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United States Senate
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Chairman Wicker, Ranking Member Cantwell, and distinguished members of the Committee: thank you for inviting the Commercial Spaceflight Federation (CSF) to present our members' views on the state of the U.S. commercial space industry. We also appreciate the opportunity to highlight our members' engagement with various regulatory reform efforts that are underway and other policy issues facing our industry.

CSF is the leading national trade association for the commercial spaceflight industry, with more than 85 member companies and organizations across the United States. Founded in 2006, CSF is focused on laying the foundation for a sustainable space economy and democratizing access to space for scientists, students, civilians, and businesses. CSF members are responsible for the creation of thousands of high-tech jobs driven by billions of dollars in investment. Through the promotion of technology innovation, CSF is guiding the expansion of Earth's economic sphere, bolstering U.S. leadership in aerospace, and inspiring America's next generation of engineers and explorers.

Prior to our country's successes over the last decade in capturing a majority share of the commercial space launch market, the majority of launches in the United States were undertaken by the U.S. Government. With increased commercial launch and reentry activities the need to more efficiently integrate our activities into the National Airspace System (NAS) has led to coordinated efforts within the U.S. Government and industry to find solutions that mitigate impacts while promoting safety. Of course, since rockets and balloons predate airplanes, these are not new entrants to the NAS, simply a changing economic landscape that is vibrant, growing, creating jobs and establishing American leadership. This economic growth leads some to believe that an obsolete NAS will become congested, inefficient, and perhaps less safe.

Because the NAS is a shared public resource, we are eagerly working with other NAS users to promote technology tools and operational improvements that will optimize the use of the NAS in a safe and efficient manner. Those efforts are the major focus of my testimony today.

I. Commercial Space Today

This year, the United States commercial space industry is poised for another record-setting year. Last year, U.S. commercial space companies achieved an unprecedented 32 licensed orbital and suborbital launches as well as 14 licensed reentries. The majority of those licensed activities were attributable to SpaceX, which conducted 21 launches that involved 12 first stage landings. 2018 also saw the first commercial launch of Rocket Lab's *Electron*, and the first

licensed flights to space of two American suborbital reusable launch vehicles, Blue Origin's New Shepard and Virgin Galactic's SpaceShipTwo. I emphasize the word licensed, because a license allows the company to earn revenue from the flight, unlike an experimental permit.

Today's commercial space transportation industry is growing in frequency of operation and in the diversity of capabilities offered. In addition to smaller suborbital launch vehicles and medium, heavy and super-heavy-lift launch vehicles, many of which are reusable, we now have a broad range of smaller orbital launchers entering the marketplace to give smaller satellites a dedicated ride to space.

This year the U.S. conducted a successful flight qualification mission of the first of two independent commercial crew vehicles being developed in partnership with NASA, and we expect to see another this fall. Two suborbital operators are likely to fly spaceflight participants for revenue by the end of the year. With a lot of hard work and some luck, U.S. astronauts will launch to the International Space Station again from U.S. soil in the next twelve months. As of today, we have already had 11 commercial launches this year.

Much of this progress may seem sudden, but is the culmination of years of policy work in Washington and high-tech manufacturing efforts across the country. Blue Origin was founded in 2000, SpaceX in 2002, and Virgin Galactic in 2004. Vector Space's innovative small launch vehicle has its roots in many years of amateur rockets built and launched by university students. These companies and many others are in fact decade-plus "overnight successes" facilitated by efforts to provide a regulatory environment that is focused on protecting the uninvolved public without stifling the industry.

II. Optimizing the Transit of Airspace by Launch/Reentry Operators

In the past few years, the increasing frequency of space launch and reentry activities, along with the emergence of new entrants to aviation, has raised congestion and safety concerns among some traditional aviation stakeholders. It is important, though, to keep the number of launches and reentries in context with the level of aviation activity in the NAS. As already noted, there were 32 commercial launches and reentries that transited the NAS in 2018. In a given year, approximately 15.5 million flights transit the NAS. So while 32 is a significant increase over the 12 launches 5 years ago, it is barely a blip on the radar.

While there has been great progress in traditional aviation and commercial space transportation, like new entrants, drones, and personal air vehicles – all good and desirable developments – that progress is highlighting the need to improve the hardware, software, and human systems that manage the NAS. In particular, the way that we restrict airspace around launch or reentry events – an approach called "segregation" – is an inefficient use of the airspace.

Historically, going back to the 1960s with the dawn of the space age, we closed large blocks of airspace around launches to keep airplanes and their crew and passengers far away from any potential catastrophic accident. Today we should be capitalizing on improved modeling and

airspace control capabilities, instead, we continue to use out-dated approaches and systems that look essentially the same as those used in the 1960s. Those systems do not reflect the diversity of vehicles and operations that exist today, much less the innovation and industry expansion we expect over the next decade.

The problem is with the space launch risk analysis and air traffic control tools that the FAA uses to close airspace. Those tools are decades old, and not designed for today's aviation or space transportation needs. Stated simply, we close too much airspace, for too long, without real-time information available to air traffic controllers regarding the status of the launch or reentry. To improve the situation, we need to invest in fixing the following problems:

- Obsolete tools that dictate the safety area around a launch or reentry - they are overly conservative and not dynamic;
- The air traffic control systems' inability to accept data on the position and velocity of space vehicles; and
- The lack of a tool for space operators to share and compare their launch and reentry schedules to aviation schedules to minimize conflicting operations.

We are eager to work together across industries to address these challenges.

III. To Successfully Integrate Launch and Reentry Operations into the NAS, the Following Tools are Necessary:

Instead of closing large blocks of airspace for hours, it should be possible to dynamically manage air traffic around a launch or reentry. That requires real time safety area calculation and information flow, including the current position and velocity of the launch vehicle, to individual en route air controllers, so they can release airspace immediately behind the launch vehicle as it flies.

Since early 2018 I have co-chaired the FAA Aviation Rulemaking Committee (ARC) on Airspace Access with representatives of airlines, pilots, airports, business aviation, and many other stakeholders, plus many large and small commercial space operators and the most active spaceports. While the FAA originally wanted us to attempt to prioritize aviation and space uses of the airspace, we quickly realized that we needed to integrate and optimize our use of the shared resource rather than cutting back on either sector's growth.

I won't tell you that the past year and a half has been easy. Leaders in both industries have often struggled to understand each other's priorities and perspectives, and even our respective vocabularies. But with that said we have come a long way, and our final report should be ready in the next few months.
More specifically, CSF recommends the following actions and investments by the FAA in collaboration with industry, which aligns well with a lot of the work we've done in the ARC. The FAA should:

1. Immediately emphasize and accelerate efforts to efficiently integrate space vehicle operations into the NAS.
2. Establish a space operations committee (including operators, Department of Defense, and NASA) to recommend appropriate information to be exchanged with the FAA for more dynamic airspace management and situational awareness.
3. Establish a Steering Committee to provide ongoing input to the FAA as NAS improvements are developed and implemented.
4. Invest in developing tools and capabilities that will enable a future NAS state where air traffic management shifts from segregation to integration with separation assurance.
5. Implement the ability to create dynamic airspace areas on controller automation systems that can be conflict probed.
6. Implement decision support tools in automation systems for air traffic controllers and traffic managers.
7. Develop procedures and training to enable future automation capabilities.
8. Further develop its Hazard Risk Assessment and Management (HRAM) capability and make that tool available to ATC to allow for dynamic airspace management.
9. Implement and enable a capability, such as the Space Data Integrator (SDI) that allows space operators to share telemetry data with ATC systems and use that tool to supply telemetry to HRAM and other automation platforms as necessary.
10. Implement a NAS operational airspace utilization assessment for both planning and post analysis capability and make it available to operators online.
11. Require minimum advanced notification times prior to an event requiring Special Access Airspace (SAA).
12. Ensure sharing of real-time status of the vehicle for both pre- and post-launch.
13. Implement procedure updates for tactical information exchange between operators and FAA regarding on-time operations to enable more dynamic airspace activation/deactivation.

As the NAS using industries have begun working more closely together, it is clear that the Next Generation Air Transportation System, or NextGen, is central to a more integrated, safe, and efficient use of the NAS. The recommendations I just enumerated are an obvious part of the NextGen portfolio. But it is not sufficient to just add them to a to-do list that will take a decade or more to complete. The FAA needs to utilize its Other Transactions Authority (OTA) and other innovative procurement methods to dramatically accelerate these critical improvements to airspace management.

While these tools are being developed, there are things that space operators can do to help aviation operators minimize system delays during launch and reentry events. If FAA/AST were to create an integrated schedule of licensed or permitted launches and reentries, industry could authorize FAA/AST to share much of that information a few months, rather than about ten days, with aviation operators. The benefit of earlier notice is that aviation operators can still reallocate their crews and airplanes to create some slack in higher value scheduled flights that are more vulnerable to delays.

Ultimately, however, the challenge is getting the FAA to the point where it can adapt, move, and innovate quickly enough to keep up with the advancement of aviation, commercial spaceflight, and new NAS entrants. Given the importance of aviation and space to our economy, our freedom, and our national security, we have to find a way to help the FAA to move much faster and get ahead of industry, rather than struggling to catch up.

IV. Scaling Launch and Reentry Regulation

Today's launch and reentry rates, together with innovative operations and increased industry diversification, are bringing to light new challenges. The first of these is the obsolete, burdensome, and duplicative body of regulations for launch and reentry. Today's rules were mostly crafted in the 1980s and 1990s, and they take a very narrow, prescriptive approach that does not support innovation in technology and operations, including changes that improve safety, efficiency and industry growth.

Thanks to leadership from the President, Vice President, National Space Council, Secretary of Transportation, and senior FAA officials, a much-needed reform process has begun. Last March an Aviation Rulemaking Committee (ARC) was chartered on Streamlining Launch and Reentry Licensing Requirements. This was critical because many industry experts believed that the best way to rewrite these regulations would be via a negotiated rulemaking.

The resulting Notice of Proposed Rulemaking (NPRM) to streamline the launch and reentry regulations is now open for comment. The goals for the NPRM were outlined in Presidential Space Policy Directive No. 2 (SPD-2). It stated, in part:

> The Secretary of Transportation shall consider the following:
> (i) requiring a single license for all types of commercial space flight launch and re-entry operations; and
> (ii) replacing prescriptive requirements in the commercial space flight launch and re-entry licensing process with performance-based criteria.

Importantly, neither SPD-2 nor the resulting NPRM has changed the level of safety applied to spaceflight activities. Nobody in industry (or government) is asking for a lower level of safety. The goal of SPD-2 and the NPRM is only to streamline the regulatory process and create a performance-based approach to regulating an innovative, evolving industry while making it even safer.

We complement the FAA for getting the proposed rule out fairly quickly, delayed only by the government shutdown. Unfortunately, instead of a giant leap, the FAA seems to have taken only a half step towards the regulatory regime America needs to enable the growth and diversity of new space transportation providers and users. The 580-page NPRM grants industry 60 days to provide comments, which might be possible if the industry's input through the ARC were more fully reflected in the NPRM, and if all referenced material were included (advisory circulars are referenced but not provided). Unfortunately, inputs that reflected the position of a majority

of industry members were not included; therefore, many CSF members have requested an extension of the comment period to fully review and provide substantive comments and recommendations.

In assessing the NPRM so far, the draft rule fails to achieve the key objectives of SPD-2 and industry's highest priority: streamlined, performance-based rules that accommodate all licensed launches and reentries at all operating locations, including federal ranges.

Historically, AST's regulations have been very specific and prescriptive for expendable launch vehicles. The regulations have taken a more general approach for reusable vehicles that examines the safety of the system as a whole. The rules for expendable rockets were written that way partly because they were based on, or referenced, the Air Force's detailed procedures at the federal ranges, which go back to the days of the earliest ballistic missiles.

Importantly, the ARC had stipulated in its report that the FAA needed to rewrite the terms of their partnership with the Air Force to meet Congress' and industry's call for singular regulatory authority for public safety that would apply the same approach to launch sites on federal ranges and those in other locations. The ARC's recommendations reflect Congressional action on this issue in recent legislation, including the Commercial Space Launch Competitiveness Act (CSCLA) of 2015 and the 2018 National Defense Authorization Act. Under the CSLCA, the Department of Transportation is supposed to have sole federal jurisdiction over space launch and reentry. The Air Force (USAF), acting as a landlord, can prescribe safety rules for ground operations, but is not supposed to have duplicative authority or promulgate duplicative (and potentially conflicting) regulations. The NPRM does not address duplicative requirements imposed by the USAF on commercial space operations.

CSF members believe it would be tremendously helpful if the FAA were to reconvene the ARC to provide feedback on the NPRM, currently the FAA has said it has no plans to do so. To be sure, industry appreciates all of the support for regulatory reform from so many policymakers in Congress and the Executive Branch, and we do thank the FAA for their incredible hard work over the past year-plus with the ARC and the draft rule. We are hopeful that our requests for more time to review and comment will be granted. The importance of this rulemaking process cannot be overstated and we are ready to engage to ensure that the rules are optimized for protecting the public and ensuring an efficient launch and reentry licensing regime.

V. Suborbital Platforms Support National Priorities

Recently, a few public critics have written off suborbital reusable launch vehicles' operations in the NAS as just providing adventure rides for millionaires. Nothing could be further from the truth. Commercial suborbital platforms aren't a nuisance to the Nation or the NAS; they're a national asset, supporting national priorities. According to the National Academies of Science, "[S]uborbital [platforms] play a vital and necessary strategic role in NASA's research, innovation, education, employee development, and spaceflight mission success, thus providing the foundation for achievement of agency goals." This principle has application and implication that

extends beyond NASA, and extends to national priorities and goals. More specifically, the growing number of commercial launch platforms:

1. Expand hands-on STEM engagement and training for students;
2. Enhance scientific understanding of the Earth and the Universe;
3. Increase hands-on training opportunities and workforce development experiences for the next generation of space scientists and engineers;
4. Improving program management by flight-testing new technologies and techniques relatively inexpensively;
5. Expand economic activity - Creating a pipeline for commercial economy Low-Earth Orbit (LEO) and on the International Space Station (ISS);

Expand hands-on STEM engagement and training for students. The growing number of commercial space companies providing cost-effective and frequent access to the spaceflight environment is making it easier for students to participate in hands-on STEM engagement and training. For example, in 2017, a Cumberland Elementary School second grade class, led by eight-year-old Yashi Varma, wanted to create a science project to test whether fireflies glow in space.[1] And that's just what they did. Yashi and her classmates teamed up with their local university, Purdue University, and built an experiment using a $7 "Launchbox."[2] In December 2017, Yashi and her classmates' experiment flew on a Blue Origin New Shepard suborbital launch, and conclusively showed that fireflies do glow in space. Following their successful mission, Yashi and her classmates turned their science project into a political science project, and successfully petitioned to make the firefly the official state insect of Indiana. In March 2018, Governor Eric Holcomb signed legislation designated the firefly as the state insect.[3] This was all made possible at the cost of $5,300[4] to design, build, and fly the firefly experiment to space. That's the amount raised from a couple of weekend bake sales or raffles. Although there is only one member from Indiana on this Committee, I share this story as an example of opportunity: every classroom, in every state, can now have a space program, and they should. CSF and our members look forward to working with you in the upcoming NASA Authorization to make that a reality.

Enhance scientific understanding of the Earth and the Universe. The growing number of commercial space companies providing cost-effective and frequent access to the spaceflight environment is enabling a greater scientific understanding of our Earth and the universe. For example, commercial suborbital platforms are enabling scientists to better study and understand

[1] See: Meghan Holden, Journal & Courier, "Second graders' experiment will launch into space," May 2017. Available at: https://www.jconline.com/story/news/education/2017/05/24/second-graders-experiment-launch-into-space/102083064/

[2] See: Purdue University, "Purdue School Launchboxes available to send school experiments into space," July 2018. Available at: https://www.purdue.edu/newsroom/releases/2018/Q3/purdue-school-launchboxes-available-to-send-school-experiments-into-space.html

[3] See: Scott Miley, News and Tribune, "Score one for the kids: Say's firefly dubbed state insect. Available at: https://www.purdue.edu/newsroom/releases/2018/Q3/purdue-school-launchboxes-available-to-send-school-experiments-into-space.html

[4] See: Meghan Holden, Journal & Courier, "Second graders' experiment will launch into space," May 2017. Available at: https://www.jconline.com/story/news/education/2017/05/24/second-graders-experiment-launch-into-space/102083064/

the Earth's upper atmospheric conditions (90 kilometers and above), which we know little about due to lack of access to this region, which was too high for balloons and too low for spacecraft.[5] In fact, we know more about the upper atmosphere of Saturn's moon, Titan. Now, commercial suborbital vehicles are enabling new scientific study of that region, along with other areas. Overall, the National Academies of Science has found, "[S]uborbital [platforms] enable important discoveries in science, rapid response to unexpected, episodic phenomena, and a range of specialized capabilities that enable a wide variety of cutting edge research in areas such as Earth observations, climate, astrophysics, and solar-terrestrial observations, as well as calibration and validation of satellite mission instruments and data."[6]

Increase hands-on training opportunities and workforce development experiences for the next generation of space scientists and engineers. The growing number of commercial space companies providing cost-effective and frequent access to the spaceflight environment is enabling greater hands-on training opportunities and workforce development experiences for the next generation of space scientists and engineers. The National Academies of Science has found, "[S]uborbital [platforms] provide effective, hands-on, engineering and management experience that transfers readily to NASA spaceflight missions. These opportunities, which provide for cradle to grave hands-on mission experiences and training for students, researchers, principal investigators, project managers, and engineers, are vital to future space endeavors."[7]

This point was driven home in a recent NASA Office of Inspector General report outlining key factors contributing to NASA's project management challenges, "[M]ost [NASA] project managers and senior officials we spoke with said that experience and on-the-job training were keys to a project manager's ability to manage cost, schedule, and performance goals. In that regard, managers described NASA's small projects [e.g. NASA's Flight Opportunities Program] as invaluable for developing management skills and learning the key elements of project management, including making appropriate trade-offs among cost, schedule, and performance goals when necessary."[8]

Improve program management by flight-testing new technologies and techniques relatively inexpensively. The growing number of commercial space companies providing cost-effective and frequent access to the spaceflight environment is improving program management by flight-testing new technologies and techniques relatively inexpensively. The National Academies of Science has found, "[S]uborbital [platforms] provide essential technical innovation

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[6] See: National Academies of Science (NAS), "Revitalizing NASA's Suborbital Program: Advancing Science, Driving Innovation, and Developing Workforce," 2010. Available at: https://www.nap.edu/catalog/12862/revitalizing-nasas-suborbital-program-advancing-science-driving-innovation-and-developing

[7] See: National Academies of Science (NAS), "Revitalizing NASA's Suborbital Program: Advancing Science, Driving Innovation, and Developing Workforce," 2010. Available at: https://www.nap.edu/catalog/12862/revitalizing-nasas-suborbital-program-advancing-science-driving-innovation-and-developing

[8] See: The Honorable Paul K. Martin, NASA Office of Inspector General (OIG), "NASA Cost and Schedule Overruns: Acquisitions and Program Management Challenges," June 2018. Available at: https://oig.nasa.gov/docs/CT-18-002.pdf

and risk mitigation that benefit spaceflight missions through the development and demonstration of technology and instruments that later fly on NASA spacecraft."[9]

The importance of early technology risk reduction through flight-testing was driven home in a recent NASA Office of Inspector General (OIG) report outlining key factors contributing to project management challenges: "The technical complexity inherent in NASA projects remains a major challenge to achieving cost and schedule goals, with project managers attempting to predict the amount of time and money needed to develop one-of-a-kind, first-of-their-kind technologies instruments, and spacecraft. NASA historically has underestimated the level of effort needed to develop, mature, and integrate these technologies, as well as account for the extensive pre-launch testing required to reduce risk and increase the likelihood that the technologies will operate as designed in space."[10] Increased flight-testing on low-cost commercial suborbital platforms will help address this problem.

Expand economic activity - creating a pipeline for commercial economy Low-Earth Orbit (LEO) and on the International Space Station (ISS). One of the Nation's top priorities is to facilitate a robust, sustainable U.S. commercial presence in LEO and on the ISS, which is underpinned by the need for a growing sphere of microgravity economic activity. Commercial suborbital capabilities play a critical role in creating this microgravity demand pipeline by providing low-cost platforms to conduct vital technology development and research. Any successful strategy to create a robust economy in LEO should position commercial suborbital capabilities as a critical component.

Conclusion

These are exciting times in commercial spaceflight. We should all be proud of what American companies are achieving - we are establishing our Nation as the clear leader in space exploration and development. The challenges we face today are not small, but we have the ability and opportunity to address them in a thoughtful and impactful manner given Congress' and the Administration's support.

As we prepare to celebrate the 50th anniversary of the Apollo 11 moon landing, CSF members are honoring the past by working to fully realize a revolution in access to space that will open the space frontier to the American people and their enterprises. We look forward to continuing to work with this body to promote safety, reliability and the advancement of the commercial space industry.

Mr. Chairman, Ranking Member Cantwell, I appreciate your invitation to testify before the Committee today. Thank you for your attention, and I look forward to your questions.

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[9] See: National Academies of Science (NAS), "Revitalizing NASA's Suborbital Program: Advancing Science, Driving Innovation, and Developing Workforce," 2010. Available at: https://www.nap.edu/catalog/12862/revitalizing-nasas-suborbital-program-advancing-science-driving-innovation-and-developing

[10] See: The Honorable Paul K. Martin, NASA Office of Inspector General (OIG), "NASA Cost and Schedule Overruns: Acquisitions and Program Management Challenges," June 2018. Available at: https://oig.nasa.gov/docs/CT-18-002.pdf

Appendix

The Commercial Spaceflight Federation's (CSF)
FY 2020 Transportation, House and Urban Development (THUD)
Appropriations Priority Requests

Project Title: Office of Commercial Space Transportation (AST)
Agency: FAA
Account: Operations
Request Amount: $25.6M
Report Language:
The Committee directs the Office of Commercial Space Transportation to continue to prioritize licensing and regulatory streamlining activities. The Committee urges the Associate Administrator to complete negotiations with the Department of Defense to ensure that the Secretary of Transportation will be responsible for public safety during licensed and permitted launch and reentry operations on federal ranges, with the Department of Defense maintaining responsibility for public safety during ground operations.

Project Title: Commercial Space
Agency: FAA
Account: Facilities and Equipment
Request Amount: $33M
Report Language:
Continuing growth in the U.S. commercial space industry requires the urgent modernization of decades-old methodology for maintaining public safety in airspace around commercial space launches and reentries. The Committee directs the Associate Administrators for NexGen and for Commercial Space Transportation to work collaboratively and exercise the FAA's broad authority to use other transactions and other innovative partnership methods to accelerate the development and certification of tools for en-route real-time tracking, calculation and display of the flight path and dynamic hazard areas for space launch and reentry activities on air traffic controller screens.

Project Title: Commercial Space Transportation Safety
Agency: FAA
Account: Research, Engineering and Development
Request Amount: $6M

Project Title: Space Transportation Infrastructure Matching (STIM) Grants Program
Agency: FAA
Account: Space Transportation Infrastructure Matching (STIM) Grants Program
Request Amount: $10M
Report Language:

The Federal Aviation Administration (FAA) Office of Commercial Space Transportation (AST) maintains the Space Transportation Infrastructure Matching (STIM) Grants Program for the purpose of ensuring the resiliency of the space transportation infrastructure in the United States. The U.S. Congress mandated the Grant Program under §51 Chapter 511 Space Infrastructure Matching Grants. This legislation authorizes the use of Federal monies in conjunction with matching state, local and private funds to complete technical and environmental studies and design and construction of space transportation infrastructure, including real property to meet the needs of the United States commercial space transportation industry.

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