NASA'S COMMERCIAL CREW TRANSPORTATION SYSTEM REQUIREMENTS AND THE FAA HUMAN SPACEFLIGHT REGULATIONS: A STUDY IN CONTRASTS?

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On December 10, 2010, NASA issued the second version of the technical requirements that will be imposed on private companies that provide orbital crew transportation services to NASA. These Commercial Crew Transportation System Requirements for NASA Low Earth Orbit Missions impose a multitude of operational and design requirements that, among other things, extend many existing NASA technical requirements to private service providers. The sheer volume of these requirements is daunting – being composed of thousands of pages requirements, guidelines, and best practices on various areas from crew health and safety to power systems, wiring, and orbital debris mitigation. This approach to regulating private spaceflight companies stands in stark contrast to the Federal Aviation Administration's Human Space Flight Requirements which take a "hands off" approach to regulating private suborbital human spaceflight by imposing few technical requirements – opting instead to protect private passengers by requiring companies to fully disclose the risks of spaceflight. This approach has the result of both promoting innovation as well as protecting the consumer since spaceflight companies are free to innovate without having to comply with complex design and operational requirements, while private passengers are able to make a fully informed decision when taking on the risk of suborbital flight. After first comparing the different approaches taken in these two sets of regulations, this paper considers (1) whether the more onerous NASA requirements are necessitated by the different nature of orbital spaceflight related to a government program (in contrast to private suborbital spaceflight), (2) the likely effects of the NASA requirements on commercial innovation, and (3) whether NASA (and other space agencies) should adopt another model of regulation governing the engagement of private orbital service providers.

I. INTRODUCTION

Commercial human spaceflight is now emerging on multiple fronts. Space tourism companies will soon be sending their first passengers into suborbital space. Bigelow Aerospace and Excalibur Almaz are planning to place private space stations in orbit. And due to the recent retirement of the Space Shuttle fleet,[1] the United States will soon be relying on private companies to deliver crew to the International Space Station ("ISS"). NASA currently has no means of delivering crew and cargo to the International Space Station and must purchase transport service from Russia, which will cost the United States approximately sixty million dollars for each astronaut delivered to and from the ISS.[2]

In response to the advent of commercial human spaceflight, the Federal Aviation Administration ("FAA") issued the Human Space Flight Requirements for Crew and Space Flight Participants ("FAA Requirements") in 2006 pursuant to the Commercial Space Launch Amendments Act of 2004.[3] In 2010, Congress enacted the NASA Authorization Act which authorized NASA to contract with private companies with the intent to purchase commercial crew space transportation services to

[1] The Space Shuttle program ended on July 21, 2011, when the Space Shuttle *Atlantis* completed its last mission. *See* Ned Porter, *Space Shuttle Atlantis Makes Historic Final Landing, Ends 30-year Program,* ABC News/Technology (July 21, 2011), at *http://abcnews.go.com/Technology/space-shuttle-atlantis-landing-ends-nasa-shuttle-program/story?id=14117477*.

[2] NASA has already purchased 46 seats aboard the Soyuz spacecraft for flights through 2015 in order to provide for crew transportation needs while private companies develop the capability to deliver astronauts to the space station. *See* National Aeronautics and Space Administration, Audit Report, NASA'S CHALLENGES CERTIFYING AND ACQUIRING COMMERCIAL CREW TRANSPORTATION SERVICES, Report. No. IG-11-022 (Assignment No. A-10-010-00) (June 30, 2011) at 13-14, [hereinafter, Audit Report].

[3] Human Space Flight Requirements for Crew and Space Flight Participants, 14 C.F.R. Parts 401, 415, 431, 435, 440 and 460; Commercial Space Launch Amendments Act of 2004, 49 U.S.C. §§ 70101-70305.

low earth orbit ("LEO") and the ISS.[4] Soon thereafter, on December 8, 2010, NASA issued the Commercial Crew Transportation System Certification Requirements for NASA Low Earth Orbit Missions (the "NASA Requirements") which set forth health and medical, engineering, and safety and mission assurance requirements that must be met by private companies that will provide crew delivery services for NASA.[5]

The two sets of requirements, one from the FAA and one from NASA, create the framework of regulations under which the new spaceflight companies must operate. The regulatory environment of any industry is always a critical factor in the development of that industry. And the nature of that regulatory environment is particularly important when the industry is in its early and fragile stages – as is the case for the human spaceflight industry. The new space companies face a multitude of challenges that range from the technical to the financial. Regulatory burdens also exist, such as the International Traffic in Arms Regulations which subject space technology to the same stringent controls that govern munitions.[6] The nature of the requirements issued by the FAA and NASA will have a considerable impact on this emerging industry. However, whether the requirements will prove to support the growth of the industry by promoting innovation or will result in harming the industry – by not allowing sufficient flexibility for innovation – will only become clear in the coming years. At this point, however, we are presented with two models of regulation that, at least at first glance, appear to be quite different. While 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, NASA appears to take a much more aggressive approach by creating imposing design and operation requirements that run into thousands of pages This paper compares these two sets of requirements and evaluates the benefits and disadvantages of the two models.

II. THE FAA REQUIREMENTS

The FAA Requirements have been amply described by other commentators, and so this section will only provide a brief summary of the regulations in addition to a brief evaluation of the approach taken by the FAA.[7]

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.

The requirements for showing financial responsibility and executing reciprocal waivers address liability concerns and the ability of an operator to meet its obligations in the event of an anomaly. The other requirements are designed to help ensure the safety of those on the ground (as well as those on-board). However, rather than prescribe detailed design requirements, the FAA decided to require only certain minimum operations requirements and full disclosure of risks to space flight participants. For example, an operator is required to "provide atmospheric

[4] According to this statute, private companies must comply with NASA-specified certification process to show that their equipment meets the agency's safety requirements.

[5] National Aeronautics and Space Administration, *Commercial Crew Transportation System Certification Requirements for NASA Low Earth Orbit Missions,* Doc. No.ESMD-CCTSCR-12.10 (Dec. 8, 2010), at *http://www.nasa.gov/pdf/504982main_CCTSCR_Dec-08_Basic_Web.pdf* [hereinafter, CCTSCR]. NASA uses the term "human rating" only with respect to NASA vehicles to describe a vehicle as worthy of transporting humans. Stephen Clark, *'Human rating' document hits the Web with new name*, SPACEFLIGHT NOW (Dec. 16, 2010), *http://spaceflightnow.com/news/n1012/16humanrating* In contrast, NASA will "certify" vehicles and systems produced by commercial partners when they are used to transport NASA astronauts. CCTSCR, *supra* note 5, at 4.

[6] *See, e.g.,* Mark J. Sundahl, *Space Tourism and Export Controls: A Prayer for Relief*, 75 J. Air Law & Commerce 581 (2010).

[7] A general description of the FAA Requirements can be found in Tracey Knutson, *What is 'Informed Consent' For Space Flight Participants in the Soon-To-Launch Space Tourism Industry?* 33 J. Space L. 105 (2007); Stephan Hobe, *Legal Aspects of Space Tourism*, 86 Neb. L. Rev. 439 (2007); Kenneth Wong, *Developing Commercial Human Space-Flight Regulations*, in *Space Safety Regulations and Standards* (ed. Pelton & Jakhu 2010); Catherine E. Parsons, *Space Tourism: Regulating Passage to the Happiest Place Off Earth*, 9 Chap. L. Rev. 493 (2006).

conditions adequate to sustain life and consciousness for all inhabited areas with a vehicle."[8] 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.[9] The crew training requirements are also minimal in nature. For example, the pilot must (in addition to having an FAA pilot certificate with an instrument rating) possess "skills necessary to pilot and control the vehicle."[10] How the pilot acquires these skills is left largely open.

The FAA's approach has been heralded as a "hands-off" approach to regulating human space flight that enables operators the greatest possible freedom to innovate with respect to spacecraft design. Congress, in passing the CSLA, understood that prescribing design requirements would stifle innovation – after all, we do not want private operators simply to simply repeat what NASA has done, but to instead develop new spaceflight technologies that NASA have not yet contemplated.

This is not to say that the FAA has neglected the safety of the space flight participant. However, rather than certifying a spacecraft as "safe", the FAA instead addresses the issue of safety risk by requiring full disclosure of the risks to all space flight participants. In addition to having to provide, in writing, a description of the risks of space flight, the operator must give the prospective passenger the opportunity to request additional information both in writing and by means of an oral question and answer session. The passenger is then required to sign a written consent to participate in the flight.[11]

In short, Congress and the FAA resisted the risk of over-regulating the nascent human spaceflight industry by keeping the technical/training requirements to a minimum, while still protecting the public by ensuring that passengers will enter a spacecraft by their own choice after being made fully aware of the risks involved. The limited nature of the FAA regulations can also be seen in the length of the regulations which run only 14 pages in length, much of this space being dedicated to the model reciprocal waiver agreements.

[8] *Id.* §460.11(a).
[9] 49 U.S.C. §70105(c)(2).
[10] 14 C.F.R. §460.5(a).
[11] *Id.* §460.45.

III. THE NASA REQUIREMENTS

The feature of the NASA Requirements that distinguishes them most sharply from the FAA Requirements is their volume. In contrast to the 14 pages of the FAA Requirements, the NASA Requirements are composed of thousands of pages. Moreover, unlike the FAA Requirements, the NASA Requirements address design issues in great detail. It would appear from these facts that NASA has taken a heavy hand in its approach to commercial providers and will micro-manage the design and operation of private spacecraft to a degree that will prevent the type of innovation fostered by the FAA Requirements. Whether this is truly the case requires a closer examination of the NASA Requirements.

III.I. Background

In its long history of human spaceflight, NASA has never utilized the services of a private company to transport its astronauts.[12] As NASA ventures into this new paradigm of crew transportation, the main challenge for the agency will be ensuring the safety of its astronauts and success of its missions while at the same time giving private service providers the freedom to develop new technologies that will meet NASA's standards.[13] NASA does not currently require human rating for vehicles that are not developed by NASA.[14] However, as outlined in NASA's General Safety Program Requirements,[15] when using commercial vehicles to carry NASA crew members, NASA must carefully monitor any risks that commercial vehicles pose to crew members and require its commercial partners to adhere to necessary safety measures.[16] These safety measures are contained in the NASA Requirements and are based on NASA's Human Rating Requirements for Space Systems.[17]

[12] Audit Report, *supra* note 2, at *i*.
[13] *Id.*
[14] *See* CCTSCR, *supra* note 5, at 4.
[15] NASA General Safety Program Requirements, NPR 8715.3C, paragraph 1/14 (March 12, 2008), http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=8715&s=3C.
[16] *See* CCTSCR, *supra* note 5, at 4.
[17] HUMAN-RATING REQUIREMENTS FOR SPACE SYSTEMS, NASA Doc. No. NPR 8705.2 (May 6, 2008), at http://nodis3.gsfc.nasa.gov/displayDir.cfm?t=NPR&c=8705&s=2B. Note, however, that the Russian Soyuz vehicle has not obtained a NASA human-rating certification even though it carries

In Section 403(b)(1) of the NASA Authorization Act, Congress authorized NASA to create the Commercial Crew Transportation Certification Requirements, as reproduced here:[18]

> *Not later than 60 days after the date of the enactment of this Act, the Administrator shall develop and make available to the public detailed human rating processes and requirements to guide the design of commercially-developed crew transportation capabilities, which requirements shall be at least equivalent to proven requirements for crew transportation in use as of the date of the enactment of this Act.*[19]

As a result, NASA was not only given the power to set safety standards, but also to enforce those safety standards.[20] Section 50111 of the United States Code states that "if a commercial provider demonstrates the capability to satisfy certain ascent, entry, and ISS proximity operations safety requirements," then NASA will enter into an "ISS crew transfer and crew rescue services contract with that commercial provider through calendar year 2016, with an option to extend the period of performance through calendar year 2020."[21] Congress also directs NASA to use commercially provided ISS "crew transfer and crew rescue services to the maximum extent practicable, if those commercial services have demonstrated the capability to meet" NASA-prescribed safety requirements, and NASA must do it by means of "facilitat[ion], to the maximum extent practicable, the transfer of" NASA-developed technologies to potential commercial providers.[22]

At the same time, Congress intends to provide commercial partners with maximum flexibility in their technological innovations by seeking ongoing removal of legal, policy, and institutional impediments to space commerce.[23] Congressional findings state that the provision of launch services by the private sector is "consistent with the national security and foreign policy interests of the nation and would be *facilitated by stable, minimal, and appropriate regulatory guidelines that are fairly and expeditiously applied.*"[24] Congress recognizes that the regulatory standards governing human space flight must evolve as the industry matures so that "*regulations neither stifle technology development nor expose crew or space flight participants to avoidable risks* as the public comes to expect greater safety from the industry."[25]

III.II. The Nature of the NASA Requirements

The core of the NASA Requirements is a 39-page document that describes the process of certifying private companies for NASA missions and sets forth the certification requirements. The requirements contained in this document reference, in turn, further requirements and standards found in other NASA documents. The main body of this core document consists of three main sections: (1) the CCTS Operational and Design Certification Technical Requirements, which describes NASA's general expectations for system safety, human control of the vehicle, and crew survival; (2) the Technical Authority Mandatory Standards and Requirements, which list 93 documents, each containing additional requirements companies must meet in order to obtain certification; and (3) the CCTS Certification Package, which sets forth the content and timing for each of the plans, documents and other materials which are to be delivered by commercial companies to NASA to

NASA astronauts. *See* Audit Report, *supra* note 2, 2 n.14. Due to its successful operational history and demonstrated level of reliability and safety, NASA deemed the Soyuz safe for U.S. crews. *Id.*

[18] NASA Authorization Act of Oct. 11, 2010, Pub. L. No. 111 – 267, §403(b)(1), 39.

[19] *Id.*

[20] 51 U.S.C. §50132 (b).

[21] *Id.* §50111(b)(4). Congressional findings include the statements that commercial activities of private sector have substantially contributed to the strengths of both the United States space program and the national economy, and that the Federal Government should purchase space goods and services whenever such goods and services meet Government mission requirements in a cost-effective manner. Pub. L. 102-588, title V, § 502, (Nov. 4, 1992), 106 Stat. 5123.

[22] 51 U.S.C. §50111(b)(1)(A), (C).

[23] *Id.*§50702(d)(7). Chapter 507 of the Title 51 establishes the Office of Space Commercialization within the Department of Commerce, and the main function of the office is the coordination of the space related issues, programs and initiatives within the Department of Commerce. One of the duties of its director includes the removal of legal, policy, and institutional impediments to space commerce. *Id.*

[24] *Id.* §50901(a) (emphasis added).

[25] *Id.* (emphasis added).

show compliance throughout the different certification stages (or "milestones").

The NASA Requirements state that "[t]he applicable revision of documents listed shall be *the current revision in effect on the date of the agreement or contract,*" which means that commercial partners only need to comply with the version of the NASA Requirements that is in effect at the time of contracting, but the requirements shall be revised periodically.[26]

III.II.A. *The CCTS Operational and Design Certification Technical Requirements*

The Operational and Design Certification Technical Requirements are divided into the following five categories:

(1) *System Safety*
(2) *System Control Requirements in General*
(3) *System Control Requirements for Spacecraft*
(4) *System Control Requirements for Proximity Operations*
(5) *Crew Survival/Aborts*

These five categories contain a total of 31 requirements, each of which includes a "Rationale" section describing the intent and reasoning for the requirement. These requirements are not necessarily the only requirements that must be met before a private company can perform a NASA mission. NASA reserves the right to tailor the requirements and impose additional requirements as needed for a particular mission.[27]

Many of these requirements are abstract in nature, thus leaving the mechanism for meeting the requirements open to the ingenuity of the private company.[28] For example, the System Safety Requirements include standards requiring that the spacecraft should provide a safe and habitable crew environment,[29] have failure tolerance to avoid catastrophic events,[30] be designed to overcome instances of human error.[31] Along the same lines, the Crew Survival/Abort Requirements demand that the private spacecraft have the ability to evacuate the craft unassisted, both on the launch pad and after landing, and to execute an abort during ascent on computer, crew and ground commands.[32] Once again, how these requirements are met are left to the creative problem-solving capabilities of the commercial partner.

III.II.B. *The Technical Authority Mandatory Standards and Requirements*

The Technical Authority Mandatory Standards and Requirements (the "TA Requirements") contain the bulk of the requirements that must be met by private companies performing NASA LEO missions.[33] The TA Requirements reference 93 additional NASA documents, each containing further requirements companies must meet in order to obtain certification. Altogether, these 93 documents contain more than 4,000 requirements.[34]

NASA has categorized the underlying 93 documents by subject matter and by level of compliance. The documents are subdivided by subject matter into three subject matter categories:

(1) *Mandatory Health and Medical Technical Authority Requirements (6 documents), which focus on health, safety, and environmental standards;*[35]
(2) *Mandatory Engineering Technical Authority Requirements (42 documents), which contain design standards;*[36] *and*
(3) *Mandatory Safety and Mission Assurance ("SMA") Technical Authority Requirements (45 documents), which contain safety requirements of both a general and specific nature.*[37]

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[26] *See* CCTSCR, *supra* note 5, at 22 (emphasis added). NASA's Commercial Crew Program Planning Office is also developing but has not finalized the processes NASA will use to verify that these requirements have been met and to certify that a commercial partner's vehicle is capable of safely transporting Agency personnel. *See* Audit Report, *supra* note 2, at 7.
[27] CCTSCR, *supra* note 5, at 12.
[28] *Id.*
[29] *Id.*
[30] *Id.* at 13.
[31] *Id.* at 15.
[32] *Id.* at 19-21.
[33] CCTSCR, *supra* note 5, at 22.
[34] *See* Audit Report, *supra* note 2, at 9.
[35] *See, e.g., NASA Space Flight Human System Standard Volume 1: Crew Health*, Doc. No. NASA-STD-3001(March 5, 2007).
[36] *See, e.g., Fracture Control Requirements for Spaceflight Hardware*, Doc. No. NASA-STD-5019.
[37] *See, e.g., NASA General Program Requirements,* Doc. No. NPR 8715.3, as an example of a general requirements document; *and see Fiber Optic Termination, Cable Assemblies, and Installation,* Doc.

Within each of these three subject matter categories, the same 93 referenced documents are further subdivided into three levels of compliance: Type 1, Type 2, and Type 3 documents.

Type 1 documents contain requirements that must be strictly complied with by NASA's commercial partners.[38] There are only five Type 1 documents listed, and those five documents are all in the category of Mandatory Health and Medical TA Requirements. However, only three out of those five documents must currently be complied with because two of the Type 1 documents, 'Man-Systems Integration Standards' and 'Human Factors Design Standard', have been superseded by 'NASA Spaceflight Human System Standard' Volumes 1 and 2 (which are two of the three Type 1 documents in effect).[39] The total length of the three documents combined is 487 pages. There are no Type 1 documents in the second and the third subject matter categories.

Type 2 documents contain requirements that the commercial partner can either comply with strictly or else propose an alternative, which must then be approved by NASA Technical Authorities.[40] There are 70 Type 2 documents. Out of the 70 documents, 53 are currently fully available to the general public, and the total length of those 53 documents combined is 3380 pages. Any document that is referenced by a Type 1 document should be treated as a Type 2 document unless otherwise indicated.[41]

Type 3 documents describe "best practices" developed by NASA in its experience with human space flight.[42] These documents are intended to be used as reference sources for companies as they develop their technology and do not contain any requirements *per se*.[43] There are 18 Type 3 documents, with 10 documents being fully available to the general public. The total length of the available documents combined is 2245 pages.

III.II.C. *The 1100-Series Documents*

When a private company intends to deliver NASA crew members to the ISS, the company must comply with the 1100-Series documents in addition to the NASA Requirements.[44] Compliance with the 1100-Series must be shown through the same Certification Package delivered to show compliance with the NASA Requirements.[45]

The 1100-Series is comprised of six documents. The first document, entitled "Crew Transportation Plan", describes the roles of NASA and the commercial partners and the requirements for achieving certification to transport crew members to the ISS.[46] The second document, entitled "Crew Transportation System Design Reference Missions", states the design goals for a spacecraft delivering crew to LEO. The third document, entitled "Crew Transportation Technical Management Process", summarizes the processes that NASA considers critical to a successful mission. The fourth document, entitled "ISS Crew Transportation and Services Requirements", describes the nature of the service requirements demanded by NASA. The fifth document, entitled "Crew Transportation Technical Standards and Design Evaluation Criteria", sets forth critical design specifications, standards, and processes and explains the criteria NASA will use to assess commercial systems. Finally, the sixth document, entitled "Crew Transportation Operations Standards", sets forth the minimum criteria and practices for commercial space flight partners. The Crew Transportation Technical Management Processes document and the Crew Transportation Operations Standard Guidelines document are not currently available to the general public online. The other four publicly available 1100-Series documents collectively run 380 pages.

No. NASA-STD 8739.5, as an example of a specific requirements document.

[38] CCTSCR, *supra* note 5, at 22. *See, e.g.,* NASA Doc. No. NPR 8705.2B, §1.4.4. as an example of both a Type 1 document within Mandatory Health and Medical TA Requirements; *see also* NASA Space Flight Human System Standard Volume 2: Human Factors, Habitability, and Environmental Health, Doc. No. NASA-STD-3001, Vol. 2, (Jan.10, 2011). The mandatory requirements themselves set out by these documents are very specific, stating for example that the humidity must be of a certain level.

[39] *Id.* Table 6-1: Type 1 Health and Medical TA documents, at 23.

[40] CCTSCR, *supra* note 5, at 22.

[41] *Id.*

[42] *Id.*

[43] *Id.; see also id.* Table 6-3 at 24, Table 6-6 at 27, Table 6-9 at 32.

[44] Audit Report, *supra* note 2, at ii.

[45] *Id.* at 9-10.

[46] *Id.*

III.III. The CCTS Certification Package

Commercial companies need to deliver a so-called "Certification Package" to show compliance with the NASA Requirements.[47] All the materials in the package will "collectively illustrate that the system has met the technical requirements and is safe to carry NASA crewmembers."[48] There are 24 required items, which are marked as a one-time item or as initial release of item with required updates, to be provided upon one or more of the following milestones: System Requirements Review, System Definition Review, Preliminary Design Review, Critical Design Review, and Operational Readiness Review.[49] At each of the major milestones, the Certification Package contents must be reviewed and approved by the Program Manager, Technical Authorities and the Johnson Space Center Director.[50] In order to track the progress of the private company, the Certification Package must be maintained under "configuration management."[51] Just prior to the launch of the mission, the Certification Package must be submitted for approval to the NASA Associate Administrator who serves as chair of the Agency Program Management Council.[52]

IV. ANALYSIS & CONCLUSION

After this review of the NASA Requirements, I have realized that despite their terrific volume they are, in fact, quite flexible and may allow companies sufficient room to still innovate freely. There is no denying that showing compliance with the many requirements is burdensome. But the many guidelines, standards, and best practices also provide a wealth of information that will undoubtedly facilitate the development of a safe and reliable spacecraft. In the best light, one could say that NASA has released the source code for designing a spacecraft and allows companies to either use the code (by following the requirements strictly) or else to make refinements to the source code (by proposing an alternative solution).

On the other hand, I fear that the mere mass of requirements – which embody 50-year history of human spaceflight technology – will suffocate innovation. These requirements reflect the NASA's experience with the Mercury, Gemini, Apollo and Shuttle programs – and the ghosts of these programs can be felt. To create a new spacecraft with a new approach to the challenges of spaceflight may turn out to be difficult in the byzantine mass of requirements (no matter how elastic these requirements may be by allowing for alternative solutions) and under the looming shadows of these historic spaceflight programs. The fact that most of the NASA Requirements do not require strict compliance shows a desire on the part of NASA to be flexible and promote innovation among their commercial partners. However, at some point proving alternative solutions (under the Type 2 requirements) for more than a limited number of the requirements may prove to be too great a burden for a small and entrepreneurial company. This flies in the face of NASA's statements that it aspires to minimize regulatory burdens and facilitate innovation.

Some might argue that comparing the FAA Requirements and the NASA Requirements is inappropriate. After all, the FAA Requirements apply to private passengers who choose to accept the risks of commercial spaceflight, while NASA is purchasing crew delivery services from a company. NASA would be placing the safety of its astronauts and the success of its mission in the hands of a private company – and therefore it should come as no surprise that NASA imposes broad requirements on these companies to ensure safety and achieve success. Of course, Congress limited the authority of the FAA to regulate, and so this, too, explains the limited nature of the FAA Requirements.

But are these distinctions between the FAA Requirements and the NASA Requirements an acceptable justification for NASA's approach? I wonder whether innovation among private companies (innovation which would ultimately benefit NASA if the technology were truly revolutionary in a beneficial way) would be better served by a simpler set of requirements that only required the safe delivery and return of astronauts to LEO – perhaps with the requirement that such ability be proven by a series of flight tests.

In the end, I think the contrasts between the FAA and NASA requirements are lighter than expected. Flexibility and freedom to explore and

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[47] *Id.* at 8.
[48] *Id.*
[49] *Id.* Table 4-1 CCTS Certification Package Content.
[50] *Id.*
[51] *Id.* Configuration management is a process through which a system overall performance can be monitored to ensure consistency with program requirements. NASA, Intelligent System Division, *http://ti.arc.nasa.gov/software/software-management /handbook/cmmi/configuration-management* (last visited Aug. 7, 2011).
[52] CCTSCR, *supra* note 5, at 8.

innovate are preserved. However, a question still remains regarding the effect of the many guidelines and standards that make up the NASA Requirements. Perhaps they will facilitate the development of the new generation of spacecraft. But I fear that the NASA Requirements will create the burden of having to comply with an unreasonable multitude of requirements and, as a result, stifle creativity.

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14. NASA Authorization Act of Oct. 11, 2010, Pub. L. No. 111 – 267, §403(b)(1), 39.