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Standards, Standards Everywhere: Assessing Current Initiatives for Human Spaceflight Standards and Their Potential Effect on Future Regulations

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Abstract

One of the critical questions facing the human spaceflight industry is how its activities will be regulated during the infancy of the industry. It is generally agreed that regulation is necessary to address safety risks to crew, passengers and third parties. However, there is also a concern that government agencies may over-regulate the industry in a manner that could create unnecessary administrative burdens and interfere with technological innovation. In fact, the growth of regulation over the human space industry has been quite slow. Although the United States enacted the Human Space Flight Requirements for Crew and Space Flight Participants in 2006, a moratorium on design and operations requirements was imposed until 2012 (later extended to 2015). Other countries have yet to issue regulations specifically addressing the human spaceflight industry. But while formal regulation is evolving slowly, multiple initiatives have been undertaken to develop voluntary operational and design standards that would establish best practices for the industry. Most notably, in 2013 the FAA issued Draft Established Practices for Human Space Flight Occupant Safety that will likely lay the groundwork for future regulations. Non-governmental organizations are also developing operational and design standards, including the Commercial Spaceflight Federation, the International Standards Organization, and the IAASS. Multiple questions arise from this situation. Do these standard-setting processes have sufficient participation from industry to render the resulting standards legitimate? Do some standards rely excessively on legacy government program practices at the expense of innovative future practices? Could voluntary adherence to safety standards forestall excessive government regulation? Of course, the ultimate question is whether these standards will have a beneficial influence on the success of the human spaceflight industry.

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Introduction

The first suborbital flights carrying paying passengers will likely take place in 2015 with both Virgin Galactic and XCOR being close to having their spaceplanes ready to fly. When they do fly, they will do so under the Federal Aviation Administration (FAA) Human Spaceflight Requirements which implement the U.S. Commercial Space Launch Amendments Act (CSLAA). The FAA's regulations are the only regulations in force to regulate this new industry of suborbital space flight. And they regulate this industry with a light touch -- by requiring informed consent of passengers rather than certifying the spaceplanes as safe by imposing burdensome design requirements. But this will be changing soon. The FAA has indicated that new design or operational requirements will be imposed in the coming years. Other countries are also in the process of adopting their own domestic regulations. Against this background there are a number of efforts to draft standards, guidelines, and best practices to help ensure the safety of passengers and those on the ground. This article will describe the current state of regulation relevant to the suborbital industry and assess the various standard-setting initiatives. The effect of these standards on the future shape of suborbital regulations will then be considered and suggestions provided for the evolution of the regulatory landscape.

I. The FAA Human Spaceflight Requirements

The United States currently has the only regulatory regime drafted specifically for the suborbital spaceflight industry. The FAA's Human Space Flight Requirements for Crew and Space Flight Participants were issued in 2006 pursuant to the Commercial Space Launch Amendments Act of 2004. In these regulations, the FAA takes a "hands-off" approach by requiring very little of the space companies with respect to the design and operation of their spacecraft. The FAA Requirements require that a license be procured by a space vehicle operator intending to launch (or reenter) a vehicle containing passengers (or "space flight participants"). In order to obtain the license and commence launch activity, the operator must comply with a number of provisions contained in the FAA Requirements. These requirements include (i) showing financial responsibility, (ii) obtaining reciprocal waiver of claims, (iii) complying with certain minimum operational requirements, (iv) crew training, (v) fully disclosing the risks of flight to prospective space flight participants, and (vi) obtaining the informed written consent of space flight participants. Rather than prescribe detailed design requirements, the FAA requires only certain minimum operations requirements and full disclosure of risks to space flight participants. For example, an operator is required to "provide atmospheric conditions adequate to sustain life and consciousness for all inhabited areas within a vehicle." How this requirement is achieved is left to the operator. Congress only granted the FAA the authority to prohibit

design features that have resulted in a serious or fatal injury, or that may contribute to events that pose a high risk of causing a serious or fatal injury. The FAA requirements included an initial moratorium on the imposition of design requirements. The moratorium, or "learning period," was initially set to expire in 2012, but was extended to October 2015. Although some industry actors have called for a further extension of the moratorium on the grounds that no flights have yet taken place, i.e. no "learning" regarding spacecraft design and operation has taken place, and that therefore there is no data on which to base design requirements. However, the FAA is not inclined to extend the moratorium. That said, the FAA has given indications that it will proceed slowly with the enactment of any such design requirements.

Other countries are preparing to issue their own regulations for suborbital flight due to interest of the suborbital operators to fly in these countries. Curacao is developing its own regulatory regime since it will have a spaceport that will host flights by the XCOR Lynx. The United Kingdom has recently issued an in-depth report regarding the regulation of suborbital flight. The UK has shown a strong interest in the FAA model of regulation, but the report recommended that suborbital flights be licensed under the existing regime for experimental aircraft while new regulations are developed. Sweden is also likely to have suborbital flights operated by Virgin Galactic flying out of Spaceport Sweden -- and Sweden is therefore also exploring the drafting of their own set of domestic regulations. The European Aviation Safety Agency (EASA) has also explored suborbital regulation on a regional (European) level and proposed a number of options ranging from allowing individual states to adopt their own regulations to imposing a single unified set of regulations that would impose a certification regime requiring compliance with numerous design and operational requirements. Following the issuance of this proposal, EASA was awaiting a policy decision from the EU Commission. This decision has not been issued and there has been no further action on the EU level.

II. ICAO Jurisdiction

One of the fundamental questions regarding the regulation of suborbital spaceflight is whether suborbital flight falls within the jurisdiction of the International Civil Aviation Organization (ICAO). Arguments have been made that the jurisdiction of ICAO encompasses suborbital flight on the basis that the suborbital spaceplanes will for most of their flight path be in airspace (rather than outer space) and that ICAO has jurisdiction over any activity that has an effect on the safety of civilian airspace. ICAO is currently assembling a "learning group" of industry and government representatives to explore the issue. If ICAO determines that it has jurisdiction over suborbital spaceflight, we may see the development of Standards and Recommended

Practices (SARPs) governing suborbital flights. The member states of ICAO would then determine how to implement the SARPs.

III. Licensing vs. Certification

As countries consider the nature of suborbital spaceflight regulations, one of the primary questions is whether to adopt (1) a "licensing" approach in the model of the FAA or (2) a certification approach similar to the certification of civilian aircraft. The former imposes few design and operation requirements and relies instead on the informed consent of the passengers to participate in the potentially dangerous activity of spaceflight. The certification approach would take a heavier hand in regulating the design and operations of the suborbital operators by subjecting the spacecraft to a certification process requiring compliance with numerous design requirements in order to certify the spacecraft as "safe." The FAA makes clear in its regulations that it does not certify the safety of the spacecraft.
At this point, it appears that the "licensing" approach adopted by the FAA has become the likely model to be adopted by other countries. In the UK report, there was clear interest in exploring further the FAA model. Nevertheless, there are organizations, most notably the IAASS, recommending the adoption of a certification approach.

IV. The Standards-Setting Initiatives

While governments are moving forward with greater deliberation, non-governmental entities are more quickly developing guidelines, standards, and best practices in an effort to address safety concerns in the suborbital spaceflight industry. The most noteworthy of these organizations include (1) the International Association for the Advancement of Space Safety (IAASS), (2) the Commercial Spaceflight Federation (CSF), and (3) the International Standards Organization (ISO). In addition, the FAA has issued a first draft (and will soon be issuing a second version) of their Established Practices for Human Spaceflight Occupant Safety. The FAA's Commercial Space Transportation Advisory Committee is also initiating a process for developing standards. Each of these initiatives will be discussed in the following paragraphs.
The IAASS standards initiative is the most prolific - and the most controversial - of the initiatives. The IAASS has published an early version of Suborbital Spaceflight Safety Guidelines that work in conjunction with their Space Safety Standards for Commercial Human-Rated Systems, which were released in 2010. Although referred to as "guidelines", the Suborbital Safety Guidelines contemplate a certification system whereby an operator would have to receive the approval of a certifying organization that its spacecraft has met a number of design and operation requirements. Perhaps the most controversial of these requirements is the requirement that the spacecraft

attain a one in ten thousand catastrophic event avoidance probability. The IAASS has achieved a considerably high profile and has been engaged with governmental agencies around the world. However, U.S. industry has issued sharp rebukes to the IAASS approach. For example, the one in ten thousand probability requirement is seen by some as a number that cannot be tested or proved without significant flight experience and that it is therefore a useless (and potentially damaging) requirement to impose. Although the IAASS has invited the input from U.S. industry as it refines its proposals, there does not appear to be any change in their approach. Unless they respond to the concerns of U.S. industry, there is a strong likelihood that the IAASS approach will fall out of favor among governments. From the IAASS perspective, the imposition of a certification regime with its design requirements is not problematic since the organization believes that the 50 years of experience in government spaceflight provides sufficient data and knowledge to craft these requirements.

The Commercial Spaceflight Federation has also undertaken an effort to develop standards that can inform current operators of best practices while at the same time laying the groundwork for potential future regulation. The difference between the IAASS and CSF initiatives is that the CSF is moving far more gradually to keep in step with the evolution of the new suborbital spaceflight industry. More important to the CSF initiative is the challenge of putting a proper process in place for developing, discussing and adopting standards when the time is right. The CSF is also aligned with the U.S. suborbital operators which gives its initiative greater credibility from an industry perspective. The CSF will be working closely with the FAA through the COMSTAC as this process moves forward.

The International Standards Organization (ISO) has been active in setting space standards for many years now. Of particular relevance to the suborbital industry is the work of ISO Subcommittee 14 of Technical Committee 20 (TC20/SC14) which develops standards regarding Space Systems and Operations. The Subcommittee has already generated 133 sets of standards in this area. The most recent development is the movement of the draft Human Spaceflight Standards out of committee and into the public comment period. TC20/SC14 has representatives from 13 countries participating in their process (with an additional four countries participating as observers). Unfortunately, participation from U.S. industry has been limited, while the Russian delegation has played a stronger role. Efforts are now underway to increase U.S. participation. There has also been increased efforts to engage the FAA with the ISO process, which will have the added benefit of creating synergies and alignments between the standard-setting initiatives of the two entities.

Finally, as the moratorium on design requirements under the CSLAA comes to an end on October 1, 2015, the FAA has circulated their Draft Established Practices for Human Spaceflight Occupant Safety. These Established Practices

are based largely on NASA's experience with human spaceflight and were created in order to take the first steps towards building a set of safety standards that strike the balance between the need to promote safety while avoiding strict design standards that could smother innovation in an industry that is creating new solutions to extremely challenging design issues. The FAA has received a first round of comments on these Established Practices and will be circulating a revised draft soon.

V. The Effect of Standards Initiatives on the Industry and Future Regulations

Now we come to the question of the effect of the various standard-setting initiatives on the future of the suborbital space industry and the shape of future regulations. The effect of standards need not necessarily result in the adoption of regulations. In fact there are a number of ways in which standards can be applied in the industry:

1. Standards can be used merely as informational "best practices" that are available to companies as they design and operate their spacecraft.
2. Companies can impose standards on themselves in order to improve their spacecraft and operations (and then tout their compliance to prospective passengers).
3. Standards can be imposed by contract if, for example, a suborbital operator provides spacecraft on a set lease basis to the operational entity. The lease could require that the leased spacecraft comply with certain standards.
4. A certifying body, in the nature of United Laboratories, can provide certification that a spacecraft complies with a certain set of standards.
5. Standards could be incorporated into binding regulations.

Those standards that are in existence, whether promulgated by ISO or the IAASS, are certainly already available to engineers who want to make use of these standards in their design process. Existing NASA and ESA requirements for human spaceflight are also in existence (and are voluminous) for this purpose. The more interesting question is what types of standards should be adopted in future regulations (by the FAA or other regulating bodies). While some might argue that the suborbital spaceflight companies are largely self-regulating (since they understand the severe business repercussions of an accident), it is clear that we are moving toward increased regulation of some kind. For the FAA it will likely take the shape of additional design, operation, or process standards. What will occur in other countries is less clear.

As we move forward with developing standards that may evolve into regulations, I propose that the following principles be kept in mind:

1 The "licensing" approach taken by the FAA has enjoyed the support of the leading companies in suborbital space and should be emulated in other countries.

2. Harmonization (or at least interoperability) among domestic regimes would reduce the regulatory burden of multinational operators (particularly when we move to point-to-point travel).
3. As the industry matures, additional standards can be adopted, but it must be done gradually with a clear understanding of the resulting burden on the operators.
4. Performance and process standards should be favored over strict design requirements. Allowing companies to comply with performance requirements in their own way allows for the flexibility that is needed to spur innovation. Requiring companies to institute monitoring and analysis processes to discover and then address potential safety issues will be more beneficial than issuing design requirements (blindly) from the top down.
5. Broad industry participation and a thorough vetting process for new standards is necessary for the creation of standards that will meet industry and public policy needs.
6. Data should be shared to the extent competition allows for the benefit of the entire industry.
7. Standard setting bodies should collaborate to the extent possible in order to avoid reduplication of efforts or conflicting standards.

With these principles guiding the drafting of future standards and regulations, the goal of safety can be sought without preventing companies from succeeding through innovation. With the current initiatives underway, we will see the next generation of suborbital regulations evolving at a reasonable pace.