COMMERCIAL SPACE TRANSPORTATION REGULATORY REFORM: STAKEHOLDER PERSPECTIVES

(115–48)

HEARING

BEFORE THE

SUBCOMMITTEE ON
AVIATION

OF THE

COMMITTEE ON
TRANSPORTATION AND
INFRASTRUCTURE
HOUSE OF REPRESENTATIVES

ONE HUNDRED FIFTEENTH CONGRESS

SECOND SESSION

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June 22, 2018

SUMMARY OF SUBJECT MATTER

TO:	Members, Subcommittee on Aviation
FROM:	Staff, Subcommittee on Aviation
RE:	Subcommittee Hearing on "Commercial Space Transportation Regulatory Reform: Stakeholder Perspectives"

PURPOSE

The Subcommittee on Aviation will meet on Tuesday, June 26, 2018, at 10:00 a.m. in 2167 Rayburn House Office Building to explore issues related to the commercial space transportation industry, focusing on stakeholders' perspectives on the Federal Aviation Administration's (FAA) ongoing regulatory reform efforts. The Subcommittee will receive testimony from representatives of the commercial space industry and commercial airline pilots.

BACKGROUND

The United States' space industry, including launch services, satellite services, and satellite manufacturing, accounted for $158 billion in economic activity in 2016.[1] The FAA's Office of Commercial Space Transportation (AST) is the office statutorily authorized to regulate the commercial space transportation industry. AST's regulatory regime consists primarily of the licensing or permitting of space launches, vehicle reentry, and launch sites. It also ensures that the space industry mitigates the risks posed to persons and property on the ground.

AST has an impressive record of meeting regulatory deadlines, but its processes can be streamlined and improved. AST has licensed or permitted every launch or reentry within the prescribed statutory deadlines.[2] Notwithstanding this demonstrated record of success, many in the commercial space transportation industry believe that a simpler, more agile regulatory regime

[1] "The Annual Compendium of Commercial Space Transportation: 2018," FAA, January 2018, available at https://www.faa.gov/about/office_org/headquarters_offices/ast/media/2018_AST_Compendium.pdf

[2] *Federal Aviation Administration Oversight of Commercial Space Transportation (114-46): Hearing Before the Subcommittee on Aviation of the Committee on Transportation and Infrastructure*. 114th Cong. (June 22, 2016) (Statement of Dr. George C. Nield).

will be needed in the years ahead in order to make commercial space flight as routine as other modes of transportation.

Office of Commercial Space Transportation

Under the 1984 *Commercial Space Launch Act* and subsequent amendments, the Secretary of Transportation has the responsibility and authority to facilitate, regulate, and promote the commercial space launch industry.[3] In 1984, this function was assigned to the newly established AST as part of the Office of the Secretary of Transportation (OST).[4] In November 1995, AST was transferred to the FAA. AST is led by the Associate Administrator for Commercial Space Transportation who reports directly to the FAA Administrator.[5]

According to the FAA, the AST's mission, "is to ensure protection of the public, property, and the national security and foreign policy interests of the United States during commercial launch or reentry activities, and to encourage, facilitate, and promote U.S. commercial space transportation."[6] AST issues launch and reentry licenses for commercial space launches and permits for experimental launches. Each process includes opportunities for pre-application consultation, which allow AST and industry to work collaboratively to ensure regulatory compliance and facilitate the timely approval of commercial space launch applications. Since 1989, FAA has licensed 290 commercial space launches, permitted 44 launches, and licensed 16 reentries.[7]

Since fiscal year 2009, AST's budget has grown from $14.1 million to $22.6 million while its staffing has increased from 71 full time positions (FTPs) to more than 110 FTPs.[8] AST began systematically measuring its workload metrics in August 2014. Between fiscal year 2009 and 2016, the number of companies seeking at least one new or modified authorization has increased from 14 to 44 while the total number of authorization projects in all phases prior to the issuance of a license or permit increased from 26 to 66.[9] FAA has requested a fiscal year 2019 budget of $21.6 million, although the request was submitted before final passage of the *Consolidated Appropriations Act, 2018*.[10] The House-passed *FAA Reauthorization Act of 2018* would authorize $33.0 million to be appropriated for AST in fiscal year 2019.

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[3] *See* the 1984 *Commercial Space Launch Act* (P.L. 98-575), the *Commercial Space Launch Act Amendments of 1988* (P.L. 100-657), the *Commercial Space Act of 1998* (P.L. 105-303), the *Commercial Space Launch Amendments Act of 2004* (P.L. 108-492), and the 2015 *U.S. Commercial Space Launch Competitiveness Act* (P.L. 114-90).

[4] AST is the acronym assigned to the FAA's Office of Commercial Space Transportation and was not the office's designation when it was part of the Department of Transportation. It is used throughout this document to refer to the office, regardless of its administrative location, for clarity.

[5] FAA, "About the Office: Office of Commercial Space Transportation," available at https://www.faa.gov/about/office_org/headquarters_offices/ast/about/

[6] Ibid.

[7] Permitting statistics are measured from 2006, available at http://www.faa.gov/data_research/commercial_space_data/

[8] FAA Budget Estimates for Fiscal Year 2010 and 2019.

[9] FAA Briefing to Aviation Subcommittee Staff (May 16, 2016).

[10] FAA Budget Estimates for Fiscal Year 2019.

Launch Licensing Process

Federal law requires a license from the Secretary of Transportation (through AST) for a person to conduct either: (1) a commercial space transportation launch inside the United States or; (2) for a U.S. citizen to conduct a launch outside the United States.[11] AST does not typically license federal government launches, such as those conducted by the Department of Defense (DoD) or National Aeronautics and Space Administration (NASA).[12] In general, AST will issue a license if it determines that a launch proposal, "will not jeopardize public health and safety, property, U.S. national security or foreign policy interests, or international obligations of the United States."[13] AST has 180 days to issue a license determination after completion of a license application, a deadline which the office has never missed. However, AST requires that companies enter into pre-application consultation with AST to ensure application completeness and maximize the likelihood of approval.

Using an interagency process that can include DoD, NASA, the Federal Communications Commission, the Department of State, and the Department of Commerce, AST ensures that a proposed launch complies with all statutory and regulatory criteria. These reviews include a policy review, safety review, financial responsibility determination, and environmental review. License regulations differ for expendable and reusable launch vehicles. A launch-specific license enables a launch provider to conduct multiple launches using a single type of launch vehicle with the same operational parameters. AST also issues launch or reentry operator licenses, which authorizes a launch provider to conduct multiple launches with the same launch vehicle family within a range of operational parameters.

Safety

The human commercial space transportation industry continues to mature within a regulatory "learning period" first established under the *Commercial Space Launch Amendments Act of 2004*.[14] Under that law, Congress found that "the regulatory standards governing human space flight must evolve as the industry matures so that regulations neither stifle technology development nor expose crew… to avoidable risks."[15] Currently, the FAA may not implement regulations regarding spacecraft design or operation. The industry currently operates under an informed consent model, in which participants must acknowledge the inherent risks of spaceflight and the absence of government safety regulations such as those applicable to commercial air service. Notwithstanding this moratorium, the FAA may "issue requirements or regulations to protect the public health and safety, safety of property, national security interests, and foreign policy interests of the United States."[16]

The learning period was most recently extended by the 2015 U.S. Commercial Launch Competitiveness Act (CLCA) through fiscal year 2023. The CLCA also structured a process by which the commercial space transportation industry and the FAA would jointly create interim voluntary industry consensus standards that will ultimately form the basis of future regulations.

[11] 51 U.S.C. §50904.
[12] If DoD or NASA uses a commercial launch provider to conduct a mission, AST will typically license that launch.
[13] https://www.faa.gov/licenses_certificates/commercial_space_transportation.
[14] 51 U.S.C. § 50905(c)(9).
[15] 51 U.S.C. § 50901(a)(15).
[16] 51 U.S.C. § 50905(c)(10).

Furthermore, the law contains several reporting requirements that will serve as benchmarks for measuring industry maturity and anticipating the scope of any future regulations.

Integration into the National Airspace System

As commercial space transportation activities increase in volume and complexity, safer and more efficient methods of integrating their operations into the National Airspace System (NAS) are needed. Currently, commercial space transportation is accommodated within the NAS rather than integrated into it, requiring the temporary closure of large volumes of airspace for several hours and consequently disrupting commercial aviation traffic. Reusable launch vehicles that fly back to the launch pad or another location increase the complexity of launch operations. The process of blocking and releasing airspace is not automated and remains labor intensive. FAA personnel, including air traffic controllers, must speak by telephone to share spacecraft trajectories and manually input them into air traffic control systems. The FAA is currently working on the Space Data Integrator, which will feed commercial spacecraft data into FAA systems and enable more automated airspace releases.

The FAA is also seeking to harmonize AST and Air Traffic Organization (ATO) safety standards through a concept known as "acceptable level of risk (ALR)." ALR changes the scope and duration of temporary flight restrictions required to safely separate commercial space transportation launches from traditional air traffic. No aircraft has ever been struck by debris from a commercial space transportation launch, making the necessity of safety margin harmonization between two different industries unclear. However, as commercial space transportation traffic grows, greater harmonization of safety standards for airspace users may become more necessary to minimize disruption to air traffic. AST is currently soliciting feedback from industry on its ALR construct through the Commercial Space Transportation Advisory Committee.[17]

Spaceports

There are 22 active launch and reentry sites in the United States.[18] AST is responsible for licensing 10 commercial launch and reentry sites, also known as spaceports. However, AST does not license or oversee the eight federal launch sites or the non-profit launch site operated by the University of Alaska. There are three additional launch sites from which AST licensed and permitted launches occur, but because the three are owned, operated, and exclusively used by a single private company each, they do not require an AST spaceport license. Of the ten licensed spaceports, the most active is the Florida Spaceport, which had 14 AST-licensed or permitted launches in 2017. Seven of the ten spaceports had no AST-licensed or permitted launched in 2017.[19]

[17] Commercial Space Transportation Advisory Committee meeting, June 14, 2018.
[18] "The Annual Compendium of Commercial Space Transportation: 2018," FAA, January 2018, available at https://www.faa.gov/about/office_org/headquarters_offices/ast/media/2018_AST_Compendium.pdf; One of these 19 sites, the Ronald Reagan Ballistic Missile Defense Test Site, is located in the Marshall Islands, a sovereign country that has entered into a Compact of Free Association with the United States.
[19] Ibid.

Current Rulemaking

In 2017, President Trump revived the National Space Council to coordinate administrative policy on national space programs.[20] On May 24, 2018, President Trump signed Space Policy Directive-2, which instructed the Secretary of Transportation to review existing regulations and issue a notice of proposed rulemaking (NPRM) to revise FAA launch and reentry regulations by February 1, 2019. In particular, the directive requires the Secretary to consider requiring a single license for all types of commercial space transportation launch and reentry operations, as well as replacing prescriptive regulations with performance-based criteria.

In anticipation of the directive, the FAA chartered the Streamlined Launch and Reentry Licensing Requirements Aviation Rulemaking Committee (ARC) on March 8, 2018.[21] The FAA is looking to revise launch regulations, including regulations relating to expendable and reusable launch vehicles. While the ARC did produce recommendations for AST, the timeline for such recommendations was extremely compressed because of the ambitious rulemaking timeline set by the National Space Council. The ARC is chartered through March 2020, leaving open the possibility that the FAA may solicit further comments from the ARC later in the rulemaking process.

The FAA has two other ongoing ARCs relating to commercial space transportation: the Spaceport Categorization ARC and the Airspace Access Priorities ARC. The prospect of the commercial space transportation industry acting as an economic development tool has led several state and local governments to open purpose-built spaceports or co-locate spaceports at existing airports. While this enthusiasm can lead to a distributed and resilient national launch infrastructure, insufficient launch demand and airspace integration issues effectively limits the number of financially viable spaceports. To help set expectations for prospective spaceports and ensure that AST is not misallocating resources to license and inspect unused launch facilities, the Spaceport Categorization ARC was chartered to consider a new, simplified spaceport categorization scheme.[22] The Airspace Access Priorities ARC was chartered to plan for an increase in commercial space transportation activity and determine ways that scarce airspace resources can be allocated between commercial space transportation and other airspace users in ways that minimize disruptions to both.[23]

Current statute permits the FAA Administrator to exempt ARCs from the provisions of the Federal Advisory Committee Act, which can enable expedited or negotiated rulemakings.[24]

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[20] The National Space Council was formally established under the *National Aeronautics and Space Administration Authorization Act, Fiscal Year 1989* (P.L. 100-685) and Executive Order 12675 of April 20, 1989. The Council was never formally disestablished, but went dormant in 1993. Executive Order 13803 of June 30, 2017 directed that the Council resume operations.

[21] "Streamlined Launch and Reentry Licensing Requirements Aviation Rulemaking Committee Charter," FAA, March 8, 2018, available at: https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/FINAL%20Rulemaking%20ARC%20Charter%20(effective%203-8-18).pdf.

[22] "Spaceport Categorization Aviation Rulemaking Committee Charter," FAA, December 5, 2017, available at: https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/Spaceport%20Categorization%20ARC%20Charter%20(FINAL).pdf.

[23] "Airspace Access Priorities Aviation Rulemaking Committee Charter," FAA, February 12, 2018, available at: https://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/document/information/documentID/3443.

[24] 49 U.S.C. §106(p)(5).

The House-passed *FAA Reauthorization Act of 2018* contains a provision clarifying that ARCs relating to commercial space transportation are eligible for the same exemption.[25]

WITNESS LIST

Captain Tim Canoll
President
Air Line Pilots Association

Audrey Powers
Deputy General Counsel
Blue Origin

Caryn Schenewerk
Senior Counsel and Director of Government Affairs
SpaceX

Kelly Garcheime
Associate General Counsel
United Launch Alliance

[25] §316, *FAA Reauthorization Act of 2018* (House engrossed), H.R. 4, 115th Congress.

COMMERCIAL SPACE TRANSPORTATION REGULATORY REFORM: STAKEHOLDER PERSPECTIVES

TUESDAY, JUNE 26, 2018

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON AVIATION,
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:01 a.m. in room 2167, Rayburn House Office Building, Hon. Frank A. LoBiondo (Chairman of the subcommittee) presiding.

Mr. LOBIONDO. Good morning. The subcommittee will come to order. Without objection, the Chair is authorized to declare a recess at any time.

I would like to thank you all for being here today. We will be hearing from representatives of the commercial space transportation industry and other airspace users on the Federal Aviation Administration's regulatory reform efforts.

This is the fourth subcommittee hearing we have held over the past two Congresses that touched on commercial space transportation issues. Over that time, we have come to know and understand the commercial space transportation industry better, just as you have come to know us a little bit better.

These past 2 years have been ones of tremendous growth for the industry. There have been more FAA-licensed launches in the first half of 2018 than there were in all of 2016. Blue Origin and SpaceX continue to push the boundaries of launch vehicle reusability, while driving down the price of a launch. ULA [United Launch Alliance] continues to deliver highly reliable launch services to the Federal Government and commercial partners. And the industry has a number of exciting new vehicles under development, including those that will soon be used to transport huge amounts of cargo and the first passengers into commercial space. And Rick assures me he is going to be on that first run.

[Laughter.]

Mr. LOBIONDO. I have only scratched the surface when it comes to the tremendous game-changing innovation that is occurring in this industry. We are poised to reap the benefits of these investments that you have made.

I am particularly impressed by the job that the FAA's Office of Commercial Space Transportation, or AST, has done in enabling the industry's success. Facing an unprecedented rise in the volume

and complexity of commercial launches, AST has managed to meet its statutory deadlines for each and every launch license or permit.

But AST cannot rest on its laurels, and neither can we. As this industry grows and evolves, we must ensure that our regulatory structure keeps pace. Every doubling of licensed launches cannot mean a doubling of AST staff or budgetary resources. What is needed is a more streamlined regulatory approach that reduces complication, duplication, and uncertainty, while preserving safety and leveraging the expertise of the commercial space transportation sector.

FAA and AST are moving at breakneck speed to achieve the deadline imposed by Space Policy Directive-2, something that we all hope that they are able to achieve. But we also want to continue the discussion on launch and other commercial space transportation regulatory reform.

As launch cadences increase, the impact on other National Airspace System—or NAS—users could increase, as well. FAA is currently working on different procedures and technologies that can integrate commercial space operations into the NAS, rather than merely accommodating them.

One of those technologies, the Space Data Integrator, should allow the automated release of airspace back to other users once a launch vehicle has passed by. Much of the work on SDI is being conducted at the FAA's flagship Technical Center in my district in Egg Harbor Township, New Jersey, which, if anyone is not sure, is at the Atlantic City International Airport.

We look forward to hearing from our more traditional airspace users on additional ways to ensure safety in the NAS.

I would now like to recognize Mr. Larsen for any opening remarks.

Mr. LARSEN. Thank you, Chairman LoBiondo, for calling today's hearing on commercial space transportation.

It has been 2 years since the subcommittee convened a hearing on commercial space. And since that time, the U.S. has experienced tremendous growth and innovation in the industry. The economic footprint of this segment of the aerospace industry is significant. According to the FAA, the U.S. space industry represents about $158 billion, which is just shy of half of the global space economy, estimated at $345 billion, according to 2016 figures.

The U.S. is not alone, however—it is not the only nation making significant advances in commercial space. Last year I visited the Paris Air Show, where the role of commercial space itself was prevalent, as well, and companies across Europe represented at the show appeared to be thriving. And New Zealand itself is developing its own space industry. So it is critical that we ensure the U.S. and its companies remain competitive on the international stage in commercial space, just as we have done that in traditional aviation for decades.

Commercial space transportation has opened the door to a wide host of new applications for satellite services and space research. Some companies are inching closer to providing personal space flight. So this is not only exciting from a national perspective, but from a local one, as well. This growth supports more than 200,000 aerospace jobs across the Nation.

And, notably, more than 136,000 folks who make up the aerospace workforce call Washington State home. According to the Bureau of Labor Statistics, Washington State employs aerospace engineers at 5.7 times the national average, and has the highest density of aerospace engineers in the U.S. Snohomish County, which is part of the district I represent, is home to the State's second largest concentration of aerospace jobs, with more than 43,000—nearly 44,000 in aerospace manufacturing. And according to our State's department of commerce, more than three dozen space-related companies are part of Washington State's space cluster, including companies represented here today, like Blue Origin, SpaceX, Spaceflight Industries, Boeing, and, of course, many others.

Pioneering innovative research and development in the State is driven by two world-class universities and national research lab and groundbreaking R&D teams. And in addition, we have companies that are NASA suppliers, as well, for the *Orion*, the *Starliner*, and SpaceX *BFR* spacecraft. So we have got a lot riding on commercial space in Washington State.

And before I go further, I do want to take the opportunity to introduce one of our witnesses, Audrey Powers, who is here today to represent Blue Origin in Kent, Washington. Blue Origin supports a growing ecosystem of commercial space suppliers and manufacturing services in our State and the country and the world. So I would like to say welcome to Ms. Powers.

I can barely see that far, I lost my glasses last year—on an airplane, by the way, a very appropriate place for me to lose my glasses.

FAA reports launch licenses are on an upward trend, and are expected to continue over the next decade. So since the first FAA-licensed launch in 1989 there have been 278 licensed commercial space launches. Nearly one-quarter of these have occurred in the last 5 years, alone. And in fact, a record 23 FAA-licensed launches occurred last year.

It is also vital for our national security for this segment of the aerospace industry to remain strong and competitive. The promise of commercial space is endless, but safety still must remain the number-one priority. The President has directed the FAA to overhaul its launch license and reentry regulations in an aggressive, 1-year timeframe.

We have heard from some stakeholders that FAA's regulations were drafted 25 years ago and are, in fact, in desperate need of a rewrite. But we have also heard from folks who caution safety might be compromised if the FAA is forced to "streamline" its regulatory framework in just 12 months.

It was just 4 months ago this subcommittee convened to discuss the state of aviation safety. I mentioned then—and it bears repeating now—the U.S. has the safest aviation system in the world. And any effort to reform regulations must not roll back safety requirements. We have to keep in mind that more than 2½ million passengers fly through U.S. airspace each day. With an increasing number of space ports and launches on the horizon, we have to ensure our airspace remains safe.

This subcommittee's job is to ensure the FAA has the authority and resources needed to make the system even safer. And maintaining our unparalleled safety through new integration into the system requires all aviation stakeholders be at the table.

And that said, as well, I am pleased to have Captain Tim Canoll, from ALPA [Air Line Pilots Association, International] here with us this morning to discuss the potential effects that this booming industry is having on existing legacy aviation users.

I also hope to learn from our other witnesses why and what reforms to the FAA's commercial space regulations are needed, and whether there are concerns regarding the administration's approach.

It is too soon to know what the FAA will propose next year. And while flexibility is necessary so the industry can continue to grow, I trust the subcommittee will keep a close eye on any efforts that undercut safety.

Again, Mr. Chairman, thank you so much. I look forward to hearing from our witnesses.

And Mr. Chairman, I would ask for unanimous consent that a white paper entitled, "Addressing the Challenges to Aviation from Evolving Space Transportation," prepared by Air Line Pilots Association, International be entered into the record.

Mr. LOBIONDO. Without objection, so ordered.

[The white paper is on pages 85–99.]

Mr. LARSEN. Thank you, Mr. Chairman.

Mr. LOBIONDO. OK. Thank you, Rick. Let's see, do we have Mr. DeFazio?

Mr. DEFAZIO. Thank you, Mr. Chairman. Sorry, I was a little late. I was at a caucus meeting, talking about the sea lions. Far from this subject. A terrestrial problem.

Well, thank you for holding this hearing, the first in a couple of years. Obviously, there is incredible excitement in the potential for commercial development in space, and we want to maintain the U.S. lead in this area.

We do also—as I believe I came in at the end of the ranking member's remarks—want to be certain that we are moving forward in a way that doesn't impinge on creativity and moving quickly, but also is as safe as possible.

There used to be a dual mandate for the FAA that was left over from the old Civil Aeronautics Board, an immature industry. And it was that they were both to regulate and promote the industry. And for years on this committee I raised the issue that I thought that there was an inherent conflict. And, you know, person after person from the FAA marched in and said, no, there is no conflict, no problem.

And then, in an FAA reauthorization one year, I tried to strip away the—I said it is a mature industry, you don't need to promote it any more, you just need to regulate it and make sure it is safe, and I lost that amendment in the committee by a close vote.

And then we had the—I think—I am trying to remember. I guess it was ValuJet, I think was the name of the crash. And we had already done the bill out of the House and done the bill out of the Senate, and I got a phone call saying, "Where would we put your

language into this bill," realizing that, indeed, we had not been overseeing repair stations and subcontractors of repair stations and others adequately, and a lot of people died because of it. So, you know, we just need to move forward in a way that does not create problems.

And another issue is we have the largest, most robust commercial aviation system in the world, and there are potentials for conflicts with space ports and commercial aviation. And we have to be very cognizant of that, as we move forward. I think there are some great places to put space ports. There are others that are in very heavily congested, heavily used commercial corridors, which means either that space port is going to have very limited opportunities for use, or we are going to be causing delays and disruptions of the already overloaded commercial system. So this needs to be approached with some significant thought and care, as we move forward.

So I really welcome this committee holding this hearing to air these and other issues so we can maintain our leadership, but do it in a way that also maintains the best of safety, and also does not interfere with our very robust commercial aviation industry.

With that, Mr. Chairman, I yield back.

Mr. LOBIONDO. Thank you, Peter. I thank our witnesses for being here today. And they are Captain Tim Canoll, the president of Air Line Pilots Association, International; Ms. Audrey Powers, deputy general counsel for Blue Origin; Ms. Caryn Schenewerk, senior counsel for SpaceX; and Ms. Kelly Garehime—I hope I got that right—associate general counsel for United Launch Alliance.

Again, thank you for being here today. I ask unanimous consent that our witnesses' full statements be included in the record.

Without objection, so ordered.

I also ask unanimous consent that the record of today's hearing remain open until such time as our witnesses have provided answers to any questions that may be submitted to them for a followup response, and unanimous consent that the record remain open for 15 days for additional comments and information submitted by Members or witnesses to be included in the record of today's hearing.

Without objection, so ordered.

Since your written testimony has been made a part of the record, the committee requests that you try your best to keep your oral remarks to 5 minutes.

Captain, you are recognized to kick it off.

TESTIMONY OF CAPTAIN TIM CANOLL, PRESIDENT, AIR LINE PILOTS ASSOCIATION, INTERNATIONAL; AUDREY POWERS, DEPUTY GENERAL COUNSEL, BLUE ORIGIN; CARYN SCHENEWERK, SENIOR COUNSEL AND DIRECTOR, SPACE FLIGHT POLICY, SPACEX; AND KELLY GAREHIME, ASSOCIATE GENERAL COUNSEL—REGULATORY AFFAIRS, UNITED LAUNCH ALLIANCE, LLC

Mr. CANOLL. Thank you, Chairman LoBiondo, Ranking Member Larsen, and Ranking Member DeFazio, and the subcommittee for the opportunity to be here today. It is my privilege to represent

ALPA's more than 60,000 pilots who fly for 34 U.S. and Canadian airlines.

I want to say, thanks to this subcommittee's leadership in encouraging collaboration among Government, industry, and airspace users, the U.S. airline industry is the safest mode of transportation the world has ever known. This safety record has helped make commercial aviation a significant economic driver in the United States. Safe flying simply equals a strong aviation industry and contributes to a solid economy.

Airline pilots share this subcommittee's commitment to safety. ALPA is the largest, nongovernmental aviation safety organization in the world. We feel certain—and the facts show—that having at least two fully qualified, well-trained, and adequately rested pilots in every airliner cockpit has made flying safer. ALPA believes that the spirit of collaboration this subcommittee helped foster in the U.S. airline industry will also allow aviation and space transportation to succeed together.

The future growth of the aerospace industry, both aviation and commercial space transportation, relies on safe, dependable, and efficient access to the National Airspace System, air traffic management, and ground infrastructure. As the U.S. airline industry works to meet future passenger and shipper demand while space flight operations also increase, the aerospace industry must jointly create policies, regulations, and procedures to share resources efficiently and, most of all, safely.

We know the work to safely integrate commercial space transportation must succeed because space ports are, or plan to be, located near some of this country's busiest airports and airspace.

For example, an FAA study of a spacecraft launch and reentry at Cape Canaveral in 2013 found that airline flights around Jacksonville and Miami air traffic control centers were forced to fly as many as 23 minutes longer than on days without launch activity. Given the interest in increasing the number and scale of spaceflight launches, it is easy to extrapolate the tremendous effect that commercial space operations could have on the U.S. airline industry, as well as on its passengers, cargo shippers, and workers if integration isn't managed correctly.

ALPA has long embraced new technology and innovation. We have helped develop and implement some of the important safety systems on airliners flying today. ALPA's experience with technology and operations in the national airspace makes it clear that a comprehensive plan is essential to safely and efficiently integrate commercial spaceflight and airline operations. Moreover, Congress must provide the FAA with adequate funding to develop and execute this plan.

While the FAA is currently prevented from enacting commercial space transportation regulations until 2023, there is no reason why the FAA and our industries can't get started now on a plan for safe integration. For the moment, commercial space operations must continue to take place in segregated airspace until we know we can maintain a high level of safety for all users following an integration.

However, Congress can encourage the FAA to get started now on providing the more complex analysis, safety oversight, and air traf-

fic control services that will be necessary for integration. Regulators can also act today to develop communication, navigation, and surveillance requirements. Regulations must ensure safety in space vehicle design and flightcrew qualification training and certification.

All of this will require the FAA and all stakeholders involved in aviation and commercial space transportation to communicate and coordinate their efforts. ALPA pilots, who offer a deep bench in safety expertise, are ready to assist.

It is an exciting time to be part of the aerospace industry. In just a few years, passenger and cargo aircraft will share the national airspace with space tourists and unmanned aerial system operators. With this subcommittee's continued leadership, ALPA feels confident that the FAA and the aerospace industry can work together to achieve this high level of safety that Americans expect and, yes, demand from U.S. air transportation.

Thank you very much.

Mr. LOBIONDO. Thank you, Captain.

Ms. Powers?

Ms. POWERS. Chairman LoBiondo, Ranking Member Larsen, Ranking Member DeFazio, and members of the subcommittee, thank you for the opportunity to speak before you today on commercial space transportation regulatory reform, a topic that Blue Origin has been heavily focused on for over 2 years.

Blue Origin's mission is to enable a future where millions of people live and work in space. This vision demands higher flight rates, lower cost access to space, and an unwavering attention to safety. This can only be achieved with full operational reusability of our launch vehicles.

Our fully reusable *New Shepard* suborbital launch vehicle has flown to space and back eight times, achieving five of those flights with the same vehicle in less than 12 months. While the booster lands vertically on landing gear, our capsule separates from the booster in space, and offers 4 minutes of weightlessness before returning for a soft landing on Earth. *New Shepard* traverses the National Airspace System and exceeds 60,000 feet of altitude within 90 seconds of lift-off, and the full flight duration is about 11 minutes.

Blue Origin also is developing a next generation reusable orbital launch vehicle called *New Glenn*, which will launch people and payloads from Cape Canaveral Air Force Station to low Earth orbit and beyond.

Reusable launch vehicles, or RLVs, vary widely in design and operation. Some, like *New Shepard* and *New Glenn*, launch and land vertically, allowing the booster stage to be reused. Others launch and land horizontally, while others are high-altitude balloons.

Expendable launch vehicles, or ELVs, launch vertically, and their booster stage falls into the ocean, never to be used again.

FAA regulates ELVs and RLVs differently. FAA's ELV regulations are voluminous and prescriptive. ELV regulations identify risk limits that operators must meet, and they define how to design, test, and operate the launch vehicle to meet those risk limits. FAA promulgated these regulations by codifying Air Force requirements for launch vehicle operations at Federal ranges. This regu-

latory approach was not designed for the cadence of operations or the new vehicle architectures realized in recent years.

FAA developed an entirely separate set of regulations for reusable launch vehicles that are wholly different than FAA's ELV regulations. Instead of FAA defining how to design, test, manufacture, and operate a vehicle, FAA conducts a performance-based review of the RLV operator's system safety case. The operator identifies hazards and presents appropriate mitigation measures for those hazards. In short, the RLV regulations impose safety thresholds that an operator must meet, but the operator can choose any number of acceptable approaches to meet those thresholds.

Blue Origin operates *New Shepard* at a private launch site under these RLV regulations. While they are outdated and could be improved to help increase launch cadence, the RLV regulations are the best approach to regulatory oversight that currently exist. They promote innovation without compromising safety.

In the case of *New Glenn*, because it will launch from an Air Force facility, it must be authorized by both FAA and the Air Force. The Air Force has one set of requirements for all launch vehicles. They are the prescriptive requirements that FAA used for its ELV model. This means that reusable launch vehicle operators lose the benefit of FAA's performance-based approach to regulating RLVs, because we must also meet the Air Force's prescriptive requirements.

Blue Origin welcomes the efforts by this administration, the National Space Council, FAA, and industry to develop one set of regulations applicable to all launch vehicles that are flexible, streamlined, and performance-based. The best path forward will use FAA's current RLV regulations as a model.

Space Policy Directive-2 specifically directs the Secretary of Transportation to replace prescriptive requirements with performance-based criteria. Blue Origin's difficult situation at Cape Canaveral shows that this directive cannot be met without also addressing the Air Force's prescriptive requirements. The administration recognized this need by directing that DoD and DOT and NASA coordinate to examine and minimize all existing U.S. Government requirements associated with activities at Federal ranges.

The right solution to today's overbearing regulatory environment is to review and reform all regulations and requirements applicable to launch activities. Blue Origin is eager to continue working with Congress, FAA, the Air Force, the National Space Council, and industry members to ensure that new regulations promote safety above all, while also supporting the expansion of commercial efforts and new technologies.

Thank you again for the opportunity to speak with you today, and for your attention to this important matter.

Mr. LOBIONDO. Thank you, Ms. Powers.

Ms. Schenewerk?

Ms. SCHENEWERK. Mr. Chairman, Ranking Member Larsen, Ranking Member DeFazio, and members of the committee, thank you for the opportunity to address the subcommittee today. I also want to thank the FAA for their hard work licensing and supporting the industry. On behalf of my more than 6,000 colleagues

at SpaceX, we appreciate your interest in modernizing regulations associated with the commercial space industry.

SpaceX's mission is to dramatically improve the reliability, safety, and affordability of space transportation. Since 2010 we have successfully launched our *Falcon 9* rocket 55 times. And earlier this year, we successfully conducted the inaugural mission of the *Falcon Heavy* rocket.

Our diverse set of launch customers include NASA, DoD, and the broader national security space community, as well as commercial satellite operators and allied international governments. Commercially, SpaceX is the largest launch services provider in the world, with more than 100 missions on manifest representing $12 billion in signed contracts.

Having entered the commercial satellite launch market in 2012, SpaceX has restored the U.S. as a market leader, reversing a troubling trend in American competitiveness. The rapid pace of innovation in the U.S. commercial space industry is redefining access to space for commercial and Government customers. It is also advancing technology, growing the economy, and creating new jobs. Given ground-breaking technological advances like rocket reusability and the expanding scope of commercial space activities, regulatory reform is both timely and necessary.

Despite a record year for U.S. launches, it is important to keep in perspective that space launch continues to be a relatively small user of the national airspace, compared to commercial aviation. While the FAA supports more than 42,000 commercial airline flights per day, in 2017 there were only 23 U.S.-licensed launches; 17 of those were SpaceX.

When we launch, we are in the NAS very briefly. *Falcon 9* crosses 60,000 feet in a quick 90 seconds. After stage separation, the rocket reenters the NAS for roughly 1 minute prior to landing.

It is worth noting that commercial space and commercial aviation are symbiotic. Many of the satellites we launch are key enabling technologies for our aviation colleagues. For example, GPS satellites, weather satellites, and communication satellites that provide in-flight connectivity.

Nevertheless, FAA launch licensing regulations, designed decades ago, are outdated and unnecessarily onerous. They are not reflective of new technologies such as reusable rockets and autonomous flight safety systems. For the U.S. to stay at the leading edge of space innovation, we must reform these regulations in a way that preserves public safety and accommodates innovation. We must also optimize use of the NAS.

I have submitted a detailed written statement with SpaceX's recommendations, but I would like to highlight a few key initiatives.

First, SpaceX strongly supports the direction contained in Space Directive 2, which calls for the Secretary of Transportation to review regulations governing launch and reentry. We support the direction to require a single license for all types of commercial space launch and reentry operations, and we strongly support replacing outdated, prescriptive requirements with a performance-based regulatory regime for all launch types.

The transition to performance-based regulations is crucial and consistent with sound regulatory policy. I want to emphasize that

SpaceX is not seeking any change to weaken safety requirements. Rather, we are encouraging the adoption of new tools and processes to make licensing more efficient for both the FAA and launch operators. A performance-based system will enable new technologies that will improve safety.

Second, FAA regulation should allow launch providers to receive a single license for multiple launch sites without the need to obtain a separate license per site. Currently, we have two launch sites in Florida: one at NASA's KSC [Kennedy Space Center] and one at Cape Canaveral Air Force Station. *Falcon 9* frequently launches from both sites, which are roughly 3 miles apart. Yet if we change sites prior to the mission, we have to undertake a license modification process. That is not a practical situation.

In addition, FAA and U.S. Air Force range requirements should be harmonized to end conflicting and confusing differences. These changes are about process, and will help the industry better achieve safety objectives.

Finally, commercial space launch needs to be better integrated into the national airspace. SpaceX is committed to working with the FAA and commercial airline operators to achieve this goal. Current FAA operations do not use real-time information regarding the actual position and trajectory of the launch vehicle. In addition, debris propagation software used today results in larger volumes of airspace being closed for longer periods of time than is necessary.

We encourage this committee to accelerate FAA's adoption of new analytical tracking and display tools that will better integrate space and aviation users of the NAS.

SpaceX is honored to be part of the ongoing process of regulatory reform, and looks forward to continuing the collaborative effort with the FAA, industry, and Congress.

Mr. Chairman, thank you again for the opportunity to share our views with the committee.

I look forward to any questions.

Mr. LOBIONDO. Thank you very much.

Ms. Garehime, you are recognized.

Ms. GAREHIME. Chairman LoBiondo, Ranking Member Larsen, Ranking Member DeFazio, and members of the subcommittee, thank you for the opportunity to appear before you today on behalf of United Launch Alliance to discuss regulatory reform and safety.

ULA is the most successful commercial launch company. Since we formed in 2006 we have launched 128 missions with 100 percent mission success. No other launch company matches that record. ULA is the only launch provider certified to meet all national security space requirements. For more than a decade we have launched nearly every major national security asset and NASA mission to orbit. GPS, secure communications, weather forecasting, tracking and data relays, and missile warning satellites are among the many payloads ULA has delivered to space.

ULA builds and launches the *Atlas* and *Delta* families of rockets which trace their heritage back to the dawn of the space age. John Glenn made his historic trip into orbit aboard an *Atlas* in 1962, and astronauts will be flying on *Atlas V* aboard Boeing's *Starliner* to the International Space Station as part of NASA's commercial

crew program. The *Atlas* and *Delta* family of rockets have enabled science missions to every planet in the solar system.

We are also working to take commercial companies to distant destinations. Astrobotic, a commercial lunar logistics company in Pittsburgh, recently selected ULA to launch their *Peregrine* lander to the surface of the moon. This will mark the first launch of a commercial vehicle to the lunar surface from the United States.

Eighteen of our one hundred and twenty-eight missions to date have been commercially licensed through the FAA. Our commercial customers cannot afford launch mishaps or significant delays. And one of ULA's key differentiators is our ability to launch quickly and on time.

In 2016 we unveiled RapidLaunch, which allows customers to go from contract to launch in as little as 3 months. This offering would not be possible without help from the FAA. And we have successfully worked with the FAA in the past on accelerated timelines.

When Orbital ATK needed ULA to launch the OA–7 cargo mission to the International Space Station, the requested launch date was within the FAA's allotted 180 days for review of a new license application. Thanks to our relationship with the FAA and its familiarity with the *Atlas V*, they expedited their review and we successfully launched the mission less than 6 months after going on contract.

In the past, FAA AST has lacked adequate resources. But Congress acted to rectify that. I would like to thank this committee in particular for its work on the FAA Reauthorization Act of 2018, which increases AST's authorized budget to more than $33 million in 2019, and continues increases in future years.

ULA has been participating in multiple Aviation Rulemaking Committees, or ARCs, and continues to engage Congress and the administration on safe, commonsense regulatory reform. The President, National Space Council, Congress, Department of Commerce, and the FAA should be applauded for their efforts to empower America's space industry.

In my written testimony I have provided several recommendations that, if implemented, would increase efficiency without sacrificing safety.

In the launch business, when something goes wrong it impacts everyone. A worst-case scenario would be loss of life resulting from a commercial space launch. The FAA is doing an excellent job ensuring public safety in today's regulatory environment, and we urge all parties to remain focused on safety. Space launch is not the same as driving a car or flying a plane. A launch accident that damages a launch facility could significantly delay or even halt the Government's ability to get critical life-saving assets to space.

I want to thank this committee for taking an interest in this topic, and making sure that licensing and regulatory reform are done properly. It is critical to ensuring the United States remains the world leader in space.

Thank you for inviting me to appear today, and I look forward to answering any questions.

Mr. LOBIONDO. Thank you all for your testimony.

Mr. Larsen?

Mr. LARSEN. Thank you, Mr. Chairman. So I want to first start with a couple of questions about the process of the rulemaking.

I will start with you, Captain. As we sit here today, do you believe that the process in this 1-year timeframe is open enough? Is it transparent enough? Are you and other—I guess the term is legacy users, someone was using—was talking about legacy users of the NAS—do you feel that you have enough both insight and input into the 1-year rulemaking process?

Mr. CANOLL. So I have been called worse than legacy. It does fit, though.

So safety is always paramount. And we are never in favor of any time restrictions or deadline that could impact safety. That being said, if the FAA strives with this committee's oversight to include all stakeholders, there are advancements that could be made to streamline the current process of licensing and permitting. And as it impacts my members, that would also streamline, hopefully, the establishment and the reduction of the amount of airspace required for these launches.

Mr. LARSEN. Yes. Am I hearing in your answer that FAA is not including folks?

Mr. CANOLL. So we see—and I think my panel is going to probably agree—that more collaboration between my part of the industry and their part of the industry is something we could all use. And that is not something we are waiting for the FAA to do for us; we are organizing ourselves on the aviation side right now, in hopes that we can have our collective positions all set up for when we get a chance to integrate and talk with these operators in a more detailed manner. The FAA can't do this by themselves, they are going to have to use all of us to go forward here.

And again, to the deadline, any deadline is something that should never violate the actual safety rule. If you are not ready, safety-wise, deadline or not, you shouldn't do it.

Mr. LARSEN. Yes. So, Ms. Powers, when we dealt with some streamlining on the part 23 regs for general aviation, it took a lot longer than 1 year when we attempted that, when the FAA attempted that. We did step in a few years ago to kind of push the FAA along, but it wasn't—it took a lot longer than 1 year, and that was for general aviation.

Do you think the 1-year timeframe, as aggressive as it is, and as supportive as a lot of us would want to be of it, is that realistic?

Ms. POWERS. So I have heard stories of that part 23 rulemaking, and I am not familiar with it specifically. But we also in the commercial space industry have seen lengthy rulemaking timelines for regulations in the past that have been updated.

I acknowledge that the 1-year timeline is very, very aggressive. I think that the formation of the Aviation Rulemaking Committee at the beginning of the process was very important for FAA to collect information from industry members. We were very happy to be involved in that effort.

We look forward to engaging with the FAA again on this matter, and I think it is important to understand that the 1-year deadline, although very accelerated, the result of that is an NPRM——

Mr. LARSEN. Right.

Ms. POWERS [continuing]. A notice of proposed rulemaking. So there is potential for lengthy comment periods and reviews and back-and-forths, and interim rulemaking after that point. So I think that it is left to be determined how long the actual process will take in its entirety.

Mr. LARSEN. Yes, thanks.

Ms. Schenewerk, this is a technological question. So it is not that you wouldn't understand it; I may not understand my asking of it. Is there a technological difference between an ELV and RLV with regards to the performance-based versus the prescriptive-based regulation?

Ms. SCHENEWERK. Right. So I am a lawyer, not an engineer, but I appreciate the question.

If you don't mind, though, I would like to address one of your prior questions related to the regulatory——

Mr. LARSEN. So can you get back to me on that question, though?

Ms. SCHENEWERK. Certainly.

Mr. LARSEN. Thank you.

Ms. SCHENEWERK. So in that regard, the technical difference would be your ability to recover the rocket. But that is not something that drives the regulatory approach to it. An ELV would be a *Falcon 9* if we threw the first booster away. The *Falcon 9* becomes a reusable rocket when we land that first-stage booster instead of throwing it away after the mission.

And so it is an increase in the technological capability of the vehicle and the operator, but that is not something that can't be accommodated by a performance-based regulatory approach.

Mr. LARSEN. Yes.

Ms. SCHENEWERK. There is not a reason why an ELV should take a prescriptive approach, and the same rocket, doing a more advanced operation, could operate under a performance-based system. They can both operate that way.

One of the important things, I think, about the regulatory reform undertaking that is occurring is that it is not addressing the level of safety applied to our vehicles or our operations.

Mr. LARSEN. Right.

Ms. SCHENEWERK. So we are not talking about a regulatory change, a deregulation of the industry in that manner. We are talking about the application of a performance-based system, where you set the level of safety—one that we are not advocating for changing—and then you allow operators to have flexibility with regard to the technology that they use and the operational constraints that they use to achieve that level of safety.

Mr. LARSEN. Yes, OK. So my time is up. And I will have other questions if we have a second round. But thank you, Mr. Chairman.

Mr. WOODALL [presiding]. The gentleman yields back. The gentleman from Ohio, Mr. Gibbs.

Mr. GIBBS. Thank you, Chairman, and thank you to the panel.

I guess to everybody on the panel, first of all, I guess you talked about all the launches you have had, successful launches. I assume that is mostly for putting satellites up. Is that correct? That is where your revenue stream is?

Ms. GAREHIME. Is the question to me?

Mr. GIBBS. Yes, it doesn't matter.

Ms. GAREHIME. Yes, sure.

Mr. GIBBS. OK, yes.

Ms. GAREHIME. We put all different types of payloads up: GPS, secure communications, weather forecasting, tracking and data relays, missile warning satellites.

Mr. GIBBS. OK. What is the tipping point or—I guess for commercial human space flight to be economically viable, what is kind of the timeline you anticipate?

Ms. GAREHIME. So we are on contract for a commercial crew launch under the commercial crew program, and we expect to bring astronauts to space in the near future.

Mr. GIBBS. Go ahead.

Ms. SCHENEWERK. An exciting opportunity for SpaceX is our commercial crew contract with NASA to carry astronauts to the International Space Station.

We are also working towards private passenger carriage, and we have folks very interested in that, and in fact, a contract to undertake that activity.

And I think that one of the important parts of our approach to the industry is that we leverage the *Falcon 9* launch vehicle for both commercial satellites, as you indicated, satellite carriage, cargo carriage to the International Space Station—we are up to about 15 missions with that—and that carries the *Dragon* spacecraft that we also manufacture in-house for astronaut carriage, or any other carriage beyond NASA's needs.

So I think it is a matter of holistic approach to launch, which has both the capability to launch satellites and the capability to carry humans, and the fact that those are integrated together.

Mr. GIBBS. Now, you said we are still the leader in the world. Are our competition—I suppose China or Russia would be the two key ones—what is going on, compared to us, what we're doing?

Ms. SCHENEWERK. Yes, so it is a great question. So when SpaceX entered the launch services market, the orbital commercial satellite launch services market, in 2012, the United States had, essentially, zero percent of that market. So we have recaptured 60 percent of that market share. And you are exactly right, that that is away from the Russians, also the Europeans, the Chinese, and the Indians.

Mr. GIBBS. Anybody else want to comment on that?

[No response.]

Mr. GIBBS. What do you see—do you concur with that, that we are—what you see our vulnerabilities are to not be the leader in this effort?

Ms. GAREHIME. So we are moving towards more commercial businesses, absolutely, coming back to the U.S. Our *Atlas* and *Delta* rockets were originally designed to support the commercial market. That market never materialized, and our focus turned to Government missions, and 100 percent mission success.

We are now transitioning to be a much more key player in the commercial market, and are developing a new rocket, the *Vulcan Centaur* rocket. We expect that to really help us become a larger key player in that market.

Mr. GIBBS. And those are the reusable vehicles, rockets, right?

Ms. GAREHIME. The *Vulcan Centaur* is an expendable launch vehicle. We are looking at reusability at the component level. So we would look at SMART [Sensible, Modular, Autonomous Return Technology] reuse, which would be reusing the most expensive component on the rocket, which is the engine.

We are also looking at reusing our upper stage, so that means once the upper stage gets up into orbit, usually you would dispose of it, either put it into a graveyard orbit or deorbit the upper stage. What we are looking at through our ACES technology would be leaving the upper stage in orbit, and reusing it up in space.

Ms. SCHENEWERK. If I may add to that, the *Falcon 9* first stage is entirely reusable. We have launched and landed the *Falcon 9* twenty-five times. We have reused 13 of those boosters. Our most recent version of the *Falcon 9* is the *Falcon 9 Block 5* and it is now flying. We look to be able to use *Block 5* at least 10 times with minor inspection following, and with at least 10 reuses of a first-stage booster.

That is part of the reason why SpaceX has been able to recapture 60 percent market share. Because we are able to have a highly reliable rocket as a result of that reusability. It means that you can test it, you can fly it, you can look at it again, then you can fly it again, and so you can keep getting really good data on the performance of your vehicle. And it also contributes, of course, to the safety of the vehicle.

Mr. GIBBS. Thank you.

I am out of time; I yield back.

Mr. WOODALL. The gentleman yields back. The ranking member of the full committee, Mr. DeFazio.

Mr. DEFAZIO. Thank you, Mr. Chairman.

Captain Canoll, the whole process for space port approval, you have concerns about that. I recently met, I won't say who it was, but people raising concerns about the proximity of a proposed space port that does not have an operator, which is a build-it-and-they-will-come proximate to Denver International Airport, and the potential for interference with operations there.

How do you think this process should work better?

Mr. CANOLL. So you articulated both concerns from our perspectives. One is the proximity issue either to highly congested airspace, or a heavily used airport. The segregated airspace methodology, which is the only one available to us today to deconflict space travel and aviation, would order of magnitude be more difficult at some of the locations like the one in Denver being considered.

The process currently has it as a two-stage process, where a space port is authorized, and then the operator at the space port is done in a separate authorization. It is hard for ALPA to comment on one or the other, without seeing the full picture concept. If you are going to launch from this space port, what kind of operations are they? Are they RLA? Are there EVAs? What kind of rocket will be launched? Is it traditional aircraft launched to high altitude?

So our inability to match the two to one issue is where we are running into problems with giving good comments to the FAA as they consider these.

Mr. DEFAZIO. OK. Now, the segregated airspace, obviously, is an issue. And Ms. Schenewerk implied that you envision a time where we could either dramatically shrink that, or maybe do real-time, more like air traffic control.

So I would like you to briefly comment, and then Captain Canoll to comment on whatever you say.

Ms. SCHENEWERK. Absolutely. Thank you for the opportunity. So what we see today is that when a rocket launches—and our rocket launches, just to provide some context, are from coastal areas, because we launch in an orbital trajectory. We are achieving orbit in about 90 seconds through the——

Mr. WOODALL. Miss, could I ask you to pull that microphone just a little bit closer?

Ms. SCHENEWERK. Oh, absolutely.

Mr. WOODALL. Thank you very much.

Ms. SCHENEWERK. Is that a little better?

Mr. WOODALL. You can move that whole box closer.

Ms. SCHENEWERK. Here we go, OK. Oh, thank you. So as I noted, we are through the NAS in about 60 seconds, if everything goes as planned.

So the hazard area that is imposed upon us is a keep-out zone. And that keep-out zone is applied in multidimensions, right? So it is to people on the ground, it is to aircraft in the air, and to mariners at sea. And we launch over the water so as to maintain that risk level, so that we are not putting public at risk, so it is non-populated areas. That is why we don't currently undertake orbital launches from the center of the country.

So right now, when an air traffic controller is on station during a launch, what they see is that keep-out zone, that large box hazard area keep-out zone. What they don't see is the launch vehicle actually moving across their scope in that very quick timeframe, and clearing the area. And that results in that keep-out zone being imposed for at least an hour, usually, before launch and hours post-launch, because it is not dynamic.

So what we would like to see is, some IT tools that can better model the debris dispersion that could occur if you were to have a bad day with the vehicle, based on that day's weather, whether it is wind direction or air density, and that specific vehicle and that specific trajectory, so that we could see when it moves through it quickly and successfully, we can open the airspace dynamically, instead of having phone calls and big boxes blocking space.

This is essentially an IT solution. It is modeling capabilities and data integration capabilities.

Mr. DEFAZIO. OK. Captain Canoll, what do you think of that impression?

Mr. CANOLL. Absolutely correct. Caryn got it exactly right. The real-time feedback is something that they are using now in very small instances. It needs to be on every launch.

But the ultimate goal, if we are going to meet the anticipated cadence, is full integration. And there is one larger issue in full integration that we have to work together through as a team, and that is the allowable risk.

Right now we model in the traditional aviation 10 to the minus 9, so catastrophic mishaps, 1 in 1 billion. The space, commercial

space, is modeling at 1 to the minus 6, 1 in 1 million. Well, that is a big difference, that is 10,000 times bigger. So we have to work through that. It is completely doable, it is completely doable, but it is going to take starting now, and money, and oversight.

Mr. DEFAZIO. OK. Thank you.

Anybody else want to comment on that particular point?

Ms. POWERS. Yes, sir. I would like to add a couple of things.

I think it is very important that tool development be the focus, because we are smart enough to solve this problem. There are a lot of great people at AST and FAA working on this. I know that SpaceX and Blue Origin have worked on flowing telemetry through the SDI system that the chairman mentioned earlier to try to figure out how to get real-time telemetry to the air traffic controllers to minimize disruptions, so that everybody who needs to use the airspace can use the airspace. This is a very solvable problem.

Mr. DEFAZIO. OK, thank you.

Thank you, Mr. Chairman.

Mr. WOODALL. The gentleman yields back. The gentleman from Indiana, Mr. Rokita.

Mr. ROKITA. I thank the chairman, I thank the witnesses. I am learning a lot this morning.

How wide is the keep-out zone, again? Is that what you call it? Yes. How—in miles, nautical miles or statute, what is—what kind of area are we talking about?

Ms. SCHENEWERK. Right. So it is—the hazard area that is around the rocket launch, the trajectory—so, essentially, if you imagine that I was going to launch from where I am sitting today towards Mr. Mitchell's placard there, then I would have an area of space that would travel with me that is closed along the way, that is a box around me.

Mr. ROKITA. Hundreds and hundreds——

Ms. SCHENEWERK. It is essentially a bubble.

Mr. ROKITA [continuing]. Of miles that is boxed out.

Ms. SCHENEWERK. So the box travels out hundreds of miles, where the rocket—in the direction of the rocket's trajectory. But its width is in the—maybe I have to get back to you on that one. But it is not thousands or hundreds of miles wide. It is more that it is hundreds of miles long with the trajectory of the rocket.

Mr. ROKITA. So—and that accounts for debris, or not?

Ms. SCHENEWERK. Right. The goal of that is to account for the idea that—of debris propagation from that vehicle. So if you were to have an unintended disassembly, then where that debris would fall from that vehicle——

Mr. ROKITA. So, Captain, how is that different than a line of thunderstorms that you might have to get vectored around——

Mr. CANOLL. That is a——

Mr. ROKITA [continuing]. On any given day?

Mr. CANOLL [continuing]. Great analogy, because it is the same essential thing, it is denying use of the airspace.

Mr. ROKITA. Right.

Mr. CANOLL. We just don't fly——

Mr. ROKITA. Which you deal with every day.

Mr. CANOLL. We do deal with it every day.

Mr. ROKITA. I dealt with it yesterday.

Mr. CANOLL. Yes.

Mr. ROKITA. So we deal with it. And in fact, weather accounts for 72 percent of the delay in the system.

Mr. CANOLL. Right——

Mr. ROKITA. As we learned from another debate on ATC privatization.

Mr. CANOLL. The element being there we don't have any control of where the thunderstorms are, that is a force of nature.

Mr. ROKITA. Right, right.

Mr. CANOLL. This is something we can manage together.

Mr. ROKITA. Right. But we also learned that there is 22 launches or something from SpaceX alone, versus the thousands of air flights a day, and that kind of thing. So certainly many more lines of thunderstorms in a given day and a week than any kind of space launch.

Are the three of you—I am looking at the companies—do you consider yourselves direct competitors? Especially with your change in business plan a little bit.

Ms. GAREHIME. We certainly see ourselves as a competitor with SpaceX. We partner with Blue Origin. We are working together on a new first-stage engine. We haven't made a final decision on that yet. So we work with Blue Origin. But yes, we see SpaceX as a competitor.

Mr. ROKITA. Do you guys like each other, generally?

[Laughter.]

Ms. GAREHIME. We do.

Ms. SCHENEWERK. Lovely people.

Mr. ROKITA. There are so many opportunities that there is room for everybody.

But on the other hand, Ms. Powers, you have 1,400 employees. Is that right? Or—yes, 1,400 employees, and they are all being paid, and you have investors. But you haven't had a return on investment yet, have you?

Ms. POWERS. So we have entered into a number of commercial contracts. As Kelly mentioned, we are engaged with ULA for sales of our BE–4 engine. We have a number of customers that are interested in our engine production programs, as well as our suborbital and orbital launch capabilities.

So for—taking *New Shepard* as the example, our suborbital launch vehicle that flies at our west Texas launch site, we have a relationship with the NASA flight opportunities program, we fly a number of suborbital payloads on every flight of *New Shepard*.

Mr. ROKITA. OK, thank you.

Ms. POWERS. So we are generating some amount of revenue.

Mr. ROKITA. I appreciate that.

And Ms. Schenewerk, really quick, because I have some questions, if you wanted to add something there, you wanted to get a word in—OK.

Ms. SCHENEWERK. That is fine, no.

Mr. ROKITA. So let's talk about the relicensing process example that you brought up, and performance-based regulation. That is intriguing, about—to me it seems performance-based regulation requires you to have data, in terms of outcome. And then it is either failure or success, and that is how you measure performance based.

Go ahead.

Ms. SCHENEWERK. Well, that depends on the performance metric that you set.

Mr. ROKITA. Yes.

Ms. SCHENEWERK. Right? So in the case of this industry, we have a performance metric that is a level of safety. So can you protect the public to the 10 to the minus 6, which is the risk——

Mr. ROKITA. Which the captain brought up.

Ms. SCHENEWERK. Right, exactly, which is the flight safety analysis that occurs.

Mr. ROKITA. Yes. But you have to fly a bird. You have to fly something to get your data, to see if you are meeting that metric or not, right?

The other way of regulating is a prescriptive way. Don't fly anything——

Ms. SCHENEWERK. Right.

Mr. ROKITA [continuing]. Unless it is done this way. So I get that.

Does ALPA, Captain, believe in performance-based or not?

Mr. CANOLL. Yes, we believe in performance-based risk analysis.

Mr. ROKITA. OK.

Mr. CANOLL. And prescriptive is needed in some areas, but performance-based works.

Mr. ROKITA. Are you willing to partner with the——

Mr. CANOLL. Absolutely.

Mr. ROKITA. OK.

Mr. CANOLL. Absolutely.

Mr. ROKITA. And then, with regard to NextGen or anything else the FAA is doing, do you find that the IT, Ms. Powers, that you all kind of referenced, is it being actively engaged in? I might have missed this in your testimony. Is it being actively engaged with in terms of NextGen or anything else the FAA is working on?

Ms. POWERS. Right. So this is an important point. The FAA developed an Aviation Rulemaking Committee focused on——

Mr. ROKITA. OK, that is——

Ms. POWERS [continuing]. Integration of the NAS. And one of the things they are focusing on very heavily is the development of tools like NextGen, SDI, some of the things——

Mr. ROKITA. And, real quick, happy or not with that progress so far?

Ms. POWERS. I think the progress is slow. I think they could be developed more quickly. I think the resources and budgetary constraints are hindering that process.

Mr. ROKITA. Budgetary constraints, it is all about the monies.

Ms. POWERS. In many cases.

Mr. ROKITA. There is a lot of money out there.

Ms. POWERS. There is.

Mr. ROKITA. Captain, do you feel the same way?

Mr. CANOLL. I won't comment on the pace, I just want to make sure we do it in an order that doesn't violate any of the safety rules, and we got to fire out how to reconcile the difference in the safety 10 to the minus 6, 10 to the minus 9th when we get to that final end stage. We can do it.

Mr. ROKITA. So it is a little bit of a tango on what the performance metric will be.

Mr. CANOLL. Correct.

Mr. ROKITA. OK.

Mr. CANOLL. Correct.

Mr. ROKITA. OK, fair enough.

Thank you, Chairman.

Mr. WOODALL. The gentleman yields back. The gentlelady from the District of Columbia, Ms. Holmes Norton.

Ms. NORTON. Thank you, Mr. Chairman. I thank these witnesses. This is exciting to hear of the rapid growth of commercial space in the transportation industry. And I don't—nobody wanted to slow it down. But I would like to hear you elaborate on this 1-year timeframe for streamlining regulations.

Now, I have been on this committee for a long time. I have never seen regulations done within 1 year. And, of course, Congress gets impatient with it, but here—and I go—because perhaps you elaborated more, Ms. Garehime, perhaps more than others, although Captain Canoll has spoken of it, as well. And your testimony has a headline that says "Safety Must Remain the Top Priority," and I think everybody on this committee would agree with it.

You indicate that—and I am looking directly at your testimony—you cite *Atlas* and *Delta* vehicles that apparently have considerable experience in launching. But you said during the—here I am quoting you—"During the regulation streamlining process, it has often seemed that the stakeholders being given the reins by Government to drive the conversation include companies that are very new to the launch market or have yet to fly anything in space. These companies may not understand how challenging it is to reliably and safely launch to space."

So I would like to hear your comments on these twin goals, streamline regulations and make sure you do it safely, to ask you whether you think this can be accomplished. And, indeed, any comments you have would, I think, educate the committee we hold the industry accountable.

Ms. GAREHIME. Thank you for the opportunity. You are right, *Atlas* and *Delta* are launch vehicles with 100 percent mission success, and we think we have the most experience in this realm. We are the most reliable launch provider.

We think, with regard to the ARC process, it has been a very beneficial process. We have a lot of collaboration among industry, and we all agree—at least through the ARC process—that the regulations should move to a performance-based approach.

One thing that you mentioned was the timeline. So we have concerns that the timeline is so aggressive and now the ARC has provided its comments to the FAA and the FAA is off writing the regulations, and we understand at this point there won't be collaboration between the ARC and the FAA until the notice of proposed rulemaking comes out. So we have some concerns there——

Ms. NORTON. So what does that do to the timeline?

Ms. GAREHIME. What does that do to the timeline? Well, it probably—you would have to ask the FAA, but it probably makes it easier for the FAA to meet their deadlines without the collabora-

tion, because if the ARC and the FAA were working together, that may delay the process with industry input.

But if we wait until the notice of proposed rulemaking comes out for industry input through the ARC, our concern at ULA is that the regulations don't necessarily address the input that we provided through the ARC.

Ms. NORTON. Captain Canoll, you mentioned safety, and I can understand that pilots always think of safety first. But that may not mean everybody in the industry does. And I wonder what you think of this timeline. And if something must be sacrificed, what would you sacrifice?

Mr. CANOLL. So, as I mentioned before, that safety is going to always take precedence over any timeline that is established. There is just no way to avoid that. The FAA needs time to do their safety data analysis so that they propose rules that they are comfortable meet the safety standard, be it in the segregated airspace or in integrated airspace.

There is just no variance on that. Whether we are sitting on the end of the runway, deciding if it is safe to take off now with the weather that is on our departure path, again, whether it is a scheduled operation with 300 people sitting behind you, you always default to the safest course. And if the safest course means we are not going to make the 12-month deadline, well then, we are just not going to make the 12-month deadline.

Ms. NORTON. I very much appreciate that understanding. I assume it goes for the entire panel.

Thank you very much, Mr. Chairman.

Mr. WOODALL. The gentlelady yields back. The gentleman from Pennsylvania, General Perry.

Mr. PERRY. Thank you, Mr. Chairman. Thank you, folks, for your involvement today. I know we are talking about rules and the regulatory process, but I want to kind of look at it from a macro sense. And I lament that we have—I think at some point we were—at least in my mind—losing in this global competitive space market. And I think we have regained a fair amount, but I just want to kind of—that is how I want to kind of fashion my remarks, or my questions.

You folks are on the forefront of commercial space operation. I am just wondering how is the U.S. space sector faring regarding our competition, globally? Are we doing better?

Ms. SCHENEWERK. Well, so, sir, we are doing better at this point, in the sense that if there is 100 percent available, and we are capturing 60 percent, that is a lot better than we were doing 6, 8, 10 years ago.

You are right. At one point in the 1980s we had 100 percent of that market, and we ceded it.

Mr. PERRY. Right.

Ms. SCHENEWERK. And now we are recapturing it. And I think that is a source of pride, especially at SpaceX, but particularly for the Nation.

Mr. PERRY. Yes, I think it is a source of pride for the Nation. And I think us folks in Congress want to make sure we don't get in the way, right? We don't want regulations to get in the way. But as the Delegate from Washington said, if you are in aviation, it is all

about safety. I mean that is just paramount, right? Nobody wants to, as you said—what was that, an unintended——

Ms. SCHENEWERK. Disassembly.

Mr. PERRY. Disassembly? That is a fascinating way of putting that.

[Laughter.]

Mr. PERRY. That is interesting. But anyhow, so in that vein, we still want to deliver our astronauts to space.

Ms. SCHENEWERK. Right.

Mr. PERRY. What is—but you have a vehicle that is ready to go, according——

Ms. SCHENEWERK. Correct, we are——

Mr. PERRY [continuing]. To your testimony, right? So what is the——

Ms. SCHENEWERK. We are very excited and honored to be partnered with NASA in the commercial crew program to deliver NASA astronauts to the International Space Station from U.S. soil for the first time since 2011. That vehicle, the *Dragon* spacecraft, the crew version, on the *Falcon 9 Block 5*—have been built, and will be certified to meet NASA's requirements. That is a very specific, very high intensity——

Mr. PERRY. Sure.

Ms. SCHENEWERK. High, intense—very intense level of requirements to meet NASA's safety standards.

Mr. PERRY. And what is the timeline? What can our——

Ms. SCHENEWERK. So our first demonstration mission under the commercial crew program without crew is later this summer. And the second mission is supposed to be in December. And that is with two astronauts on board.

Mr. PERRY. And that will go to the International Space Station, or that——

Ms. SCHENEWERK. Correct.

Mr. PERRY. OK.

Ms. SCHENEWERK. We will do a demonstration mission with two. Those—and following that, we will be carrying up to four NASA astronauts with an FAA-licensed launch for NASA to the International Space Station.

Mr. PERRY. OK. What about you folks? You are delivering everything without flaw, it sounds like. So when are you getting in the game?

Ms. GAREHIME. We are in the game.

Mr. PERRY. OK.

Ms. GAREHIME. So we also have a commercial crew contract with—we are the launch service provider under a NASA prime contract. And Boeing is our customer, and will be delivering astronauts, and——

Mr. PERRY. Do you have a timeframe?

Ms. GAREHIME. We do have a timeframe and we understand NASA will be providing an update in the near future.

Mr. PERRY. OK, all right. Do we have primary barriers in the United States vis-a-vis China, Russia that are problematic that this rulemaking tends to solve, or we are not going to hit the mark on that?

Ms. SCHENEWERK. What I think that this rulemaking works to solve is creating an optimal regulatory regime for the U.S. Government to attract launches to the United States.

So I have been personally contacted by representatives from other governments who are interested in learning from us about how we are reforming our regulations, because they are interested in not starting where we started, which is with the Air Force requirements from, you know, 20, 30 years ago, but with a modernized, streamlined approach. So like the performance-based approach that we are talking about implementing here.

Mr. PERRY. What do other governments that are competing—what do they use?

Ms. SCHENEWERK. So most other governments are just starting to develop their launch licensing regulatory regimes for——

Mr. PERRY. But the ones that we are——

Ms. SCHENEWERK [continuing]. Commercial——

Mr. PERRY [continuing]. Competing with now, the——

Ms. SCHENEWERK. So their government—yes. So the—it is more like having a government—essentially, government owned and operated system. So, as opposed to having a commercial licensing regime like we do, under which, you know, SpaceX flies predominantly, they have government systems. So it is more like being a commercial provider, where the government covers your system.

Mr. PERRY. And do they do the same thing—would—I think about it as a TFR [temporary flight restriction], but what did you call it? What is the terminology?

Ms. SCHENEWERK. The hazard area, the coordination with their airspace.

Mr. PERRY. You called it something else, like a—it is not a no-fly-box, it is a—what——

Ms. SCHENEWERK. Well, they issue NOTAMs, notice to airmen——

Mr. PERRY. Yes, yes.

Ms. SCHENEWERK [continuing]. To implement what is a TFR, a temporary flight——

Mr. PERRY. It is a TFR?

Ms. SCHENEWERK. Yes, yes.

Mr. PERRY. It is essentially a TFR?

Ms. SCHENEWERK. They used to be—yes.

Mr. PERRY. And they use the same thing?

Ms. SCHENEWERK. Absolutely.

Mr. PERRY. OK.

Ms. SCHENEWERK. Well, I don't—well, actually, I was going to say——

Mr. PERRY. Or some——

Ms. SCHENEWERK. As far as other governments are concerned, I would assume that they are similar. But I am not familiar with aviation rules in other nations.

Mr. PERRY. OK. Thank you, Mr. Chairman. Time has expired.

Mr. WOODALL. The gentleman yields back. The gentleman from Georgia, Mr. Johnson.

Mr. JOHNSON. Thank you, Mr. Chairman. In my home State of Georgia there are thousands of aerospace employees working for

large aerospace corporations that export more than $8.5 billion in aerospace products annually.

Additionally, the Georgia Institute of Technology School of Aerospace Engineering is the largest aerospace engineering program in the United States, and was ranked third in the 2014 rankings of the best undergraduate engineering programs by U.S. News and World Report.

Because of our educational institutions, skilled workforce, and large manufacturing operations, I believe Georgia is poised to become a leader in the space sector if we remain vigilant and focused on preparing our workforce. As commercial space exploration increases, how will aerospace workforce needs change, and what should we be doing to prepare the next aerospace workforce?

Ms. POWERS. I will take that. I think what is important is there is amazing innovation going on in this industry right now. And some of the leading universities, much like Georgia Tech, is responsible for training the next generation of engineers that will innovate in that way.

So when we talk about things like reusability and alternative architectures, finding the way to enhance the safety of these vehicles while driving cost down through innovative measures, that has been really, really important for this industry, and it will be, going forward. Blue Origin has proudly partnered with a number of great engineering universities to support those efforts.

Mr. CANOLL. I will add on that we have seen it quite dramatically in my profession, in my industry. Commercial success entices people to want to go join them. It is exciting, it is doing well. There is a career opportunity to be productive and add something exciting to the economy and to your family and to science, in many cases. It will naturally attract the best and the brightest.

During periods of my industry, when bankruptcies were rampant and there was not any commercial success, we had a horrible time attracting people to become airline pilots. And we are paying for a little bit there right now. Over the last 10 years, though, it has improved dramatically, and the flight schools are full. So I think that is great evidence that if the expected commercial success we see from these companies happens, they are not going to have any trouble attracting people to the industry.

Mr. JOHNSON. Thank you. And I will ask this of the panel. In your opinion are there any current FAA regulations that are inhibiting private-sector growth?

Ms. SCHENEWERK. Well, I would say that there are examples within the launch-licensing regime, regulatory regime, that is inhibiting innovation, and that is the prescriptive approach to the expendable launch vehicle regulations in part 415 and 417.

So if you look at a performance-based approach like we are advocating for, and you look at an example like flight safety systems, one of the most important aspects of our vehicle, and the thing, really, that is the focus of the FAA's regulatory approach, if you take a prescriptive approach, and you tell industry that this is exactly what to do to be safe, so to speak, then you limit innovation that can actually improve safety.

And we see that with the flight safety system that is dictated by the current regulations. It takes a traditional approach, whereas

we, at SpaceX, in partnership with the Air Force, have actually moved to what is called an autonomous flight safety system, which is a much more responsive approach to safety than a traditional flight safety system. And that would not have happened under the existing regulations. It happened because the Air Force took the initiative to drive that. We worked with the Air Force, and then we convinced the FAA to accept this other approach, despite the fact that their regulations demand a less-safe approach.

Ms. POWERS. And I will add—and I think an important point to that—given that the FAA licenses reusable launch vehicles differently.

Blue Origin has been operating its *New Shepard* system from west Texas, and on board that vehicle is an autonomous flight safety system that we have used now for 2 years. And we were able to move through review of that system and vetting of that system with FAA under their reusable launch vehicle regulations because the approach of those regulations is not prescriptive. They are a system safety review, a performance-based review. And that is why we have advocated for using that set of regulations as the basis for development of a new set of regulations, going forward.

So there is this dichotomy in the industry where some of us have been able to have a little bit of flexibility in innovation. And the primary hurdles that we see—back to your original question, are there regulations that inhibit progress—the process-based regulations, as far as how you move through the application process, are very, very difficult for the cadence that we are trying to achieve, as launch operators.

So the 6-month review timeline of a license application, when you update something about the vehicle, having to maintain that information with the FAA and have them review, sometimes starting anew an entire license application. So FAA is a bit constrained into how they can move through the licensing process because of the existing regulations. And that applies to any vehicle architecture. And that is something that we focused on very heavily in this ARC effort to update.

Mr. JOHNSON. Thank you.

I have exceeded my time. Thank you, Mr. Chairman.

Mr. WOODALL. The gentleman yields back. The gentleman from Arkansas, Mr. Westerman.

Mr. WESTERMAN. Thank you, Mr. Chairman. Thank you to the witnesses.

NASA says that there are up to 500,000 objects in space that are 1 to 10 centimeters in diameter, this water bottle is about 6 centimeters in diameter [holding up a water bottle]. And then over 20,000 objects that are over 10 centimeters in diameter, or roughly larger than the size of a softball, that are floating through space. And they also say that space junk can reach speeds of about 17,500 miles per hour. And if my math is correct, that is 530 times the speed of a .50-caliber machinegun bullet. So that is pretty potent objects that are flying through the galaxy, or through the atmosphere.

And I have got a question when you think about safety and space travel. Is there a proper regulatory framework to provide commercial operators such as yourselves the necessary information to track

this debris and to keep your launch vehicles—and in the future, astronauts—safe in space? And how do you coordinate with the Federal Government to track this?

And I also read that even the space shuttle had damage done by pieces of debris the size of paint flecks, and there are millions of those floating around in space.

Ms. SCHENEWERK. Excellent question, thank you. So in the course of undertaking the licensing—licenses that we receive from the FAA right now today for launching, we receive what is called a COLA, essentially a collision analysis to look for any kind of collision that would occur, most importantly, with the International Space Station, our permanently manned laboratory in space. And that helps us design our trajectories and our timing of our launch. It goes to the point that there is only so much movement we can have, so sometimes we can't launch on a specific day because of this collision avoidance concern. That is part of what happens today. And the JSpOC [Joint Space Operations Center] actually provides that service, so it comes through the Department of Defense.

There are discussions underway led by the National Space Council—and I want to show appreciation for the work in the House Committee on Science, Space, and Technology, as well, on the space situational awareness piece of legislation that Chairman Babin, I believe, plans to move tomorrow. SpaceX supports that legislation and the idea of moving that space situational awareness service that is provided to launch operators, as well as to satellite operators. So our launch customers want to know that their satellite is going to be entering into an orbit that is safe, and that other things won't be colliding with it. Whatever the size may be.

And that also goes to a point about the bill that is a very important one, and that is that we need to improve our capability of tracking. So one of the ideas behind the legislation that we certainly think is very important is improving the fidelity of the information that we receive so that it is more actionable for operators, be that satellite operators who might need to expend vital fuels, moving their satellites to avoid debris in space, or launch operators who are looking to book launch windows that perhaps don't disrupt the NAS quite as much.

Mr. WESTERMAN. Would anybody else like to address that?

Ms. POWERS. Well, I think this is a very important topic, and I echo many of Caryn's comments. The Department of Defense has provided this service for the industry for a long time. And looking at the increase in commercial activities in space, it is certainly understandable that we revisit whether DoD is the right person to be providing that service for all of industry any more.

And we also support the efforts to move a lot of that capability to the Department of Commerce. Certainly the existing tools and infrastructure that are in place will still be relied upon and, hopefully, improved to make the entire system more safe as we increase the number of objects that are in space. So——

Mr. WESTERMAN. Yes. So as we put more objects in space, that lends you to think there is going to be more space debris over time. Are there activities being taken to reduce the amount of space debris, and also any efforts to clean up some of the space debris?

Ms. SCHENEWERK. So as far as reducing or containing the amount of space debris, when we launch to orbit, be it with our second-stage vehicle that is delivering a payload, or if we are going to be operating, for example, a constellation of satellites in orbit, there are requirements in the licensing of the launch vehicle, as well as operating spacecraft in orbit that go to orbital debris propagation, so their ability to protect against, as you indicated, debris in space causing a catastrophic event to that spacecraft, as well as any kind of propagation of debris.

So, for example, at SpaceX we often deorbit our second stage, or we move the second stage into a safe parking orbit. That is part of the licensing regime. So the license regime looks at the safety of the public through the NAS. But in that regard, with the vehicle itself, it looks to the space safety, as well. And I will assure you that SpaceX is certainly very interested in preserving the space environment, as we not only want to launch our own constellation, we want to launch customers, and we want them to all be able to operate safely in space.

Mr. WESTERMAN. Out of time, Mr. Chairman.

Mr. WOODALL. The gentleman yields back. The gentlelady from Nevada, Ms. Titus.

Ms. TITUS. Thank you very much. A lot of my technical questions have been asked and answered, but I would just like to continue with this notion of how crowded space is getting, and not just with this trash that is floating around.

If you look at our airspace, now you got more small regional airlines, you have got more international flights that can travel longer, you have got open skies, you have got the UAV [unmanned aerial vehicle] industry that is out there, we have got a possible creation now the President has talked about a space force, and now this commercial space industry.

I am wondering, if you move from accommodation to integration, are all of these people at the table with the FAA, which tends to be very slow and hidebound anyway, or are you just operating in silos and then we are going to have to put it all together somewhere down the road?

Mr. CANOLL. So, in the instance of the NextGen Advisory Committee, most representatives—I do not believe there is a commercial space operator on the NextGen Advisory Committee. ALPA is a member of the NextGen Advisory Committee. The Drone Advisory Committee is another one where we have good representation, but I don't think it is all-encompassing. And Commercial Space Transportation Advisory Committee, ALPA is not a member of that.

A lot of the issues solved in this—and you are absolutely correct, it is a finite resource, the national airspace—that we need to find ways to accommodate all these users. We just have to. And, technologically speaking, there are ways to do it. But it is going to take all the players to be in the same room.

So we would urge to expand the cross-section on the NextGen Advisory Committee, the Drone Advisory Committee, and the Commercial Space Transportation Advisory Committee, to include all the players.

Ms. TITUS. Did you all hear that?

Ms. POWERS. I think those are great points. I will highlight that the Aviation Rulemaking Committee focused on national aerospace issues and integrations and space ports. That seems to be an effort to engage a lot of these interests that have not previously been on the same panels together.

So that seems to be the one recent effort that does the best job of bringing all of these interests in to collaborate on some of these issues.

Ms. SCHENEWERK. And I will add that the Federal Advisory Committee, the FACA for commercial space, the COMSTAC, the Commercial Space Transportation Advisory Committee, was recently reinstituted, and it includes not only, I think, stakeholders from every aspect of the aviation industry, but was actually reconstituted with aviation members for the first time.

Ms. TITUS. That is good. My other question is it is called commercial space transportation activities, and yet what I have heard you all say is you have contracts with NASA to take some astronauts to the International Space Station, you depend on the Department of Defense for tracking the trash that is out there, you work with the Air Force. What are you doing commercially? What are you doing in the private sector? Is this for tourism, is it for scientific research, is it for communications, is it just because you can fly out there and want to prove it? What are some of the commercial applications you anticipate?

Ms. SCHENEWERK. Well, I will point out that our ranking member today noted that there are $158 billion of space investments occurring on an annual basis. And the majority of those are actually satellite-related. So satellite manufacturing, satellite operations. So DIRECTV, communications, the Wi-Fi on board your flight across the country, all of those kinds of applications that we see, in addition to the Government applications that you noted.

So the majority of SpaceX's contracts are actually commercial contracts. They are to launch those satellites, the commercial satellites that provide those services for commercial entities to space. So while we do provide launch services to the U.S. Government, one of the things that is notable about the way that we provide those services is that we provide them under a firm, fixed-price contract. And that is a commercial-like contract. So that is why you hear commercial space talked about even with regard to NASA, like the commercial crew program, or the commercial transportation program for delivering cargo to the space station. It is because those are conducted under commercial-like contracts.

But it is important to know that we had 18 launches at SpaceX last year, 17 of those were FAA-licensed as commercial-style launches. And the majority of those were for commercial customers, non-U.S. Government customers.

Ms. GAREHIME. Right now ULA does work with the FAA for commercial—like Caryn was saying, commercially licensed contracts. In the past we have worked with various companies—Digital Globe, EchoStar, the Cygnus missions—I am sorry, not Cygnus, it is—the name is escaping me. But we have had strictly commercial missions. Right now we—our commercial missions are—have Government end customers. But again, our fixed-price contract is licensed through the FAA.

And then, looking forward, we expect to have more commercial missions with, for example, Astrobotic, which has a lunar lander that—it is planning to launch in the 2020 timeframe.

So the different launch services really vary across the board.

Ms. POWERS. And I will add from Blue Origin's perspective. Every example that you provided of a commercial endeavor are ones that we are currently undertaking and pursuing. So we have private research interests whose payloads we are launching on every *New Shepard* flight. We also—I mentioned our collaboration with NASA, so we are launching payloads with Government interests, too.

We are very, very methodically and rapidly moving towards a day when we will fly private astronauts to space. So we certainly envision a day, not just on our *New Shepard* program, but also on our *New Glenn* orbital vehicle program that we are developing, where we will fly commercial satellites, we will fly commercial research payloads, as well as Government payloads, as well, and Government satellites, as well as people. So Government astronauts, private actors. We approach this as we are providing a commercial service, a commercial launch service, to whatever type of customer might be out there wanting to get to space.

So our approach is we are not providing Government launches when we have a Government payload on board; we are providing commercial services to a Government customer, a private customer, a commercial business entity. So we hope to cover the entire scope that you mention in your question.

Ms. TITUS. Well, let's promote tourism. I am from Las Vegas, we always believe in tourism. Thank you.

Mr. WOODALL. The gentlelady yields back. The gentlelady from Michigan, Mrs. Lawrence.

Mrs. LAWRENCE. Thank you. Panel, I have a very strong passion for workforce issues. Today every industry is facing challenges for a skilled workforce. Standards of education, barrier to entry, lack of collaborations between public and the private sector, racial and gender diversity are just a few of the factors that impact our workforce.

In the next 10 to 15 years it is estimated that the size of the global space economy will nearly double. To meet such needs, the workforce also has to grow. So what do you believe we need to do to ensure that we have a workforce equipped to manage the future commercial space transportation venues and projects. I have been in contact with the—worked closely with the pilots, knowing there is a critical need now for pilots in the commercial arena. And now we are talking about the space arena.

So please comment. I will start with you, Captain. What—when we start elevating—and this all sounds good, and we get the laws and the plans. Will we have the workforce ready to step in and do the work?

Mr. CANOLL. So I completely agree. We have to have a long vision here to understand how we are going to do it. And not everyone is suited for the same job. The aptitude for becoming an aerospace engineer is different than an aptitude for becoming a pilot. Someone has to desire it, as well.

To my earlier point, success breeds desire from those who look at the industry that they are beginning to really grow at a rapid rate now will breed success and those will want to be part of it. But there are challenges in making sure everyone has an equal opportunity here.

Currently, we do have a dip in the availability of pilots, due to the factors I mentioned earlier, where, for example, the industry was doing very poorly, and I personally took a 42-percent pay cut, lost my retirement. My benefits were slashed. We have built back, and people are starting to come back to the industry, but still, only 6 percent of airline pilots are women in this country. That has got to be addressed.

So we are taking efforts to ensure at even the primary school level, that our association is out there, visiting thousands of schools every year, making sure that the guidance counselors and the kids are exposed to aviation as a potential career early on, so that they find out if they have the aptitude and they want to join this.

And I would urge our friends from commercial space to do the same thing. There is a natural attractiveness to commercial space. I mean it is the Buck Rogers effect. People are going to want to do it. That doesn't mean you are going to get the cross-section from society that you really need to do it.

Mrs. LAWRENCE. Yes, Ms. Powers.

Ms. POWERS. Well, you have touched on something that I am personally very passionate about, and I am proud to say that Blue Origin has a great interest in this, as well. I was an engineer for a long time before I became a lawyer. So something that I have great interest in is making sure that I personally and Blue Origin, as a company, supports STEM efforts for young children in grade school and high school.

We have a number of outreach efforts that many Blue Origin employees are engaged in to make sure that young children and high school students have the opportunity to be exposed to science and technology and engineering, regardless of their gender, regardless of their race, regardless of their socio-economic status.

Mrs. LAWRENCE. Thank you.

Ms. POWERS. This is very important to us.

And the other thing that I am very proud to talk about as far as Blue Origin's efforts is we have an amazing university outreach program that organizes a number of women's and diversity initiatives. We have events on our campus in Seattle, where we invite women of college age to come and interact with our engineers and learn about the work that we do at Blue Origin, and to support tech careers in technology and engineering. And we very proudly partner with some of the Michigan universities, too.

Mrs. LAWRENCE. And the next two comments, could you just tell me also—because we talk about the engineers, but there is a whole workforce that is needed that is not an engineer, it is the skilled trades, like your electronic technicians, your computer programmers. And this is a work group that we know is the—growing and the most abandoned right now workforce, because if you do not go to college, there is still an amazing amount of opportunities in skilled trades. Will you please talk to that?

And I just want to say, Ms. Powers, thank you for saying socio-economics. Because a child is not in this elitist zip code does not mean that child does not have the capacity nor the dream to enter into the commercial space industry. And frankly, because the baby boomers are dropping off and this industry is growing, we are going to have to look past our bias that if you are poor you don't belong in this industry. And women have traditionally been bypassed. So thank you for that.

Ms. SCHENEWERK. And Representative Lawrence, I want to point out that the child that you are speaking of that might come from that socio-economic background that is a little bit more challenging could grow up to be one of the technicians that we depend upon at SpaceX. You know, I am very honored to be part of a 6,000-strong workforce that does include engineers, but that heavily relies on technicians that come from a whole host of backgrounds.

So today that means that we hire folks that were working in the house-building industry, maybe the automotive industry, and we bring them in and we train them to work in aerospace because when we started building this company, there weren't exactly dozens and dozens of aerospace-trained engineers and technicians who were looking to start at a new startup company that was wanting to be as innovative as SpaceX is. And so we are very honored to have those very important members of our team.

I am also honored to work for the president of our company, Gwynne Shotwell, who works tirelessly to promote women's engagement in the aerospace industry, and also honored to be part of various interest groups within the company. So while we work external to the company to promote these interests, we also have really good, strong support networks within our company that we understand are vital to maintaining that workforce internally, and also to then promote our efforts externally.

Mrs. LAWRENCE. Thank you.

Mr. WOODALL. The gentlelady yields back. While we have all of this expertise gathered in one place, with your indulgence, we would like to pursue it. I would like to yield to a second round.

The gentleman from Washington, Mr. Larsen.

Mr. LARSEN. Thank you, Mr. Chairman. I want to go back to something Ms. Powers said nearly an hour and a half ago, I guess, and it was about the use—the DoD site, and then—and therefore, the requirement that you have to use USAF requirements, even if you have an RLV.

And so the question is then why did you use it? And second, you know, must you use it? And third, what would be the alternative if the requirements didn't change?

Ms. POWERS. And, I am sorry, why did we use the——

Mr. LARSEN. You said you—no, the—because you used a Federal range, you had to do the prescriptive——

Ms. POWERS. Right.

Mr. LARSEN [continuing]. Rules, even though you are using an RLV.

Ms. POWERS. Right.

Mr. LARSEN. Yes.

Ms. POWERS. Why did we go to a Federal range?

Mr. LARSEN. Yes.

Ms. POWERS. Yes. So there is—I think probably secret to no one, there is an amazing legacy that exists at our Federal ranges. There are folks working for the Space Wings that have a great deal of expertise in this area. And we saw it as a benefit not just from existing infrastructure that was already there—there are launch pads and launch sites where we had the opportunity to either refurbish or build new structures, relying on the infrastructure that already existed.

We definitely have brought a commercial approach to that relationship, and this is where we see the struggle with the prescriptive requirements in many ways, whether it is building infrastructure or launching and returning a vehicle to that location.

So it was definitely a cost-benefit analysis, and we decided that we had an opportunity to go to a Federal range and rely on some of that amazing legacy expertise and infrastructure and the support that they could bring our program, while also progressing that model forward to be accepting of a more modernized, commercial approach in some ways.

So we see it as a system that can progress the same way that the administration has directed——

Mr. LARSEN. Yes. So——

Ms. POWERS [continuing]. That the Air Force progress.

Mr. LARSEN. So if, as the numbers show, the commercial launches out of the U.S. are going to increase, does that become less of an incentive as the numbers increase to use Federal ranges?

Ms. POWERS. To use——

Mr. LARSEN. Or is it more of an incentive?

Ms. POWERS. Well, I will say, given that we also have the experience of flying *New Shepard* at a private launch site, we enjoy a lot of flexibility at our private launch site that we don't see at Cape Canaveral.

And we feel that we have succeeded at setting up a vehicle that operates very safely from a public safety perspective at our west Texas launch site, and there are a lot of benefits to operating from a private site. And I think we have seen, with the increase in the number of space ports in any number of locations around this country, that other actors might be behaving in the same way.

Mr. LARSEN. Yes. Ms. Schenewerk, do you have a comment on that?

Ms. SCHENEWERK. Sure. One of the comments that I would like to make about being on a Federal range versus being on a non-Federal range—and we are on both about 3 miles apart from each other—is that when we operate with the Air Force, one of the benefits is the Air Force's ability to update its requirements with some level of regularity and ease that does not exist to rules that are written in the Federal Register and subject to the Administrative Procedures Act.

So what we see as being——

Mr. LARSEN. Some would see that as—for some things, yes.

Ms. SCHENEWERK. So for one of that actually drives one of the recommendations that we have with regard to the FAA rulemaking process, which is to create a performance-based approach, but then move—you could move some of the things that are prescriptive in the ELV regulations to guidance or to advisory circulars that could

be updated more regularly, and then you could accommodate these operations under two different authorities in a much more streamlined manner, and they could keep pace with each other much better.

Mr. LARSEN. Yes.

Ms. Garehime, do you have a thought on this, as well?

Ms. GAREHIME. Well, ULA operates at the Federal ranges.

Mr. LARSEN. Yes.

Ms. GAREHIME. Only at the Federal ranges. So no real comment there.

Mr. LARSEN. So—OK, that is fine. That is fine. It is about 10 members of this committee that are also on the House Armed Services Committee, and it might be time for the 10 of us to—probably past time for the 10 of us to maybe sit down as a group amongst ourselves and brainstorm this cross-over between DOT and DoD.

Can I get some clarification on the use of the NAS for launches that—generally, do each of you believe that the technology is progressing and we have the people to narrow the amount of space that we absolutely have to use for commercial launches to address some of the issues about conflict in the NAS? Generally?

Ms. POWERS. I think we absolutely do at this time. There have been a number of initiatives in the past, some of them mentioned today——

Mr. LARSEN. OK.

Ms. POWERS [continuing]. That just really need to be finalized, right? So we have practiced and achieved flowing telemetry from flying space vehicles into the data center in New Jersey. And the final piece is getting those integrated into the air traffic system so that air traffic controllers can actually rely on that data.

Mr. LARSEN. Yes.

Mr. CANOLL. Yes, I agree. I think the real-time data will allow us to shrink the airspace that we have to segregate.

The next step after that—because that will limit it to a certain point—is the actual integration, so there isn't segregated airspace. They are operating with us.

Mr. LARSEN. Right.

Mr. CANOLL. That is where we run into the problem of adopting a 10 to the minus 9 or 10 to the minus 6. There is the challenge, scientifically.

Mr. LARSEN. Yes.

Ms. SCHENEWERK. In that regard, my understanding is that we are years out from this if we don't expedite that approach soon. So right now there are folks within the NextGen office who are looking at how to design those. They have been running some test cases and designing some tests of this capability. They have some designs. But there is a next level of procurement that needs to occur, and then an integration testing and verification that needs to occur. I have been told that that could be as long as 7 years.

Mr. LARSEN. Yes. Ms. Garehime?

Ms. GAREHIME. We are just becoming part of this conversation through the airspace integration ARC, and I think there is a lot of education that needs to be done on both sides. We just participated in the ARC committee meeting where we learned the airlines' perspective, and we have agreed to give a similar presentation back

to the airlines, so that they can better understand why do we have these long launch windows like some of the other panelists have discussed.

So I think there is a lot of work that needs to be done, and we are doing that through the ARC.

Mr. LARSEN. OK. If the chairman will indulge me—thank you.

So Captain Canoll testified earlier about the presence of the moratorium until—is it 2023? On a lot of what the FAA can do, but there are some exceptions.

But yet your argument, Captain, is that it doesn't prevent the FAA from working on these issues that it might be able to bring folks together outside of regulation because there are outstanding issues that need to get addressed. Is that generally what you——

Mr. CANOLL. Absolutely. We shouldn't wait to 2023 and begin the process. We can start right now. As a matter of fact, we must start right now if we want a nice set of comprehensive, safe procedures and rules for us to jointly operate in the national airspace. We have to start right now.

Mr. LARSEN. Well, I think we have to clear the room after we are done with the hearing, but maybe you guys could meet out in the hall.

Mr. CANOLL. I am willing. I got the rest of the——

Mr. LARSEN. It is that urgent. Do the rest of the panelists believe the same, you don't need to be waiting for the moratorium to lift, because——

Ms. SCHENEWERK. So——

Mr. LARSEN [continuing]. And my personal view—this is kind of a classic thing, where Congress will come to 2022 and say, "Let's extend it for about 5 more years," which may be a good idea and may be a bad idea. But it is a matter of work having to get done being stymied by a moratorium that may not be necessary at the time, so——

Ms. POWERS. I think it is important to clarify that that moratorium is applicable to passenger safety. So human astronaut——

Mr. LARSEN. Yes.

Ms. POWERS [continuing]. Safety on board the vehicle.

Mr. LARSEN. OK.

Ms. POWERS. The airspace issues, those are within the realm of the public safety efforts that are ongoing. So there is just a little bit of a difference there.

Mr. LARSEN. Sure.

Ms. SCHENEWERK. Yes, that is a very important point of clarification, and I think a misconception about this learning period.

The FAA regulates our activities for public safety so that is to prevent harm to any people or Government property on the ground or in the air or at sea. So it is regulated for that safety aspect. This question of the learning period specifically has to do with carrying human space flight participants on board a spacecraft.

So as far as the public is concerned, the difference between having a human on board and having a satellite on board is—it is the same level of safety to protect the uninvolved public.

I will also point out that many of us that are engaged in carrying human space flight participants, we are doing so at SpaceX in collaboration with NASA. So we are building our *Dragon* spacecraft

to meet NASA human space flight requirements, and to achieve their certification level. So that is a significant level of what you could otherwise call regulation, but because it is NASA it is requirements that go to the design and build and operation of that vehicle.

Mr. LARSEN. Right, right.

Ms. Garehime?

Ms. GAREHIME. We think it is time to start the discussion about ending the moratorium.

Mr. LARSEN. Yes, OK, great. So thanks.

In closing, I would like you all—and I invite the subcommittee, if it is possible—to come back and report in a year, once the FAA has issued its proposed rule. Clearly, there is still a lot of opportunity to ensure the continued growth and success of the commercial space industry, but being mindful of the safety mandate.

And I would be interested in hearing from all of you before then, as well, but—on what the FAA's proposal seems to address and what requirements might need further evaluation and time to work through.

So thank you, and thank you, Mr. Chairman. I yield back.

Mr. WOODALL. The gentleman yields back.

Captain, I was looking at the enthusiasm on your face when you were talking about your Buck Rogers moment there. I don't know how many folks that reference might have been lost on, it is becoming more and more dated.

Mr. CANOLL. Legacy reference, sorry about that.

[Laughter.]

Mr. WOODALL. Folks are excited, though. I have got a letter here from all 14 Georgia congressmen promoting a space port down in Camden County. As you may know, we don't have any folks committed to flying out of there yet, though we would love to share that with the folks who are interested. But that kind of enthusiasm is driving a lot of these discussions.

I saw in your testimony your concern that commenting before you know how a facility is going to be used makes it a little more difficult to comment. Distinguish for me, thinking about a legacy reference, if I am thinking about BQK, our little Brunswick Glynn County Airport down there on the coast, we can come and expand that airport's purpose many times over many years, separate comment period for each expansion down there, lots of opportunity for folks to get involved. How are we disadvantaging American airspace with commenting before we understand an intended purpose for a space port, rather than after?

Mr. CANOLL. So I don't think I want to use the word "disadvantaging," because someone is going to use the airspace for their benefit, be it unmanned aircraft system or be it commercial space transportation. Someone is going to use it. It is a matter of fairness in who got displaced so we can do it.

Mr. WOODALL. OK.

Mr. CANOLL. Short of our implementation, or integration, complete integration, we are still stuck with this, well, we have to displace the users while we launch. OK? Even for a short period.

And if you take the south Georgia proposal, the issue there is while there isn't a lot of local traffic, except for maybe Savannah

nearby, Jacksonville just to the south, there is a tremendous amount of north-south overhead traffic transiting up and down the east coast. And if you were to look at the FlightAware diagrams, you would see that.

So the concept in that instance would be, OK, we are going to authorize the space port, but we really don't know what it is going to do—to your point—until we see what the operator intends to fly out of the space port. So it is a little disconnected right now. We think, you know, a joint application, so you could see the whole picture when making comments as to the impact, not only from a safety perspective, but from the economic perspective for my members to have access to the airspace that they need to earn their income.

Mr. WOODALL. It certainly makes sense, limited resource, understand the impact on other potential users of the resource.

From the commercial perspective, you would agree with the captain, that we should understand what the use of a space port would be before we initially license it, or that we are advantaged by licensing first and understanding utilization later?

Ms. SCHENEWERK. So one of the things that I would like to point out about this—and this isn't an agreement or a disagreement—is that when a space port puts forward its application, my understanding is they have to—and I have not undertaken this effort, but this is my understanding—is that they have to put forward types of vehicles and types of trajectories that would be launching from that site. But that is separate and apart from the actual launch license that an entity would have to get to even be able to operate from that site.

So if you are going to have a space port and a licensed space port that is going to be a multiuser space port, that space port can get a license that covers the idea that you would have activities there. But any operator of a launch vehicle or a reentry vehicle is going to have to go and acquire a separate license covering their specific activities, their kinds of trajectories, their kind of vehicle, and their kinds of operations from that site.

Mr. WOODALL. Now, understanding that Congress is sometimes slow and delay is often the norm, as Mr. Larsen just referenced, help me understand when—if we are setting deadlines, of when the synthesized airspace should occur, the day we leave blocked space, and we have a synthesized system. Your expectation as experts in the field is that that date is when? When are we prepared, as an industry, even if we are not yet prepared as regulators?

Ms. SCHENEWERK. For the—clarification. For the NAS integration tools that we are looking at?

Mr. WOODALL. That is right.

Ms. SCHENEWERK. Yes. So we are prepared to work today—we already are, actually, through the Space Data Integrator—to provide our trajectory data directly to the FAA to be integrated into a tool that could show a controller our vehicle on the scope as it moves through the NAS. So that is something that we are eager to engage in today.

I think that our understanding is that the timeframe is a little further out, due to the testing and procurement and integration schedule that is part of the FAA process. But as far as SpaceX is

concerned, we would happily build that tool together and provide that information today.

Mr. WOODALL. Captain, as one who represents all the other users of the airspace today, are—do you feel like we are prepared to move in that——

Mr. CANOLL. We are certainly getting closer. There are other tools that will be needed to actually make it a reality. It is a great enhancement to have the real-time data of the space vehicle transiting the national airspace.

But the controller not only has to go through training, and has to be tested, and has to be verified, there is a slight difference—excuse me—the controller today has the ability to control the airspace. It sees a user and says, "No, you need to turn right to 270." Well, that is not an option in this instance. You can see it, but you can't manipulate it. You are just using it for deconfliction purposes to shrink the amount of airspace needed to be deconflicted.

The follow-on is the one we need to keep working on. This is a good program that is going to really advance our ability to operate multiple users in the airspace. But we need to be thinking always to the next generation. I hate to use that term, because we are always working on it. And you always think, well, we have reached the next generation, we are done. No, it is the one after that that we need to be focusing on, as well.

Mr. WOODALL. Yes. I did watch "Hidden Figures" on the airplane coming up here, and I did see the *Atlas* heavily referenced there in the 1960s—I don't know what next generation means, in terms of *Atlas*, but, well, that is a different conversation for a different day.

Thank you all so much for committing your time and your intellect to the committee today.

And if there are no other questions from committee members, the committee stands adjourned.

[Whereupon, at 11:52 a.m., the subcommittee was adjourned.]

WRITTEN STATEMENT OF

AIR LINE PILOTS ASSOCIATION, INTERNATIONAL (ALPA)

BEFORE THE

SUBCOMMITTEE ON AVIATION

OF THE

COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

U.S. HOUSE OF REPRESENTATIVES

JUNE 26, 2018

"COMMERCIAL SPACE TRANSPORTATION REGULATORY REFORM: STAKEHOLDER PERSPECTIVES"

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Mr. Chairman and members of the committee, thank you for giving me the opportunity to join you today, along with this panel of industry leaders. I would like to say right up-front that we are all here today as members of the same community, the aerospace industry. But before I share our thoughts on this important subset of the industry, please allow me to introduce my organization to you.

I'm the president of the Air Line Pilots Association, International (ALPA), which represents more than 60,000 professional airline pilots flying for 34 airlines in the United States and Canada. ALPA is the world's largest pilot union and the world's largest non-governmental aviation safety organization. We are the recognized voice of the airline piloting profession in North America, with a history of safety and security advocacy spanning more than 85 years. As the sole U.S. member of the International Federation of Airline Pilots Associations (IFALPA), ALPA has the unique ability to provide active airline pilot expertise to aviation safety issues worldwide, and to incorporate an international dimension to safety advocacy.

Setting the Stage

Commercial space operations are not new. In fact, it has been more than 30 years since Congress established a commercial space office in the Department of Transportation (DOT), which now resides at the Federal Aviation Administration (FAA). The industry is mature, and thanks to a series of events over the past decade, it is thriving. We'll dive into those events further in our testimony.

However, we must keep commercial aviation part of this discussion today. Future growth and success of U.S. commercial aviation depends upon continued safe, dependable and efficient access to shared public resources such as the National Airspace System (NAS), air traffic management, ground infrastructure and airport services.

It is clear that expanded markets and technology advances in space are enabling new commercial companies to access these limited resources, which has become a critical challenge for the aviation community. Air traffic management, airports and the NAS are regulated and managed according to strict operational and safety regulations, which will not sufficiently accommodate the projected growth and evolution of space transportation, without enhancements. Anytime there is significant growth in a segment of the airspace user community, there must be a means to safely integrate with existing aircraft operations and infrastructure without decreasing the level of safety or efficiency for existing operations.

Neither industry would be successful today without the other. Each sector generates $100's of billions in annual economic returns for the U.S. and unmeasurable benefits to society. The FAA has coordinated the activities of both airplanes and rockets successfully for over sixty years. In many ways, there is a false distinction between the two sectors since several aircraft types travel into outer space and all space vehicles travel through the atmosphere.

As spaceflight becomes more diffuse and routine, both sectors must cooperate to create policies, regulations and procedures to manage shared national aerospace resources safely and efficiently.

Early Developments in U.S. Aviation and Space

In order to fully articulate the complementary nature of commercial space and commercial aviation, we have developed a white paper that documents the role of the government agencies and industry, both historically as well as today. That whitepaper can be found online at www.alpa.org/whitepapers.

Commercial Space Industry Growth

Over the past several years, commercial space operators have added new launch facilities, increased launch frequency and have begun returning rockets to land for reuse. Several companies sell space tourism fights, and plan to begin taking passengers to space as early as next year, which could accelerate this expansion and growth. Space companies are now testing new concepts of operations that include horizontal liftoff and/or landing, which is driving the development of commercial spaceports at or adjacent to existing airports. Today's regulatory environment has not kept pace with these developments and new solutions are now required.

Several aerospace companies have recently developed technologies that lower costs even more significantly. These reduced costs and increased frequency are driving new markets into space, such as space tourism, which could in-turn, drive growth

over the next few years. The charts below depict the breakdown of the types of orbital space launches in the last few years. It is notable that U.S. commercial launches increased significantly between 2013 (6) and 2017 (21):

U.S. Orbital Space Launches, 2013–2017				
Year	Civil	Military	Commercial	Total
2017	2	6	21	29
2016	4	7	11	22
2015	4	8	8	20
	Noncommercial		Commercial	Total
2014	12		11	23
2013	13		6	19

In addition to frequency, launches take place from more locations and use different concepts of operations. U.S. space launches have historically operated out of a small number of coastal launch sites, managed by civilian and military government agencies. The chart below depicts the space launch sites in the USA.

U.S. Space Launch Sites						
Launch Site	Operator	License First Issued	Expires	2017 FAA AST-Licensed or Permitted Flights	State or Country	Type of Launch Site
California Spaceport	Harris Corporation	1996	9/18/2021	6	CA	Commercial
Cape Canaveral Air Force Station	U.S. Air Force				FL	Government
Cecil Field Spaceport	Jacksonville Airport Authority	2010	1/10/2020	0	FL	Commercial
Edwards Air Force Base	U.S. Air Force				CA	Government
Ellington Airport	Houston Airport System	2015	6/25/2020	0	TX	Commercial
Florida Spaceport	Space Florida	1999	6/30/2020	14	FL	Commercial
Kennedy Space Center	NASA				FL	Government
Mid-Atlantic Regional Spaceport	Virginia Commercial Space Flight Authority	1997	12/18/2022	1	VA	Commercial
Midland International Air and Space Port	Midland International Airport	2014	9/14/2019	0	TX	Commercial
Mojave Air and Space Port	East Kern Airport District	2004	6/16/2019	0	CA	Commercial
Oklahoma Spaceport	Oklahoma Space Industry Development Authority	2006	6/11/2021	0	OK	Commercial
Pacific Missile Range Facility	U.S. Navy				HI	Government
Pacific Spaceport Complex Alaska	Alaska Aerospace Corporation	1998	9/23/2018	0	AK	Commercial
Poker Flat Research Range	University of Alaska Fairbanks Geophysical Authority				AK	Nonprofit
Ronald Reagan Ballistic Missile Defense Test Site	U.S. Army				Republic of the Marshall Islands	Government
Spaceport America	New Mexico Spaceport Authority	2008	12/14/2018	0	NM	Commercial
Vandenberg Air Force Base	U.S. Air Force				CA	Government
Wallops Flight Facility	NASA				VA	Government
White Sands Missile Range	U.S. Army				NM	Government
Source:						

Note: In addition to the sites in the table above, there are three non-licensed sites where individual companies conduct launches using a licensed or permitted vehicle. Because the companies own and operate these sites using their own vehicles exclusively, a site license is not required. SpaceX conducts flight tests at its McGregor,

Texas site and Blue Origin conducts FAA-permitted flight tests from its site near Van Horn, Texas.

Existing Regulations and Requirements

Current launch licensing procedures and regulations were created at a time when there were significantly fewer launches, launch operators, types of operations, and launch facilities. Federal policy related to our shared national aerospace resources needs to reflect current growth projections and the potential for further acceleration.

The FAA provides aircraft and pilot certification, operational approval, air traffic control and safety oversight of commercial airline operations in the NAS. Each operator is responsible for ensuring their aircraft fleet is managed and operates according to FAA requirements. The FAA also provides the necessary permits and licenses for space operations, for the space vehicles used by space operators, and the licensing of space ports.

Operational Approval of Space Launches

Title 14 of the Code of Federal Regulations (CFR) Volume 4, Chapter III, Commercial Space Transportation, FAA, DOT, outlines requirements pertaining to commercial space operations. This section of the rules defines the policy and procedures in support of commercial space operations in the United States.

When NASA and other government agencies purchase a launch for their own spacecraft, no launch licenses are required. When launches are provided for commercial spacecraft, the FAA's Office of Commercial Space Transportation (AST) is responsible for licensing. AST was established in 1984 and has licensed 286 launches and 16 reentries to date.

Commercial Spaceports

Independent of issuing approvals for the commercial space operations (launch, recovery, etc.), the FAA AST also issues launch site operator licenses for airports or spaceports who desire to conduct commercial space operations. A graphic below describes the process.

Public input to the licensing process is currently limited to the environmental review portion of the process, as highlighted below. In some cases, airports are applying for spaceport licenses without a companion commercial space operator license application. Therefore, even if the spaceport license was issued, no commercial space operations would be allowed without additional FAA approval.

Because the FAA evaluates spaceport applications completely separate from commercial space operator applications, a spaceport could be established without a specific use in mind. For organizations like ALPA, this presents challenges when it comes to providing the FAA with comments during the only public comment period for spaceports. The comment period is for public review of the environmental

assessment. Currently there is not a comment period for stakeholders to submit with regards to the operations envisioned at the spaceport. This creates a challenging situation for stakeholders and the FAA to have comprehensive review of all aspects of the spaceport licensing criteria, including safety of the operations in proximity to other aviation operations.

Airspace and Air Traffic Control

The FAA AST appears to serve as the single focal point for space companies to coordinate operational approval and air traffic control procedures to segregate the volume of airspace required for the space operation from other NAS operations. The airspace and air traffic control management strategies continue to evolve with the new types of technologies used by commercial space operators. Also, the new types of commercial space activities that are being planned by a wide range of commercial space companies is requiring the FAA to conduct new risk assessments to ensure that their historic airspace management policies and plans are adequate for the envisioned operations.

To protect passengers and crews aboard commercial aircraft operating in the vicinity of space operations, airspace boundaries are established to sterilize the airspace needed by the space vehicle. These airspace areas are sized to provide an adequate safety margin should a catastrophic failure occur at any time from the launch until the space vehicle was well clear (above) aviation operations. These large airspace areas are designed to contain the operation and to segregate the space operation from

airline and other aeronautical operations. The FAA utilizes special activity airspace (SAA) to segregate space and aircraft operations.

Each SAA has defined dimensions based on the space vehicle's launch and reentry trajectories, which mitigate the risk in the event of a catastrophic failure and ensure that non-participating aircraft remain outside the SAA boundaries. These restrictions have led to extensive and expensive delays to commercial air traffic that are unsustainable. However, until policies, procedures, and airworthiness certification requirements are developed based on improved data, today's commercial aviation and space operations will continue to use this same methodology to manage and restrict the NAS. Integration of commercial space operations in the NAS would benefit from increased collaboration and coordination with other elements in the FAA, such as Flight Standards.

Aircraft design approvals.

The FAA serves as the safety and oversight regulator for aircraft design and certification. For traditional civil aircraft, Title 14 CFR Chapter I, Subchapter C, contains aircraft certification policy and standards required for aircraft airworthiness certification. These regulations are used by aircraft manufacturers in the development, maintenance, and periodic inspections of aircraft. Compliance with the airworthiness standards is mandatory before an aircraft can integrate/operate in the NAS without restrictions or without containment in segregated airspace. Aircraft

manufacturers may be granted an experimental airworthiness certification during the developmental phase of new aircraft.

By contrast, the FAA AST issues either a license or experimental permit for spacecraft operations. Compliance with 14 CFR Chapter I is not required. The license or experimental permit allows space operators to launch a space vehicle into orbit/sub-orbit and reenter the earth's atmosphere. Before AST grants a license/permit, the space operator must demonstrate compliance with the criteria in 14 CFR Chapter III that safeguards the public, including persons in non-participating aircraft.

As written originally, the FAA space licensing requirements did not envision the frequency of operations or spacecraft designs now being used, nor those anticipated in the future. As a result, the FAA is undertaking a review and a re-write of requirements in 14 CFR Chapter III to shift to a "performance based" set of design and operational requirements. In support of this activity, the FAA formed the Streamlined Launch and Reentry Licensing Requirements Aviation Rulemaking Advisory Committee (ARC). Launched in March 2018, the ARC is tasked with developing recommendations for a performance-based regulatory approach in which the regulations will state safety objectives to be achieved and leave design or operational solutions up to the applicant.

Passengers as Participants

More than 1,000 individuals have pre-paid space companies for suborbital spaceflights. The Commercial Space Launch Competitiveness Act of 2015 (P.L. 114-119) gives the FAA the specific responsibility of regulating commercial human space flight. The act prohibits the FAA from regulating crew and passenger safety except in response to high risk incidents, serious injuries or fatalities, or an event that poses a high risk of causing a serious or fatal injury. The act defines paying individuals as "participants", rather than "passengers" to allow them to be transported with an experimental airworthiness certificate.

ALPA's Safety Concerns

Any new technology introduced into the NAS requires a carefully crafted risk management, risk mitigation, and implementation strategy. While commercial space operations are not new, the increase in the frequency of launches and associated segregation of airspace, combined with the growing number of commercial spaceports, means that the elevated demand for access to airspace will likely place pressure on regulators and operators to reduce the size of the airspace protection zones, to minimize commercial space's operational impact on commercial aviation. Without proper mitigations in place, the elevated levels of risk may not be acceptable.

In the longer term, there is discussion of the full integration of space vehicles into the national airspace, where the space vehicles operate within the existing framework of aircraft operations and infrastructure. Accomplishing this goal without decreasing

the level of safety of the existing operations will be a significant challenge. However, we are confident that it can be successfully achieved.

ALPA will continue to support the FAA, other government agencies and industry, and participate in the safety risk analysis activities as well as rulemaking processes to ensure safety risk is addressed for all phases of the operations.

Current and Emerging Operational Challenges

Managing more frequent and diverse space activities under current FAA policies and regulations has resulted in significant impacts to commercial aviation including flight delays, flight plan alterations, increased distance flown, longer flight times, flight cancellations, crew duty cycle, gate slot management and added fuel burn.

According to the Airlines for America[1], in 2017, the average cost of aircraft block (taxi plus airborne) time for U.S. passenger airlines was $68.48 per minute. If 10 aircraft are delayed for 10 minutes each, the associated cost would be $68,480. If the same delay were incurred each day of a year, the cost of the delays would be nearly $25M. These costs do not include the passenger's value of time, the costs of lost opportunities, and the costs of missed meetings/vacations where expenses are incurred prior to completion of air travel.

[1] See: http://airlines.org/dataset/per-minute-cost-of-delays-to-u-s-airlines/

ALPA sought to understand the impacts of the Space-X Falcon Heavy launch on aviation operations. The launch was at the Kennedy Space Center on February 6, 2018. According to the FAA:

- 563 flights were delayed.
- 34,841 additional nautical miles flown.
- 62 additional nautical miles flown on average per flight.
- 4,645 total minutes delayed.
- 8-minute average delay per flight.
- 5,000 square nautical miles impacted.
- 62 departure and 59 arrival delays were experienced at the Orlando International Airport.

ALPA also noted that the FAA completed a report in 2014[2] where they evaluated impacts caused by space operations conducted at Cape Canaveral.

In this study, the FAA's Concept Analysis Branch studied a historical launch and reentry to quantify the current NAS impact of commercial space operations and to identify air traffic control (ATC) practices used to minimize this impact. On March 1, 2013, the SpaceX Falcon 9/Dragon capsule was launched from Cape Canaveral Air Force Station in Florida. Several Special Activity Airspaces (SAAs) were activated to protect air traffic from debris in the event of a vehicle explosion. After being docked to the International Space Station, the Dragon capsule reentered the atmosphere and

[2] See: https://acy.tc.faa.gov/data/_uploaded/Publications/SVO_Impact_TechNote_Final_v4b.pdf

splashed down in the Pacific Ocean off the coast of California on March 26, 2013. This reentry also required a SAA to block air traffic from entering the potentially dangerous airspace.

Results showed that flights in the Jacksonville and Miami Air Route Traffic Control Centers (ARTCCs) during the launch were significantly impacted by the operation. The Falcon 9/Dragon launch caused impacted flights to fly between 25 and 84 nautical miles (NM) longer, burn between 275 and 2,387 pounds (lbs) more fuel, and fly between 1 and 23 minutes (min) longer as compared to similar days with no launch activity. However, the launch operation did not negatively impact the total hourly operations at key Florida airports. The reentry analysis showed that flights traveling to or from Hawaii and Australia would be impacted by the reentry operation, but domestic and other international flights would be minimally impacted. Flights to or from Hawaii and Australia flew between 15 and 27 NM more, burned between 458 and 576 lbs more fuel, and flew between 1.5 and 7 min longer to avoid the reentry airspace. The FAA's analysis of the impacts of launches at Cape Canaveral indicates that the continued use of segregated airspace on an increasingly frequent basis could become a prohibitively expensive method of supporting space operations.

Spaceport Challenges

Space launch facilities - now called spaceports – were historically located independent from airports and near the coastline. This geography allowed for

separate operations and access to NAS through SAA's without significant disruption to commercial aviation.

In anticipation of increased launch activity, new spaceports are being developed across the country and in some cases are co-locating with or using the airport facilities. The table previously presented above lists the 10 licensed spaceports currently in operation.

The FAA has publicly announced that Front Range airport, near Denver, Colorado has submitted an application for FAA spaceport licensing. However, no operator plans to utilize the spaceport, should it be approved by the FAA.

Space launch operations that are adjacent to airports or overfly land pose a safety risk to the public as well as to commercial aviation. Spaceports co-located with airports would need to overcome many operational issues such as hazardous fueling, noise abatement, traffic volume/capacity and controller workload. Sharing the NAS in this environment would add a level of complexity that we do not have the ability or resources to manage within the current system at this time. In order for launches to occur at many of these spaceports, significant safety and operational challenges must be addressed.

Key Stakeholders

Unlike the entrance of hundreds of thousands of drone/UAV operators, commercial spaceflight operators have existential incentives and a growing history of safe operations. Existing commercial players in the space transportation arena are well known, several operate in both sectors and the barriers to entry remain high. Since 1989 (nearly 30 years) there have been 290 launches by commercial space operators.

Finding Solutions

The increased frequency and diversity of space launch operations requires the development of new policies, procedures and licensing criteria. Cooperation between all stakeholders is necessary and discussions about real solutions to these emerging problems have already begun.

As noted above, the FAA has recognized that the growing number of space flight operations requires them to reevaluate their management of the airspace and as a result, tasked an Aviation Rulemaking Committee (ARC) with providing recommendations on airspace prioritization policies. As a member of the ARC, ALPA will continue to support the FAA and participate in the safety risk analysis activities as well as rulemaking. Recommendations for this ARC are due in late 2018.

The FAA has also established the spaceport categorization ARC, which will develop recommendations for the FAA to establish a spaceport categorization scheme. The ARC includes participants from both the commercial space and the aviation community. With new spaceport categorizations, it is likely that more airports or

other locations could become designated spaceports. However, with a narrower set of intended operations, it should be easier for all stakeholders to understand how the spaceport is intended to support the space industry.

A Transition to Integration Is Needed

The FAA needs a comprehensive plan to integrate commercial space operations and avoid major disruptions for the other users of the NAS as the demand for access to the NAS for commercial space operations increases. As commercial space operations increase, and as the locations where the commercial space operations continue to expand, the FAA may need to evaluate and standardize the spectrum of commercial space vehicles and operations to reduce NAS impacts while maintaining a high level of safety. At some point, segregation of commercial aviation operations from commercial space operations will not be a viable solution.

Prior to reaching this point, a significant amount of planning and investment is needed to create and implement a commercial space integration strategy very similar to an integration plan drafted for Nextgen. Full integration into the NAS will require strategic and tactical policy and regulations for:

1. Standardized airworthiness certification and equipage standards for space vehicle design.
2. Pilot / Astronaut / Operator training and qualifications requirements
3. Airspace redesign and procedure deconfliction to integrate commercial space operations near major hub airports.

4. Enhancements to ATC Automation tools to better manage terminal, enroute, and oceanic traffic in real-time.
5. Separation standards that allow ATC to separate spacecraft from other aircraft without the use of segregated airspace.
6. Traffic Flow Management tools to effectively manage NAS operations.

Legislation Restricts the FAA From Establishing Integration Rules

To ensure that the commercial space industry has an ample "learning period", Public Law 114-90 prohibits the FAA from promulgating any regulations governing the design or operation of a launch vehicle intended to protect the health and safety of crew and spaceflight participants until the year 2023, absent death, serious injury, or close call. However, when Congress passed The U.S. Commercial Space Competitive Act of 2015, it encouraged the FAA to continue to work with the commercial space and airline industry on ways to improve human space flight safety.

ALPA maintains that commercial space operations require segregated airspace until the "learning period" has gathered enough quantitative data to validate a high level of safety is maintained before the integration of commercial space operations begins. However, it is not too early for the FAA and the industry to begin making plans for the integration of space and aviation operations without segregated airspace.

FAA Needs to Regulate Space Vehicle Design

The FAA should proactively begin developing policies for spacecraft airworthiness and certification to fully maximize the time available for safe integration of commercial space operations. Policies are needed that standardize the design requirements for the range of space vehicles. As part of this set of requirements, the FAA should include Communication, Navigation, and Surveillance (CNS) requirements so that the space vehicles are compatible with commercial aviation operations in the same airspace areas.

FAA Needs to Regulate Flight Crew Qualification, Training, and Certification Requirements

The FAA should require each flight crew member to obtain a space vehicle operator license for the type of vehicle the pilot will operate. The requirements must include:

- Mandatory training requirements and flight time with a certified space flight instructor,
- Critical safety training
- Operator and crew qualifications
- Crew resource management and crew roles and responsibilities
- Use of standard operating procedures
- An annual medical examination by a licensed physician board certified in aerospace medicine

The FAA should also establish commercial space operator training requirements, standards, and any currency requirements to ensure flight crew, ground crew,

maintenance inspections, and safety critical ground operations are fully trained and qualified for the operations.

More Collaboration Needed Between Space and Aviation Stakeholders

The three ARCs that the FAA initiated in 2018 are getting some dialogue started, but additional interaction and collaboration is needed. Although the two sectors are symbiotic, they have developed independently with distinct trade associations and communities. A concerted effort is needed to overcome the lack of communication and coordination between traditional aviation and commercial space segments of the industry. Open debate and exchange of information will be critical to successful future operations of both segments of the aerospace industry. ALPA is willing to take a leadership in facilitating discussions between the two sectors.

Governmental Resources Need Enhanced

Sufficient government resources are required to support the safe and efficient integration of commercial space operations into existing aviation infrastructure and operations. The AST has the sole responsibility for approval of commercial space launches and space operations in the NAS and also authorize licenses to operate the launch and landing facilities for space operations. In conjunction with other FAA offices, AST safeguards the public through trajectory and catastrophic event modeling to determine the volume of airspace required for segregated airspace. It is not possible for the AST to manage this important responsibility with 98 employees and an annual budget of around $20 million.

Existing FAA resources are not adequate to conduct the research and analysis needed to adapt and adopt necessary new policies, regulations and procedures. Significant data exists from past successful and unsuccessful flights that should inform the establishment of new policies and procedures to protect aircraft and minimize operational disruption for either sector. The FAA should consider establishing capabilities such as a "space and air traffic management system" (SATMS) to more equitably support both the evolving and expanding space transportation industry and the mature and continuously growing airline industry in a systematic and integrated manner.

Safety oversight and air navigation services by the FAA's air traffic control organization and the AST must receive sufficient funding to support a more complex system and fulfill their congressional directives. Without adequate resources for planning, oversight and provision of services, safe and efficient operations of both sectors will be negatively impacted.

Inter-Governmental Coordination

In addition to increased resources, the government needs more formal mechanisms for coordination. Competing departments within the FAA, the new National Space Council and a new role for the Department of Commerce (DOC) in space traffic management have led to increased confusion. A clear leader and defined roles within

these government entities must be established, along with regular communications structures.

Distinct governmental advisory committees should assign overlapping members, hold combined meetings or be merged. Clear and consistent government roles must be identified as soon as possible.

Conclusions and Recommendations

The magnitude and complexity of space transportation operations are placing new demands on aviation infrastructure, including the NAS. As more space vehicles transition through airspace that is primarily used by traditional aircraft new policies, regulations and procedures are necessary to provide for safe and efficient operations of both important industries.

- ALPA has an important role in the integration of space transportation operations into commercial aviation infrastructure, operations and the NAS.
- As with any new entrant or in the case of commercial space where the introduction of enhanced technologies are introducing significant advancements in capability, there must be a means to safely integrate with existing aircraft operations and infrastructure without decreasing the level of safety of the existing operations.
- In addition to the existing FAA environmental review process for commercial spaceports, the FAA should create additional opportunities for public

comments in the spaceport approval process, that discuss the intended operations at the spaceports.

- The FAA should include Communication, Navigation, and Surveillance (CNS) requirements so that the space vehicles are compatible with commercial aviation operations in the same airspace areas.
- The FAA should evaluate the need to require each flight crew member to obtain a space vehicle operator license for the type of vehicle the pilot will operate.
- The FAA should establish commercial space operator training requirements, standards, and any currency requirements to ensure flight crew, ground crew, maintenance inspections, and safety critical ground operations are fully trained and qualified for the operations.
- Commercial airline and space operators need to better understand each other's operations. This in turn reduces the likelihood of disruptive operations affecting both groups of operators.
- The safety of the traveling public needs to remain the highest priority for the FAA and the aerospace industry. Commercial airline and space transportation operators need to better understand each other's operations to reduce the likelihood of disruptive operations affecting both sectors.
- Stakeholder collaboration, planning and analysis that informs new policies, procedures and regulations should begin now. ALPA can provide leadership to bring stakeholders together from both the commercial aviation and the commercial space segments.

- The FAA must be given the adequate resources to support more complex analysis, licensing operations, safety oversight, air traffic control services and NAS integration driven by these demands.
- A coordinated government-wide effort is needed to develop and carry out new policies, regulations and procedures for NAS integration, space vehicle certification and spaceport development.
- Unless and until new, fully informed policies, regulations and procedures are put in place, airspace segregation may be the safest risk mitigation.

Thank you for the opportunity to engage. We look forward to continued collaboration to further innovation in aerospace and maintain the safety of our system.

Testimony of Audrey Powers
Deputy General Council
Blue Origin
Before the House Subcommittee on Aviation
Hearing on Commercial Space Transportation Regulatory Reform – Stakeholder Perspectives
June 26, 2018

Chairman LoBiondo, Ranking Member Larsen, Chairman Babin, and members of the Subcommittee, thank you for the opportunity to speak before the committee today on Commercial Space Transportation Regulatory Reform – a topic that Blue Origin has been heavily focused on for the past two years.

Blue Origin's vision is to enable a future where millions of people live and work in space. Our passionate workforce of over fourteen hundred employees work tirelessly to make this future a reality, every day. We recognize that this vision demands higher flight rates, lower cost access to space, and an unwavering attention to safety. This can only be achieved with full operational reusability of our launch vehicles. You can imagine what the cost of air-travel would be if new aircraft were discarded after every flight, so you can appreciate the prohibitive cost of space launch without reusability. Blue Origin has made great strides with our fully-reusable *New Shepard* suborbital launch vehicle, which has flown to space and back seven times – achieving five of those flights in less than 12 months. *New Shepard* launches and lands at our site in West Texas. While the booster lands vertically on landing gear, our capsule separates from the booster in space – 100 km altitude – and offers the six astronauts in our capsule four minutes of weightlessness. For reference, *New Shepard* traverses the National Airspace System and exceeds 60,000 feet altitude within 90 seconds of liftoff, and the full flight duration is about 11 minutes.

We also are developing our next-generation reusable rocket, *New Glenn*, which will launch people and payloads to low Earth orbit and beyond. We have agreements in place for nine commercial launches with a number of leading commercial satellite operators.

We are ready to help end the nation's reliance on Russian engines for national security launches with our BE-4 engine, and we are prepared to bring private capital to partner with NASA for a return to the lunar surface. We are committed to building the next generation of space transportation infrastructure, providing reliable, affordable, and frequent rides to space for people, satellites, and deep space exploration.

Expendable versus Reusable Launch Vehicles

Traditional launch vehicles are expendable launch vehicles, or "ELVs" for short. They launch vertically and are aptly named for the first booster stage which is expended when it falls into the ocean after burning its fuel to lift a payload into space. Conversely, reusable launch vehicle, or "RLV," architectures vary in design - some RLVs launch and land vertically, allowing the booster stage to be reused. Other RLVs are horizontal launch and landing vehicles that operate akin to an aircraft; others are high altitude balloons. These vehicle architectures and operations can vary widely, as do their performance characteristics and safety systems. While these innovative designs and reusable systems have only recently been realized in the mainstream launch market, the regulations governing their operation were created when reusability was largely limited to the Space Shuttle.

Commercial Space Industry's Regulatory Environment

The Federal Aviation Administration's (FAA) Office of Commercial Space Transportation (AST) is responsible for regulating "the U.S. commercial space transportation industry, to ensure compliance with international obligations of the United States, and to protect the public health and safety, safety of property, and national security and foreign policy interests of the United States." AST was created by the Commercial Space Launch Act of 1984, as amended and re-codified in 51 U.S. Code Chapter 509, and AST implements this statutory authority through regulations under Title 14 Code of Federal Regulation Parts 400 – 460.

The FAA rules specific to ELVs are a voluminous set of prescriptive and detailed regulations. FAA promulgated these ELV regulations almost 15 years ago by codifying United States Air Force (USAF) requirements governing launch vehicle operations at Federal Ranges.[1] FAA's ELV regulations and their corresponding USAF requirements impose great oversight on vehicle programs. For example, these requirements allow FAA and Range officials to define the design of flight safety systems, and then to review and approve every step of test and verification procedures that an operator executes on those systems. They also require that the regulating authority approve production procedures and observe the installation of certain safety-related components. They must review and approve design changes or changes to test or operations procedures. Such oversight is not appropriate for the cadence of operations today's commercial operators are trying to achieve. Furthermore, these regulations were created for expendable, vertical launch vehicles using a specific type of flight safety system that requires human activation from the ground. Recent commercial launch industry successes in reusability, autonomy, and alternative vehicle architectures necessitate reform of the current rules.

Nearly 20 years ago, the FAA developed a separate set of regulations for RLVs. These take a different approach to review and licensing, using system safety to evaluate the hazards posed by the vehicle and the mitigations undertaken by the operator to lessen those risks.[2] Instead of telling the operator how to design, test, manufacture, and operate a vehicle, the operator presents a comprehensive safety case founded upon the process of identifying and controlling hazards. This performance-based approach allows the operator to present their design and describe the methods used to control the risks posed by the design, in order to meet the required risk limits set by FAA. In short, the RLV regulations impose risk limits that an operator must meet, and the operator can choose any number of acceptable approaches to meet those limits. While the RLV regulations offer an alternative approach to review of a launch vehicle system, safety requirements are not compromised.

The FAA's RLV regulations are the more appropriate way to regulate a growing commercial space industry, as opposed to the ELV approach, which will not support the increasing cadence of launch activities. A prescriptive process cannot operate that fast, and therefore will act as a restraint to operations. Furthermore, FAA and the USAF do not and should not have the resources required to support the ELV process at the launch rates the industry is driving towards.

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[1] FAA's Expendable Launch Vehicle Regulations are contained in 14 C.F.R. Parts 415 and 417. The USAF requirements for launch operations on a Federal Range is Air Force Space Command Manual 91-710 and Range Commanders Council commonality standards (*e.g.*, RCC-319).

[2] FAA's reentry vehicle regulations, found in 14 C.F.R. Part 435 are nearly identical to the RLV regulations.

Blue Origin currently operates our *New Shepard* vehicle, licensed by the FAA under the RLV regulations, from our private launch site in West Texas. FAA's RLV regulations allow FAA to focus on the aspects of the *New Shepard* vehicle design that pose risks to public safety, and to scrutinize Blue Origin's management of those risks. While there are outdated and inflexible aspects of FAA's RLV regulations that require updating, we view these regulations as the best general approach to regulatory oversight of launch vehicle programs.

The more difficult situation for Blue Origin comes with our development of the *New Glenn* orbital reusable launch vehicle, which we will operate from Cape Canaveral Air Force Station (CCAFS). *New Glenn* must be both licensed by FAA and authorized by the USAF for launches from CCAFS. As described above, FAA's RLV regulations differ significantly from the current USAF Range requirements for launch. This means RLV operators lose the benefit of the FAA's performance-based approach to regulating RLVs because we must meet the USAF's prescriptive requirements. This renders FAA's RLV regulations ineffectual for any reusable vehicle launching from a Federal Range.

Blue Origin fundamentally disagrees with the approach that FAA's ELV regulations and USAF requirements take to review and authorize a launch vehicle program. In recent regulatory reform efforts undertaken by industry members with FAA, we recommended using FAA's RLV regulations as a basis for developing a new modernized set of performance-based regulations. This would offer the flexibility to address novel or controversial technical issues within a launch license process while meeting the overall intent of legacy requirements and maintaining the same level of safety. It would also appropriately use FAA and USAF resources to apply an appropriate level of review to the increasing numbers of operators building programs at Federal Ranges and elsewhere.

More importantly, the National Space Council and the Administration in Space Policy Directive-2 (SPD-2) specifically direct the Secretary of Transportation to "replace prescriptive requirements in the commercial space flight launch and re-entry licensing process with performance-based criteria." Blue Origin's difficulty in pursuing an RLV launch license for *New Glenn* to operate at CCAFS has confirmed that this directive cannot be met without also addressing the prescriptive USAF Range requirements, or the entire effort will be done in vain.

Regulatory Reform Engagement & Recommendations

Both as a member of industry coalitions and on its own, Blue Origin has been an extremely active participant in regulatory reform efforts. As such, Blue Origin is particularly grateful for the increased awareness and action being brought to the topic by this Administration and the National Space Council.

Recently, Blue Origin and a host of operators participated in the FAA's Streamlining Launch and Reentry Regulations Aviation Rulemaking Committee (ARC), which was tasked with addressing the following:

1. How should the FAA modify its current launch and reentry licensing regulations?
2. What performance-based regulations are needed to streamline launch and reentry licensing?
3. What standards are needed to demonstrate compliance with recommended performance-based regulations for launch and reentry licensing?

As part of the ARC, Blue Origin and other operators coalesced around seven characteristics of new regulations that would solve significant difficulties with the current rules. Capturing these characteristics

in new rules will result in initial and recurring safety and economic benefits through increased flexibility, reduced paperwork burden, and an expansion of commercial activities. These characteristics are:

1. *Performance Based* – All commercial launch and reentry operators should be regulated using regulations that are performance based rather than mandatory, prescriptive, and overly burdensome technical solutions.
2. *Flexibility* – New architectures and technological advancements should not be stifled by the regulatory environment. A single license structure to accommodate a variety of vehicle types and operations and launch/reentry sites will reduce uncertainty and allow operators to better predict costs and optimize interactions with FAA. A licensing regime that enables operators to meet regulations without waivers will also increase efficiencies and reduce costs for operators and FAA.
3. *Reform Pre-Application Process and Requirements* – Criteria for entering application evaluation should be clearly defined and completion of a pre-application process should not be a requirement for application acceptance or determination of completeness. Additionally, the FAA should give consideration based on operator experience level and vehicle heritage.
4. *Defined Review Timelines* – Reduced application review timelines and improved processing of applications will support the launch cadence commercial operators are striving to achieve.
5. *Continuing accuracy requirements* – A licensee should only be required to submit updated information to FAA about a licensed vehicle program if a change to the vehicle design or operations impacts public safety.
6. *FAA Jurisdiction* – Oversight should be focused on activities that meet a predefined criteria for hazard to the public. Further, vehicle and site inspection criteria should be clearly set.
7. *Eliminate Duplicative Jurisdiction on Federal Ranges* – One of the most important aspects of any regulatory reform is the elimination of duplicative authorities for commercial operations at Federal Ranges. As explained above, FAA's ELV regulations codified preexisting USAF regulations. Additionally, FAA's RLV regulations are entirely different from FAA and USAF's ELV requirements. Subsequent oversight at Federal Ranges results in commercial ELV operators answering to two authorities – FAA and the USAF – who impose largely similar requirements, while RLV operators answer to two authorities imposing different requirements. The result is an onerous approval process for launch operators pursuing reusability that is based in ELV requirements. RLV regulations are rendered useless in these cases.

FAA AST, informed by the ARC, is now working on an accelerated timeline to produce a Notice of Proposed Rulemaking (NPRM) with one set of draft rules that contain licensing requirements for *all* launch and reentry vehicles by February 2019. Understanding that there are important procedural rules to adhere to during rulemaking, a path was not developed for industry to remain involved either through a negotiated rulemaking model or further interaction with the ARC industry members. The accelerated rulemaking timeline recommended by the National Space Council was intended to rapidly effect change in commercial space regulations to the benefit of both industry and FAA. Blue Origin believes that continued engagement between FAA and industry is critical during FAA's efforts to draft new rules for proposal next year. Without the practical insights of launch license applicants and operators, the NPRM may lead to protracted comment submissions and a consideration period lasting several years, and ultimately fail to achieve the desired reforms.

It is imperative that FAA not work in a vacuum to achieve the new performance-based set of regulations directed by the National Space Council and SPD-2. As described above, this result will not solve the issue of duplicative authorities for operations from Federal Ranges, and the vast majority of launch vehicles operate from Federal Ranges at this time. Without reform to the USAF's prescriptive requirements (which are the basis for FAA's prescriptive ELV regulations), operators at Federal Ranges will be required to continue meeting rules that may not offer consideration for their vehicle designs, without hope of negotiation or resolution within the launch license process. This is why SPD-2 specifically directed:

> "The Secretary of Defense, the Secretary of Transportation, and the Administrator of the [NASA] shall coordinate to examine all existing U.S. Government requirements, standards, and policies associated with commercial space flight launch and reentry operations from Federal launch ranges and, as appropriate and consistent with applicable law, to minimize those requirements, except those necessary to protect public safety and national security, that would conflict with the efforts of the Secretary of Transportation in implementing the Secretary's responsibilities under this section."

Any improvement to FAA's regulations must be a coordinated effort with the USAF and Federal Ranges or there will be no net benefit to operators. The duplicative authority will remain and the Ranges will continue to impose their prescriptive, and outdated requirements. Disregarding the USAF in this effort will ultimately negate any progress made as a result of FAA regulatory reform efforts. The right solution to today's overbearing regulatory environment, and the solution that answers the direction of the National Space Council and the Administration, is establishment of DOT as the sole authority for commercial space launches, even from Federal Ranges, and that DOT implements that authority through a new set of performance based regulations.

Conclusion

The increasing cadence of launch operations and the rapid entry of varied reusable vehicle architectures into the mainstream launch market requires a serious reevaluation of the existing regulatory structure. Reform efforts must account for the unique performance characteristics and safety systems across these varied architectures and operations – whether a reusable first stage booster or a high altitude balloon. We are confident that safe operations can remain the paramount focus even with a new, modernized approach to regulating this industry.

The cumbersome ELV regulations that exist today as well as the duplicative authorities associated with operations from a Federal Range threaten commercial progress as existing operators increase their launch cadence and new companies begin operations with reusable vehicle architectures. In the near term, ensuring incorporation of the aforementioned seven characteristics of new regulations into the FAA's rulemaking would solve significant difficulties with the current rules. Further, active and ongoing engagement with the USAF as well as industry partners during the accelerated rulemaking process would increase transparency and benefit the ultimate NPRM.

The right solution to improving today's regulatory environment, and the solution that answers the direction of the National Space Council and the Administration, is reform of *all* regulations that apply to launch activities to a performance-based approach. Blue Origin is eager to continue working with the National Space Council, the FAA, the USAF, as well as other industry operators to ensure that new rules

and regulations promote safety above all, while also supporting the expansion of this new and varied set of commercial reusable systems.

Thank you again for the opportunity to speak with you today and for your attention to this important matter.

STATEMENT OF
CARYN SCHENEWERK
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SPACE EXPLORATION TECHNOLOGIES CORP. (SPACEX)

BEFORE THE
SUBCOMMITTEE ON AVIATION
TRANSPORTATION & INFRASTRUCTURE COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

JUNE 26, 2018

Mr. Chairman, Ranking Member Larsen, and Members of the Committee,

Thank you for the opportunity to participate in today's hearing on commercial space transportation regulatory reform. We appreciate the Committee's interest in exploring how regulatory reform can facilitate the continued growth of the commercial space industry. Given the increase in the cadence of U.S. launches, ground-breaking technological advances like rocket reusability, and the expanding scope of commercial space activities, regulatory reform is timely and necessary. The recommendations discussed in my testimony today are borne of practical experience, and offer an opportunity to streamline processes while fulfilling the government's responsibility to ensure that missions are carried out in a manner that protects public safety.

Founded in 2002, SpaceX's mission is to dramatically improve the reliability, safety, and affordability of space transportation and, in so doing, to make humanity a multi-planetary species. Since 2010, we have successfully launched the Falcon 9 rocket 55 times and, earlier this year, we successfully conducted the inaugural mission of the Falcon Heavy rocket. SpaceX's diverse set of launch customers include NASA, the Department of Defense ("DOD") and national security space community, commercial satellite operators, and allied international governments.

For NASA, SpaceX routinely conducts critical uncrewed cargo resupply missions to and from the International Space Station (ISS) with our Dragon spacecraft. Later this week, we will launch the 15th operational Dragon mission to the International Space Station ("ISS") under our Commercial Resupply Services ("CRS") contract with NASA. SpaceX is also working to restore U.S. human spaceflight capability in partnership with NASA. Later this year, SpaceX is scheduled to launch NASA astronauts to space from U.S. soil for the first time since the Space Shuttle retired in 2011.

SpaceX's Falcon 9 and Falcon Heavy rockets are also certified to launch critical national security satellites for the U.S. Air Force and the intelligence community. SpaceX has already conducted several successful national security space launches, and we have a number of such missions on contract in the coming years.

Commercially, SpaceX is the largest launch services provider in the world, with more than 100 missions on manifest representing $12 billion in signed contracts. Having entered the commercial satellite launch market in 2012, SpaceX has restored the U.S. as a market leader, reversing a troubling trend in American competitiveness. Prior to SpaceX's entry into the market, U.S. market share in commercial satellite launch had collapsed from 100 percent in 1980 to zero percent in 2010, with the existing domestic launch suppliers ceding the market to French and Russian competitors. In 2017, SpaceX conducted over 60 percent of all U.S. launches with 18 completed missions—12 of those missions were for commercial satellite customers.

We are exceeding this cadence in 2018, and plan to launch 50 percent more this year. In 2018, as with 2017, SpaceX will launch the majority of the world's commercial geostationary satellites.

SpaceX has significantly increased its launch cadence while reducing launch costs due to advances in the design and manufacturing process and, importantly, rocket booster reusability. In December 2015, SpaceX's Falcon 9 first stage successfully delivered its payload to orbit and then returned to a landing site at Cape Canaveral Air Force Station ("CCAFS")—the first time an orbital-class booster had ever been recovered intact following a launch. Since then, SpaceX has successfully launched and landed 25 first-stage boosters. Thirteen of those boosters have since launched a second time for operational missions.

The onset of launch vehicle reusability—now being adopted by others in the industry, and increasingly embraced by purchasers of launch—represents a significant shift in technology that will further lower launch costs and make space launches more reliable. Reusing boosters provides invaluable insight into the reliability and safety of launch vehicle design and build, including inspection and analysis of hardware after it has flown.

In May of this year, SpaceX launched the final iteration of the Falcon 9 rocket—Falcon 9 Block 5. Highly and rapidly reusable, Block 5 will be SpaceX's workhorse vehicle for years to come; it has the capability to be re-flown up to 10 times following a thorough inspection, and without refurbishment.

The rapid pace of innovation in the U.S. commercial space industry is redefining access to space for commercial and government customers, unleashing new scientific and technological advancements in space, and creating high-tech, high-paying manufacturing and engineering jobs in America. The U.S. should continue to lead in this area to stay at the cutting edge of space innovation. To do so, it is critical that federal regulations governing space launch are updated to keep pace with the speed of this innovation, while maintaining public safety and ensuring the efficient and fully integrated use of the National Airspace ("NAS") through modern technology.

Although the commercial space industry is undergoing significant growth and activity, it is important to keep in perspective that the launch industry continues to be a very small overall user of the NAS. As a point of comparison, for example, FAA's Air Traffic Organization ("ATO") "provides service to more than 42,000 [commercial] flights and 2.5 million airline passengers across more than 29 million square miles of airspace" *every day*.[1] By contrast, there were only 90 orbital space launches *globally* in all of 2017; in the U.S., the FAA issued a *grand total* of 23 commercial launch licenses that year, the highest ever granted.[2] Equally importantly, the duration of an orbital space launch is exceedingly brief compared to a standard airline flight; during launch, SpaceX's rockets are propelled beyond 60,000 feet—the demarcation of the NAS—in approximately 90 seconds.

My testimony today will focus on SpaceX's recommendations for updating the FAA's commercial space launch regulations, including the following areas:

1) Revise FAA regulations governing the licensing of launch and reentry vehicles by adopting performance-based regulations;
2) Streamline regulations to facilitate a single license structure for launch and reentry;

[1] https://www.faa.gov/air_traffic/by_the_numbers/
[2] https://www.faa.gov/about/office_org/headquarters_offices/ast/media/2018_AST_Compendium.pdf

3) Allow for licensing a launch vehicle from multiple launch sites;
4) Eliminate conflict between US Air Force range requirements and FAA space regulations; and
5) Ensure effective and efficient utilization of the NAS by updating analytical and technology tools.

The FAA Office of Commercial Space Transportation ("AST") is responsible for encouraging, facilitating, and promoting commercial space launches and reentries.[3] Under this authority, AST is the office that grants launch and reentry licenses, as well as licenses for launch and reentry sites. Notably, AST's responsibility is to ensure that launch and reentry activities are conducted in a manner that protects the public and certain government interests; the operator, contractors and customers are responsible for mission success and accept the risk of spaceflight.

Reforms should focus on creating a licensing regime that efficiently regulates launches, reentries, and spaceports in a manner that prioritizes public safety without limiting technological or operational advances. SpaceX strongly recommends that regulations be performance-based rather than prescriptive processes, techniques, or procedures, as has historically been the case. Performance-based regulations result in successful public safety outcomes while enabling the best, most innovative, and least burdensome tools for achieving regulatory ends. Such a regime promises immediate, long-term safety and economic benefits, and will help attract more commercial space activities to the U.S., and result in more efficient use of the NAS.

The FAA's launch licensing regulations in Title 14, Chapter III were published three decades ago when commercial launch activities were exceedingly rare, and when reusable rockets were an unrealized hope.[4] As such, the regulations are struggling to accommodate the type and frequency of current commercial launch operations. In some instances the regulations actually conflict with modern operations that result in greater safety. For example, FAA regulations specifically prescribe that launch vehicles use a traditional flight termination system ("FTS"), which is radar-tracked system that terminates the mission if the launch vehicle strays from its planned trajectory, a technology as old as rockets themselves. To enhance safety and streamline operations, SpaceX developed an autonomous flight safety system ("AFSS"), and worked in tandem with the U.S. Air Force to certify this new technology for our missions. Rather than use expensive and antiquated radars to track a rocket's trajectory from the ground and manually terminate a stray rocket, AFSS leverages new, safer technology through which the rocket tracks itself against its trajectory and will self-command destruct, if necessary. The Air Force Range Safety Office ("RSO") was able to quickly update its regulations to accommodate this technological advancement, while the FAA was unable to do so as a result of its regulatory structure and lengthy regulatory timetables. Here, a performance-based regulatory approach would have enabled SpaceX to demonstrate to the FAA the enhanced safety of AFSS and how it exceeds safety requirements.

Overall Framework

Two recent efforts hold promise for making needed reforms and updates to the launch and reentry licensing regime. On May 24, 2018, President Trump issued Space Policy Directive 2 ("SPD-2"), which calls for the Secretary of Transportation to review Department of Transportation ("DOT") regulations governing launch and reentry licensing. During this review process, the Secretary is directed to consider: 1) requiring a single license for all types of commercial space flight launch and reentry operations; and, 2) replacing prescriptive

[3] 51 USC § 50903
[4] 53 Fed. Reg. 11004, April 4, 1988

requirements in the commercial space flight launch and reentry licensing process with performance-based criteria. Additionally, SPD-2 calls for DOD and DOT, as well as NASA, to coordinate in order to minimize U.S. Government requirements related to commercial space launch and reentry from Federal launch Ranges, except where necessary to protect public safety and national security.

These proposed reforms are a positive first step, and SpaceX strongly supports streamlining the licensing process to make it more flexible for operators. Doing so will enhance public safety and make the regulatory structure more efficient and effective. These efforts will help refocus regulatory efforts on the Government's core mission of protecting public safety. SPD-2 also specifies that the Secretary of Transportation shall rescind or revise the DOT launch and reentry regulations, or initiate a notice and comment rulemaking to revise or rescind these regulations by February 1, 2019. We believe this timeline is feasible, and encourage the FAA to fully implement this direction.

As part of this process, the FAA sought recommendations throughout the spring of 2018 for launch and reentry licensing reform through the Streamlined Launch and Reentry Licensing Requirements Aviation Rulemaking Committee ("ARC"). The ARC's aim was to develop recommendations for a performance-based regulatory approach in which the regulations state safety objectives and leave design or operational solutions up to the applicant. SpaceX supports the recommendations issued in the Committee's Final Report, and we recommend that launch safety requirements be performance-based and flexible, with the AST licensing and inspecting based on the operator's individual means of compliance.

SpaceX and other commercial launch companies are also working with the FAA and other airspace users on improving integration in the NAS. SpaceX, for its part, recognizes that increasing the frequency of launch to once a week or less will have an impact on other uses of the NAS. We are working with the FAA through a separate ARC process to recommend and advance new technologies that will enable launch activities to be seamlessly integrated into the NAS by leveraging real-time data that optimizes our usage of the NAS. This can and should be achieved without prioritization of particular use cases.

Policy Recommendations to Reform FAA AST's Commercial Launch Regulations

1. **Revise and Streamline FAA's launch licensing regime**

As the FAA undertakes regulatory reforms that balance the interests of protecting public safety and encouraging innovation, an important step should be modernizing and streamlining the launch licensing process. Launch licensing is currently fragmented between several regulatory sections including 14 CFR Parts 415, 417, and 431, which take different regulatory approaches for expendable and reusable launch vehicles. This distinction between expendable and reusable launch vehicles is inappropriate given modern space technology and operations. Further, the launch licensing Parts contain numerous inefficiencies, duplications and ambiguities that do not promote public safety.

Consolidation of these Parts should create one set of governing launch-licensing regulations that can accommodate all vehicle types, mission profiles and launch sites. The regulations should impose a performance-based review of the applicant's System Safety Program, as well as the applicant's design, manufacturing, operations systems, and processes, rather than an onerous, piece part review. The FAA should supplement the updated regulations with agency-developed guidance that can be updated more readily as the industry expands and evolves.

SpaceX has joined other members of industry in promoting a revision of AST's launch regulations that creates a flexible framework for licensees, avoids detailed, prescriptive requirements and provides for timely, transparent reviews.

2. Revise License Application Requirements

Another challenge with the current regulatory structure is the timeliness of decisions on licensing, which has a significant impact on launch companies. Currently, 51 U.S.C. § 50905 establishes a deadline for a license review of "not later than 180 days after accepting an application," and allows 60 days for reviewing the application before it is accepted. A 180-day review period cannot accommodate the launch tempo commercial companies are under contract to undertake in the near-term.

The regulations should also be updated to consolidate the application procedures in Part 413 and clarify that the pre-application process is not mandatory. The process is described as helping an applicant "identify possible regulatory issues as the planning stage" for an application. It should be up to an applicant whether to utilize the pre-application process for assistance or to submit an application in pursuit of a license. The pre-application process should not be a means for preventing an applicant from having its application accepted to begin the official review process. Should an applicant choose to submit an application without pre-application discussions, the regulations define a process for dealing with an application that is not complete enough for the FAA to being review.

For SpaceX, launches currently are occurring on average every two weeks or less, with that rate likely to increase in the coming years. For example, we plan to launch more than 25 times in 2018, and each launch that requires a new license or a modification to an existing license may be subject to a 180-day clock. Taken together, the 180 days to review an application and the 60-day timeline to accept an application for review can result in an 8-month wait for an applicant on top of the time the FAA imposes for the pre-application consultation. This is clearly impractical and will, over time, degrade the viability of the commercial space sector. SpaceX recommends that FAA implement a new standard with a 60-day timeframe for granting a license, and a 15-day review period to determine if an application is complete. Orbital launches tend to be relatively similar to each other with well-understood trajectories and orbital insertion parameters, so a more streamlined and timely review process will not impact the FAA's ability to protect the uninvolved public.

3. FAA AST's Regulations Should Allow for Licensing Launch Vehicles for Multiple Launch Sites

FAA regulations governing commercial space launch should be revised to allow for licensing a launch vehicle from multiple launch sites under a single launch operator's license. For example, SpaceX's Falcon 9 should be able to operate from Space Launch Complex 40 ("SLC-40"), located within Cape Canaveral Air Force Station, and Launch Complex 39A ("LC-39A"), located within NASA's Kennedy Space Center, under the same license. These sites are effectively on the same premises. Launch operators that utilize multiple launch sites should have the flexibility to move launches between sites, particularly sites as proximate as LC-39A and SLC-40 are, without having to apply for a new or modified license. This would not change the underlying safety calculus or analysis of the FAA, and it makes practical sense.

The long-term goal of these revisions should be to implement a process through which applicants can receive multi-launch operator licenses through a less burdensome application process. Licensed operators could then file a "flight plan" within a reasonable period prior to launch. A "File & Fly" framework would

become increasingly feasible as launch vehicles become more reliable, fly more frequently, and flight plans and trajectories are repeated and standardized.

4. Allow Launch Providers to Comply with USAF Range Requirements

The U.S. Air Force is able to regularly revise, update, and improve its Range requirements—as it did with AFSS—since it is not subject to the Administrative Procedures Act ("APA"). In instances where a launch operator demonstrates compliance with USAF requirements, the FAA should accept the USAF's requirement in place of the FAA regulatory requirement as an equivalent level of safety, regardless of whether the launch is operated on a Federal or non-Federal range. 14 CFR Chapter III should not create a competitive disadvantage for commercial launch operators that invest in non-Federal range locations. Conversely, FAA regulations should be updated and the U.S. Air Force should move quickly to accept that launch operators in compliance with FAA regulations are also in compliance with Air Force Range safety requirements—in other words, there should be reciprocity between FAA and the Air Force in order to avoid duplication in licensing requirements, which creates regulatory confusion, adds costs, and does not enhance safety.

5. Enhance Integration of the NAS

Today's commercial space launch operations require airspace to be cleared and traffic rerouted based upon prelaunch trajectory analysis and debris modeling assumptions that have not been optimized for this purpose. Current FAA operations do not use real-time information regarding the actual position and trajectory of the space vehicle, and debris propagation software used today must be run well in advance of the mission, resulting in larger volumes of airspace being closed than is necessary with greater impact to commercial air traffic. The FAA tracking and display systems used to manage air traffic were never designed to manage integrated air and space operations. As a result, ATO personnel today lack the necessary tools to effectively integrate commercial space operations that are occurring in the NAS.

To successfully integrate launch and reentry operations into the NAS, the size and duration of normal launch and reentry hazard areas must be significantly reduced. This will require:

1) Real-time tracking information for space vehicles being made available to ATO operators through En Route Automation Modernization ("ERAM"), Standard Terminal Automation Replacement ("STARS"), and Traffic Flow Management System ("TFMS"); and
2) Real-time debris response capability for ATO operators.

Simply put, the ability to track the space vehicle and calculate a debris hazard area in real-time will enable airspace closures to be substantially reduced in both size and duration. Additional airspace would only be closed in the event of an actual space vehicle failure.

FAA has demonstrated the capability to handle these inputs in order to optimize use of the NAS. For example, AST has demonstrated the ability to gather real-time telemetry from commercial space operators, although the critical next step is to transfer this data to ATO real-time systems using the technology tools outlined above. Additionally, the FAA's Office of NextGen has demonstrated the ability to generate optimized real-time debris hazard areas through the Hazard Risk Assessment and Management ("HRAM)" prototype.

In order to successfully integrate commercial space operations in the NAS, the critical capabilities of space vehicle tracking and debris hazard management must be fully integrated into systems used by the NAS operators. To this end, as noted, SpaceX and other commercial space companies are currently engaged in another ongoing ARC process related to NAS integration specifically. We look forward to concluding this process in a way that advances the most efficient and fair use of the NAS.

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Mr. Chairman, I appreciate your invitation to testify before the Committee today. This is an exciting time for the commercial space industry, and we are on the cusp of realizing the promise of rapid technological and scientific advances. SpaceX looks forward to being part of the solution to ensure that regulations keep pace with industry advances, and facilitate a future where space launch is increasingly safe, reliable, and affordable.

Testimony of
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United Launch Alliance, LLC (ULA)

Subcommittee on Aviation
Committee on Transportation & Infrastructure
United States House of Representatives

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Chairman LoBiondo, Ranking Member Larsen, Chairman Shuster, Ranking Member DeFazio and Members of the Subcommittee, thank you for the opportunity to appear before you today on behalf of United Launch Alliance (ULA) to discuss space launch regulatory reform. ULA is the world's most successful commercial launch company. Since ULA was formed in 2006, we have launched 128 missions to space with 100% mission success. No other launch company matches that record. ULA also remains the only launch provider certified to meet all national security space requirements. For more than a decade, we have launched nearly every major national security asset and NASA science mission to orbit. GPS, secure communications, weather forecasting, tracking and data relays, and missile warning satellites are among the many payloads ULA has delivered to space.

ULA builds and launches the Atlas and Delta families of rockets, which trace their heritage back to the dawn of the space age. These vehicles have served government and commercial customers successfully for decades. John Glenn made his historic trip into orbit aboard an Atlas in 1962, and astronauts will be flying on Atlas V aboard Boeing's Starliner to the International Space Station (ISS) as part of NASA's Commercial Crew program. These missions to the ISS will mark our nation's return to launching U.S. astronauts from U.S. soil. NASA has also counted on Atlas V to carry cargo to the ISS reliably and rapidly in difficult circumstances as part of its Commercial Cargo program.

The Atlas and Delta family of rockets have enabled science missions to every planet in the Solar System and beyond. When NASA needs to go to the Moon, the

Sun, Mars, Pluto, or anywhere else in the Solar System, our civil space agency relies on a ULA rocket.

We are working to take commercial companies to distant destinations as well. Astrobotic, a commercial lunar logistics company in Pittsburgh, Pennsylvania, recently selected ULA to launch its Peregrine lander to the surface of the Moon. This will mark the first launch of a commercial vehicle to the lunar surface from the United States.

Eighteen of our 128 missions to-date have been commercially licensed. These customers cannot afford launch mishaps or significant delays. Every day a spacecraft is waiting for a launch vehicle that is behind schedule, the satellite operator is losing money. That is why our customers fly with ULA; they know they are getting the most reliable, on-time service in the industry. Even though commercial launches represent a relatively small percentage of our business, we expect this number to rise in the future. ULA remains committed to supporting all NASA and national security requirements in the years to come and performing more commercially licensed launches. Thus, the effectiveness of the Federal Aviation Administration's (FAA) Office of Commercial Space Transportation's (AST) launch licensing regime is critical to ULA's future success of important civil and commercial missions to space.

ULA enjoys a good working relationship with the FAA and addresses licensing issues with the agency in real-time. Earlier this year, ULA assumed marketing and sales responsibilities for commercial sales of our rockets. Previously, Lockheed Martin Commercial Launch Services held that responsibility for the Atlas V. As a result, ULA submitted an application for an operator's license to support our Atlas V commercial missions from Cape Canaveral, Florida. On May 31, 2018, the FAA granted ULA an operator's license that will cover commercial sales of Atlas V for the next five years. This allows ULA to fly commercial missions under one license, assuming we fly flight profiles and rocket configurations specified in the license.

One of ULA's key differentiators in the launch market is our ability to launch quickly and on time. In 2016, we unveiled RapidLaunch, which allows customers to go from contract to launch in as little as three months. This offering would not be possible without help from the FAA, and we have successfully worked with the FAA in the past on accelerated timelines. For example, when Orbital ATK came to ULA

to launch the OA-7 cargo mission to the ISS, the requested launch date was within the FAA's allotted 180 days for review of a new license application. Thanks to our relationship with the FAA, and their familiarity with Atlas V via previous licenses, they were able to expedite their review, and we were able to launch that mission less than six months after going on contract.

Another customer that has benefited from the FAA's expertise, responsiveness, and professionalism is Astrobotic. As previously stated, a commercial lunar lander has never been launched from the United States. Payloads such as this require certification that the mission does not violate the United States' obligations under international law. Astrobotic has already kicked off that process with the FAA and is pleased with the experience.

In the past, the FAA AST has lacked adequate resources to meet the demands of the launch market, but Congress has acted to rectify that. I would like to thank this committee in particular for its work on the recent *FAA Reauthorization Act of 2018*, which increases the FAA AST's authorized budget to more than $33 million in 2019 and continues increases in future years.

Safety Must Remain the Top Priority

The President, Vice President, National Space Council, Congress, Department of Commerce and the Department of Transportation should be applauded for their efforts to empower America's space industry. As reform efforts move forward, we must take great care to not sacrifice safety for convenience.

In the launch business, when something goes wrong, it impacts everyone. A worst-case scenario would be damage inflicted on a third party or even loss of life resulting from a commercial space launch. The FAA is doing an excellent job ensuring public safety in today's regulatory environment, and we urge all parties to remain focused on safety rather than sidestepping oversight for convenience. Space launch is not the same as driving a car or flying a plane. A launch accident that damages a launch facility could significantly delay or even halt the government's ability to get critical, life-saving assets into space.

The Atlas and Delta vehicles have been safely launching commercial missions for decades, yet during the regulation streamlining process, it has often seemed that the

stakeholders being given the reins by government to drive the conversation include companies that are very new to the launch market or have yet to fly anything to space. These companies may not understand how challenging it is to reliably and safely launch to space, and in some instances have experienced repeated, damaging and dangerous launch failures.

The recent Aviation Rulemaking Committees (ARC) have proven to be a good forum for key industry stakeholders to engage and provide guidance to the FAA on how best to shape future regulations. However, due to time restrictions, we have concerns about the process and worry the final regulations may not reflect the views of the ARC. The Streamlined Launch and Reentry Licensing ARC was conducted on an incredibly short timeline of just a few weeks and is no longer able to interface formally with the FAA to provide comments and feedback as the FAA develops proposed rules. ULA strongly encourages the FAA to reengage with the ARC in this process.

The FAA is working under a tight deadline to propose new regulations by early next year, and we fear that in this rush to produce a product, the FAA will forgo the inputs of the rushed ARC and rely heavily on inputs provided by a select group of new and aspiring launch companies that the FAA has been meeting with in private regarding new launch regulations for more than a year. ULA was not included in these conversations. Because ULA has not been a squeaky wheel and has instead focused on working effectively within the current launch regulation paradigm, we are concerned the FAA will pay less heed to our decades of experience and instead cater to start ups that have little real experience with the licensing process and with meeting stringent safety requirements. It is my observation that many actors portray the FAA as a barrier to success to explain program delays. ULA does not view the agency that way because we understand why their mission is important to the promotion of commercial space.

We treat the FAA as a partner, and we depend on them for our success to ensure that we remain the world's safest, most reliable launch company. It is critical that any new regulations do not trade safety for convenience. A catastrophic launch failure traced to lax regulations would predictably result in a costly swing of the administrative pendulum toward a return to excessive government intervention.

Regulatory Reform Efforts

While our experience with the FAA has been positive, there is room for regulatory streamlining. ULA commends the efforts of the President, Vice President, National Space Council, Congress, Department of Commerce and the Department of Transportation to empower industry by streamlining regulatory requirements of commercial space companies. In response to direction from the National Space Council, the FAA stood up several ARCs. ULA is participating in multiple ARCs and continues to engage Congress and the Administration on safe, common sense regulatory reform. The following are recommendations that, if implemented properly, ULA believes will improve efficiency to the licensing process without introducing unacceptable risk.

From an administrative perspective, reduced launch license processing times would be helpful, especially if a launch service provider already has other licenses for similar vehicle configurations and launch trajectories. This would help a launch provider respond to requests for quick-turnaround launches when a spacecraft customer wishes to swap launch vehicles because another provider is unable to satisfy technical concerns or meet the required launch date. The FAA deserves credit for voluntarily reducing their review times to support these situations.

From a technical perspective, ULA also has recommendations. First, a general reduction in the number of requirements, especially for specific mission compliance after a license is issued. The FAA is addressing this issue in response to direction from the National Space Council to provide new language on licensing requirements for review in early 2019.

The FAA is investigating a move away from prescriptive requirements to performance-based requirements. A performance-based approach means that the FAA would define requirements at the most fundamental level, the number of requirements would be minimized, and launch service providers would have the opportunity to demonstrate compliance without the need to incorporate specific components or processes into their systems.

The pros of a performance-based approach include maximum flexibility for launch service providers and the ability to deal with widely differing launch system designs and operational procedures. Additionally, this option has the least financial impact

on providers in an increasingly competitive environment. This approach could also result in the simplest regulations and, potentially, a less complicated compliance and enforcement regime.

The following is an example of a current issue that a performance-based approach could address:

> FAA launch regulations were developed based on United States Air Force (USAF) Range Safety documents that address requirements applicable to specific system configurations. ULA often launches configurations that are close to, but not the same, as the configuration the rule originally addressed. When this happens on a NASA or USAF launch, we work with the 30th and 45th Space Wings to develop a solution that meets the intent of the rule. Because the FAA regulations are law, there is no easy way to deviate when we collectively agree we meet intent. The FAA needs a process that can deal with system configurations not specifically addressed by the original Range Safety documents, and that will continue to evolve.

The cons of a performance-based approach include the risk of over-simplification that could incentivize launch service providers to cut corners to the point that public safety is compromised. Enforcement and compliance monitoring on the government side could also be complicated by different providers using significantly different methods.

ULA favors a performance-based approach that addresses the cons described above and that continues to recognize public safety as paramount.

The second improvement would be to coordinate and consolidate requirements between different government agencies involved in launch site regulation, something Congress is taking important steps to address. NASA, USAF, the FAA, and other agencies have overlapping requirements that are redundant in many, and conflict in some areas. Ideally, one government agency (or one joint-agency group) would act as a single point of contact with a single set of rules for overseeing safety regulations and enforcing compliance for all space launches. There is no material difference when a provider launches for NASA, USAF, or under a FAA license, but the regulatory requirements are different. Even more burdensome than the multiple sets of requirements is the need to interface with each individual agency separately.

For a FAA-licensed launch, ULA has to demonstrate compliance to similar requirements to three or four government agencies. This entails identification of the requirements, notifying, scheduling, and paying travel cost for inspections. One agency will not accept the results of another agency's inspection. Consequently, there is tremendous opportunity for consolidation, simplification, and increased efficiency in this area. A single safety document that covers requirements from initial manufacturing through launch, developed by a government-led working group with direct industry participation, is one option for making progress in this area.

The following example illustrates one issue launch providers currently face as a result of agency differences at the launch site:

> During a commercial launch campaign, the FAA treats major operations at nearby facilities (e.g. a static test firing at a different launch provider's facility) differently than the USAF does for one of its missions. One difference relates to the Flight Hazard Area /Flight Caution Area. Specifically, the 45th Space Wing is more accommodating when it comes to allowing ULA Mission Essential Personnel to remain at Space Launch Complex 41 (SLC-41) during major operations at SLC-40 for non-FAA licensed missions. This enables ULA to keep personnel working and not delay operations for the next Atlas V launch. However, the FAA is less accommodating in allowing ULA personnel to remain at SLC-41 during FAA licensed operations at SLC-40, which can cause monumental delays and schedule perturbations. There can be several FAA licensed missions per year at each launch site, and the resulting deleterious effect on the other party's launch operations are significant. Launch providers and the USAF Range spend much time and significant resources de-conflicting SLC-40 and SLC-41 operations due to the FAA-unique requirements that other agencies do not impose.

Airspace Integration

Through the ARC process, the FAA is also seeking to address airspace integration issues. When we prepare to launch a rocket, safety requirements dictate that a certain amount of airspace around the flight range be temporarily shut down to protect third parties from any flight mishaps. ULA is sensitive to the aviation community's concern about airspace closures as launch rates and the number of launch sites increase. Minimizing airspace impacts from launch events is in our

common interest. The search for optimal solutions that integrate the needs of the space and aviation communities begins with an understanding of the constraints and challenges faced by each community.

Earlier this month, an ARC met near our launch facilities in Cape Canaveral, Florida. Aviation representatives provided valuable insight to the space community on the operational challenges faced by airlines on a daily basis, and on how temporary airspace closures impact airlines and the Air Traffic Control system. ULA is preparing a similar briefing for the July meeting that will summarize constraints and challenges associated with launch. Emerging analysis and communication capabilities have the potential to significantly reduce the size and duration of airspace closures in the future. Specifically, analysis tools will reduce the size and duration of stay-out zones through better predictive capability, and improved communication will allow launch status to be disseminated more quickly, allowing airspace to be reopened at the earliest possible moment.

It should be noted that this ARC was formed without ULA inclusion or notification. As the most experienced launch provider in the nation, this is an oversight that could have severely hindered the effectiveness of the ARC. We believe the ARC felt the commercial space industry was represented by trade organization participation, but no single organization represents the views of the entire commercial space industry.

The discussion is just beginning, but it is clear that there is education needed on both sides. We are pleased with the aviation industry's willingness to share and receive information, and hope this leads to a mutually beneficial path forward.

Looking Ahead

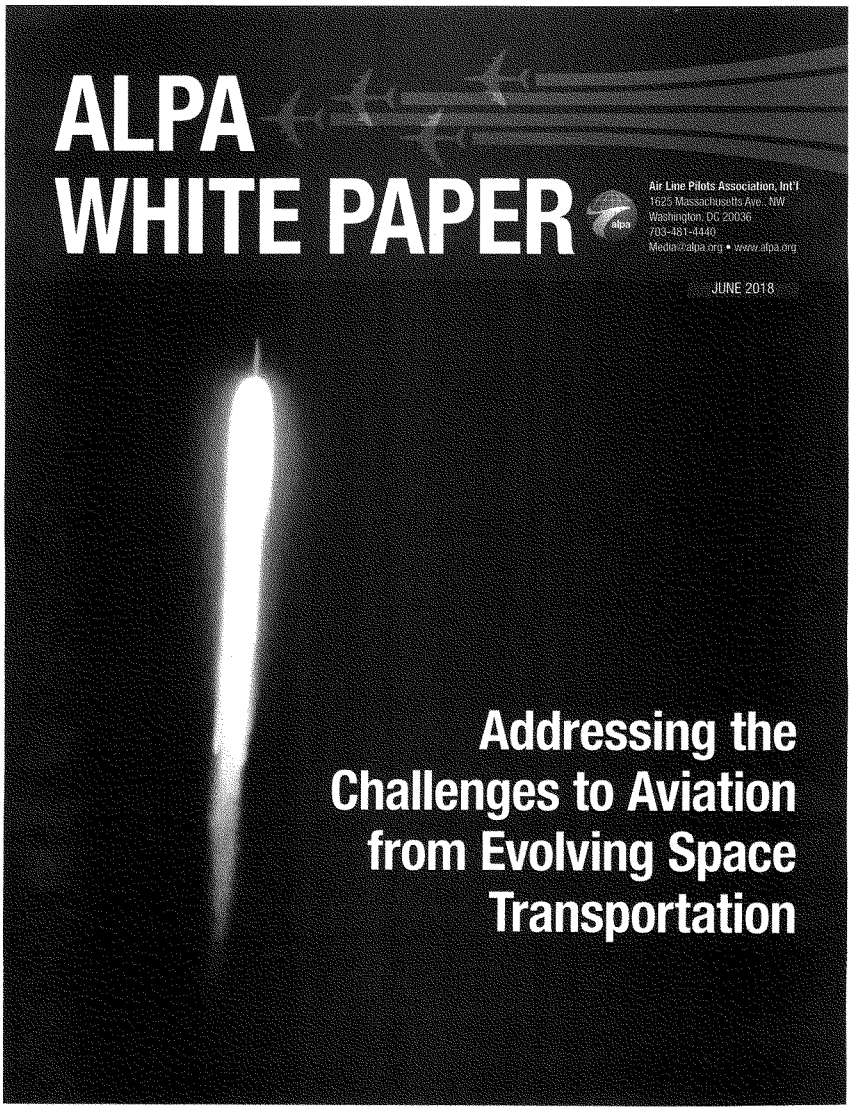
Looking ahead, ULA is undergoing a transformation. While Atlas and Delta will continue to operate into the next decade, we are working to retire those vehicles and phase in our new Vulcan Centaur rocket. Vulcan Centaur will contain the same DNA as Atlas and Delta; it will be a launch vehicle built to fulfill all national security requirements with maximum reliability. Like Atlas and Delta, the majority of Vulcan Centaur is commercially funded, with two thirds of Vulcan Centaur development being paid for by industry.

Vulcan Centaur will one day be ULA's sole product line, as opposed to the three product lines ULA maintains today. This, along with advancements in technology and new, innovative manufacturing techniques will allow us to significantly reduce the cost of launch.

We look forward to aiding in the continued success of the FAA. ULA has enjoyed a good working relationship with the FAA AST under the leadership of Dr. George Nield. Kelvin Coleman has recently taken over as the Acting Associate Administrator for Commercial Space Transportation and has continued the open communications and industry focused approach of Dr. Nield. We look forward to continuing our work with him to ensure commercial space launch continues to be a safe and efficient process.

I want to thank the committee for taking an interest in this topic. Launch licensing and regulatory reform are some of the most mundane topics in space, and all of us would much rather be talking about Pluto, Mars, and other galaxies, but making sure this is done properly is critical to ensuring the United States remains the world leader in space.

Again, thank you for inviting me to appear today, and I look forward to answering your questions.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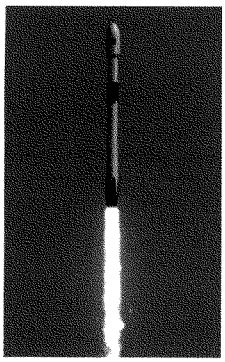
Addressing the Challenges to Aviation from Evolving Space Transportation

Executive Summary

The future growth and success of U.S. commercial aviation depends upon continued safe, dependable, and efficient access to shared public resources, such as the national airspace system (NAS), air traffic management, ground infrastructure, and airport services. Expanded markets and technology advances in the commercial space industry are enabling new entrants to access these limited resources, which has become a critical challenge for the aviation community. Air traffic management, airports, and the NAS are regulated and managed according to strict operational and safety rules, which will not sufficiently accommodate the projected growth and evolution of space transportation without enhancements. Any time there is significant growth in a segment of the airspace user community, there must be a means to safely integrate with existing aircraft operations and infrastructure without decreasing the level of safety or efficiency of existing operations.

The commerical space industry is often viewed as an extension of aviation, and neither industry would be successful today without the other.



Falcon9 Block5 Rocket launch, May 5, 2018.

Each sector generates hundreds of billions of dollars in annual economic returns for the United States and provides unmeasurable benefits to society. The Federal Aviation Administration (FAA) has successfully coordinated the activities of both airplanes and rockets for over 60 years. In many ways, there is a false distinction between the two sectors, since several airplanes travel into outer space, and all space vehicles travel through the atmosphere. This commonality is signified in the word "aerospace," created to describe the branch of industry that builds and operates vehicles and systems in the atmosphere and beyond.

As spaceflight becomes more diffuse and routine, both sectors must cooperate to create policies, regulations, and procedures to manage shared national aerospace resources safely and efficiently. This paper provides a comparison of the development of each sector, as well as an overview of the challenges and safety concerns that evolving space development poses to commercial aviation. It identifies key stakeholders, investigates areas for potential collaboration, and recommends immediate steps necessary to provide for the continued safe operations of airplanes and spacecraft, with a focus on prioritizing the safety of the flying public and flight crews.

Early Developments in U.S. Aviation and Space

A brief comparison of U.S. aviation and space development shows important similarities and differences and highlights the close and symbiotic relationship between the two sectors. Lessons learned from these comparisons should inform how both communities can better collaborate to make decisions that will enhance the safety of operations and maximize the benefits to all of aerospace in the future.

During the first half of the twentieth century, aviation was seen as the most important technological symbol of our nation's strength and innovation. The United States sought to dominate the global arena as a way to demonstrate military and industrial leadership. In the latter half of the twentieth century, as technological advances led to successful spaceflight, the United States sought

to dominate space for similar reasons.

NASA/Getty Images

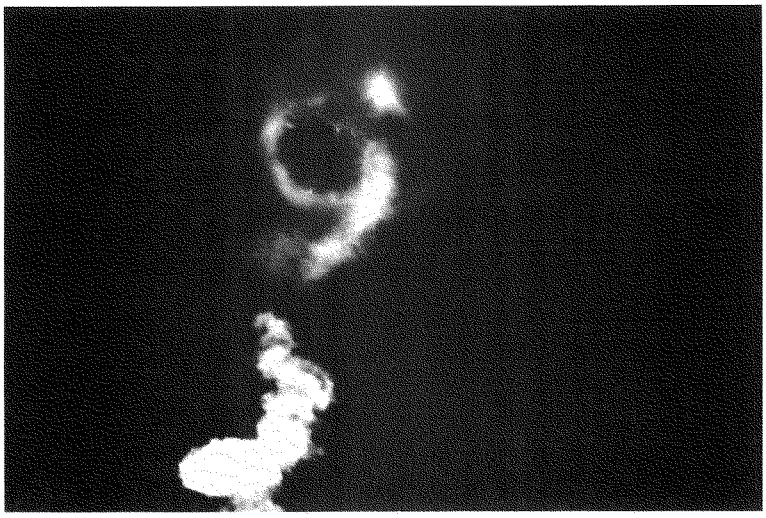
Military interests and investments have advanced capabilities in both sectors, and our national defense continues to depend upon the success of the aerospace industry today. While aviation began as primarily a private endeavor, the government has thus far played a larger role in space development. This trend is now changing, and according to the Commercial Spaceflight Federation in June 2017, only 28 percent of all space launches are for the United States government. The remainder are for commercial purposes.

Over the past several years, commercial space operators have added new launch facilities, increased launch frequency, and have begun returning rockets to land for reuse. Several companies plan to sell space tourism fights as early as next year, which could rapidly accelerate this expansion and growth. U.S. space launches have historically operated out of a small number of coastal launch sites, managed by civilian and military government agencies. Space companies are now testing new concepts of operations that include horizontal liftoff and/or landing, which is driving the development of commercial spaceports at or adjacent to existing airports. Today's regulatory environment has not kept pace with these developments, and new solutions are now required.

Aviation Development

Early development of aviation in the United States was driven primarily by the private sector. When the U.S. government sought to increase our aviation capabilities over advancing European developments, the National Advisory Committee for Aeronautics (NACA) was created in 1915. The Air Mail Act of 1925 jump-started the commercial airline industry, which began delivering cargo and passengers without significant government involvement. In 1926, the Air Commerce Act gave the Department of Commerce power to establish airways, certify aircraft, license pilots, and issue and enforce air traffic regulations, and in 1938, the Civil Aeronautics Act established the Civil Aeronautics Board (CAB), responsible for determining airlines' routes and regulating passenger fares. By 1944—just over 40 years since the first airplane flew at Kitty Hawk—the Aircraft Industries Association reported that the U.S. airlines carried 4.7 million passengers and 50.8 million tons of mail.

By the 1950s, much of NACA's work had evolved to missile development, and in 1958 it became the National Aeronautics and Space Administration (NASA). The FAA was created that same year to manage the safety of aviation operations and to manage the airspace. The dual role of the FAA was to oversee aviation safety and to ensure that the airspace is safely managed by providing air traffic control (ATC) services. In



SpaceX PAZ launch, February 2018.

1963, 60 years after the Wright brothers' flight, U.S. airlines carried 62 million people and 616 million ton-miles of mail.[1] The Airline Deregulation Act of 1978 allowed U.S. airlines to price at competitive market rates, and the CAB was disbanded. Today, the FAA continues to maintain its role in safety oversight and the provision of ATC services, however the airspace is much more complex and the forecasted growth in air traffic over the next several decades will continue to require the FAA to be at the forefront of airspace and air traffic control management. In 2017, commercial aviation provided a record $15 billion in revenue last year. In 2018, U.S. airlines will carry nearly a billion passengers, haul more than 12 billion ton-miles of cargo,[2] and will contribute $1.5 trillion to the U.S. economy.

1 Business Statistics 1963–1991, U.S. Department of Commerce, Economic and Statistics Administration, Bureau of Economic Analysis

2 Bureau of Transportation Statistics. See: www.bts.gov/content/us-ton-miles-freight

Space Development

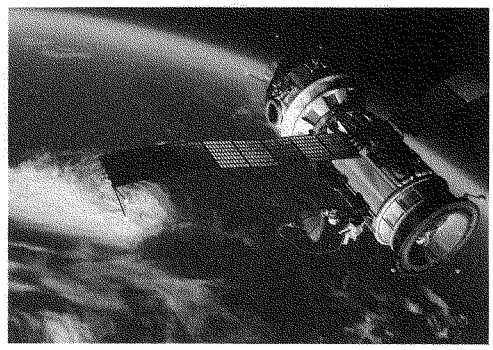
The Space Age began with the Soviet launch of Sputnik in 1957. After several failures, the United States successfully launched its first satellite, Explorer 1, in 1958. Trailing the Russians in human spaceflight as well, NASA began recruiting astronauts from America's best pilots and became the undisputed leader in space, with six successful Moon landings in the late 1960s and early 1970s. After Apollo, NASA's spending power dropped from ~3 percent of the federal budget to ~0.5 percent today. NASA's 2018 budget is ~$19 billion, which is roughly equal to the total spending of every other international space agency combined. U.S. investments in military space are ~$35–40 billion; exact amounts are classified.

Sixty years since spaceflight began, the United States has launched a total of ~2,000 rockets at an average rate of ~30 per year. Worldwide, there have been ~8,000 rocket launches and a total of

U.S. Orbital Space Launches, 2013–2017				
Year	Civil	Military	Commercial	Total
2017	2	6	21	29
2016	4	7	11	22
2015	4	8	8	20
	Noncommercial		Commercial	Total
2014	12		11	23
2013	13		6	19

Source: FAA

563 people have flown in space—350 of which were Americans. The success rate for space launches has improved from 72 percent in the 1960s to 93 percent today. Close to 50 percent of launches have been for military vs. civilian purposes, ~3 percent have sent spacecraft beyond low Earth orbit (LEO), and ~2 percent have launched humans. The majority of these launches have been for communications, navigation, and remote sensing satellites—shared resources utilized by commercial aviation.



NASA is not a regulatory agency, and has spent the majority of its budget developing spacecraft and launch vehicles, which have begun competing with more efficient private-sector activities. Recognizing this conflict, NASA is now partnering with industry in new ways to maximize innovation and reduce costs on routine operations, allowing for greater investment in government-unique exploration activities. Military space programs are also contracting with the private sector more efficiently and launch solely on commercial rockets. When the U.S. government transitioned ownership and operation of launch vehicles to the private sector in the mid 1980s, France, China, and Russia launched 90 percent of commercial satellites. Private-sector investment and innovation made the United States the current dominate commercial launch provider.

Several aerospace companies have recently developed technologies that lower costs even more significantly. These reduced costs and increased frequency are driving new markets into space, such as space tourism, which could in turn drive growth over the next few years. The chart above depicts the breakdown of the types of orbital space launches in the last few years. It is notable that commercial launches increased significantly between 2013 (6) and 2017 (21).

In addition to frequency, launches take place from more locations and use different concepts of operations. U.S. space launches have historically operated out of a small number of coastal launch sites, managed by civilian and military government agencies. The chart on the next page depicts space launch sites in the United States.

U.S. Space Launch Sites						
Launch Site	Operator	License First Issued	Expires	2017 FAA AST-Licensed or Permitted Fights	State or Country	Type of Launch Site
California Spaceport	Harris Corporation	1996	9/18/2021	6	CA	Commercial
Cape Canaveral Air Force Station	U.S. Air Force				FL	Government
Cecil Field Spaceport	Jacksonville Airport Authority	2010	1/10/2020	0	FL	Commercial
Edwards Air Force Base	U.S. Air Force				CA	Government
Ellington Airport	Houston Airport System	2015	6/25/2020	0	TX	Commercial
Florida Spaceport	Space Florida	1999	6/30/2020	14	FL	Commercial
Kennedy Space Center	NASA				FL	Government
Mid-Atlantic Regional Spaceport	Virginia Commercial Space Flight Authority	1997	12/18/2022	1	VA	Commercial
Midland International Air and Space Port	Midland International Airport	2014	9/14/2019	0	TX	Commercial
Mojave Air and Space Port	East Kern Airport District	2004	6/16/2019	0	CA	Commercial
Oklahoma Spaceport	Oklahoma Space Industry Development Authority	2006	6/11/2021	0	OK	Commercial
Pacific Missile Range Facility	U.S. Navy				HI	Government
Pacific Spaceport Complex Alaska	Alaska Aerospace Corporation	1998	9/23/2018	0	AK	Commercial
Poker Flat Research Range	University of Alaska Fairbanks Geophysical Authority				AK	Nonprofit
Ronald Reagan Ballistic Missile Defense Test Site	U.S. Army				Republic of the Marshall Islands	Government
Spaceport America	New Mexico Spaceport Authority	2008	12/14/2018	0	NM	Commercial
Vandenberg Air Force Base	U.S. Air Force				CA	Government
Wallops Flight Facility	NASA				VA	Government
White Sands Missile Range	U.S. Army				NM	Government

Source: FAA

Note: In addition to the sites in the tables above, there are three nonlicensed sites where individual companies conduct launches using a licensed or permitted vehicle. Because the companies own and operate these sites using their own vehicles exclusively, a site license is not required. SpaceX conducts flight tests at its McGregor, Tex., site, and Blue Origin conducts FAA-permitted flight tests from its site near Van Horn, Tex.

A number of new markets (including flying people) require space vehicles to be returned to land and offer the benefits of reusability, which will lead to even lower costs and potentially even more frequent launches and landings.

Current launch licensing procedures and regulations were created at a time when there were significantly fewer launches, launch operators, types of operations, and launch facilities. Federal policy related to our shared national aviation

resources needs to reflect current growth projections and the potential for further acceleration.

Existing Regulations and Requirements

The FAA provides aircraft and pilot certification, operational approval, air traffic control, and safety oversight of commercial aircraft operations in the NAS. Each airline is responsible for ensuring its aircraft fleet is managed and operates according to FAA requirements. The FAA also provides the necessary permits and licenses for space operations, for the space vehicles used by space operators, and the licensing of spaceports.

Operational Approval of Space Launches

Title 14 of the Code of Federal Regulations (CFR) Volume 4, Chapter III, Commercial Space Transportation, FAA, Department of Transportation, outlines requirements pertaining to commercial space operations. This section of the rules defines the policy and procedures in support of commercial space operations in the United States.

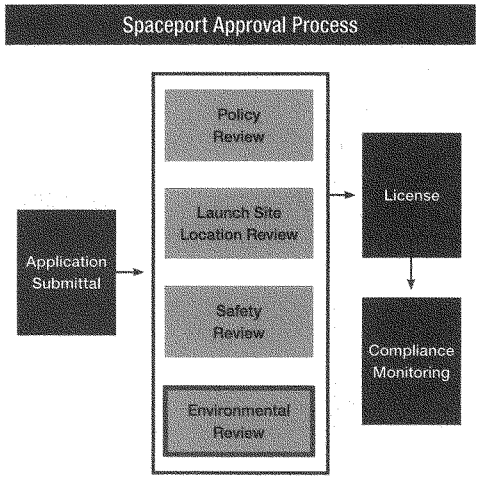
When NASA and other government agencies purchase a launch for their own spacecraft, no launch licenses are required. When launches are provided for commercial spacecraft, the FAA's Office of Commercial Space Transportation (AST) is responsible for licensing. AST was established in 1984 and has licensed 286 launches and 16 reentries to date.

Commercial Spaceports

Independent of issuing approvals for the commercial space operations (launch, recovery, etc.), the FAA AST also issues launch site operator licenses for airports or spaceports that desire to conduct commercial space operations. A graphic below describes the process.

Public input to the licensing process is currently limited to the environmental review portion of the process, as highlighted below. In some cases, airports are applying for spaceport licenses without a companion commercial space operator license application. Therefore, even if the spaceport license were issued, no commercial space operations would be allowed without further FAA approval.

Because the FAA evaluates spaceport applications completely separate from commercial space operator applications, a spaceport could be established without a specific use in mind. For organizations like ALPA, this presents some challenges when it comes to providing the FAA with comments during the only public comment



period for spaceports. The comment period is for public review of the environmental assessment—there isn't currently a comment period for stakeholders to submit with regards to the operations envisioned at the spaceport. This creates a challenging situation for stakeholders and the FAA to have comprehensive review of all aspects of the spaceport licensing criteria, including safety of the operations in proximity to other aviation operations.

Airspace and Air Traffic Control

The FAA AST serves as the single focal point for space companies to coordinate operational approval and air traffic control procedures to segregate the volume of airspace required for the space operation from other NAS operations. The airspace and air traffic control management strategies continue to evolve with the new types of technologies used by commercial space operators. Also, the new types of commercial space activities that are being planned by a wide range of commercial space companies are requiring the FAA to conduct new risk assessments to ensure that their historic airspace management policies and plans are adequate for the envisioned operations.

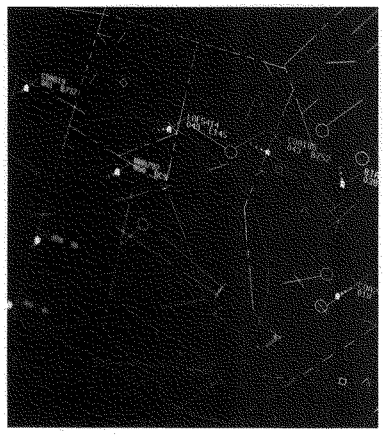
To protect passengers and crews aboard commercial aircraft operating in the vicinity of space operations, airspace boundaries are established to sterilize the airspace needed by the space vehicle. These airspace areas are sized to provide an adequate safety margin should a catastrophic failure occur at any time from the launch until the space vehicle was well clear (above) aviation operations. The large airspace areas are designed to contain the operation and to segregate the space operation from airline and other aeronautical operations. The FAA utilizes special activity airspace (SAA) to segregate space and aircraft operations.

Each SAA has defined dimensions based on the space vehicle's launch and reentry trajectories, which mitigate the risk in the event of a catastrophic failure and ensure that nonparticipating aircraft remain outside the SAA boundaries. These restrictions have led to extensive and expensive delays to commercial air traffic that are unsustainable. However, until policies, procedures, and airworthiness certification requirements are developed based on improved data, today's commercial aviation and space operations will continue to use this same methodology to manage and restrict the NAS. Integration of commercial space operations in the NAS would benefit from increased collaboration and coordination with other elements in the agency, such as Flight Standards.

Aircraft Design Approvals

The FAA serves as the safety and oversight regulator for aircraft design and certification. For traditional civil aircraft, Title 14 CFR Chapter I, Subchapter C, contains aircraft certification policy and standards required for aircraft airworthiness certification. That title is used by aircraft manufacturers in the development, maintenance, and periodic inspections of aircraft. Compliance with airworthiness standards is mandatory before an aircraft can integrate/operate in the NAS without restrictions or without containment in segregated airspace. Aircraft manufacturers may be granted an experimental airworthiness certification during the developmental phase of new aircraft.

By contrast, the FAA AST issues either a license or experimental permit for spacecraft operations. Compliance with 14 CFR Chapter 1 is not required. The license or experimental permit allows space operators to launch a space vehicle into orbit/suborbit and reenter the Earth's atmosphere. Before AST grants a license/permit, the space operator must demonstrate compliance with the criteria in 14 CFR Chapter III that safeguards the public, including persons in nonparticipating aircraft.



As written originally, the FAA space-licensing requirements did not envision the frequency of operations or spacecraft designs now being used, nor those anticipated in the future. As a result, the FAA is undertaking a review and a rewrite of requirements in 14 CFR Chapter III to shift to a "performance based" set of design and operational requirements. In support of this activity, the FAA formed the Streamlined Launch and Reentry Licensing Requirements Aviation Rulemaking Committee (ARC). Launched in March 2018, the ARC is tasked with developing recommendations for a performance-based regulatory approach in which the regulations will state safety objectives to be achieved and leave design or operational solutions up to the applicant.

Passengers as Participants

More than 1,000 individuals have prepaid space companies for suborbital spaceflights. The Commercial Space Launch Competitiveness Act of 2015 (P.L. 114-119) gives the FAA the specific responsibility of regulating commercial human spaceflight. The act prohibits the FAA from regulating crew and passenger safety except in response to high-risk incidents, serious injuries or fatalities, or an event that poses a high risk of causing a serious or fatal injury. The act defines paying individuals as "participants," rather than "passengers," to allow them to be transported with an experimental airworthiness certificate.

ALPA's Safety Concerns

Any new technology introduced into the NAS requires a carefully crafted risk-management, risk-mitigation, and implementation strategy. While commercial space operations are not new, the increase in the frequency of launches and associated segregation of airspace, combined with the growing number of commercial spaceports, means that the elevated demand for access to airspace will likely place pressure on regulators and operators to reduce the size of the airspace protection zones, so as to minimize commercial space's operational impact on commercial aviation. Without proper mitigations in place, the elevated levels of risk may not be acceptable.

In the longer term, there is discussion of the full integration of space vehicles into the NAS, where the space vehicles operate within the existing framework of aircraft operations and infrastructure. Accomplishing this goal without decreasing the level of safety of the existing operations will be a significant challenge. However, we are confident that it can be successfully achieved.

ALPA will continue to support the FAA, other government agencies, and industry, and participate in the safety-risk analysis activities as well as rulemaking processes to ensure safety risk is addressed for all phases of the operations.

Current and Emerging Operational Challenges

Managing more frequent and diverse space activities under current FAA policies and regulations has resulted in significant impacts to commercial aviation, including flight delays, flight-plan alterations, increased distance flown, longer flight times, flight cancellations, crew duty cycles, gate slot management, and added fuel burn.

According to the Airlines for America,[3] in 2017, the average cost of aircraft block (taxi plus airborne) time for U.S. passenger airlines was $68.48 per minute. If 10 aircraft are delayed for 10 minutes each, the cost is $68,480 in delays. If the same delay were incurred each day of a year, the cost of the delays would be nearly $25 million. These delay costs do not include the passenger's value of time, the costs of lost opportunities, and the costs of missed meetings/vacations where expenses are incurred prior to completion of air travel.

ALPA sought to understand the impacts of the SpaceX Falcon Heavy launch on aviation operations. The launch was at the Kennedy Space Center on February 6, 2018. According to the FAA:

- 563 flights were delayed.
- 34,841 additional nautical miles (NM) flown.
- An additional 62 NM were flown on average per flight.
- 4,645 total minutes delayed.
- There was an average eight-minute delay per flight.
- 5,000 square NM impacted.
- Orlando International Airport experienced 62 departure and 59 arrival delays.

ALPA also noted that the FAA completed a report in 2014[4] that evaluated impacts caused by space operations conducted at Cape Canaveral.

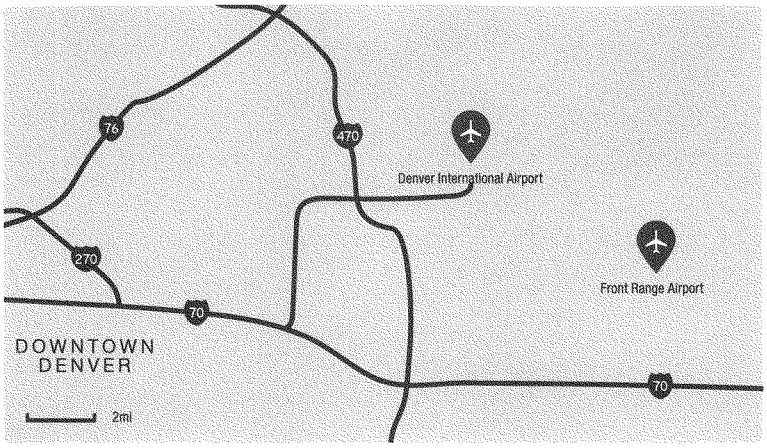
In this study, the FAA's Concept Analysis Branch studied a historical launch and reentry to quantify the current NAS impact of commercial space operations and to identify ATC practices used to minimize this impact. On March 1, 2013, the SpaceX Falcon 9/Dragon capsule was launched from Cape Canaveral Air Force Station in Florida. Several SAAs were activated to protect air traffic from debris in the event of a vehicle explosion. After being docked to the International Space Station, the Dragon capsule reentered the atmosphere and splashed down in the Pacific Ocean off the coast of California on March 26, 2013. This reentry also required an SAA to block air traffic from entering the potentially dangerous airspace.

Results showed that flights in the Jacksonville and Miami Air Route Traffic Control Centers (ARTCCs) during the launch were significantly impacted by the operation. The Falcon 9/Dragon launch caused impacted flights to fly between 25 and 84 NM longer, burn between 275 and 2,387 pounds more fuel, and fly between 1 and 23 minutes longer as compared to similar days with no launch activity. However, the launch operation did not negatively impact the total hourly operations at key Florida airports. The reentry analysis showed that flights traveling to or from Hawaii and Australia would be impacted by the reentry operation, but domestic and other international flights would be minimally impacted. Flights to or from Hawaii and Australia flew between 15 and 27 NM more, burned between 458 and 576 pounds more fuel, and flew between 1.5 and 7 minutes longer to avoid the reentry airspace.

While the Falcon Heavy is only scheduled to launch two to three times per year, FAA's analysis of the impacts of launches at Cape Canaveral

3 See: http://airlines.org/dataset/per-minute-cost-of-delays-to-u-s-airlines/

4 See: https://acy.tc.faa.gov/data/_uploaded/Publications/SVO_Impact_TechNote_Final_v4b.pdf



indicates that the continued use of segregated airspace on an increasingly frequent basis could become a prohibitively expensive method of supporting space operations.

Spaceport Challenges

Space launch facilities—now called spaceports—were historically located independent from airports and near the coastline. This geography allowed for separate operations and access to the NAS through SAAs without significant disruption to commercial aviation.

In anticipation of increased launch activity, new spaceports are being developed across the country and in some cases are co-locating with or using the airport facilities. The table on page 6 lists the 10 licensed spaceports currently in operation.

The FAA has publicly announced that Front Range airport, near Denver, Colo., has submitted an application for FAA spaceport licensing. However, there is no current operator planning to utilize the spaceport, should it be approved by the FAA.

Space launch operations that are adjacent to airports or overfly land pose a safety risk to the public as well as to commercial aviation. Spaceports co-located with airports would need to overcome many operational issues such as hazardous fueling, noise abatement, traffic volume/capacity, and controller workload. Sharing the NAS in this environment would add a level of complexity that we do not have the ability to manage within the current system. In order for launches to occur at many of these spaceports, significant safety and operational challenges must be addressed.

Key Stakeholders

Unlike the entrance of hundreds of thousands of drone/UAV operators, commercial spaceflight operators have existential incentives and a growing history of safe operations. Existing commercial players in the space transportation

Key Stakeholders					
Company	Crew	Launch Site(s)	Type	Configuration	Experience
ULA	No	FL/CA	Orbital	Traditional	113 from 2006-2-16
SpaceX	Both	FL/CA	Orbital	Traditional Launch with Reentry	62 from 2006–2017
Boeing	Yes	FL	Orbital	Traditional Launch with Reentry	Operational in 2019
Blue Origins	Yes	TX	Orbital	Traditional Launch with Reentry	Operational in 2019
Virgin Galactic	Yes	CA/NM	Suborbital	Captive Carry	Operational in 2019
Orbital/ATK	No	VA	Orbital	Traditional Launch	~20 out of . . .
World View	Yes	AZ	Suborbital	Balloon Launch	Operational in 2019
Stratolaunch	Yes	CA	Both	Captive Carry	Operational in 2020

Source: FAA

arena are well known; several operate in both sectors and the barriers to entry remain high. Since 1989, there have been 290 launches by commercial space operators. The chart above is a summary of commercial space operators, including some of the new entrant companies expected to emerge before the end of the decade.

Finding Solutions

The increased frequency and diversity of space-launch operations requires the development of new policies, procedures, and licensing criteria. Cooperation between all stakeholders is necessary, and discussions about real solutions to these emerging problems have already begun.

As noted earlier, the FAA has recognized that the growing number of spaceflight operations requires a reevaluation of its airspace management and as a result, the FAA tasked an ARC with providing recommendations on airspace prioritization policies. As a member of the ARC, ALPA will continue to support the FAA and participate in the safety-risk analysis activities, as well as rulemaking. Recommendations for this ARC are due in late 2018.

The FAA has also established the spaceport categorization ARC, which will develop recommendations for the FAA to establish a spaceport categorization scheme. The ARC includes participants from both the commercial space and aviation communities. With new spaceport categorizations, it is likely that more airports or other locations could become designated spaceports. However, with a narrower set of intended operations, it should be easier for all stakeholders to understand how the spaceport is intended to support the space industry.

A Transition to Integration Is Needed

The FAA needs a comprehensive plan to integrate commercial space operations and avoid major disruptions for the other users of the NAS as the demand for access to the NAS for commercial space operations increases. As commercial space operations increase, and as the commercial space operations locations continue to expand, the FAA may need to evaluate and standardize the spectrum of commercial space vehicles and operations to reduce NAS impacts while maintaining a high level of safety. At some point, segregation of commercial aviation operations from commercial space operations will not be a viable solution.

Prior to reaching this point, *a significant amount of planning and investment is needed* to create and implement a commercial space integration strategy very similar to an integration plan drafted for NextGen. Full integration into the NAS will require strategic and tactical policy and regulations for:

1. Standardized airworthiness certification and equipage standards for space vehicle design.
2. Pilot/astronaut/operator training and qualifications requirements.
3. Airspace redesign and procedure deconfliction to integrate commercial space operations near major hub airports.
4. Enhancements to ATC automation tools to better manage terminal, en route, and oceanic traffic in real time.
5. Separation standards that allow ATC to separate spacecraft from other aircraft without the use of segregated airspace.
6. Traffic flow management tools to effectively manage NAS operations.

Legislation Restricts the FAA From Establishing Integration Rules

To ensure that the commercial space industry has an ample "learning period," Public Law 114-90 prohibits the FAA from promulgating any regulations governing the design or operation of a launch vehicle intended to protect the health and safety of crew and spaceflight participants until 2023, absent death, serious injury, or close call. However, when Congress passed the U.S. Commercial Space Launch Competitiveness Act of 2015, it encouraged the FAA to continue to work with the commercial space and airline industries on ways to improve human spaceflight safety.

ALPA maintains a position that commercial space operations require segregated airspace until the "learning period" has gathered enough quantitative data to validate that a high level of safety is maintained before the integration of commercial space operations begins. However, it is not too early for the FAA and the industry to begin making plans for the integration of space and aviation operations without segregated airspace.

FAA Needs to Regulate Space Vehicle Design

The FAA should proactively begin to develop policies for spacecraft airworthiness and certification to fully maximize the time available for safe integration of commercial space operations. Policies are needed that standardize the design requirements for the range of space vehicles. As part of this set of requirements, the FAA should include communication, navigation, and surveillance (CNS) requirements so that the space vehicles are compatible with commercial aviation operations in the same airspace areas.

FAA Needs to Regulate Flightcrew Qualification, Training, and Certification Requirements

The FAA should require each flightcrew member to obtain a space vehicle operator license for the type of vehicle the pilot will operate. The requirements must include:

- Mandatory training requirements and flight time with a certified spaceflight instructor,
- Critical safety training,
- Operator and crew qualifications,

- Crew resource management and crew roles and responsibilities,
- Use of standard operating procedures, and
- An annual medical examination by a licensed physician who is board certified in aerospace medicine.

The FAA should also establish commercial space operator training requirements, standards, and any currency requirements to ensure flight crew, ground crew, maintenance inspections, and safety-critical ground operations are fully trained and qualified for the operations.

More Collaboration Needed Between Space and Aviation Stakeholders

The three ARCs that the FAA initiated in 2018 are getting dialogue started, but additional interaction and collaboration is needed. Although the two sectors are symbiotic, they have developed independently with distinct trade associations and communities. A concerted effort is needed to overcome the lack of communication and coordination between traditional aviation and commercial space segment of the industry. Open debate and exchange of information will be critical to successful future operations of both segments of the aerospace industry. ALPA is willing to take a leadership role in facilitating discussions between the two sectors.

Governmental Resources Need to Be Enhanced

Sufficient government resources are required to support the safe and efficient integration of commercial space operations into existing aviation infrastructure and operations. The AST has the sole responsibility for approval of commercial space launches and space operations in the NAS, and also to authorize licenses to operate the launch and landing facilities for space operations. In conjunction with other FAA offices, AST safeguards the public through trajectory and catastrophic event modeling to determine the volume of airspace required for segregated airspace. It is not possible for the AST to manage this important responsibility with 98 employees and an annual budget of around $20 million.

Existing FAA resources are not adequate to conduct the research and analysis needed to adapt and adopt necessary new policies, regulations, and procedures. Significant data exists from past successful and unsuccessful flights that should inform the establishment of new policies and procedures to protect aircraft and minimize operational disruption for either sector. The FAA should consider establishing capabilities such as a space and air traffic management system to more equitably support both the evolving and expanding space transportation industry and the mature and continuously growing airline industry in a systematic and integrated manner.

Safety oversight and air navigation services by the FAA's air traffic control organization and the AST must receive sufficient funding to support a more complex system and fulfill their congressional directives. Without adequate resources for planning, oversight, and provision of services, safe and efficient operations of both sectors will be negatively impacted.

Intergovernmental Coordination

In addition to increased resources, the government needs more formal mechanisms for coordination. Competing departments within the FAA, the new National Space Council, and a new role for the Department of Commerce in space traffic management have led to increased confusion. A clear leader and defined roles within these government entities must be established, along with regular communication structures.

Distinct governmental advisory committees should assign overlapping members, hold combined meetings, or be merged. Clear and

consistent government roles must be identified as soon as possible.

Conclusions and Recommendations

The magnitude and complexity of space transportation operations are placing new demands on aviation infrastructure, including the NAS. As space vehicles transition through airspace that has primarily been used by traditional aircraft, new policies, regulations, and procedures are necessary to provide for safe and efficient operations of both important industries.

- ALPA has an important role in the integration of space transportation operations into commercial aviation infrastructure, operations, and the NAS.
- As with any new entrant or, in the case of commercial space, where enhanced technologies are introducing significant advancements in capability, there must be a means to safely integrate with existing aircraft operations and infrastructure without decreasing the level of safety of the existing operations.
- As part of this set of requirements, the FAA should include CNS requirements so that the space vehicles are compatible with commercial aviation operations in the same airspace areas.
- The FAA should evaluate the need to require each flightcrew member to obtain a space vehicle operator license for the type of vehicle the pilot will operate.
- The FAA should establish commercial space operator training requirements, standards, and any currency requirements to ensure flight crew, ground crew, maintenance inspections, and safety-critical ground operations are fully trained and qualified for the operations.
- Commercial airline and space operators need to better understand each other's operations. This in turn reduces the likelihood of disruptive operations affecting both groups of operators.
- The safety of the travelling public needs to remain the highest priority for the FAA and the aerospace industry. Commercial airline and space transportation operators need to better understand each other's operations to reduce the likelihood of disruptive operations affecting both sectors.
- Stakeholder collaboration, planning, and analysis that informs new policies, procedures, and regulations should begin now. ALPA can provide leadership to bring stakeholders together from both the commercial aviation and the commercial space segments.
- The FAA must be given the adequate resources to support more complex analysis, licensing operations, safety oversight, air traffic control services, and NAS integration driven by these demands.
- A coordinated government-wide effort is needed to develop and carry out new policies, regulations, and procedures for NAS integration, space vehicle certification, and spaceport development.
- Unless and until new, fully informed policies, regulations, and procedures are put in place, airspace segregation may be the safest risk mitigation.