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Introduction

Chairman Nelson, Ranking Member Boozman, and Members of the Subcommittee, thank you for inviting me to testify on behalf of the commercial spaceflight industry.

Last month, SpaceX launched a Dragon spacecraft atop its Falcon 9 rocket to the International Space Station (ISS), successfully completing the demonstration phase of its Commercial Orbital Transportation Services (COTS) agreement with NASA. For the first time since the Space Shuttle retired last year, the world watched as Americans accomplished a new achievement in space. People across the country cheered when Dragon launched, berthed and landed safely, and all of us here joined them. With the Shuttle orbiters headed for their final homes, Dragon showed the American people that America's leadership in space is alive. By partnering with commercial spaceflight companies for cargo and crew companies in addition to its other great work, NASA continues to do great things.

At the same time, many other companies are making progress here on Earth and in the skies, using similar, innovative partnerships with NASA. Two days before Dragon was unberthed from the Space Station to return home, Sierra Nevada Corporation flew its winged Dream Chaser vehicle for the first time in a captive carry test. Not long before, another commercial aerospace company, Boeing, tested its CST-100 capsule by dropping and landing it with parachutes and airbags. The Commercial Crew Program is moving forward rapidly, and we expect to see more exciting accomplishments in the months to come.

In the suborbital arena, many companies are competing to be the first to launch a reusable vehicle to space since SpaceShipOne, including Armadillo Aerospace, Blue Origin, Masten Space Systems, Virgin Galactic and XCOR Aerospace. The reusability and quick turnaround of these vehicles will offer frequent opportunities for scientists and the interested public to launch to space on a regular schedule, on safe and reliable vehicles, for a relatively affordable price. This will improve the value of research conducted on other platforms while transforming STEM education. In addition, these suborbital vehicles will speed learning and likely form the basis for fully reusable orbital systems that hold the promise to fundamentally transform the space industry.

The Commercial Spaceflight Federation is the industry organization for the companies that are competing in these new space races, companies that are working to make commercial human spaceflight a reality. The Federation's members are spaceports, vehicle builders, launch services providers, robotic explorers, suppliers and many others that are building a web of commercial activity in space. The industry is concentrated in

the United States, and builds on two venerable American traditions: our entrepreneurial and inventive spirit, epitomized by heroes like Benjamin Franklin, Orville and Wilbur Wright, and the many creators of the modern Internet; and our half-century of leadership in human spaceflight, from Mercury, Gemini and Apollo to the Space Shuttle and the International Space Station.

These companies are made up of people who are passionate about space, who were inspired by NASA to reach for the stars, and who are living their dream: To open up space to the American people, and help NASA explore the solar system. Across the nation, we have seen how our excitement engages young people, giving them pride in their country and encouraging them to enter Science, Technology, Engineering and Mathematics disciplines.

On behalf the members of the Commercial Spaceflight Federation, I would like to provide this subcommittee with our observations and recommendations on the following issues: commercial partnership in NASA programs; the importance of extending the current risk-sharing regime; and overall commercial space regulation as it relates to the safe, efficient growth and promotion of the industry. Finally, I will discuss several market sectors that will benefit from safe, reliable U.S. space transportation capabilities and provide the basis for future market growth.

NASA Programs

When Dragon was berthed to the Space Station last month, the media declared the dawn of a new commercial space age. Those who have been paying attention know that this is not the true beginning, but perhaps the end of the beginning. SpaceShipOne flew in 2004, winning the X Prize and sounded the starting gun for a new suborbital space race. NASA started the COTS program in 2006 to develop a reliable and affordable American capability to resupply the Space Station through public-private partnerships codified in Space Act Agreements. Congress supported and funded the program, displaying faith in America's tradition of ingenuity, invention and competition.

Those who work on complicated NASA programs often must overcome tough technical and organizational challenges to achieve their goal. The COTS program has proven that complex tasks can be accomplished with Space Act Agreements, offering NASA a new tool that it can deploy in other areas. NASA's projects are generally big—big ideas, big vehicles, big teams and big costs. Because Space Act Agreements are milestone-based, companies are only paid when they perform and NASA is able to remove a company for not progressing according to those milestones. Because they are fixed-price, the cost of schedule delays is borne by the companies, rather than the taxpayers. The success of the COTS program shows that a lean team can accomplish a big mission, and has set the stage for commercial companies to move beyond hauling cargo to carrying crew.

NASA's Commercial Crew Program is also a public-private partnership with commercial space companies that utilizes competition to develop safe, affordable, and reliable systems to carry astronauts to and from the ISS and relieve our reliance on our Russian

partners. As the program has progressed, NASA has worked with Congress to plan its full arc, culminating in an outline for the program that preserves competition while ensuring that NASA has the insight it needs to certify the vehicles to carry NASA astronauts. The companies in this competition believe that with appropriate funding and management, they can fly crew to the ISS by as early as 2015. We hope that with a shared agreement on the program plan, Congress will see fit to fund the Commercial Crew Program as close to the President's request as possible. Every year that the Commercial Crew Program is delayed or its milestones prolonged due to funding, NASA sends approximately $400 million to Moscow. Keeping this domestic program strong will reduce our dependence on aging Russian infrastructure, protect our investment in the ISS, fully realize the its potential, and create jobs here at home.

At the same time, NASA is working hard with another sector of the industry—the suborbital vehicle builders. Companies like XCOR Aerospace, Virgin Galactic, Masten Space Systems, Blue Origin, and Armadillo Aerospace are racing to safely and efficiently launch scientists and citizens on reusable vehicles that can reach the edge of space. These vehicles will provide high-quality microgravity and access to the upper atmosphere at a reasonable price for scientists across the country, and a life-changing view of the Earth and weightless experience for participants.

NASA's Flight Opportunities Program has agreed to purchase flights on these vehicles for scientists and engineers who have experiments that require microgravity or access to space. Because suborbital launches will be flexible, safe, affordable and frequent, they offer an opportunity to perform scientific experiments that otherwise wouldn't fly and test instruments in real environments, supplanting ineffective ground or expensive flight testing, and developing new technologies faster.

By making a small commitment through the Flight Opportunities Program, NASA has provided certainty to the market and demonstrated that suborbital vehicles are exciting new tools for science and engineering. There has been one rocket flight under this program already, and in the next two years we expect to see many more, out of spaceports across the country.

Finally, NASA works with many innovative companies on specific projects that bear great fruit for the nation. NASA's Innovative Lunar Demonstrations Data (ILDD) program is leveraging and incentivizing private sector investment in exploration beyond Earth orbit, extending a COTS-like model to lunar exploration, so that risk remains with the private sector and fixed-price payment is made only for successful completion of pre-determined milestones. One of our members, Moon Express, and five other U.S. companies were selected by NASA for the ILDD program in 2010, with the first private lunar robotic landings anticipated in 2014 or 2015. The data from this program will contribute to NASA's efforts to create a sustainable and affordable space exploration program beyond low-Earth Orbit.

FAA Risk-sharing Regime

Under the Commercial Space Launch Amendments Act (CSLAA), the industry is regulated by the Federal Aviation Administration's Office of Commercial Space Transportation (FAA AST). FAA played an important role in the recent SpaceX mission to the space station, licensing both the launch and the re-entry of the Dragon spacecraft.

The CSLAA designates the FAA AST as the licensing agency for commercial space launch and reentry. As described in greater detail below, in order to obtain a launch license, a provider is required to purchase insurance against possible damage to third parties that could result from a launch or reentry. It also provides for risk sharing by the U.S. government should third-party damages exceed the required insurance amount. To date, third-party claims have never surpassed the required insurance amount; therefore, this provision has had zero cost on the taxpayers since it was instituted in 1988.

The FAA AST's insurance requirements are based on their calculation of the Maximum Probable Loss (MPL), which is the maximum amount of damage to the uninvolved public that could possibly be done in any launch or entry of the vehicle in 99.99999% of cases. The company must purchase insurance up to the MPL. Above this figure, which averages around $100 million and has a maximum of $500 million, the Federal government may provide additional coverage for the next $2.7 billion, dependent on expedited Congressional appropriation. If there were to be any damage above this level, the liability would be the responsibility of the parties involved with the launch, such as the launcher and payload provider. The coverage provided by the CSLAA's risk-sharing regime only applies to damage to uninvolved third parties. It does not cover damage suffered by the launch provider, payload provider, crew, or spaceflight participants.

This regime has been in place since 1988 and it is important to provide certainty to the marketplace. The launch industry's primary foreign competitors in Russia, Europe, and China receive even stronger liability protections from their governments (see Table 1). In fact, none of the other large spacefaring nations has a limit on the total amount of government risk sharing. The law expires at the end of the 2012 calendar year, and in order to protect and enhance American competitiveness in the launch market, it is important that it be extended.

Table 1: Liability Risk-Sharing Regimes for Various Countries

Country	Third Party Liability Insurance Requirements	Number of Tiers of Risk-Sharing	Launch Licensee's Required Third-Party Liability Insurance ($US)	Limit on Government Risk Assumption
United States	Yes	3	MPL, not exceeding $500 million	Up to $2.7 billion
France	Yes	2	$72 million	No limit
China	Yes	2	$100 million	No limit
Russia	Yes	2	$80-$300 million (vehicle dependent)	No limit
Japan	Yes	2	$42-$168 million (vehicle dependent)	No limit

**Vedda, J.A. "The Study of the Liability Risk-Sharing Regime in the United States for Commercial Space Transportation." The Aerospace Corporation, August 2006.*

If the risk-sharing provision expires, American launch providers may have to purchase additional insurance from risk-averse insurers, or if that is not available, exit the market. In addition, this would act as a deterrent for any new entrants into the marketplace. If these companies become uncompetitive on the world market, high-tech American jobs will be lost. America's share of the commercial launch market is currently not large, but companies with competitive pricing and reliable services are demonstrating that America can recapture commercial launch market share that it has ceded over the last three decades.

Because of the safety measures taken by industry, the regulations issued by the FAA AST and the very small probability of significant damage (1 in 10 million), the Federal government has never had to pay one cent in the 24 years the regime has been in place. Highly unlikely, but damaging, risks are the hardest to insure in any insurance market, and the space insurance market is relatively small. This creates a potential market failure that the government can solve with minimal risk and virtually no cost, and we encourage you to extend the risk-sharing regime for as long as possible to provide certainty to launch companies and customers whose plans are often made years in advance.

The Government Accountability Office (GAO) has suggested certain changes to the calculation of the MPL. We have no objection to making modifications to that calculation, and look forward to working with FAA AST and Congress to accomplish that, as long as the benefit outweighs the cost. It should be noted that there are many endemic uncertainties in the calculation of any loss of this type, and an exceptionally detailed analysis could be an unwise use of taxpayer funds if it leads to no more precision in calculating the MPL.

Regulation

Over its two decades of existence, the FAA AST has appropriately focused its efforts on promoting the commercial space industry, protecting the uninvolved public from harm and encouraging continuous safety improvement throughout the industry. CSF has worked closely with the agency to make certain that vehicles are safe for participants and the uninvolved public. AST has issued several regulations to improve safety, and we are developing industry consensus standards to ensure that best safety practices are shared throughout the trade.

Congress passed the Commercial Space Launch Amendments Act in 2004, which directed the FAA AST to issue regulations to protect third parties and the crew of any manned vehicle, and established an informed consent regime for spaceflight participants. In the absence of specific data indicating a safety risk, the FAA AST was constrained from regulating for passenger safety "in the dark," until an eight year learning period had passed. That learning period was broadly supported by the Congress for good reason—to enable a new industry to mature, and to provide the regulator with real-world data on which to base sound regulatory policy.

Many observers expected there would be many commercial human spaceflights by the time the learning period expired in 2012, which would allow FAA to regulate with a robust set of data about safety. Unfortunately, the industry did not develop as quickly as expected, largely due to industry behaving with extreme caution and developing safe systems prior to any flight. Consequently, no commercial human spaceflights have occurred since 2004, providing no data on which to develop sound regulatory policy. For this reason, we thank Congress for acting in January to extend the learning period through October 1, 2015, with an eye toward restoring the original intent of the learning period provision.

Despite the passage of time, the concerns that led to the establishment of the learning period are still valid. There are no hard data from commercial human spaceflights on which to base regulations. Spacecraft designs are in flux, and regulations would be very difficult to draft in a way that would not eliminate some potential designs, most of which are impossible to evaluate at this point. In addition, in a nascent industry like commercial spaceflight, safety lessons are learned and applied rapidly, and regulation could easily fall behind. These factors mean that regulation should be data-driven and careful, a conclusion that has been implemented in the establishment of the learning period.

We share a concern with FAA AST that the end of the learning period, whenever it may come, represents a drastic change in regulatory environment. Recently, based on continued requests from CSF and in compliance with Congressional report language, FAA AST has started to provide industry with information on the general approach that it is planning to take toward regulating for spaceflight participant safety when the learning period expires. We support those efforts wholeheartedly and look forward to ongoing conversations with FAA AST and Congress about our common goal of protecting spaceflight participants, crew and the public. We also encourage FAA AST to work with

us to share data that they have gathered on safety issues with the industry, in a form that does not compromise confidential or proprietary information, so that best practices can be quickly and effectively spread throughout the industry.

There are other existing regulations that have a detrimental impact on American aerospace companies and our national security. The International Traffic in Arms Regulations (ITAR) have been ripe for reform for many years, and the House recently took the first step in that direction by including a provision in the National Defense Authorization Act of 2012 that would allow the President to remove communications satellites and other related technologies from the U.S. Munitions List so that they could be more appropriately regulated through the Department of Commerce.

Over the last decade, much of the commercial space launch business has moved overseas. There are many reasons for this, including subsidies from foreign governments, but ITAR has also played a major role. The U.S. market share of satellite exports has decreased from 75% in 1995 to 40% in the last decade since the regulations went into effect. Returning some of that business would not only strengthen our defense industrial base but restore the U.S. market share and ultimately result in the creation of high-tech jobs here in America.

Therefore, we strongly support efforts to reform ITAR by returning to the President the ability to move satellites and related items from the U.S. Munitions List to the Commerce Control List, where they can be more appropriately regulated as dual use items. We particularly support the immediate removal of commercial space items, such as manned suborbital vehicles, from the Munitions List, and we look forward to working with Congress and the Executive branch to create an export control regime that better protects our national security and keeps high-tech jobs here in America.

Federal Government Demand for Commercial Services

The International Space Station is an invaluable resource to the science and research community if it is fully utilized. It will also be an important market for both commercial launch service providers and researchers. Current NASA plans involve the purchase of six seats per year aboard Soyuz flights to the ISS at a cost of about $400 million per year. The result is that at any one time there are three Unites States Orbital Segment astronauts available to perform utilization tasks in addition to their other duties.

Due to the necessity of performing spacecraft operations, maintenance and other tasks, these three crewmembers are having a difficult time achieving the NASA target of 35 research hours per week. Indeed, a November 2009 GAO report cited “limited crew time as a significant constraint for science on board the ISS.” The ISS is outfitted and will be provisioned to increase its full time crew complement from six to seven. The fourth USOS crewmember will dramatically increase the research capacity of the ISS.

All of the vehicles being proposed in the Commercial Crew Program have the capacity to carry seven crewmembers. While four would remain aboard as long duration astronauts,

there are many options under consideration for the remaining three seats: They could be used for short duration sortie missions by NASA or other international partner astronauts; they could be likewise filled by highly specialized researchers in a program akin to the use of payload specialist aboard the Space Shuttle; they could be filled with science-related up-mass that is critical to onboard research; or they could be sold to non-professional space flight participants to offset the costs to NASA. The realization of cost-effective and reliable commercial service to the ISS will provide NASA with myriad flexible options to optimize the utilization of our national orbital asset.

NASA Administrator General Charlie Bolden testified in March that he expects ISS to operate past 2020 and that conversations were already under way with international partners on this topic. Equipment reliability aboard the ISS has surpassed engineering expectations, and there are no immediate maintenance concerns that could require deorbiting. NASA and our international partners have yet to identify any technical reason the ISS would need to close down before 2028. Given the large investment the American taxpayers have made, we support measures to preserve and extend the ISS and believe that there will continue to be an ISS commercial crew market beyond 2020.

In addition, regardless of the long-term fate of the ISS, we believe that NASA and other government agencies will have a long-term need for cost-effective, reliable and safe crew and cargo access to low-Earth orbit. Two hundred years after Lewis and Clark set off to find the Northwest Passage, the Federal government continues to require the services of geologists, naturalists and other scientists in the Western states. We expect that NASA and the rest of the Federal government will similarly continue to have a need, and as prices drop and volume increases, those markets will grow.

Finally, suborbital spaceflight companies will also provide services to the Federal government, from testing of components that will later fly on high-value missions for NASA or DoD, to science experiments that test microgravity regimes that are otherwise much more expensive to achieve. And these examples are just the start—as the capability arises, many more may arise. As one example, in 2007 NASA Administrator Michael Griffin said, "If I was still at the helm of NASA when [suborbital spaceflight] became available, I would guarantee you that we would use it to begin entry-level training of astronauts."

Other Demand for Commercial Services

Historically, space has been the domain of science, defense and communications. Scientists have been studying the Earth, the solar system and the universe, through spacecraft for decades, but in many ways that study has only just begun. Scientists at universities and research centers across the country are interested in flying experiments, interplanetary probes and satellites to space. Scientists in countries that do not have active space programs have wanted to fly missions to space for years, but have had little opportunity.

Furthermore, a 2010 Avascent study found that astronauts from only 50 of the world's 195 nations have gone to space, and very few of those nations have had continued access. But many nations and companies see astronauts and space research as valuable commodities, and they represent a largely untapped market for commercial space. These customers are interested in access to space for scientific and industrial research, but also for public relations, advertisement and other purposes.

Over the last decade, private astronaut access to space has become a reality. Space Adventures, a member of the Commercial Spaceflight Federation has sold several trips to the ISS on Russia's Soyuz rocket to private individuals. In fact, every additional seat available on the Soyuz has been sold, with unfulfilled demand, even as the price has increased over the years. As our members develop an American commercial crew capability, and plans for private on-orbit facilities progress, we expect that market to flourish. According to a market analysis performed by Futron in 2010, 60% of surveyed individuals are more likely to fly on a more convenient American vehicle than the Soyuz alternative.

On the suborbital front, the Southwest Research Institute, another CSF member, has purchased six seats on suborbital vehicles, with options for more, to allow researchers to perform experiments that would otherwise be unattainable. Other researchers have expressed great interest as well, with more than 400 people attending the Next-Generation Suborbital Researchers Conference in February. Competitors in the Google Lunar XPRIZE competition, who are planning to return data from rovers on the Moon, are also looking for rides to space. As capabilities increase, flight rates rise and prices fall, we expect a great deal more interest.

The commercial satellite market is an international market with many billions of dollars in revenue each year. Historically, satellite providers have only been able to choose from a limited set of commercial space capabilities, primarily launch and on-orbit maneuvers. However, as new techniques emerge from the commercial space sector, we expect the commercial satellite industry to become a customer for a wider set of services.

Spaceflight has a unique ability to inspire students, and commercial spaceflight offers the opportunity to open space to a large population of young people as prices for small experimental payloads to suborbit may be just a few thousand dollars, well within reach for foundations and even school districts. With frequent, recurring flights to space, citizen-astronauts could be teachers and mentors to countless pupils and more students could have a role in an experimental payload that flies to space. Many education programs could be birthed from safe, reliable flights to space, stimulating the next generation of STEM students.

The first airplane companies could not conceive of the many uses that their vehicle would one day be put to, uses that now include rapid package delivery and commuting to work. An early computer pioneer named Howard Aiken said in 1952, "[o]riginally one thought that if there were a half dozen large computers in this country, hidden away in research laboratories, this would take care of all requirements we had throughout the country."

Clearly, we do not have certain knowledge in any detail of the markets that will emerge for the commercial space industry. What we can say is that the currently available markets for government and private access to space are large enough for a successful industry and that there are many possible avenues for growth.

Many of our member companies were founded by experienced business leaders who have led highly successful companies involved in many sectors of the economy. They have invested a large amount of their capital into these businesses. If they did not believe there would be a market outside of the government, that level of investment would be unlikely. It is difficult to predict several years ahead what the most important sector of an emerging market will be, and it is likely that our members have somewhat different opinions on each sector. However, we believe that markets have been demonstrated to exist and that they will grow rapidly as capabilities increase, volume increases and prices are reduced.

Conclusion

The last month has been an important one for commercial space, with successes and exciting new announcements across the industry. I greatly appreciate the opportunity to provide testimony for this hearing and I look forward to working closely with all of you and your staff as the Commercial Spaceflight Federation promotes the development of this promising American industry, pursues ever higher levels of safety, and shares best practices and expertise throughout the industry.