

TESTIMONY FOR HEARING ON THE OFFICE OF COMMERCIAL SPACE
TRANSPORTATION'S FISCAL YEAR 2012 BUDGET REQUEST

UNITED STATES HOUSE OF REPRESENTATIVES
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I appreciate the opportunity to testify today on the Federal Aviation Administration's Office of Commercial Space Transportation's role in the supervision and regulation of commercial space flight and am pleased that the Committee has begun the important process of reviewing these matters. The space industry in the United States is poised for very significant changes and it is very timely to begin the process of reviewing national and international issues that will need to be resolved in the years ahead as commercial activity in space grows and evolves.

Since its inception the Office of Commercial Space Transportation (OCST) within the DOT and subsequently within the FAA has actively and successfully developed a regulatory environment for commercial space launches and related activities. During the past decade the OCST has fulfilled its legislative mandates to regulate commercial spaceflight. It has also licensed private spaceports and other space and space-related activities reflecting the growth of interest and investment in these areas by both entrepreneurs and established companies.

Of particular interest are the Amendments to the CSLA in 2004, which gave the FAA the authority to develop regulations for private human space flight. The regulatory framework was oriented to encouraging the development of commercial human suborbital flights and was stimulated by the success of the X-Prize competition.

However, those promises have not yet, nearly eight years later, resulted in any private paying passengers, although the companies developing those vehicles are still planning to initiate space adventure/tourist businesses.

Beyond the continued promises of suborbital commercial activity there are other new developments. Among them are: 1) NASA plans to send cargo and astronauts to the International Space Station on commercial vehicles, 2) foreign nations are developing new capabilities which will compete with U.S. commercial companies in all space efforts, 3) one U.S. company has plans to transport paying customers to an in-orbit space facility, 4) the Google Lunar X Prize could put a private vehicle on the Moon that might be capable of performing relatively simple activities with commercial value, and 5) commercial UAVs will begin operations which will require new air traffic management in the same high altitudes where suborbital vehicles will fly. These UAVs may have functional capabilities that will compete with suborbital vehicles as well as LEO satellites.

Until recently, the OCST focus for human space flight regulations has been on sub-orbital vehicles and passengers. The experimental permit period will end soon without any database on flights, safety, or passengers. **This experimental period should be continued, but instead of an arbitrary period of years being designated for the sunset of that provision, other tests should be developed to determine when the regulations should be re-evaluated by Congress.**

Those tests should focus on the availability of enough experience and data from the industry to develop meaningful safety rules. Tests should take into account factors such as:

- The maturity of the business,
- The ability to fly on a routine scheduled basis,
- The number of passengers and the amount of cargo transported or research experiments flown,
- The standardization of vehicles and systems that could provide the basis for a vehicle certification regime, and

- A quantification of the different risks involved.

Ultimately, the safety of both people and property in flight as well as the safety of people and property terrestrially should be the paramount objective of regulations. Rather than go beyond my own technical capabilities and suggest a specific test in this testimony, **I would recommend a panel of appropriate experts (e.g. COMSTAC) be commissioned to study this issue and develop a set of specific recommendations.** While no statistical analysis will be perfect, a more objective set of requirements will better meet the Congressional intent than an arbitrary time horizon.

Five Different Space Regimes (when viewed from a legal/regulatory perspective)

The OCST is primarily organized to license commercial space launches and related activities including spaceports. Congress has given additional responsibility to the FAA OCST to license re-entry space vehicles and, most recently in 2004, to license commercial human space flight.

OCST regulated launch activities include suborbital vehicles that may or may not go into space but are separated from aircraft regulations by a definition based on vehicle propulsion characteristics that have a thrust greater than the lift during the greater part of their ascent.

The current division of regulations is fast approaching overlapping and unsettled areas of regulation and jurisdiction. We are at a point where the FAA has to do more than just license ELVs for launch. Specifically, the most difficult future issues will be to regulate commercial in-orbit activities, both for human space flight as well as for other purposes. Because of the growing danger to space operations from the crowding of certain orbits with human-created space debris as well as the projected increased use of commercial services in space by NASA and other government entities, we will need new regulatory authority over in-orbit activity. This involves

uncharted issues of safety as well as financial responsibility to meet the needs of international treaty obligations, the viability of U.S. space operations, and fairness and equity for near-term activities that could have a very long horizon of future responsibilities.

Simply extending the safety review and financial requirements of a launch license regime to include in-orbit activities will not be sufficient to solve the upcoming issues.

In order to try to understand these developing concerns in space regulations, I suggest that we consider the following reorientation of the categories of spaceflight regulation:

The categories are:

1. Launches to orbit	Activities under both domestic law and the Outer Space Treaties
2. In-orbit activities	
3. Non-orbital launches and activities	
4. Sub-orbital launches and activities	Activities under domestic law
5. Spaceports	

The first three involve activities that fall under the international space treaty obligations and therefore must take into account several factors:

1. Outer space is, through Article II of the Outer Space Treaty (OST), a place without sovereignty;
2. Article VI of the OST makes States Party to the Treaty responsible for government activities and the activities of non-government entities in space as well as requiring continued national supervision;
3. Article VII of the OST makes States liable for their launch activities.

What is unique to space is the requirement of State responsibility and liability. No other industry faces this. In fact, other high technology industries with low probabilities of catastrophic accidents but with a very high probability of severe

damage (e.g. civil nuclear power plants, oil platforms) are covered by different treaty obligations. If an accident occurs under those international legal regimes the operator will be primarily responsible and liable with the States party to those treaties and agreements in a position as a guarantor of payment.

The last two categories, suborbital launches and spaceports are domestic, involving the use of national airspace and of terrestrial spaceports. When (and if) suborbital markets develop, either for cargo or people, these activities of the OCST should be transitioned to other parts of the FAA, as they are closer to aircraft than to space from a legal regulatory perspective. The question is when to begin that transition.

I would recommend postponing a consideration of any transition of responsibilities for suborbital launches to the indefinite future. As described above, we need to develop a methodology to evaluate the emerging suborbital activity. **When we have the proper amount of data on safety and reliability of the equipment and operating procedures and when the companies have demonstrated that they can operate as a business, then Congress can address this issue.**

In outline format below, I have listed a more detail description of each category. Currently, only Category 2 (in-orbit activities) and possibly parts of Category 3 (non-orbital activities) are largely unregulated and will require a thorough study of three serious issues: 1) liability, 2) coordination among U.S. Agencies, and (3) coordination and harmonization with other nations and international organizations.

1) Launches to orbit

- a. This category represents the current FAA licensing regime for launches vehicles and re-entry vehicles.

2) In-orbit activities

- a. In general, in-orbit activities are unregulated. However, there are some situations that have required the U.S. Government to develop specific rules. These are spread among a number of agencies and are

not well coordinated. Specifically, the Federal Communications Commission requires that geosynchronous satellites at the end of their useful life retain enough fuel to be transported into “graveyard” orbits; enforcement and verification remains problematic. Additionally, the FCC is the agency responsible for representing the U.S. at the International Telecommunications Union meetings and for authorizing the use of spectrum in the United States.

- b. NOAA has a similar requirement for the commercial earth observation satellites under its jurisdiction. Rather than a specific requirement for end-of-life, their regulations require companies to submit a plan for disposal of the satellite that will meet the approval of the Secretary of Commerce.
- c. The FAA OCST has the authority to oversee launches and defines the end of the launch period as the time when the launch vehicle last exercises its control over the payload. Normally, this includes some in-orbit activities. They also have authority for re-entry vehicles to oversee in-orbit preparations for the re-entry.
- d. Finally, IADC Guidelines on Space Debris Mitigation are voluntary rules with no specific enforcement provisions. However, some of the recommended guidelines have become enforceable through enactment of specific legislation and agency regulations in the United States.

Congress has not given authority for any Agency to coordinate or regulate most in-orbit commercial activities. Consideration should now be given to studying in-orbit activities and for the United States to take a leadership role in addressing a number of possible legal problems associated with commercial in-orbit operations. These include addressing:

- i. Liability issues under Treaties that are inadequate and need attention through national legislative initiatives

- ii. Sustainability and debris issues remain unresolved including legal uncertainties with future servicing satellites
- iii. Human safety on private in-orbit vehicles may have conflicting authority
 - 1. NASA ISS transportation for astronauts on commercial vehicles could fall under FAA jurisdiction or be exempt and under NASA regulations
 - 2. Interface with the ISS and international partners will involve not only NASA directives but also those of other nations.
 - 3. Proposals for a “hotel” or private research facility remain open question on regulatory and liability exposure.

Additionally, other nations as well as the United Nations Committee on Peaceful Uses of Outer Space are beginning to address issues of in-orbit regulations mainly through activities on space debris and space sustainability. The United States will need to coordinate its activities with these on-going efforts.

3) Non-orbital activities:

(I am suggesting the use of a new term *non-orbital*, to separate true suborbital flights within airspace from launches of rockets that enter into outer space but have a planned trajectory that returns to Earth without achieving orbit.)

Currently sounding rockets that can reach altitudes as high as 1000km, which is roughly 10 times the distance defined as the “edge of space” are included in the definition of a suborbital trajectory. This is confusing, as the term, suborbital, should mean just what it says: below the point where a rocket or payload cannot reach orbital altitude. Since once something reaches outer space there are different rules that may apply due to international treaty agreements. Therefore a separation between non-orbital activities and suborbital activities may clarify a definitional

problem, particularly when and if separate in-orbit regulations of commercial spacecraft are issued. An example of a non-orbital commercial activity might be a launch vehicle used for point-to-point delivery of cargo.

4) Sub-orbital activities

These should be limited to those non-aircraft activities that stay within airspace (but could cross borders and also fly over the open seas); they should be under FAA jurisdiction and be treated similarly to aircraft. If the market becomes truly commercial, these activities can graduate from the current experimental phase. At that point these activities should be transitioned from OCST licensing to another part of the FAA whether private human passengers are aboard or just cargo is being flow.

5) Domestic spaceport regulations

These are currently being licensed by FAA under domestic law.

Accident Investigations

In the Congressionally-mandated 2008 Analysis of Human Space Flight Study we discussed a potential conflict in the delegation of authority for investigating an accident involving humans in space flight. After the Shuttle *Columbia* accident, Congress passed legislation requiring a Presidential Commission to be formed following certain types of space accidents. (That legislation is now found at Title 51 of the U.S. Code, Chapter 707.)

Those conditions are outlined in §70702, Establishment of Commission. The relevant parts of that section for the issues presently before this Committee are: ...*(3) any other United States space vehicle carrying humans that is owned by the Federal Government or that is being used pursuant to a contract with the Federal Government* or *(4) a crew member or passenger of any space vehicle* described in this subsection.

Clearly, Congress intended that a high profile investigation occur in the event of a space accident. Private launch vehicles and spacecraft, whether licensed by the FAA or not, are within the purview of this law. Furthermore, if humans are on board and are injured, a Commission is also mandated. This section can also be read to include suborbital vehicles (as now defined under OCST legislation) if they are being used to carry research or other instruments that are under an agreement with a Federal Agency. And these types of commercial services onboard suborbital vehicles are the subject of current agreements and discussions between government agencies and private companies, although they have yet to actually fly.

We also were informed during the 2008 study that the FAA OCST has a Memorandum of Agreement with the NTSB that in case of an accident with more than \$25,000 property damage and/or injury or death to a human being onboard a vehicle licensed by the FAA, the NTSB will lead an accident investigation. At present, the NTSB has legislative authority to investigate virtually all modes of transport accidents except space. However, in discussions the General Counsel of the NTSB in 2008, he was clear that the NTSB was consulted and did actively participate in the Columbia accident investigation and that there was good cooperation among Federal Agencies.

Therefore, although there may not be any negative or competitive issues regarding the cooperation among Agencies in the case of an accident investigation, **it would be advantageous for Congress to clear up any ambiguities and to clearly designate who will be in charge of a space accident under the specific situations that currently have overlapping jurisdiction.**

Inherent Conflicts Between FAA Role as Promoter and Regulator

A survey of firms involved in developing commercial space flight capabilities done in connection with the 2008 Study found that none of the companies had any issues with the FAA's dual roles of promoter and regulator.

In my testimony in 2003 before this Subcommittee on this issue, I pointed out that there is an inherent possible conflict if the same Agency that is charged with promoting an activity is also in charge of regulating it. The conflicts arise two ways: 1) since regulations cost industry money and possibly market share or profits, there will always be pressure from industry to minimize regulations, and 2) as competing firms with different types of vehicles capable of serving similar markets develop, they will pressure an Agency to favor specific products or types of services with the larger and more powerful firms prevailing.

Elements of these conflicts are present in commercial space, even if today the industry is still too small and too risky for serious issues to arise in regard the Agency's dual role. More specifically, when the role of promotion was given to the FAA's commercial space operations there was only one type of vehicle, the ELV. Today under FAA regulatory authority there are ELVs plus companies developing reusable launch vehicles (RLVs), suborbital commercial vehicles, and unmanned high altitude vehicles (UAV), all of which can compete against each other for air traffic control as well for services in certain markets. For example, future UAVs will need coordination with all launch vehicles in traffic management. But, even more importantly, UAVs will perform services such as regional remote sensing and telecommunications for private end users. These are the very same types of services that companies now provide with LEO satellites and possibly may also provide using suborbital rockets.

Congress should monitor the maturity of the industry. When and if one regulatory Agency or one office within an Agency is burdened with either

regulating closely competing transportation services and/or burdened with choices of which transport mode to promote and which to ignore, these functions should be assigned to another Agency or to different offices within an Agency.

ISS Crew Transfer Issues

As mentioned above under in-orbit regulatory activities, recent plans of NASA rely on commercially provided services for transportation to the ISS. Commercial vehicles will do what has been done previously by government owned and operated vehicles or by payments to the Russian Government for Soyuz launches. FAA licenses were not required or involved. But, they clearly could be if NASA's plans materialize.

There are a number of issues to consider before granting licensing authority to the FAA for transporting U.S. Government astronauts or payloads to the ISS. First, NASA already has a complex and well-developed set of safety regulations in place for both human and non-human space flights as well as for approaching and docking with the ISS. What would a new set of regulations add? Would they be less expensive? Would they compromise safety? Since there are no commercial flights to the ISS at present, there is no database to judge the wisdom of changing regulations and/or the regulatory agency.

This then could become a chicken-and-egg problem. NASA will possibly be the prime customer of the first commercial U.S. in-orbit flights with humans on board. It is unlikely that a human-rated private vehicle will be available from any company before the planned ISS flights. Therefore, there will be no database without NASA. The larger question is, given cost and price, whether NASA will pay for what it will demand (that is, safety regulations that are most likely more costly and more comprehensive)? And, if so, will that become the standard for FAA regulations for completely private passenger in-orbit flights as well as NASA in the future, or will the FAA develop a different set of regulations for private flights? Over time, if

successful, NASA could use those, but in the near-term it may be a wiser path for Congress to allow NASA to determine the safety standards for its missions.

There is yet another issue with the safety of the ISS itself that involves not only NASA but also its international partners. Each has veto powers in the ISS agreement. Just recently an announcement was in the press that the Russians would not allow a private U.S. vehicle to dock at the ISS. Whether they are concerned about their near-monopoly power with the Soyuz flights to the ISS or whether they are truly concerned about safety is immaterial. If they have the right to deny a U.S. vehicle access to (at least) their docking mechanism, then either costs will be greater and/or there will be no market large enough for the commercial U.S. vehicle. In this case the FAA will have no input into the decision, as it is not a direct party to the ISS agreement.

Considering other non-government U.S. in-orbit commercial activity, the FAA clearly should have a role in both safety and financial responsibility. As with launch activities, where the FAA itself does not have the technical competence, they can and should establish agreements with NASA and the DOD to aid in the safety review process. And, as they now do in aircraft certification, they can work with the manufacturers of components to insure the best standards for quality control and safety. At some future point when space vehicles are more standard, the FAA should work toward a certification program that is different technically but similar in process to the one now used for aircraft.

The financial responsibility issue is more difficult for on-orbit activities. The difficulties with the current space treaty liability regime are too numerous and complex to describe in this brief summary. As explained below, the core of the issue is determining how to implement a fault liability regime as described in the Liability Convention.

With the advent of commercial in-orbit vehicles as well as the more traditional satellites and the ever-increasing probability of accidents in space, diplomatic negotiations as required by the Treaty for the first-order settlement of claims may not be successful. If these issues are put before a tribunal, it is likely that nobody will be compensated since there currently are no rules of evidence, no clear definition of what a space object is, no standard of care that is commonly accepted, and no history of prior court decisions. Adding to that is the possibility that debris may create an accident many years ahead. Even with insurance policies for liability on-orbit, the guarantee of a payment to an innocent party is nonexistent. Extending the financial responsibility regulations that now exist for launch vehicles and their component parts to in-orbit activity will require much study, analysis, and creativity. This difficult task will involve many Agencies of the U.S. Government, foreign governments, international entities (e.g. ESA) and the United Nations. The FAA will have an important role in these discussions and in the future regulation of commercial in-orbit activities.

Consent and Waiver for Private Passengers/Participants in Space

In the 2004 Amendments to the CSLA, Congress mandated that private passengers on space flights were required to be informed by the operator of the vehicle of the risks involved and were also required to execute a reciprocal waiver of claims with the FAA. The legislation was quite specific and, among many requirements to be disclosed also included a full disclosure of the accidents that space vehicles of all types have had.

The FAA decided to let the companies develop the consent form rather than to develop a standard one. **It may, at this time, be advantageous for the FAA to draft model clauses for the form with the generic information about all space accidents and other non-company and non-vehicle related clauses that are required.** The FAA is in a better position to collect and distribute uniform, accurate, and full data on those topics. Companies would be responsible for including those clauses as well as drafting the informed consent agreement appropriate to their vehicle and services.

Several States that have or are developing private spaceports have enacted legislation that protects operators (private companies) from being sued by passengers for liability in case of an accident. Florida, Virginia, and most recently, Texas, have different versions of these provisions. I would question whether this trend in competition among the States in the form of protecting companies is beneficial.

First, this type of waiver can provide an incentive for carelessness in safety. The States do exclude gross negligence or willful actions from the waiver of liability. However, safety can be jeopardized in other ways that simply may be financial decisions based on reasonable risk analyses, but ones that are not standard practice in most of today's space vehicles. Companies will argue that safety is paramount since any accident in an infant industry situation will mean serious economic losses to the company. But, that may not be sufficient when dealing with the many unknowns and risks of spaceflight, as we know it today.

Second, launches from non-coastal states will likely fly over adjacent states. Accidents are adjudicated according to the laws of the state where the accident occurs. Contract and tort laws are different in each state. Therefore, there is a question as to whether a consent and waiver form signed under the law of a state where the vehicle originated would be honored in another state where the accident occurred.

In short, **it is time to study this issue more closely and for Congress to make a clear determination of what authority states may have in issuing waivers of passenger liability to the operator of commercial space vehicles.** Federal preemption would be appropriate action to avoid an uncoordinated hodgepodge of different state rules for an activity that is primarily national in character.

Summary of Recommendations:

1. **Experimental permits:** The experimental permit for human suborbital commercial flight should not be permitted to expire. Instead of another arbitrary period of years being designated for the sunset of experimental permits, other tests should be developed to determine when the regulations should be re-evaluated by Congress. I would recommend a panel of appropriate experts be commissioned to study this issue and develop a set of quantifiable tests to evaluate the maturity of this industry segment and to make recommendations based on the development of a mature market and a reliable and safe operating record. At that point these suborbital activities should be transitioned from OCST licensing to another part of the FAA and have a regulatory framework that is technically different but otherwise similar to aircraft, whether private human passengers are aboard or cargo is being flow.
2. **On-orbit Regulations:** Simply extending the safety review and financial requirements of a launch license regime to include in-orbit activities will not be sufficient to solve the complex future issues of liability and sustainable space activities. In addition to in-orbit regulations of satellites, non-orbital activities that enter outer space should also be similarly regulated. Under international treaty obligations they create the same U.S. Government liability exposure as any other in-orbit activities. Congress should recommend that the FAA commission a study to evaluate the complex legal environment of in-orbit liability in order to develop effective and workable

U.S. regulations that will clearly provide protections that will not unfairly burden industry or governments.

3. **Accident Investigation:** Congress should clearly designate who will be in charge of investigation a space accident under the specific situations that currently have overlapping jurisdiction.
4. **Informed Consent Waivers:** It may, at this time, be advantageous for the FAA to draft model clauses for the form with generic information about all space accidents and other non-company and non-vehicle related clauses that are required. Companies would still be responsible for the form and for providing information about any specific vehicle they operate.
5. **State Laws Limiting Operator Liability to Passengers:** Congress should study this issue and make a clear determination of what authority states have in permitting waivers of passenger liability to the operator of commercial space vehicles. Issues of vehicle safety, interstate commerce, and conflicts of laws among the various states raise possible future problems.
6. **Promotion and Regulation in One Agency:** When the OCST was formed it had only one type of vehicle (ELVs) to regulate. It is foreseeable that the OCST could be burdened with regulating closely competing economic activities (e.g. ELVs, RLVs, suborbital vehicles and UAVs all may be using or transporting payloads capable of providing similar telecommunications or remote sensing services to end-users). And, it is also possible that the OCST will be in charge of licensing competing vehicles. Choices of which type of vehicle to promote and which to ignore are as difficult as issues of developing different rules and oversight for different vehicles. If any of these conditions develop into true conflicts, Congress should consider a clear separation of functions among different agencies.

Closing Statement

The future role of the FAA OCST in commercial space will be very important. But it will also require changes from today's regulatory structure. Those changes will changes will reflect the changing commercial space environment. If the projections of some advocates materialize and a vibrant suborbital business is created, then these activities that occur mainly in national airspace might logically be moved to other parts of the FAA that manage domestic airspace and coordinate with ICAO on international matters.

The licensing of in-orbit commercial activities will grow as governments contract with commercial firms for different services. There are many new issues that have domestic and international implications with regulating in-orbit activities. The FAA will be instrumental in shaping these rules for U.S. operations. However, it is unlikely that these services will grow without a large initial market funded by the traditional government space agencies (NASA, DOD, DOC/NOAA) as the prime customers. Commercial firms initially will need to abide by many existing government safety rules. Eventually, after gaining practical experience, these rules may be subject to modification, codification, and implementation by the FAA for licensing of private operations in-orbit. Before the point where these firms have obtained a level of expertise in safety that satisfies the Congress, the operations of government missions in space should remain with the Agencies that have historically demonstrated an excellent overall safety record in a very hazardous and risky environment.