2004

Let There Be Flight: It's Time to Reform the Regulation of Commercial Space Travel

Charity Trelease Ryabinkin

Follow this and additional works at: https://scholar.smu.edu/jalc

Recommended Citation
https://scholar.smu.edu/jalc/vol69/iss1/5

This Article is brought to you for free and open access by the Law Journals at SMU Scholar. It has been accepted for inclusion in Journal of Air Law and Commerce by an authorized administrator of SMU Scholar. For more information, please visit http://digitalrepository.smu.edu.
LET THERE BE FLIGHT:
IT'S TIME TO REFORM THE REGULATION OF COMMERCIAL SPACE TRAVEL

Charity TRELEASE RYABINKIN*

I. AND WE HAVE LIFT-OFF: THE BIRTH OF AVIATION ........................................ 103
   A. Aviation Regulation & The Warsaw Convention: A Forgiving Regime .......... 103
   B. Lessons for Space Travel Regulation ............................................. 106
II. SPACE TOURISM & RLVs: IT'S TIME TO BOLDLY GET GOING ALREADY ........ 107
    A. The Potential of Space Tourism ............................................ 107
    B. Space Tourism & RLVs: Cosmic Symbiosis .................................. 109
    C. Other Economic Incentives for RLV Development ................................ 111
III. DEVELOPMENT OF RLV TECHNOLOGY .............................................. 113
    A. Government RLV Development: A Bumpy Ride So Far .......................... 113
    B. The Growth of Private RLV Development .................................... 114
IV. CHALLENGES TO RLV DEVELOPMENT & SPACE TOURISM .................................. 116
    A. Challenge Number One: Public Perception ................................... 116
    B. Challenge Number Two: International Space Station Obligations ........ 118
    C. Challenge Number Three: RLV Regulatory Regime ............................. 119
V. RLV REGULATORY REGIME ............................................................. 119
    A. Liability and Indemnification ............................................... 119
    B. Evolution of RLV-Specific Licensing Regulation ................................ 120

* J.D. candidate, Georgetown University Law Center, May 2004. This note was prepared for the Space Law Seminar taught by Paul B. Larsen. The author extends her deep appreciation to Professor Larsen, Jim Dunstan, and Esta Rosenberg for their guidance and encouragement.
C. FAA/AST Final Rule: RLV Launch and Reentry Licensing

1. Covered Activities and Types of Licenses ........................................ 122
2. Licensing and Approval Process ................................................... 123
   i. Policy Approval ....................................................................... 124
   ii. Safety Approval .................................................................... 125
   iii. Payload Reentry Review ...................................................... 126
   iv. Environmental Review ........................................................... 127
   v. Post-Licensing Obligations of RLV Operators .............................. 127

3. Unique Safety Concerns of RLVs & Risk Levels ............................. 128

VI. REFORM & IMPROVEMENT: CURRENT AND FUTURE MEASURES ........ 130
A. FAA/AST Efforts to Improve the RLV Regulatory Environment ............ 130
   1. COMSTAC .............................................................................. 130
   2. RLV Mission License Application Workshop .................................. 131
   3. Reports & Studies .................................................................... 133
B. The Case for Deregulation ................................................................ 133
C. Improve Government Indemnification and Risk Allocation .................. 135
D. Simplify the RLV Licensing Process .............................................. 136

VII. CONCLUSION ............................................................................. 137

INTRODUCTION

"The old way of doing things got Aldrin into space. It will take a whole new way to get everyone else there."

SPACE TRAVEL has a distinctly far-out ring to it. A staple of science fiction and Star Trek conventions, the concept seems out of place as the topic of a serious law review article. But contrary to popular belief, commercial space travel has the potential to be as down-to-earth as the daily commute. Within the last five years, important steps have been taken in realizing this potential. Most notably, the world’s first two private space tourists secured a ride into orbit. While most people would be unwilling to shell out $20 million dollars for a visit to space, many would be inclined to buy a less expensive ticket. In fact, market research reveals a desire to visit space among the majority of people in the U.S., Canada and Japan. Other studies suggest space

---

travel could blossom into a $10 to $20 billion dollar-a-year industry.

Crucial to the success of the space travel industry is the development of reusable launch vehicle technology. Reusable launch vehicles (RLVs) represent a more efficient alternative to the expendable launch vehicles currently used to deliver payloads into space. According to some estimates, RLVs could reduce space launch costs from $10,000 per pound to $1,000 per pound. In addition to laying the foundation for a successful space travel industry, the development of RLV technology carries countless other benefits. These benefits include reducing the cost of communication and increasing U.S. market share in the commercial space launches sector.

More than a dozen companies worldwide have begun work on RLV technology. However, these initiatives have yet to come to fruition. At publication, not a single RLV company had applied for a launch license in the United States. Likewise, non-U.S. companies continue to struggle with realizing this new technology. Impediments to RLV development include a lack of public acceptance of, and support for, space travel along with a cumbersome, costly, and unsupportive regulatory regime. Although great strides have been made in curbing public resistance to space travel and improving the regulatory framework, more remains to be done.

This note discusses the potential for a commercial space travel industry and advocates changes to the existing regulatory framework. Part I begins with a history of aviation regulation. Part II describes the emergence of space tourism and the potential it holds. Part III discusses government and private development of RLV technology. Part IV examines general challenges to RLV development and space tourism. Part V assesses the international and domestic regulatory regime surrounding space travel and RLVs. Part VI concludes with recommendations for reform.

I. AND WE HAVE LIFT-OFF: THE BIRTH OF AVIATION

A. AVIATION REGULATION & THE WARSAW CONVENTION: A FORGIVING REGIME

The accommodating regulatory regime surrounding the aviation industry provides a useful framework within which to assess

---

the regulation of space travel and RLVs. In particular, the forward-looking Warsaw Convention and a lack of domestic regulatory interference facilitated the aviation industry's growth. An analysis of these factors is helpful in understanding the shortcomings of the regulations governing space travel and RLVs, and determining what reforms should be made.

Humans' first attempts at flight were hardly graceful. Lacking the wings and feathers of the animal kingdom's more loftily equipped creatures, we resorted to clumsy contraptions to reach the heavens. Often these devices produced unpleasant results—early film reels document crash after crash after crash.\(^3\) Hind-sight brings into focus one inescapable conclusion: humans may not be smart, but they sure have guts.

Undeterred by these failures, humans ultimately persevered: in 1903, the Wright Brothers flew the first airplane at Kitty Hawk.\(^4\) By 1918, air mail flights were well established.\(^5\) Regularly scheduled commercial passenger service began the following year.\(^6\) The early days of commercial air travel, however, were not without setbacks. Planes were falling out of the sky on a regular basis, with aircraft fatality rates that would translate into more than 250,000 deaths per year in modern times.\(^7\)

Despite the hazards posed by early air travel— or perhaps because of them—representatives of the world's developed nations gathered in 1929 to develop a forward-looking international aviation regime. Recognizing the need to shield the fledgling airline industry from cost-prohibitive insurance premiums and unlimited liability for accidents, these nations signed the Warsaw Convention. The result was a radical convention that, for international flights, rejected strict liability in favor of a negli-

---


\(^6\) Id. at 229.

\(^7\) Id. The death rate in 1929 was 45 fatalities per million miles flown. Based on the number of miles flown today, this rate would translate into more than 250,000 deaths per year in aircraft accidents. In reality, fewer than 1,000 people perish each year in aircraft accidents. In 2002, 702 people died in commercial aircraft accidents. Boeing Com. Airplane, Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations 1959-2002 (2003), at http://www.boeing.com/news/techissues/pdf/statsum.pdf.
gence standard and capped maximum damages an individual could collect from an air accident at $10,000.8 Domestically, early regulation of airline carriers was contingent upon their participation in the U.S. airmail system – commercial airlines remained unregulated until 1938.9

Fortunately for the jetsetters among us, the Warsaw Convention and initial lack of domestic regulation provided the U.S. airline industry with the combination of protection and freedom it needed to flourish.10 Today, commercial air travel is an enormous and growing industry. In the U.S., passenger traffic exceeds 650 million enplanements per year, up from 300 million per year in the early 1980s.11 Globally, more than 3 trillion passengers travel each year.12 More important, air travel has become the safest form of transportation available: in 2002, only 702 people died in commercial airplane accidents,13 and be-

8 Dunstan, supra note 5, at 229. At the Montreal Convention in 1966, the United States demanded that the standard be changed to strict liability. Although strict liability applies in the United States and in the other countries that signed the Montreal Agreement, many nations did not sign this Convention and are still bound by the Warsaw Convention’s negligence standard. Id. The damage cap was retained under the Montreal Convention at $75,000.


10 Dunstan, supra note 5, at 229.


13 Boeing Com. Airplane, Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations 1959-2002 (2003), at http://www.boeing.com/news/techissues/pdf/statsum.pdf. The accident statistics presented in this document apply to worldwide commercial jet airplanes that are heavier than 60,000 pounds maximum gross weight, not including airplanes manufactured in the Commonwealth of Independent States or commercial airplanes operated in military service. Between 1959 and 2002, there were 1,337 accidents worldwide out of a total of 412 million departures, amounting to a fatality rate of far less than 1 percent. Compare this number with the approximately 40,000 people who die in automobile
between 1994 and 1998, that number averaged 169 per year.\textsuperscript{14} According to a recent Department of Transportation study, only 1 in 1.6 million passengers die in plane crashes, compared with 1 in 6,800 drivers in auto accidents and 1 in 242,000 in train wrecks.\textsuperscript{15}

B. Lessons for Space Travel Regulation

The story of man's first foray into the skies—and the accommodating regulatory framework that kept him in the air—is instructive in the context of space travel. Like air travel in the early 1900s, space travel represents uncharted territory for the average modern passenger. The thought of cruising into lower earth orbit for an afternoon probably seems as far-fetched today as the idea of keeping a 435-ton\textsuperscript{16} hunk of metal aloft long enough to traverse the Atlantic Ocean. Adding to the public's skepticism is its fear. If the Challenger disaster soured the nation's palate for the Space Shuttle program, the more recent Columbia explosion sounded the program's death knell. These two incidents—however isolated—cemented the perception of many that commercial space travel is too dangerous to pursue.\textsuperscript{17}

The regulatory framework surrounding RLV licensing reflects this cautious and conservative attitude toward space travel. In contrast to other international transport industries, which are governed largely by commercial law, existing space law comprises inter-governmental treaties negotiated during the Cold War.\textsuperscript{18} The lack of commercial influence on the regulatory framework for space transport has had some costly ramifications.

\textsuperscript{14} Id.
\textsuperscript{15} Id.
\textsuperscript{17} See Dunstan, supra note 5, at 232 (noting the tendency of some to deify Christa McAuliffe and advocating for a negligence standard in space travel); see also Federal Aviation Administration, About Commercial Space Transportation, at http://ast.faa.gov/aboutcst/ (last visited Jan. 22, 2004) (noting that commercial payloads aboard the Shuttle were banned after the Challenger disaster).
COMMERCIAL SPACE TRAVEL

The international treaties governing the law of outer space impose strict liability on entities engaged in commercial space transport. See Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Jan. 27, 1967, 18 U.S.T. 2410, art. 6, T.I.A.S. 6347 [hereinafter 1967 Outer Space Treaty] (requiring states to bear international responsibility for national activities in outer space "whether such activities are carried on by governmental agencies or non-governmental entities"); Convention on International Liability for Damage Caused by Space Objects, Sept. 1, 1972, 24 U.S.T. 2389, art. 2, T.I.A.S. 7762 [hereinafter Liability Convention] (making states absolutely liable for damage caused by their space objects on the surface of the earth or to aircraft in flight).

II. SPACE TOURISM & RLVS: IT'S TIME TO BOLDLY GET GOING ALREADY

A. THE POTENTIAL OF SPACE TOURISM

The age of aviation opened up the world and created an industry with huge economic rewards. Space tourism has similar
potential. Tourism is arguably the world’s largest industry, with global spending on travel estimated to have surpassed $4.3 trillion in 2000. In the U.S., the travel and tourism industry is a $584 billion business, representing 2.2 percent of the nation’s GDP in 1999. Tourism in space is simply the next logical extension of a well-established and profitable industry. As stated by Buzz Aldrin in a recent article, “Space tourism is based upon a firm commercial foundation, being a natural evolutionary outgrowth of the booming multi-billion-dollar adventure travel sector of the multitrillion-dollar travel and tourism business.”

Some estimate that space tourism could eventually generate from $10 billion to $20 billion per year. Market research demonstrates that space tourism is a popular aspiration of the majority of the population in rich countries, and a recent NASA survey confirms the huge potential market for space tourism. The current popularity of other space-related tourist activities heralds this potential. More than ten million people each year visit space museums, space camps, rocket launch-recovery sites, and government space research and development centers, generating approximately $1 billion in revenue per year.

Recent developments in space tourism reflect this growing interest. Demonstrating—or perhaps contributing to—public

---


29 Collins, supra note 18.

30 Kelly Space & Technology, Inc. completed a NASA-sponsored survey of future space markets. As reported by Kelly Space president Robert Davis, “[w]e found that the most easily quantifiable market that we could really touch, smell, understand and model was private space travel for everyday citizens.” Leonard David, *Space Tourism in the 21st Century: High Hopes, High Stakes*, Space.com (June 29, 2001), available at http://www.space.com/missionlaunches/tourism_stakes_010629-3.html.

31 O’Neil, supra note 28.

32 Id.
awareness of space tourism, *Time* magazine published its first feature article on the topic in 1998. In addition, both the U.S. Government and the private sector have begun to evince a less myopic view of space tourism. In 1998, NASA published a report that endorsed the feasibility of space tourism. In 1999, Virgin Airlines CEO Richard Branson announced Virgin Galactic Airways, which he claimed would offer short tourist flights into space within eight years.

While short tourist flights into space have yet to materialize, important developments have taken place. Optimistic hypotheses about space tourism blossomed into dazzling reality in 2001. In defiance of the aerospace industry's gloomy prognosis for commercial space travel, MirCorp and Space Adventures brokered a deal with the Russian Aviation and Space Agency to send humanity's first tourist into space. On April 28, 2001, Dennis Tito paid $20 million to ride a Russian Soyuz rocket to the International Space Station (ISS). Just one year later, South African businessman Mark Shuttleworth signed a contract with the Russian Aviation and Space Agency to become the second space tourist to the ISS.

**B. Space Tourism & RLVs: Cosmic Symbiosis**

The successful development of space tourism is inextricably linked with favorable regulation of RLVs. As one expert stated, "[s]pace tourism more than any other commercial space venture has the potential to support low-cost-launcher operations and therefore justifies development of RLV technology." A 2001 NASA study likewise concluded that only space tourism offers a large enough market to enable RLVs to reduce the cost of getting in to orbit.
Access to space has been dominated by expendable launch vehicles (ELVs) since the inception of spaceflight in the 1950s.\(^4\) While one-time-use rockets have an impressive track record, they suffer from one unavoidable defect: high cost.\(^4\) Current estimates put the cost of delivering one pound of cargo into Earth's orbit at $5,000 to $10,000.\(^4\) U.S. Space Shuttles represent a reusable alternative to ELVs. Unfortunately, they too are prohibitively expensive; NASA has spent more than $3 billion annually on its fleet of Shuttles.\(^4\) A Space Shuttle launch requires several thousand support personnel and two or more months of preparation, amounting to a launch cost of approximately $20,000 per kilogram.\(^4\) More important, the Space Shuttle program has been a public relations disaster.\(^4\)

It is not surprising, then, that a new class of spacecraft is emerging to provide a less costly means of delivering payload. As the name would suggest, reusable launch vehicles survive launch and reentry. Their capacity for repeated use enables them to recover the huge costs involved in building a launch vehicle and provides tremendous cost benefits over comparable ELVs.\(^4\) According to some estimates, RLVs could reduce...
space launch costs from $10,000 per pound to $1,000 per pound.47

Such a radical reduction has obvious implications for space tourism – an industry whose costs are still far beyond the fiscal grasp of most people. While few could afford to spend $20 million dollars on a visit to space, lower price tags are sure to come with private development of RLVs. Because space tourism depends on the success of RLV development, the regulations governing this industry must be reexamined.48

C. OTHER ECONOMIC INCENTIVES FOR RLV DEVELOPMENT

In addition to helping space tourism take off, RLV development will be a boon to the overall commercial space industry. This industry, like tourism, is already well established: the Satellite Industry Association49 estimates that world revenues in the commercial space industry exceeded $65 billion in 1998.50 RLV development, and the concomitant reduction in launch costs, will only enable this industry to grow. Whether the U.S. space launch industry will reap the benefits of this growth—and regain some of the market share it lost to Arianespace and other foreign companies in the 1980s51—will depend largely on the regulation of RLVs.

Until the 1980s, the U.S. had a virtual monopoly on the commercial launching market.52 Any entity interested in launching

47 Moore, supra note 2, at 251.

48 Id.


50 The Satellite Industry Association (SIA) is a U.S.-based trade association representing leading U.S. and international satellite service providers, manufacturers, launch services companies, and ground equipment suppliers. As stated on its website, the SIA is “the unified voice of the commercial satellite industry on policy, regulatory, and legislative issues affecting the satellite community.” See The Satellite Industry Association’s website at http://www.sia.org/ for further information (last visited Jan. 22, 2004).


52 Some predict the reduction in launch costs resulting from RLV development would allow the United States space launch industry to dominate the global satellite launch services market. Moore, supra note 2, at 251.
a satellite had one option: contract with NASA, which would then deliver the payload via an ELV purchased from one of three U.S. rocket manufacturers.53 This changed in the 1980s when NASA began the Space Shuttle program and phased out its ELV inventory.54 Meanwhile, the European Space Agency (ESA) had begun work on its Ariane rocket, an ELV that proved to be both reliable and less expensive than NASA's Shuttle.55 The lack of NASA support for the ELV industry, combined with the French government's "unwavering backing" of the Arianespace in the form of an uncapped indemnification,56 ultimately enabled Arianespace57 to dominate fifty-five percent of all commercial payloads between 1990 and 1995.58

Since then, other countries have joined the commercial launch industry,59 leaving the U.S. launch providers with only 29 percent of the market in 2000, down from 49 percent in 1998.60 A supportive regulatory environment for RLV development therefore is imperative if the U.S. is to remain competitive in the commercial launch sector.61

54 Id.
55 Id.
56 Id.; see also Ann Florini, Developing the Final Frontier 44 (1985) (stating that NASA was budgeted to spend about $121 million for each of the 14 Shuttle flights scheduled for 1986, but that fewer than half of the flights would earn that much).
57 See Extension of Space Launch Indemnification: Hearing Before the Subcommittee on Space and Aeronautics of the House Committee on Science, 106th Cong. (1999) [hereinafter Hearings] (opening statement of Rep. Dana Rohrabacher, Chairman, House Subcommittee on Space and Aeronautics, discussing need for the U.S. to indemnify U.S. launch companies so that they can be competitive with Arianespace, whose launches were indemnified by the French government); see also id. (statement of Patricia A. Mahoney, Chair, Satellite Industry Association).
58 Arianespace is a multinational semi-public corporation created by the ESA to market and operate the Ariane rocket.
59 Twibell, supra note 53, at 621.
60 Id.
61 Press Release, U.S. Dep't of Commerce, Technology Administration, Commercial Space Trends (June 5, 2001), available at http://www.technology.gov/Prel/pr010607.htm (indicating that U.S. providers' 29 percent market share was down from 49 percent only two years earlier and that for the period from 1996 to 2002, projected U.S. sales growth lagged behind the rest of the world not only in space transportation (1.5 percent, U.S., versus eight percent, rest of world) but in satellite manufacturing (nine percent versus 13 percent)).
III. DEVELOPMENT OF RLV TECHNOLOGY

A. GOVERNMENT RLV DEVELOPMENT: A BUMPY RIDE SO FAR

Both NASA and the U.S. Air Force have been involved in experimental programs to develop RLV technology. Unfortunately, technical problems and funding issues have plagued the programs, raising the question of whether government RLV development will ever bear fruit.

In 1996, NASA unveiled its X-33 and X-34 programs to spark development of commercial RLVs. Work on the X-33 spaceplane, a single-stage-to-orbit spaceliner, was conducted in a cooperative project between NASA and the Lockheed Martin Aeronautics Company. As for the X-34, NASA awarded Orbital Sciences Corporation (OSC) a contract for the design, development, and testing of the reusable unmanned suborbital spacecraft. After spending more than $912 million on the X-33 and $205 million on the X-34 project, NASA decided in 2001 to cut funding for both programs. The X-33 program had experienced a myriad of technical problems and design challenges, prompting intense renegotiation conversations between NASA and Lockheed Martin and the ultimate decision to cut funding. Arthur Stephenson, director of NASA’s Marshall Space Flight Center explained the decision simply: “What we’re hearing from industry and our own evaluation is that we believe a single-stage-to-orbit vehicle for a second-generation vehicle... is not viable at this time.”

Bob Haltermann, executive director of STA’s Space Travel and Tourism Division described the cancellation of the X-33 project as a step backward: “NASA spent $1 billion dollars and Lockheed Martin spent $400 million... and NASA just dropped it. That’s tragic. If you’re thinking about greatly reducing launch costs, you’re never going to get there by not taking greater risks to make greater advances.”

On a more positive note, development of RLVs remains a stated priority for NASA, and the agency has continued alone

62 Collins, supra note 18.
64 Leonard, supra note 30.
66 Savitt, supra note 63, at 517; David, supra note 30.
67 David, supra note 30.
68 Id.
with the X-37 program despite announcements from Boeing and the U.S. Air Force that they would not invest any additional funding of their own into the program.\textsuperscript{69} NASA also recently kicked off its $5 billion Space Launch Initiative, which allowed for nearly $800 million of funding to several U.S. companies and universities for RLV technology and systems engineering development.\textsuperscript{70}

If the X-33 and X-34 programs are any indication, however, it could be many moons before NASA develops a viable RLV. Many are looking instead to the private sector, which has become increasingly active in RLV development over the last decade.

\subsection*{B. The Growth of Private RLV Development}

Until the 1980s, there was no commercial space transportation industry. Only the United States launched commercial satellites, and these were launched on vehicles owned by the government, including NASA's Space Shuttle.\textsuperscript{71} Events of the 1980s — including the birth of Arianespace, the recognition of the value of commercial space transportation by U.S. government officials, and the ban of commercial payloads from flying aboard the Space Shuttle after the Challenger disaster, promoted the development of this industry in the United States.\textsuperscript{72} By 2000, U.S. commercial space transportation and the services and industries it encompasses accounted for more than $60 billion in economic activity.\textsuperscript{73}

Both the rapid growth of the commercial space transportation industry and NASA's decision to scrap its X-33 and X-34 programs suggest that private companies are in the best position to pursue RLV development.\textsuperscript{74} The private sector appears to agree. Despite the many challenges facing the RLV industry, private development of reusable technology presses on. More than 20 private companies worldwide are actively engaged in RLV development, thanks in large part to the "X" Prize Founda-

\textsuperscript{69} Id.
\textsuperscript{70} Savitt, \textit{supra} note 63.
\textsuperscript{71} Id.
\textsuperscript{72} Twibell, \textit{supra} note 53, at 621.
\textsuperscript{73} Federal Aviation Administration, \textit{About Commercial Space Transportation}, at http://ast.faa.gov/aboutcst/ (last visited Jan. 22, 2004).
\textsuperscript{74} Id.
Following in the footsteps of aviation incentive prizes offered between 1905 and 1935, the Foundation created the “X” Prize in 1996 to jumpstart the space tourism industry. The goal of the contest is to make space travel possible for all through competition among the most talented entrepreneurs and rocket experts in the world. To this end, a $10 million cash prize will be awarded to the first team that privately finances, builds and launches a spaceship that carries three people to 100 kilometers (62.5 miles), returns safely to Earth, and repeats the launch with the same ship within two weeks. So far, 24 teams from seven different countries have registered with the Foundation and are competing for the prize.

Most formidable among the competitors is Burt Rutan, founder of Scaled Composites. The company recently unveiled SpaceShipOne, a white rocket ship fueled by nitrous oxide. The ship will be launched from a turbojet carrier plane called the White Knight. Scaled Composites has the financial backing of an “undisclosed customer,” who many aerospace insiders believe is Microsoft co-founder Paul Allen. Paul Allen would not be the first filthy-rich entrepreneur to get involved in RLV development. Jeff Bezos, CEO of Amazon and cosmically-minded billionaire, recently created a space research company called Blue Origin. With a staff of physicists, ex-NASA scientists, veterans of unsuccessful space start-ups, and sci-fi writers, Blue Origin’s goal is to launch an RLV into suborbital space, with seven tourists onboard, within the next few years. Likewise, PayPal founder Elon Musk is building his own rocket company,

---

75 Private RLV developers are not the only companies unwilling to wait for NASA. The Planetary Society is sponsoring a private project called “Cosmos I” to boost a 200-pound experimental solar sailboat into high Earth orbit as early as September 2003 without waiting for NASA, which is also working on solar sails technology. Robert S. Boyd, NASA, Private Group Developing “Solar Sails” Vessels Would Be Able to Travel Through Space Powered by Sunlight, THE STATE, June 5, 2003.


77 Id.

78 Id.

79 Id.

80 Rutan’s company has been involved in numerous advanced aeronautical projects such as the Voyager, the first aircraft to fly around the world without refueling, and the Pegasus rocket, which is launched into space from beneath the wing of a carrier aircraft and has placed many small satellites into orbit. David Whitehouse, U.S. Pioneer to Offer Spaceflights, BBC NEWS, May 31, 2003.

81 Stone, supra note 36.

82 The company is also known as Blue Operations, LLC.
SpaceX, which is working on the development of a dual-stage, liquid-oxygen-and-kerosene-powered rocket called the Falcon. According to Musk, the Falcon will be able to launch satellites at a cost of $6 million. Finally, John Carmack, the man who coded the hugely successful games Doom and Quake, has joined the quest to build an RLV. His company, Armadillo Aerospace, is one of many competing for the "X" Prize and is one of only three companies in pre-application consultation for a launch license with the Federal Aviation Administration's Office of Space Commercialization.

IV. CHALLENGES TO RLV DEVELOPMENT & SPACE TOURISM

While the U.S. private-sector space information industry generates nearly $68 billion a year, the U.S. space transportation industry has had more difficulty getting off the ground. According to a report by the Office of Space Commercialization, the U.S. space launch industry generated only $1.54 billion in 2000 and was projected to generate only $2.57 billion in 2002. There are many reasons the space transportation industry generally—and space tourism specifically—have been slow to develop. Each of these challenges is discussed below.

A. CHALLENGE NUMBER ONE: PUBLIC PERCEPTION

The first challenge to space tourism is public perception. Mention the concept of "space tourism" to any person and chances are you'll be met with a dismissive roll of the eyes or an incredulous chuckle. The so-called giggle factor—the idea that only astronauts and cosmonauts have any business in space—is one facet of the overall public-perception problem that has im-

---

83 Stone, supra note 36.
84 Id.
85 E-mail from John Weglian, Space Systems Development Division, Office of the Associate Administrator for Commercial Space Transportation, Federal Aviation Administration (June 23, 2003, 17:41 EST) (on file with author).
87 Trends in Space Commerce, supra note 85, at 2-5.
peded the development of RLV technology. The tendency to write off space tourism as sci-fi chimera is prevalent even among experienced aerospace systems engineers, especially those unfamiliar with potential new capabilities that are inherent in recent technological advances. So skeptical are some in the U.S. aerospace industry that aerospace companies’ first study of the potential market for commercial space transportation concluded that space tourism was infeasible.

In the early 1980s, NASA attempted to broaden public perception of space tourism by launching the Space Shuttle program. The Challenger disaster swiftly put a damper on these early hopes of space tourism. Nearly two decades later, companies like MirCorp and Space Adventures made history when they sent the world’s first space tourist into outer space. As promising as these milestones have been, the recent Columbia disaster has once again cast a shadow over the industry, prompting many to question whether humans are fit for space travel at all.

A recent USA Today/CNN/Gallup Poll captures the mercurial nature of American public perception and reveals an interesting twist. Though each disaster has resulted in vocal criticism of the Shuttle program, the poll indicates that American support for increasing NASA’s budget actually increased after both Challenger and Columbia. Of those people polled in 2003, only 17 percent believed NASA spending should be decreased, compared with 41 percent in 1993. In addition, only 17 percent of people polled said any Shuttle accident was unac-

---

89 Collins & Yonemoto, supra note 88.
92 See, e.g., supra note 45; Dunstan, supra note 5, at 232.
93 On April 28, 2001, Dennis Tito paid $20 million to visit the International Space Station. One year later, South African businessman Mark Shuttleworth signed a contract with the Russian Aviation and Space Agency to become the second space tourist to the ISS. See Stone, supra note 36.
94 See, e.g., supra note 45.
While such statistics are encouraging, the poll also suggests that America's support is qualified: when asked about other areas of spending, people overwhelmingly favored other programs over the space program.\footnote{Id.} Despite these challenges, plans to send the next pair of space tourists into orbit are underway.\footnote{Id.} With each new space tourist to reach orbit will come greater public acceptance of the notion of commercial space travel. However, until space tourism ceases to cater exclusively to the upper economic echelon of society, average people will continue to view the industry as nothing more than an oddity. The development of RLVs is therefore crucial to lowering launch costs and making space tourism accessible to a broader base of people. The evolution of aviation provides a heartening model: services that come with exorbitant price tags eventually come down to earth. Air travel—a luxury once beyond the financial grasp of most people—is now available and affordable to some one billion people all around the world.\footnote{Id.}

\section*{B. Challenge Number Two: International Space Station Obligations}

Another impediment to the development of space tourism is the International Space Station's crippling dependence on Russian rockets—the only vehicles that have thus far been used to send tourists into space. The Columbia disaster was a sad reminder that space tourism is a fragile business in a polycentric universe of international obligations and economic limitations. Shortly after the Columbia perished, NASA grounded its remaining Shuttle fleet. Without the Shuttles and their 25-ton payload capacity,\footnote{Id.} Russian Progress cargo freighters and Soyuz rockets represented the only reliable means of delivering food, supplies, and replacement crews to the International Space Station (ISS). In an effort to make all of its rockets available, the Russian Aviation and Space Agency announced it would sus-

\begin{footnotes}
\footnote{Id.} Forty-three percent of the people polled considered one accident for every 100 flights acceptable. In a total of 113 flights, two Shuttles have crashed.\footnote{Id.} Of those polled, 74 percent rated health care a higher priority than the space program, and 60 percent rated defense spending a higher priority than the space program. Welfare was the only program to be rated a lower priority than the space program.\footnote{Id.} \footnote{Coming Soon: Millionaires in Space (the Sequel), \textit{Reuters}, June 19, 2003.} \footnote{Collins & Yonemoto, supra note 88.}
pend its space tourist program indefinitely and dropped plans to send a third tourist to the space station in April 2003. Only in June did the agency announce its intentions to resume space tourism operations by signing an agreement with Space Adventures to send two tourists to the space station at the beginning of 2005.

C. CHALLENGE NUMBER THREE: RLV REGULATORY REGIME

The final obstacle to space tourism is a burdensome and complex regulatory regime—both internationally and domestically—for RLV operations and licensing. This regime is discussed in greater detail in Section IV.

Internationally, the biggest challenge to RLV operations is the fact that RLV operations are subject to strict liability, a standard that has costly ramifications for RLV developers. Most significantly, a strict liability standard forces entities involved in RLV launching to purchase expensive liability insurance.

Domestically, recently issued regulations governing licensing requirements represent a blessing and a curse. In 1998, Congress recognized the need to enable the private sector to undertake space development and passed the Commercial Space Act (CSA). The CSA laid the regulatory groundwork for RLV licensing and opened the commercial launch industry up to the private sector. While current regulations are a vast improvement on the past framework, which lacked any RLV-specific regulation, launch and reentry licensing requirements may prove too complex and time-consuming for some RLV developers. Perhaps not surprisingly, not a single RLV developer has applied for a license.

V. RLV REGULATORY REGIME

A. LIABILITY AND INDEMNIFICATION

Internationally, RLV operations are subject to the general prescriptions of the Treaty on Principles Governing the Activi-

---

103 Coming Soon: Millionaires in Space (the Sequel), REUTERS, June 19, 2003.
104 1967 Outer Space Treaty, supra note 19, at art. 6; Liability Convention, supra note 19, at art. 2.
ties of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, which provides in relevant part that "State Parties to this Treaty shall bear international responsibility for national activities in outer space. . .whether such activities are carried on by governmental agencies or non-governmental entities." The Convention on International Liability for Damage Caused by Space Objects is even more explicit, prescribing that a launching state "shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight."

Like international law governing RLV activities, U.S. domestic law imposes strict liability on parties who launch space vehicles. As a result of this liability regime, the Commercial Space Launch Act (CSLA) requires entities that launch space vehicles to purchase $500 million in third-party liability insurance. The government will cover excess damages up to $1.5 billion, but the launch company is liable for any amount beyond the $2 billion total.

B. EVOLUTION OF RLV-SPECIFIC LICENSING REGULATION

In the mid-1990s, prospective RLV operators identified the lack of adequate regulatory oversight over RLV operations—and in particular over their reentry—as an obstacle to RLV development. These operators believed that a stable and predictable regulatory environment for RLV licensing was critical to the industry's ability to obtain the capital investment necessary for re-

---

106 E-mail from Esta Rosenberg, Attorney, Office of Chief Counsel, Federal Aviation Administration to author (June 19, 2003, 12:08 EST) (on file with author).
108 Id. at art. 6.
109 Liability Convention, supra note 19.
110 Id. at art. 2.
111 Dunstan, supra note 5, at 229; historical notes to 49 U.S.C. Pub. L. No. 106-405, § 7, Nov. 1, 2000, 114 Stat. 1752 (“[n]ot later than 18 months after the date of the enactment of this Act, the Secretary of Transportation shall transmit to the Congress a report on the liability risk-sharing regime in the United States for commercial space transportation. . .[in which it will] examine the appropriateness of deeming all space transportation activities to be ‘ultrahazardous activities’ for which a strict liability standard may be applied”).
113 Id. § 70113.
search and development. The government ultimately agreed. In 1995, the U.S. Government's Office of Commercial Space Transportation became a part of the FAA and immediately began working on developing a licensing procedure for commercially operated reusable space vehicles.

Three years later, Congress passed the CSA, which extended the Secretary of Transportation's licensing authority under the CSLA to reentry vehicle operators and operation of reentry sites by non-Federal entities. The Secretary's licensing authority was delegated to the Administrator of the FAA and further assigned to the Associate Administrator for Commercial Space Transportation (FAA/AST). In essence, the CSA authorized the FAA/AST to license commercial space transportation vehicles to reenter Earth's atmosphere and return space payloads to Earth—an essential requirement for companies developing passenger space vehicles.

The CSA was the first step in developing an RLV framework and removing regulatory obstacles to RLV licensing and development. Not long after enactment of the CSA, the FAA initiated rulemaking to define and implement the licensing process for RLV missions. On September 19, 2000, FAA/AST released the Final Rule of the Commercial Space Transportation Reusable Launch Vehicle and Reentry Licensing Regulations (Final Rule). The Final Rule amends commercial space transportation licensing regulations by establishing operational and licensing requirements for launches and reentry of RLVs.

---

115 Id.
116 Collins & Yonemoto, supra note 88.
118 Id. § 14714.
119 Final Rule, supra note 114.
120 Id.
121 Id.
122 The FAA issued the Notice of Proposed Rulemaking on Licensing and Safety Requirements for Launch on April 21, 1999. Id.
123 The Final Rule was effective November 20, 2000. Id.
C. FAA/AST Final Rule: RLV Launch and Reentry Licensing

1. Covered Activities and Types of License

The Final Rule defines reentry vehicles to include RLVs that are designed to return from Earth’s orbit or outer space to Earth, substantially intact. Until recently, it was unclear whether this definition included suborbital RLVs. An FAA notice published in the Federal Register in October 2003 resolved the ambiguity: “Suborbital RLVs, including those that employ traditional aviation characteristics, such as wings and landing gear, are regulated under the RLV mission licensing requirements [of the Final Rule].”

Under the Final Rule, a person or entity must obtain a license to launch a launch vehicle from the United States, operate a launch site within the United States, reenter a vehicle in the United States, or operate a reentry site in the United States. Additionally, United States citizens must obtain a license to

---

124 Final Rule, supra note 114.
125 Id.
126 Jeff Foust, Easing Regulatory Uncertainty, The Space Review (Nov. 3, 2003), available at http://www.thespacereview.com/article/57/1. The Commercial Space Launch Act of 1984 confers exclusive regulatory authority over launches of a “suborbital rocket” on a “suborbital trajectory” on the AST. However, neither the statute nor the Final Rule defines “suborbital” in terms of altitude or vehicle characteristics, breeding uncertainty as to whether suborbital vehicles would be regulated as aircraft or as launch vehicles. As a practical matter, the AST issued a number of suborbital launch licenses for commercial sounding rocket flights; the regulatory status of X-Prize type suborbital vehicles (those with characteristics of both aircraft and launch vehicles) was less clear. Most suborbital vehicle developers assumed that they would be regulated by AST as launch vehicles. Burt Rutan challenged that assumption in April at the unveiling of SpaceShipOne, when he said that he planned to fly the vehicle under an experimental airworthiness certificate (EAC) rather than obtain a launch license. An EAC is issued by the FAA’s Office of the Associate Administrator for Regulation and Certification (AVR) and is usually easier to obtain than a launch license. While an EAC can offer the vehicle operator more flexibility than a launch license, it precludes the vehicle from being put into commercial service. Instead, the vehicle must be certified by AVR, a process that can take years and cost ten or more times the amount spent to develop the vehicle itself. Id.

127 Id. (citing 68 F.R. 59977, Oct. 20. 2003). In addition, many suborbital vehicle developers continue to press for passage of the Commercial Space Transportation Act of 2003 (S. 1260), which would give the Secretary of Transportation six months to submit a report to Congress on the need for a clear regulatory regime for suborbital vehicles, and the Commercial Space Act of 2003 (H.R. 3245), which would direct the FAA to regulate suborbital vehicles as launch vehicles. A preference for these bills is understandable – what can be done in the Federal Register could also be undone in the Register at some later date, while regula-
launch or reenter a vehicle or to operate a launch site or reentry site outside of the United States.\textsuperscript{128}

An RLV operator has the choice between two types of licenses: an RLV mission-specific license\textsuperscript{129} or an RLV mission-operator license.\textsuperscript{130} A mission-specific license "authorizes an RLV mission to launch and reenter, or otherwise land, one model of RLV from a launch site approved for the mission to a reentry site."\textsuperscript{131} This type of license may authorize more than one RLV mission and identifies each flight authorized under the license.\textsuperscript{132} Under this license, authorization to conduct RLV missions terminates upon completion of all activities authorized by the license or the license’s expiration date, whichever occurs first.\textsuperscript{133} By contrast, a mission-operator license "authorizes a licensee to launch and reenter, or otherwise land, any of a designated family of RLVs within authorized parameters, including launch sites and trajectories, transporting specified classes of payloads to any reentry site or other location designated in the license."\textsuperscript{134} A mission-operator license is valid for a two-year renewable term.\textsuperscript{135}

2. Licensing and Approval Process

The RLV application and licensing process is complicated, to put it mildly. Perhaps recognizing the trepidation RLV developers might experience in attempting to navigate these requirements, FAA/AST recently hosted an RLV Mission License Application Workshop to help developers better understand the application process.\textsuperscript{136} Included in its presentation was a briefing on the steps involved in an RLV mission license application. The briefing, alas, was uncharacteristically lengthy at a whopping 195 pages.\textsuperscript{137}

\begin{thebibliography}{137}
\bibitem{128} 14 C.F.R. § 413.3 (2003).
\bibitem{129} Id.
\bibitem{130} 14 C.F.R. § 431.3(a).
\bibitem{131} 14 C.F.R. § 431.3(b).
\bibitem{132} 14 C.F.R. § 431.3(a).
\bibitem{133} Id.
\bibitem{134} Id.
\bibitem{135} 14 C.F.R. § 431.3(b).
\bibitem{136} Id.
\bibitem{137} Letter from Herbert Bachner, Manager, Space System Development Division, Federal Aviation Administration to author (received July 2, 2003) (on file with author).
\end{thebibliography}
One explanation for such a long and involved application process is FAA/AST's unwavering emphasis on safety. Under the Final Rule, FAA/AST assumes the Secretary’s mandate under the CSLA to ensure that public health and safety are not jeopardized by licensed operations. In the context of RLV licensing, “[t]he FAA evaluates on an individual basis all public safety aspects of a proposed RLV mission to ensure they are sufficient to support safe conduct of the mission.” RLV license applicants consequently face a grueling, multi-pronged consultation and approval process. Before applying for a license, prospective applicants must participate in pre-application consultations with FAA/AST to discuss the application process and potential issues relevant to FAA/AST's licensing decision. Following pre-application consultations, applicants must obtain policy approval, safety approval, payload and payload reentry approval, and environmental approval. Successful applicants additionally must fulfill ongoing obligations during the term of license. Each of these requirements is discussed separately in the following paragraphs.

i. Policy Approval

The FAA issues a policy approval to an RLV mission license applicant upon completion of a favorable policy review. In considering whether to grant policy approval, FAA/AST will review an application to “determine whether the proposed mission presents any issues. . . that would adversely affect U.S. national security or foreign policy interests, would jeopardize public health and safety or the safety of property, or would not be consistent with international obligations of the United States.” In an RLV mission license application, applicants must:

a) Identify the model, type, and configuration of any RLV proposed for launch and reentry;

138 Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation, RLV Mission License Application Workshop Version 1.1, PowerPoint slides from RLV Mission License Application Workshop (May 2003).
139 14 C.F.R. § 431.31.
140 Id.
141 14 C.F.R. § 413.5.
142 See 14 C.F.R. §§ 431.5, 431.7, 341.91.
143 14 C.F.R. § 431.21.
144 14 C.F.R. § 431.23.
b) Identify all vehicle systems, including structural, thermal, pneumatic, propulsion, electrical, and avionics and guidance systems used in the vehicle(s), and all propellants;\(^\text{145}\)

c) Identify foreign ownership. . .,\(^\text{146}\) [and]

d) Identify proposed launch and reentry flight profile(s), including, launch and reentry site(s), flight trajectories [and] reentry trajectories, and sequence of planned events or maneuvers during the mission.\(^\text{147}\)

ii. Safety Approval

The FAA conducts a safety review of an RLV license application to determine whether applicants are capable of launching and landing an RLV without jeopardizing public health and safety.\(^\text{148}\) In order to obtain safety approval, RLV license applicants must:

a) Maintain a safety organization and document it by identifying lines of communication and approval authority for all mission decisions that might affect public safety;\(^\text{149}\)

b) Designate a person responsible for the conduct of all licensed RLV mission activities;\(^\text{150}\)

c) Designate a qualified safety official authorized by the applicant to examine all safety aspects of the applicant's operations and to complete a mission readiness determination before an RLV mission is initiated;\(^\text{151}\) and

d) Demonstrate that the proposed mission does not exceed levels of acceptable risk.\(^\text{152}\)

To demonstrate compliance with acceptable risk criteria, RLV license applicants must:

a) Identify and describe the physical structure of the RLV.\(^\text{153}\)

\(^{145}\) 14 C.F.R. § 431.25(a).
\(^{146}\) 14 C.F.R. § 431.25(b).
\(^{147}\) 14 C.F.R. § 431.25(c).
\(^{148}\) 14 C.F.R. § 431.25(d).
\(^{149}\) 14 C.F.R. § 431.31.
\(^{150}\) 14 C.F.R. § 431.33(a).
\(^{151}\) 14 C.F.R. § 431.33(b).
\(^{152}\) 14 C.F.R. § 431.33(c).
\(^{153}\) 14 C.F.R. § 431.35(a). The risk level to the collective members of the public exposed to vehicle or vehicle debris impact hazards associated with a proposed mission may not exceed an expected average of .00003 casualties per mission. The risk level to an individual may not exceed .000001 per mission. Four quantities factor into this equation: the size of the area over which possible debris im-
b) Identify and describe any hazardous materials and their container on the RLV,\textsuperscript{154}

c) Identify and describe safety-critical systems\textsuperscript{155} and safety-critical failure modes and their consequences;\textsuperscript{156}

d) Provide drawings, schematics, and timelines for each safety-critical system;\textsuperscript{157} and

e) Provide flight trajectory analyses covering launch or ascent of the vehicle through orbital insertion and reentry or descent of the vehicle.\textsuperscript{158}

iii. Payload Reentry Review

The FAA will conduct a payload reentry review of any non-U.S. government payload whose reentry is not subject to regulation by another federal agency.\textsuperscript{159} In conducting this review, the FAA will determine whether the reentry of the payload presents any issues that would adversely affect U.S. national security or foreign policy interests, jeopardize public health and safety or the safety of property, or would not be consistent with international obligations of the United States.\textsuperscript{160} Applicants requesting payload reentry review must identify the following:

a) Payload name or class and function;\textsuperscript{161}

b) Physical characteristics of the payload;\textsuperscript{162}

c) Payload owner and operator;\textsuperscript{163}

d) Type, amount, and container of hazardous or radioactive materials in the payload;\textsuperscript{164}

e) Explosive potential of the payload;\textsuperscript{165}

\textsuperscript{154} 14 C.F.R. § 431.35(d)(1).

\textsuperscript{155} 14 C.F.R. § 431.35(d)(2).

\textsuperscript{156} 14 C.F.R. § 431.35(d)(3).

\textsuperscript{157} 14 C.F.R. § 431.35(d)(4).

\textsuperscript{158} 14 C.F.R. § 431.35(d)(5)-(6).

\textsuperscript{159} 14 C.F.R. § 431.35(d)(8).

\textsuperscript{160} 14 C.F.R. § 431.51.

\textsuperscript{161} 14 C.F.R. § 431.55(a).

\textsuperscript{162} 14 C.F.R. § 431.57(a).

\textsuperscript{163} 14 C.F.R. § 431.57(b).

\textsuperscript{164} 14 C.F.R. § 431.57(c).

\textsuperscript{165} 14 C.F.R. § 431.57(d).
f) Designated reentry site of the payload;\textsuperscript{166} and
g) Method of securing the payload on the RLV.\textsuperscript{167}

iv. Environmental Review

RLV applicants must provide the FAA with sufficient information to assess the environmental impacts associated with the proposed RLV operation.\textsuperscript{168} Specifically, applicants must provide information concerning:

a) A designated launch and reentry site, including abort locations, if not covered by existing FAA or federal environmental documentation;\textsuperscript{169}
b) A proposed new RLV or reentry site with characteristics falling outside the parameters of existing environmental documentation;\textsuperscript{170}
c) A proposed payload that may have significant environmental impacts in the event of a reentry accident;\textsuperscript{171} and
d) Other factors necessary to comply with the National Environmental Policy Act.\textsuperscript{172}

v. Post-Licensing Obligations of RLV Operators

An RLV operator that obtains a license is subject to a series of ongoing obligations throughout the course of that license. First, "a licensee is responsible for ensuring the safe conduct of an RLV mission and for protecting public health and safety and the safety of property during the conduct of the mission" and must perform safety procedures in accordance with the representations made in its license application.\textsuperscript{173} In addition, a licensee must provide the FAA with the following:

a) Within 60 days prior to an authorized RLV mission, a report containing flight and payload information for that mission;\textsuperscript{174}

\textsuperscript{166} 14 C.F.R. § 431.57(e).
\textsuperscript{167} 14 C.F.R. § 431.57(f).
\textsuperscript{168} 14 C.F.R. § 431.57(g).
\textsuperscript{169} 14 C.F.R. § 431.91.
\textsuperscript{170} 14 C.F.R. § 431.93(a).
\textsuperscript{171} 14 C.F.R. § 431.93(b)-(c).
\textsuperscript{172} 14 C.F.R. § 431.93(d).
\textsuperscript{173} 14 C.F.R. § 431.93(e).
\textsuperscript{174} 14 C.F.R. § 431.71.
b) Within 15 days before an authorized RLV mission, a notification of the time and date of the intended launch and reentry;\textsuperscript{175}

c) In the event of a launch or reentry accident or incident, a report to be submitted to the FAA Washington Operations Center.\textsuperscript{176}

Finally, an RLV licensee is required to maintain for three years all records, data, and other material necessary to verify that a licensed RLV mission is conducted in accordance with representations contained in the licensee's application.\textsuperscript{177}

3. Unique Safety Concerns of RLVs & Risk Levels

RLVs, by virtue of their capacity for reentry, present unique safety issues.\textsuperscript{178} As noted above, safety is of the utmost concern in the RLV licensing process. FAA/AST is required by law to carry out the Secretary's regulatory responsibilities and safety mandate under the CSLA to ensure that licensed operations do not jeopardize public health and safety.\textsuperscript{179} Accordingly, one crucial element of the safety approval process is a demonstration by the applicant that the proposed mission falls within acceptable risk parameters.\textsuperscript{180}

The acceptable flight risk of any commercial launch vehicle is calculated through orbital insertion.\textsuperscript{181} An applicant will not obtain safety approval unless the risk level associated with his launch proposal is less than a collective risk of thirty casualties in one million launches, or .00003 casualties per launch.\textsuperscript{182} ELV regulations set an identical minimum risk level, but do not contain the additional requirement found in the RLV regulations that the risk level to an individual not exceed .000001 per mission.

\textsuperscript{175} 14 C.F.R. § 431.79(a).
\textsuperscript{176} 14 C.F.R. § 431.79(b).
\textsuperscript{177} 14 C.F.R. § 431.79(c).
\textsuperscript{178} 14 C.F.R. § 431.77(a).
\textsuperscript{179} Final Rule, supra note 114, at 56,618 (stating "[A]lthough the FAA has had a regulatory program in place for years governing launch licensing, the FAA determined that licensing regulations developed to address existing ELV commercial launch capability were not adequate to address the unique safety issues posed by launch vehicles that are reusable.").
\textsuperscript{180} Id.
\textsuperscript{181} 14 C.F.R. § 431.35(a).
\textsuperscript{182} Id.
The operation of an RLV carries more potential risk than the operation of an ELV. Because an RLV is designed to survive reentry and return to a particular reentry site, the likelihood of damage is doubled. Another reason the risk associated with an RLV is greater is that it uses a thermal protection system—if an RLV explodes during the launch portion of the flight, the resulting debris would probably not disintegrate as easily as the debris caused by a similar ELV failure. The heat of a rocket explosion would more likely cause the debris from an ELV to break into smaller pieces as it approached the ground. In contrast, an RLV failure would most likely result in larger and more dangerous pieces of debris because the thermal protection system would keep heat in check and prevent further disintegration. Additionally, the larger debris from an RLV failure would also have a higher lift coefficient, which would make debris more likely to fly and disperse over a larger area than debris from a comparable ELV failure. Finally, an RLV is not designed to destroy itself during the launch process because they are intended for repeated use. RLV designers consequently will be more inclined to build their vehicles with higher fault tolerances.

Given that RLVs are inherently more dangerous than ELVs, it is reasonable to regulate RLVs more stringently than ELVs. However, existing requirements for RLV licensing may ultimately prevent many private companies from getting off the ground. As discussed above, any entity wishing to launch an RLV faces a formidable and lengthy application process. Whether the many RLV application requirements will prove too onerous is difficult to ascertain as there are no examples to provide guidance. At publication, no RLV licenses have been issued by FAA/AST. According to Esta Rosenberg, Senior Counsel for the Department of Transportation of Commercial Space Transportation, several companies are in pre-application consultation with FAA/AST, but none has submitted an official application.

---

183 Id.
184 Moore, supra note 2, at 247.
185 Id. at 258.
186 Id. at 258-59.
187 Id. at 259.
188 Id. at 263.
189 Final Rule, supra note 114, at 56,619 ("ELVs rely upon destructive flight termination systems (FTS) that assure flight safety by destroying a vehicle traveling..."
VI. REFORM & IMPROVEMENT: CURRENT AND FUTURE MEASURES

If the U.S. commercial space and RLV industries are to thrive, regulatory reform and improved interaction with RLV developers are necessary. FAA/AST has taken many steps to assist and cooperate with RLV developers. While these efforts are a step in the right direction, further reform is needed. First, as some have argued, deregulation may be in order. Second, greater government indemnification and risk allocation are necessary. Finally, the RLV licensing process must be simplified.

A. FAA/AST EFFORTS TO IMPROVE THE RLV REGULATORY ENVIRONMENT

FAA/AST is not unaware of the obstacles facing RLV developers and has taken several measures to improve the RLV landscape and assist RLV developers. In particular, FAA/AST has established a committee to address commercial space policy issues, hosted workshops to help RLV developers better understand the licensing process, sought industry members' input on future policy matters relating to human space flight, and made available several reports on commercial space policy. These efforts, discussed below, are a step in the right direction and reflect FAA/AST's collaborative, open-minded approach to RLV regulation.

1. COMSTAC

The Commercial Space Transportation Advisory Committee (COMSTAC) was established in 1984 to address issues relating to the U.S. commercial space industry. COMSTAC consists of representatives and officials from the U.S. commercial space transportation industry, the satellite industry, state government, academia, and space advocacy organizations. Its goals are to provide a forum for the discussion of problems involving the

---

190 Rosenberg, supra note 106.
relationship between industry activities and government requirements and to provide information, advice, and recommendations to the FAA on approaches for federal commercial space policies. COMSTAC bases its recommendations on the reports of working groups. If a report is adopted by the full COMSTAC Committee, it is then submitted to the FAA Administrator as an official industry recommendation. The Committee currently has four working groups: Technology and Innovation, Launch Operations and Support, Risk Management, and Reusable Launch Vehicles.

The RLV Working Group is headed by Michael Kelly, Chairman and Chief Technical Officer of Kelly Space & Technology, Inc., and is responsible for analyzing key technical, policy, and regulatory issues concerning RLV development and RLV operations. In April 1999, the RLV Working Group released its draft "Final Report on RLV Licensing Approaches," in which it endorsed a regulatory framework that allows for individualized approaches to RLV licensing. A single licensing regime, the group concluded, "could inhibit innovation, technical advancement, and competition in the emerging RLV industry."

2. RLV Mission License Application Workshop

FAA/AST has also begun working directly with RLV developers to help them better understand the RLV licensing process and to receive their input on future policy matters regarding commercial human space flight policy. In furtherance of this

---

192 Id.
193 Id.
195 Comstac, supra note 191, at http://ast.faa.gov/comstac/
197 Id. at 129 ("The RLV Working Group concluded, therefore, that a single licensing regime to serve all concepts is not only improbable, but also undesirable. Rather, RLV regulations should provide a legal framework within which a clear path to licensing can be determined for each system configuration.").
goal, FAA/AST hosted a COMSTAC meeting devoted to RLV issues in May 2003.198

One portion of the meeting was an RLV Mission License Application Workshop for RLV developers.199 The purpose of the workshop was to enhance the efficiency of RLV developers’ application preparation process.200 To this end, FAA/AST included in its presentation a briefing on RLV launch and reentry regulation and the steps involved in an RLV mission license application. Following the workshop, FAA/AST made the briefing, as well as other materials, available to RLV developers and other interested individuals on CD.201 Also included on the CD was a 12-page license application checklist, several advisory circulars, and an environmental licensing tutorial.202

Another segment of the meeting dealt with commercial human space flight policy concerns.203 In connection with this initiative, the agency is developing vehicle and human safety-related guidelines for commercial RLVs and has awarded a contract to the Aerospace Corporation (through Volpe) to provide technical assistance.204

FAA/AST hopes ultimately to answer four questions relating to human space flight:
1) How does the addition of humans on board RLVs affect FAA/AST’s regulatory responsibility and regulatory approach?
2) Should FAA/AST regulate human space flight by setting a limit on acceptable risk for humans on board RLVs?
3) How should FAA/AST ensure the safety of humans on board RLVs?

198 Id.
200 Bachner, supra note 137.
202 Bachner, supra note 137.
203 Id.
4) What, if any, type of liability, financial responsibility requirements, and/or liability risk-sharing regime should the U.S. government, via FAA/AST, seek to establish to protect passengers on board RLVs? FAA/AST intends to continue its development of human space flight safety guidelines. Its proposed next step is to seek comments from the commercial space transportation industry and from the public.

3. Reports & Studies

Finally, FAA/AST and COMSTAC continue to produce reports and studies relating to commercial space regulatory issues. The reports and studies address issues such as the liability and risk-sharing regime for U.S. commercial space transportation, and RLV licensing and safety. In an effort to keep RLV developers well-informed, these reports, along with materials from workshops and meetings are available on the FAA/AST website.

B. The Case for Deregulation

Existing FAA/AST regulations of RLV licensing—while not without purpose—impede the development of the commercial space industry, prompting many to advocate deregulation. An unfettered, or at least less burdensome, RLV regulatory regime would enable the U.S. to increase its market share in the commercial space launch industry. In contrast, existing RLV regulations will undoubtedly facilitate the continued foreign domination of the commercial space market for the very simple reason that they limit U.S. companies' ability to compete with foreign companies. A foreign company, after all, is not subject to U.S. RLV regulation unless it conducts a launch in the U.S.

Opposition to deregulation is typically connected with two is-

---

205 Id.
206 Id.
207 In attempting to answer these questions, FAA/AST has suggested that passengers will not be allowed on board RLVs until a flight test program has been successfully completed to validate predicted flight environments, flight control characteristics, safety critical design parameters, preflight analysis, and analytical math models. As for liability concerns and risk-sharing regimes, current insurance requirements would protect parties uninvolved in launch or reentry activities but would not cover losses or damages that passengers may experience. Thus, further insurance and liability requirements are necessary. Id.
209 See, e.g., Collins, supra note 18.
sues: (1) economics and (2) safety. Each of these concerns is addressed below.

The first argument is rooted in the fear that removing regulatory impediments will adversely affect existing commercial interests by eliminating government contracts and creating new competitors. However, this concern has limited application to the space transport industry. Although companies that receive contracts from government agencies may lose some business, deregulation would ultimately benefit the commercial space industry by removing the huge and potentially insurmountable costs of complying with FAA/AST requirements and enabling a greater number of companies to enter the RLV market. This influx of new competitors in the commercial space launch sector may drive some existing companies out of business, but the overall benefits of deregulation would outweigh the harms. First, once the RLV industry gains momentum, the reduction in launch costs will help U.S. companies regain a competitive edge over foreign companies. Second, deregulation will reduce costs to taxpayers. Apart from satellite application, space agencies' activities are not profitable in any country, and in fact, represent a net cost to taxpayers of some $20 billion per year. By facilitating competition among private companies, deregulation would reduce costs to society to the extent that it renders government-funded space expenditure unnecessary.

The second common objection to deregulation is that it will threaten the public safety that existing regulation serves to protect. This argument also rings hollow for several reasons. First, removing certain regulatory obstacles to RLV licensing would not necessarily lead to slipshod operations of launch vehicles. Other regulations exist to provide a compelling impetus for safe operations of launches. The CLSA, for example, makes parties who launch space vehicles liable for damages in excess of $2 billion. Second, few businesspeople, if any, would risk the financial ruin that would surely result from a launch malfunction or accident. The devastation following the Challenger and Columbia disasters leaves no doubt that public perception plays an enormous role in the space transport industry, providing ample

210 14 C.F.R. § 413.3 (requiring U.S. citizens to obtain a launch license, regardless of whether the launch occurs on U.S. territory).
211 See, e.g., Collins, supra note 18.
212 Id.
213 Id.
motivation for RLV operators to ensure high levels of safety for their passengers. Finally, there is no reason to demand near perfect levels of safety from the space transport industry when much lower levels are acceptable elsewhere. In the U.S. alone, nearly 40,000 people die each year in automobile accidents. As a society, we have determined that this number of fatalities is an acceptable trade-off for the benefits we receive from automobiles. One wonders why we would be unwilling to tolerate similar risk levels in the space transport sector when the development of RLV technology carries so many potential benefits.

C. **IMPROVE GOVERNMENT INDEMNIFICATION AND RISK ALLOCATION**

Unless the U.S. government creates a more supportive environment for commercial launch providers, foreign companies—in particular Arianespace—will continue to dominate the commercial launch sector. Continued and improved risk sharing is imperative if U.S. launch providers are to remain competitive in the global arena.

The current system of government indemnification under the CSLA requires launch service providers to obtain insurance of $500 million to cover claims by third parties and $100 million to protect against claims by the government. The FAA recently endorsed this partial indemnification arrangement as striking a balance between safety and competitiveness. While partial indemnification is better than no indemnification, the U.S. system nonetheless limits domestic companies’ ability to compete with foreign companies whose governments provide more protection. Arianespace, for example, is backed by the French government’s very generous risk-sharing program. In contrast to the

---

214 Id.


216 Improved RLV technology would lead to advances in medical and microgravity research as well as lower costs in commercial services such as telecommunications, data relay, and same-day international package delivery. 65 Fed. Reg. 56,618 (codified at 14 C.F.R. § 400 (2003)). In addition, some estimate that space tourism could be a $10-20 billion-a-year industry. O’Neil, supra note 28.

217 See Hearings, supra note 57.

U.S. approach, there is no cap on the French government's indemnification of third party claims.\(^{219}\)

One significant consequence is that U.S. launch companies are required to buy more insurance. As of 1999, U.S. launch companies were required to purchase up to $164 million in insurance before the U.S. government would be required to cover any excess liability claims, while Arianespace would be required to purchase only $63 million before the French government would step in.\(^{220}\) Unfortunately, insurance companies' confidence concerning the scale of risks involved in space transport depends on agreed standards of acceptable risk.\(^{221}\) Such standards are difficult to ascertain given the limited statistical base for insurance calculations.\(^{222}\) Insurance companies consequently have been reluctant to insure space transport companies, giving rise to one unavoidable conclusion: "[I]f tourism is to become a vital part of the commercial space equation, limits on liability for the owners and operators of space facilities and vehicles will be a necessity."\(^{223}\)

D. SIMPLIFY THE RLV LICENSING PROCESS

As discussed above, FAA/AST has taken numerous steps to work with RLV developers and assist them in the licensing process. Nonetheless, the application requirements—from pre-application consultations to safety, policy, payload, and environmental approval to ongoing reporting obligations—have the potential to overwhelm even the most resolute applicant. Perhaps not surprisingly, FAA/AST has yet to issue an RLV license.\(^{224}\) In fact, not a single company has even applied for a license, though three companies are in pre-application consulta-
One obvious explanation is that these companies are not yet in a position, technologically, to proceed with their applications. However, it also stands to reason that a more streamlined system of requirements would facilitate the licensing process.

VII. CONCLUSION

Commercial space travel should not be relegated to the realm of science fiction. With enormous market potential and rapidly growing private interest, space tourism and the RLV industry could soon be very real. Unfortunately, the current regulatory regime places serious burdens on the industry. The realistic and accommodating framework embodied by the Warsaw Convention was crucial to the growth of the aviation industry and provides much-needed guidance. RLV regulation must be reformed to resemble the aviation regime if the commercial space travel industry is to ever make it off the launch pad.

\[225\] Rosenberg, supra note 106.