources while being seen as the intrusive, puny interloper.

Disadvantages. Even in good economic times, proposals to establish new international organizations raise questions about where the resources will come from, both for start-up and for ongoing operations. Obviously, this concern is magnified when many countries, including those who might be expected to be major contributors, are suffering economic downturns. Domestic and international political pressures will compel some influential players to resist the new initiative, or at least attempt to minimize its bureaucratic footprint by attaching it to an existing organization like ICAO in the unsubstantiated belief that this will yield equal effectiveness for less money.

As has been the case in ICAO and other international forums, international participants may fear excessive U.S. influence. Given the prevalence of non-U.S. launchers in the delivery of commercial payloads to geosynchronous orbit, this may seem unlikely. But the commercial launch market may develop over the next two decades to include more nontraditional payloads (such as humans) in suborbital and low-Earth-orbit-bound flights, which would be the drivers of international standardization and regulatory efforts. There are indications that U.S. interests could be at the forefront of this evolution through a combination of new commercial spaceports (in New Mexico, Florida, Texas, and elsewhere), new launch vehicles (from SpaceX, Orbital ATK, Blue Origin, and others), space platforms (e.g., Bigelow Aerospace), collaborations with non-U.S. entrepreneurs (e.g., Virgin Galactic), and a head start on development of relevant domestic laws and regulations.

Even if all parties agree that a new organization is needed, its timeliness is not clear. Space tourism and the emergence of a new generation of launch providers have fallen several years behind the schedules that were projected in the last decade. A new international organization may be able to stand up more quickly than the industry it is designed to serve. It could be left with little work to do other than speculative efforts that the industry would judge to be premature and therefore would not embrace.

References

[1] Background on ICAO is derived from David MacKenzie, *ICAO: A History of the International Civil Aviation Organization* (University of Toronto Press, 2010) and the ICAO website (http://www.icao.int/).

[2] MacKenzie, p. 127.

[3] MacKenzie, Chapter 5, "Remembering the Forgotten Man: ICAO's Quest for Multilateralism," pp. 107-127.

[4] MacKenzie, pp. 357-360.

[5] Paul S. Dempsey & Michael C. Mineiro, "ICAO's Legal Authority to Regulate Aerospace Vehicles," in *Proceedings of the 3rd IAASS Conference* (2008).

[6] For example, see Stephen Hobe & Jurgen Cloppenburg, Conceptual Approach to a Space Tourism Vehicle With Respect to Technical, Commercial and Legal Aspects, Paper IAC-04-U.1.05 (AIAA 2004).

[7] For example, see Gerald J. Mossinghoff & George P. Sloup, "Legal Issues Inherent in Space Shuttle Operations," *Journal of Space Law*, 47 (1978).

[8] The FAA Office of Commercial Space Transportation (FAA/AST) 2016 Annual Compendium of Commercial Space Transportation, for example, lists 22 commercial launches in 2015 from six sites worldwide. (http://www.faa.gov/about/office_org/headquarters_offices/ast/media/2016_Compendium.pdf)

[9] Jean-Bruno Marciacq, et al., "Accommodating Sub-Orbital Flights Into the EASA Regulatory System," European Aviation Safety Agency, 2008; "Towards Regulating Sub-Orbital Flights: An Updated EASA Approach," International Astronautical Congress paper IAC-10-D2.9.5, September-October 2010; Michael Chatzipanagiotis, "Regulating the Safety of Suborbital Flights in Europe: Navigating Through the Labyrinth of Competences of the EU, Its Member States and EASA," International Astronautical Congress paper IAC-13-D6,1,1x17300, September 2013 (http://ssrn.com/abstract=2424764); Tanja Masson-Zwaan, et al., "The future regulation of suborbital flight in Europe," *Space Policy*, Vol. 30 (May 2014), pp. 75-82.

[10] Paul Stephen Dempsey & Michael Mineiro, "The ICAO's Legal Authority to Regulate Aerospace Vehicles" in J. Pelton & R. Jakhu, Space Safety Regulations and Standards (Burlington, MA: Butterworth-Heinemann, 2010), p. 252.

[11] International Civil Aviation Organization Working Paper C-WP/12436, "Concept of Sub-Orbital Flights," May 30, 2005 (http://www.oosa.unvienna.org/pdf/limited/c2/AC105_C2_2010_CRP09E.pdf). This paper was presented to the Legal Subcommittee of the U.N. Committee on the Peaceful Uses of Outer Space on March 19, 2010, at which time the ICAO Secretariat expressed its belief that the paper remained pertinent.

[12] SARPs are defined as specifications for physical characteristics, configurations, materials, performance, personnel, or procedures, the uniform application of which is recognized as necessary for the safety or regularity of international air navigation and to which member states will conform.

[13] http://www.icao.int/about-icao/Pages/member-states.aspx

[14] SARPs are nonbinding on the members, except for rules of the air over the high seas. If a member state intends not to comply with a specific SARP, notification to that effect must be provided to the ICAO Council, which will issue a public notice of noncompliance to those concerned in the global aviation community. Members of the community then can make their own decisions on how to respond. In such cases, economic and peer pressure may be sufficient to induce compliance by an otherwise reluctant member.

[15] R.S. Jakhu & Y.O.M. Nyampong, "International Regulation of Emerging Modes of Space Transportation" in J. Pelton & R. Jakhu, *Space Safety Regulations and Standards* (Burlington, MA: Butterworth-Heinemann, 2010), p. 231.

[16] MacKenzie, Chapter 7, "Growing Pains," pp. 145-170.

[17] MacKenzie, p. 162.

[18] MacKenzie, p. 179.

[19] http://www.iadc-online.org/

[20] International Maritime Organization (IMO), "SOLAS: the International Convention for the Safety of Life at Sea, 1974," October 1998 (http://www.imo.org/en/KnowledgeCentre/ReferencesAndArchives/FocusOnIMO(Archives)/Documents/Focus on IMO - SOLAS, the International Convention for the Safety, of Life at Sea, 1974 (October 1998).pdf).