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ASSURING ASSURED ACCESS TO SPACE

HEARING

BEFORE THE

SUBCOMMITTEE ON STRATEGIC FORCES

OF THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTEENTH CONGRESS

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ASSURING ASSURED ACCESS TO SPACE

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON STRATEGIC FORCES,
Washington, DC, Tuesday, March 17, 2015.

The subcommittee met, pursuant to call, at 4:13 p.m., in room 2118, Rayburn House Office Building, Hon. Mike Rogers (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. MIKE ROGERS, A REPRESENTATIVE FROM ALABAMA, CHAIRMAN, SUBCOMMITTEE ON STRATEGIC FORCES

Mr. ROGERS. Good afternoon. I want to welcome everybody to the Strategic Forces Subcommittee hearing on assured access to space. We will be conducting two panels today.

In the first panel, we have two expert witnesses from industry who represent our current and projected near-term providers of national security space launch in the Evolved Expendable Launch Vehicle [EELV] program.

In our second panel, we have three senior government officials who have responsibilities over EELV program and one advisor to the government.

Testifying on Panel 1 is Mr. Tory Bruno, President and CEO [Chief Executive Officer] of United Launch Alliance [ULA], and Ms. Gwynne Shotwell, President and Chief Operating Officer of Space Exploration Technologies Corporation [SpaceX].

We appreciate you both taking the time to be here today and offer your perspectives, including the challenges and opportunities related to our national security space launch activities.

In this job as chairman of the Subcommittee on Strategic Forces, I have come to more fully appreciate the importance of our space to our country. It is one of the underpinnings of our national security.

Let me provide an example. If a foreign adversary was to launch an intercontinental ballistic missile at our country, our military would rapidly detect this missile launch through our Space-Based Infrared System satellites, and the information would be provided to our highest national command authorities to appropriately respond.

Such response would almost certainly be transmitted across space-based communications satellites to combatant commanders all over the world, who would order our military forces to take action, and those troops would rely on space-based intelligence surveillance and reconnaissance capabilities and communication capabilities to perform their mission and return home safely.

These are extremely important capabilities that American lives may literally depend upon. We can't have space capabilities like this without an effective launch program. This is literally rocket science. So, one of my top priorities in this job is to make sure that we have assured access to space both now and in the future.

We have come a long way since the late 1990s, when we went through a span of 10 months and suffered five launch vehicle failures. Since 2006, we have benefitted from an unparalleled record of success through the Air Force partnership with United Launch Alliance with 78 successful launches in the Evolved Expendable Launch Vehicle program.

Most recently this partnership has also brought tremendous savings to the taxpayers, $4.4 billion, according to the Air Force, as a result of a 36-rocket core block-buy contract.

Now we are once again entering into a new phase for the EELV. We are transitioning to a more competitive environment. Many steps have been taken by the government, including Congress and the Department of Defense, to encourage this.

Congress provided funding that was dedicated to new entrants for the two launches. SpaceX was awarded both of those contracts. And the Air Force has spent nearly $60 million and allocated more than 100 government employees to help certify SpaceX for the EELV program, which it may do in the near months ahead.

We look forward to competition in the EELV program because that will achieve the best outcome for the benefit of our taxpayers and our warfighters.

Lastly, it is extremely important that we work to transition off relying on Russian engines for national security launch purposes. The intention of the fiscal year 2015 NDAA [National Defense Authorization Act] was to provide a reasonable transition. Section 1608 language regarding prohibition of procuring Russian rocket engines included specific exceptions and waivers.

We intended to allow the use of the Russian engines that we understood to be on contract through the period of time that we believed would allow for the development of the new U.S. engine. My understanding is the Department of Defense may not be interpreting it the same way. This remains an issue that we look forward to understanding better today.

Regarding the development of a new engine, I understand this will take time. But I believe in our U.S. history, and I believe that once the men and women in the Department of Defense have the red tape eliminated, we can do this expediently, effectively, and efficiently. We should take the lowest risk approach that is in accordance with the terms of section 1604 of the fiscal year 2015 NDAA.

Thank you again for being with us today regarding this important topic. I look forward to your testimony.

I now recognize my friend and colleague from Tennessee, Mr. Cooper, for an opening statement.

[The prepared statement of Mr. Rogers can be found in the Appendix on page 53.]

Mr. COOPER. Thank you, Mr. Chairman.

In view of the lateness of the hour, since this hearing was delayed almost 45 minutes due to votes, I ask unanimous consent that I insert my opening statement in the record.

Mr. ROGERS. Without objection.

[The prepared statement of Mr. Cooper can be found in the Appendix on page 56.]

Mr. ROGERS. However, I have read his opening statement, and I fully concur with it. I could not have said it better. As he reminds me often, I couldn't say it better.

But having said that, now I recognize Panel Number 1, Mr. Bruno and Ms. Shotwell. The witnesses are asked to summarize their prepared statements for the record. The entire statement will be submitted, but you have 5 minutes to summarize.

Mr. Bruno, we will start with you.

STATEMENT OF SALVATORE T. "TORY" BRUNO, PRESIDENT AND CHIEF EXECUTIVE OFFICER, UNITED LAUNCH ALLIANCE

Mr. BRUNO. Thank you, Chairman Rogers, Ranking Member Cooper, members of the subcommittee. Thank you very much for inviting me here this evening. I look forward to talking about the EELV program, the future of space launch, and how I am transforming the United Launch Alliance to meet this new environment.

In changing our company, I have asked our team to focus on four basic goals. First and foremost, to substantially reduce the cost of launch. Secondly, to move expeditiously and quickly towards an American rocket engine replacement so that we may retire the venerable and advanced technology, Russian RD–180.

We are going to do this while maintaining our unique capability to launch the entire suite of national security space satellites, a capability that no other provider has the technical ability to perform.

And then, finally, we are going to do all this without losing our laser focus on mission success, something we feel also sets us apart in this marketplace.

I would like to say a couple of words about our path to an American rocket engine. We entered into a strategic partnership with Blue Origin late last year, a company founded by Amazon founder Jeff Bezos.

There are a number of reasons why that engine was attractive to us from a technology point of view, but I will admit that first and foremost in my mind was the urgency I felt to move towards an American rocket engine.

The BE–4 Blue Origin engine is 3 years into its development path and offered the most expeditious track to an American engine replacement. It is a methane engine and offers novel technology and advanced manufacturing techniques that promise to substantially reduce cost.

But as a person who has done rocket development for 30 years, I can tell you that it is difficult and rocket engines are the hardest part. And the history of rocket engine development is common with the occurrence of technical challenges and those that often affect schedule. So prudence required that I have a backup plan.

So we have also entered into a partnership with Aerojet Rocketdyne for their AR–1 engine with a more conventional kerosene-based fuel. You could argue that the technical risk of that approach is lower because the fuel is more common in the industry. However, that engine is 1 to 2 years behind the Blue Origin engine.

And so we will continue both of these until we down select in about the 2016, 2017 timeframe, when sufficient testing data has been available for us to make an informed decision. I have gone to my board of directors and asked for this to be funded privately so that we can move out smartly and do both of these activities.

Now, we will place this engine underneath the next generation of launch vehicles that will continue to provide that complete support to all of the national security space satellites, to all of their intended orbits, but we will also expand our performance capability so that we are able to meet the challenges that might arise in the future as the country finds new needs to be coped with in space.

I will also substantially reduce the cost of our infrastructure by streamlining our product line and streamlining our facilities and our other launch infrastructure.

So today we maintain a fleet of 16 different rockets. Other providers may have a single rocket or two rockets. We fly 16 variants in order to cover that entire span of national security space requirements. But within that fleet of 16, there are 2 redundant systems.

The Delta IV medium class is entirely redundant to the Atlas V class in terms of its performance. We have maintained these two systems all this time in order to satisfy the country's need for assured access, which is to say two independent systems so that, in the event that there might be a failure or a flaw in one system, there would still be a second system able to launch our critical national security assets.

In this new environment where the policy has changed to assure access through the existence of two providers, I will now retire the Delta medium class of space launch vehicles when we have completed our current requirements within the manifest and that team and that infrastructure will be consolidated into Atlas, creating considerable savings to our offerings.

I will also consolidate our pads. Today we have five launch pads to support this work. We are going to consolidate to two pads, one on each coast. We are going to do that by bringing in innovative designs to the pads that will allow them to be mission-agnostic, flexible, and handle the volume of lift that is currently requiring five.

And we are going to revolutionize the way people come to us to purchase launch services. We are going to introduce a standard launch offering, fixed price, priced in advance, that customers can buy and then add to that, if they desire, standard options also at a pre-priced.

It will literally be like going to a Web site and building your own rocket. It will completely change the way launch services are purchased. Together, with all of these changes and innovations, we will substantially reduce the price of launch from where it is today.

I would also like to say a couple words about reliability. We enjoy an unprecedented perfect mission success record of 94 consecutive flights, all of which were on time and, by the way, all of which were on or under budget.

This is a record no one has yet to match. And, from our perspective, when you are launching national security missions, some of

which are multi-billion-dollar, one-of-a-kind assets upon which lives depend, reliability matters.

And so, in this environment, I am very excited about the changes in our industry. Competition is now possible. I believe competition is good for the taxpayer. I believe it is healthy for the industry. And I am looking forward to taking that field and putting my team there because I am confident that we can win.

[The prepared statement of Mr. Bruno can be found in the Appendix on page 57.]

Mr. ROGERS. Thank you very much.

Ms. Shotwell, thank you very much for being here. You are recognized.

STATEMENT OF GWYNNE SHOTWELL, PRESIDENT AND CHIEF OPERATING OFFICER, SPACE EXPLORATION TECHNOLOGIES CORPORATION

Ms. SHOTWELL. Mr. Chairman, Ranking Member Cooper, and members of the subcommittee, thank you for the opportunity to appear before this committee today. In addition to my opening statement, I have prepared a detailed written statement which I have submitted for the record.

Mr. Chairman, every day I go to work with the best and the brightest engineers, technicians, and support staff in the world, over 4,000 of them now, and I can tell you that they are prepared to support our Nation's most critical launches. Those who say that U.S. engineers can't compete or that continued foreign reliance is the only way forward are wrong.

The SpaceX mission from day one has been to leverage American innovation and technical know-how to provide the most reliable space launch systems in history. We seek to serve the Nation by offering these systems for national security launches.

To date, the SpaceX Falcon 9 launch vehicle has flown successfully 16 consecutive times for a sophisticated array of U.S. Government and commercial customers, including the Air Force. I am highly confident that the Falcon 9 will be certified for the Air Force's EELV-class missions by June of this year.

Later this year we intend to fly the Falcon Heavy, which will double the lift capability of any rocket currently flying. We believe that this vehicle, which has a great commonality with the current Falcon 9, can be certified in relatively short order.

The subcommittee's hearing today on assured access is timely. National policy law rightly calls for two completely independent launch systems that can lift the full spectrum of national security payloads. Due to the common upper stage engines flown between Atlas and Delta, Russian reliance, and only one heavy-lift rocket, we do not have assured access today.

Even without assured access, the cost of the EELV program has become unsustainable. According to the GAO [Government Accountability Office], the price per EELV launch has quadrupled, from $100 [million] to nearly $400 million.

But I want to focus my testimony today on what I believe to be constructive solutions to achieve assured access.

First, the United States does not need more Russian engines to get national security space payloads to orbit with the Falcon 9 and

the Delta, both all-American rockets, available. The notion of a capability gap is just not true.

It is noteworthy that the head of Russia's space enterprise, Dmitry Rogozin, has publicly stated that funds received from the United States for the RD–180 is free money that goes to the Russian missile program. How do we justify buying more and funding the Russian military?

Second, continue to pursue a policy of assured access through genuine competition between multiple qualified providers with redundant, truly dissimilar launch vehicle systems.

Third, eliminate the costly, inefficient, and ineffective launch capabilities contract to the incumbent. In the meantime, these subsidies must be accounted for if you are to have true and real competition.

Finally, Congress can structure engine development efforts to maximize smart investment. Government money is best spent against unique government mission requirements that otherwise would not be developed by a commercial provider.

Mr. Chairman, again, thank you. As a nation, we stand on the cusp of having real competition for national security space launches. SpaceX, with our all-American Falcon 9 and Falcon Heavy, looks forward to contributing to the Nation's assured access to space.

I am pleased to address any questions that you have.

[The prepared statement of Ms. Shotwell can be found in the Appendix on page 67.]

Mr. ROGERS. Great. Thank you, both.

Again, I know it takes a lot of time to prepare for these things. So I appreciate you all putting the time in and being here. This is a very important subject.

But let me start with a little housekeeping.

Ms. Shotwell, I understand that you requested an extension to fully respond to the requirement of the disclosure of contracts with foreign governments as required under House rules.

Do I have your commitment to provide the required disclosure, which is posted publicly per House rules, no later than 7 days after the March hearing? To be clear, that would be the close of business on the 24th of March.

Ms. SHOTWELL. Absolutely.

Mr. ROGERS. Great. Thank you.

Okay. Next off, quick question for both of you.

Do you have any concerns, from your perspective, of allowing this committee to have access to the terms of the recent settlement agreement regarding SpaceX's lawsuit against the U.S. Government?

Ms. SHOTWELL. I have no concern about the recent——

Mr. ROGERS. About us having access to the terms of that agreement.

Ms. SHOTWELL. Oh. I am sorry. I am sorry, sir.

The terms of that agreement are basically governed by the Court. And so we have no say whatsoever.

Mr. ROGERS. I understand that the Court is saying that it is a secret settlement. I want to know if you all would object if the Court let us see that.

Ms. SHOTWELL. I don't object. I am sorry. No.

Mr. ROGERS. Mr. Bruno?

Mr. BRUNO. We have no objection at all.

Mr. ROGERS. Thank you, both.

New topic. Ms. Shotwell, tell us why it is important to have competition for the EELV vehicle program.

Ms. SHOTWELL. Competition drives prices. Importantly, it drives quality of service as well. If you are truly competing against a real competitor, you are going to ensure that you have a quality product, you have a quality service, at the best possible price.

Mr. ROGERS. Mr. Bruno, same question.

Mr. BRUNO. Competition, when it is possible, is universally good for the taxpayer. It is healthy for the industry. It drives innovation, and it drives value to cost.

Mr. ROGERS. Ms. Shotwell, how do you feel about competing against ULA? Do you think that SpaceX can win a free and fair competition with ULA?

Ms. SHOTWELL. Absolutely I do.

Mr. ROGERS. Mr. Bruno, how do you feel about competing against SpaceX? Do you think you can win a free and fair competition?

Mr. BRUNO. Absolutely.

Mr. ROGERS. All right. All right. So we both agree.

Mr. Bruno, what is the impact of section 1608 from the fiscal year 2015 NDA [National Defense Authorization] based on the most current interpretation of DOD {Department of Defense]?

Mr. BRUNO. Certainly. So the most current interpretation limits us to engines that we had on hand prior to the outbreak of Crimea. The impact of that is that we will be unable to introduce the new American rocket engine before those engines are consumed.

We will have no more than 5 that we are able to use between our existing 36-core block buy. That means there will be a capability gap between when we are out of engines on Atlas and can no longer fly Atlas and when we have the earliest opportunity to introduce an American engine.

Mr. ROGERS. What will that mean for your ability to compete? Because you all both really want to compete with each other. I just heard you say it.

Mr. BRUNO. Yes, we do.

So the reason we are retiring the Delta IV medium class is because it is inherently 25 to 30 percent more expensive than the Atlas. It is not competitive in the marketplace. So without access to the Atlas rocket, we are essentially unable to compete in that timeframe.

Mr. ROGERS. To provide another perspective, Ms. Katrina McFarland, who is testifying on the second panel today, offered the Department of Defense her view of the statement for the record: "Even assuming a new entrant is certified in the near term"—which we expect you to be—"the Department is concerned that, with the loss of the Atlas V and the medium- to intermediate-class Delta IV vehicle, we could be faced with a multi-year gap without at least two price competitive launch providers servicing medium- to intermediate-class missions."

Ms. Shotwell, the Department is saying we may be faced with this multi-year gap in competition. Do you still agree that competition is important?

Ms. SHOTWELL. Yes, sir, I do. But there is many ways to achieve competition. There is also many ways to make vehicles cost-effective.

When we produce more Falcon 9s, the vehicle cost decreases. If you were to increase the number of Delta vehicles that you produce every year, the price of the Delta would come down. Certainly the cost of the Delta would come down.

Mr. ROGERS. But do you think the Delta single can compete with SpaceX on price?

Ms. SHOTWELL. I believe it would take work on the part of ULA, but I believe that is their job.

Mr. ROGERS. That is interesting.

Do you want to respond to that?

Mr. BRUNO. Certainly. So today we fly Atlas about twice as often as we fly Delta. When I said a moment ago that Delta was about 25 to 30 percent more expensive than Atlas, that was adjusting for flying an all-Delta fleet.

I would also like to point out that ULA has consistently reduced costs from the beginning of the formation of the company and the EELV program through today.

Prior to the formation of ULA, the price of lift had risen dramatically due to the collapse of the commercial telecom industry. And the average price of lift was then, in fact, $400 million each.

As we entered into our block buy, ULA had driven that cost down to more like $200 million. And, of course, our goal is to eventually drive that price to $100 or below, so cutting it in half again.

Mr. ROGERS. Before I stop, I want to go to what Ms. McFarland just described as this potential gap of time when we won't have access, particularly on the heavy-lift, because I understand that SpaceX is close to being certified on these medium- and intermediate-range missions, but you still have a way before you test on the heavy-lift.

And Mr. Bruno was saying, without the RD–180, he would not be able to continue to compete for the intermediate- and medium-range missions, which could then jeopardize his ability to maintain the Delta Heavy.

And I will start with you, Ms. Shotwell.

Do you agree that there is the potential, as outlined by Ms. McFarland, that there could be a multi-year period where we would not have assured access to space for the heavy NRO [National Reconnaissance Office] platforms?

Ms. SHOTWELL. I think it is important to note that the Atlas does not have a heavy configuration and that the heaviest NRO satellites must fly on the Delta IV Heavy, which is of the Delta line.

Mr. ROGERS. Exactly.

And Mr. Bruno has made the statement that, without the Atlas, which is his workhorse mission, that needs the RD–180, he would not be able to maintain the infrastructure that supports the heavy-lift, Delta IV, which only lifts about once every 2 years, and would make it cost-prohibitive; so, it wouldn't be in the market. Now this is his argument, not mine.

Do you agree that that could create the potential that we would not have heavy-lift capability for the NRO platforms for a 2- to 5-year period, as Ms. McFarland from the DOD has said?

Ms. SHOTWELL. So, obviously, I don't understand the intricacies of the ULA business. However, I do see the Delta IV vehicle flying and flying successfully, the Delta Heavy vehicle flying and flying successfully.

And so, with a Falcon 9 single core, which is comparable to a Delta IV, and then the Falcon Heavy, which we will bring on-line and be certified in time for competition in 2018, then you have two completely independent, dissimilar vehicle families, both from medium-lift all the way through heavy-lift.

Mr. ROGERS. With that, thank you very much.

I yield to the ranking member for any questions he may have.

Mr. COOPER. Thank you, Mr. Chairman. I thank you for calling this hearing.

And I want to welcome witnesses from two outstanding companies.

I think the taxpayer has reason to be reassured because we have come a long way toward competition, toward higher quality and better price for the taxpayer. It was heartening for me to hear Mr. Bruno's comments.

Because I think you are talking about a very different company than ULA was even just a few years ago, as you try to transform it to a more commercial model with fixed pricing and things like that. I think competition led by SpaceX is having a very good effect.

But we all are worried about the lack of assured access to space and this window of vulnerability that we may or may not be facing, and I think it is important to be aware of that risk, but not exaggerate it.

To my knowledge, there is not a backup for Marine One helicopter for the President or for Air Force One. They both rely on similar technologies, and it has worked pretty darn well. The ULA launch record is outstanding, as is SpaceX's. So, as I say, the taxpayer has a lot to be proud of.

As we transition toward real competition, though, a lot of ways of doing business have to change. The ELC [EELV Launch Capability] payment that ULA has been getting for a long time, almost a billion dollars a year, that would have to go away in a truly competitive environment, wouldn't it, Mr. Bruno?

Mr. BRUNO. No. It doesn't go away. The capability contract is generally misunderstood. So let me clarify exactly what it is.

They are costs that all providers have. The capability contract pays for pads, laboratories, day-of-launch operations, and the infrastructure that supports all of that. It is simply a contracting choice that the Air Force has made.

Other providers receive these same costs. NASA [National Aeronautics and Space Administration] contracts them in a single contract. The Air Force has chosen to break out into two contracts. The reason they have done that is because the current set of satellites currently on orbit that are now being replaced by the launches in the block buy are generally exceeding their designed

life. And so there is tremendous urgency to replace those as quickly as possible.

The replacement satellites, however, are often experiencing schedule challenges and delays. And so it is imperative that, even though we don't necessarily know which satellite is going to show up to the pad when, that when they do, they can be promptly lifted.

So the Air Force decided to break out those launch infrastructure and launch-day costs into a separate contract to ensure that we had the flexibility to do just exactly that. And in fact, it enables us, together with the block buy of 36, to set up an environment where we have essentially planned every launch in threes.

So if we are targeting a given date in a given rocket for a spacecraft, we have identified a rocket ahead of time and a rocket behind that that spacecraft could move to, should it be early or late. We have, in fact, exercised that slot-manifesting technique six times last year in total transparency to the manifest and the Air Force without delay. These are costs that everyone has. They are simply contracted differently in EELV.

Mr. COOPER. So are you saying that the other company, SpaceX, benefits just as much as ULA does from the billion dollars of ELC expenditures every year?

Mr. BRUNO. What I am saying is SpaceX has those same costs. They are folded into a single contract when they do business with NASA, just like they are with me.

And, in fact, I should have also mentioned that, when we do fly a mission outside the block-buy contract, we, in fact, reimburse the Air Force a substantial fee for that infrastructure they have supported for each and every launch.

Mr. COOPER. Do you agree, Ms. Shotwell, with what Mr. Bruno is saying?

Ms. SHOTWELL. I don't agree completely. No. I don't agree with the term substantial reimbursement of costs. In fact, if you were to take the billion dollars a year that they get and spread that over the average 8 to 10 missions they do per year, you know, that is $100 [million] to $125 million per launch.

It is my understanding that the payback—and I don't have his contract, I don't have access to his contract—is substantially less than that, possibly on the order of 10 or 15 percent of that cost.

Mr. COOPER. A number of other members are here. So I will just end with this final observation.

Washington is fortunate to have a patriotic philanthropist, David Rubenstein, who even paid personally to repair the Washington Monument. I think the country is lucky to have amazing entrepreneurs like Elon Musk and Jeff Bezos who, for some reason unknown to me, both want to participate in some of the boldest new technologies in space.

So we are fortunate that they are choosing to spend their money in that fashion, not that these companies don't have many other backers. But that is a remarkable development for this country, and I am proud of their entrepreneurial drive.

Thank you, Mr. Chairman.

Mr. ROGERS. I thank the ranking member.

The chair now recognizes the gentleman from Utah, Mr. Bishop, for any questions he may have.

Mr. BISHOP. Thank you, Mr. Chairman.

Ms. Shotwell, if I could ask you a couple questions. First of all, thank you for being here and the expertise that you bring.

The chairman did, as is customary, invite Mr. Musk, who is head of the company, to be here. So the questions I actually have are for him. But since he decided not to be here and manage his schedule to be with us, let me ask you the questions, since you are representing him.

I was reading in Space News an article in January that was entitled "Musk Questions Integrity of the U.S. Air Force Certification Process." The quote he gave in the article was, "The people fighting it"—meaning the Falcon 9 certification—"are really in the bureaucracy of the Pentagon and the procurement officers, who then go and work at Boeing and Lockheed Martin, the prime contractors, which has actually happened. It is easy to understand from a game theory standpoint, especially when you are asking them to award a contract to a company where they are probably not going to get a job against a company where their friends are. So they have got to go against their friends and their future retirement program. This is a difficult thing to expect."

Now, I don't necessarily presuppose that these are your opinions, anyway, as well, but the head of SpaceX, which is your company, appears to believe that some of the people who are in service in the Air Force and Department of Defense, many career employees, may be holding back on certification because they have friends somewhere else and they want to work there later.

So I please ask you if you could explain this statement to me. Because while Mr. Musk may find it easy to understand, I frankly find it very troubling.

Ms. SHOTWELL. I appreciate the question.

Mr. Musk had a concern about a particular procurement officer and his choice of job after leaving service. And I am sure, if there was any evidence that led to there actually being some issues with that particular choice of job, that this committee would have investigated and cleared it up.

However, I do want to state that the relationship with the Air Force and SpaceX has been extremely good. We have been working shoulder to shoulder on the certification process. It was a little slow to get going last year. But, by November, December timeframe, we were operating at an incredible pace and we just couldn't get it done by December. But I anticipate certification of the Falcon 9 launch vehicle upcoming here shortly.

Mr. BISHOP. So what you are telling me is that you no longer believe that people who may have slowed the certification process are doing it simply because they are looking out for their own retirement and because they are going against friends, that no longer reflects the attitude of the company or Mr. Musk?

Ms. SHOTWELL. What I am saying is his particular concern doesn't seem to have been borne out. He was just raising a concern.

Mr. BISHOP. That is a rather damning kind of concern to put in public, isn't it?

Let me also ask another thing. Because I appreciate your insistence on competition, but I understand NASA is ready to award SpaceX three additional cargo delivery missions to the International Space Station.

I am assuming you support NASA's decision in this regard.

Ms. SHOTWELL. Yes, sir.

Mr. BISHOP. But those are sole-source awards without competition.

So do you think it is okay for NASA to award those three missions as a sole source without having open competition?

Ms. SHOTWELL. Congressman, actually, there was a competition, and SpaceX and Orbital Sciences——

Mr. BISHOP. For these new three cargo missions to which I am referring.

Ms. SHOTWELL. So the competition for the cargo resupply [CRS] missions included pricing for out-year missions. And so, fundamentally, when we initially competed for that initial CRS awards, there were prices for out-year missions. So NASA has the ability to look at Orbital's prices, has the ability to look at SpaceX's prices——

Mr. BISHOP. And you don't see a distinction between those approaches, then?

Ms. SHOTWELL. No. We competed and we won.

Mr. BISHOP. You have also said a couple of times here as well that Falcon 9 is an all-American launch vehicle and the overwhelming material used is aluminum.

From what company do you get that aluminum?

Ms. SHOTWELL. We buy the aluminum from Constellium.

Mr. BISHOP. Is that an American company?

Ms. SHOTWELL. No, it is not.

Mr. BISHOP. So you have also said—or at least one of your senior engineers has said that most of the avionics is designed and manufactured and tested in America.

Does that mean you have some avionics that are foreign-made as well?

Ms. SHOTWELL. We have one particular box, a GPS [Global Positioning System] receiver. All-American is by percentage. And this vehicle is 99 percent American.

Mr. BISHOP. There is a statute in California that would not allow that to be advertised as all-American. You know?

Ms. SHOTWELL. I am unaware of that.

Mr. BISHOP. Yield back.

Mr. ROGERS. I thank the gentleman.

The chair now recognizes Mr. Takai for 5 minutes for any questions he may have.

Mr. TAKAI. Thank you, Mr. Chairman.

Mr. Bruno, United Launch Alliance has a very impressive launch success, and I just wanted to thank you and your employees and commend you for this success.

This hearing concerns the matter of assured access to space, and the national policy in law requires two separate vehicle systems that can execute 100 percent of the national security launch requirements.

What do you suggest we do to fulfill this legal requirement?

Mr. BRUNO. So the current policy for assured access to space has moved from maintaining two launch systems with a single company to achieving two launch systems in a competitive environment across two providers or more than two providers.

That is allowing for competition. I think that is a wise and a healthy change in the policy, now that that is possible. The best way to achieve its ends is to ensure a fair and even playing field in which both companies are able to compete effectively.

Mr. TAKAI. Thank you.

Ms. Shotwell, SpaceX has said that it can provide launches for DOD payloads at about 75 percent price reduction—I heard a little bit different reduction today—from what is currently being charged, on the average, per flight.

How have you been able to achieve this savings?

Ms. SHOTWELL. So I am not quite sure where you got that percentage.

Mr. TAKAI. What is the correct percentage? I have been hearing——

Ms. SHOTWELL. Compared to——

Mr. TAKAI. Compared to the——

Ms. SHOTWELL. My price compared to——

Mr. TAKAI. Your competitor.

Ms. SHOTWELL. Mr. Bruno?

Mr. TAKAI. Yes.

Ms. SHOTWELL. Okay. So, obviously, I don't have access to what Mr. Bruno charges per launch. However, he did receive a block buy for 28 missions for $11 billion. So that, to me, sounds like about $400 million per mission.

And I believe the GAO has found price per launch of about those numbers. So if the average price for a ULA mission is $400 million, the average price for a SpaceX Falcon 9 launch commercial is $60 million.

The government buys launch slightly differently from my commercial customers, and they add requirements and additional technical. So I would say an average price to the DOD for a Falcon 9 launch would be on the order of $80 [million] to $90 million.

Now, to be fair, my Falcon Heavy is more expensive than the single-core Falcon 9. The average price for a Falcon Heavy to the U.S. Government would be on the order of $150 [million] to $160 million.

So an overall average price to the U.S. Government, if I were to split Heavies with single-core Falcon 9s, is on the order of 120 or so million dollars per flight. So, from that math, I see that my prices are 25 percent of what the ULA prices are.

Mr. TAKAI. Okay. So my question is: How are you able to achieve that type of savings?

Ms. SHOTWELL. It is hard for me to say. I don't know how to build a $400-million rocket. So the more difficult question would be—instead how am I less expensive than ULA, I don't understand how ULA is as expensive as they are.

The next most expensive launch vehicle is the Ariane 5, produced by Europe. And though they have brilliant technology and fine engineers, it is not a particularly efficient economy. And the Ariane

5, which enjoys a similar success record—approximately similar success record, is about half the cost of a ULA launch.

Mr. TAKAI. Okay. And for my final question, you note in your statement that SpaceX designs and builds all of its own rockets in California, yet most of the other rocket engines that currently support other rockets are built in other countries, say, Russia.

Why did you choose to make your engines in the United States? And what are some of the national security advantages of an all-American supply chain?

Ms. SHOTWELL. So SpaceX did not start out thinking that we would build the majority of this rocket ourselves. And we do actually build the majority of this rocket. We build our tanks. We build our engines. We write our software. We build our launch sites. We write our ground-control software. We build our fairings.

So we build this rocket in the United States. Granted, there might be some raw materials purchased elsewhere. But this is an American rocket built by American hands and technicians.

And though we didn't necessarily start out that way, there were a number of critical technologies that we would not allow another company to build for us, and that was propulsion technology. We needed to own it because it is a critical part. It drives the vehicle design, and it can drive schedule as well.

So though President Putin might be supplying RD–180s right now, that is not a guaranteed supply chain to ULA. Even if the ban on additional RD–180s were to move forward, how do you know that he isn't going to pull the supply chain of those engines?

As a matter of fact, Dmitry Rogozin did threaten to do that. So we found it critically important. Propulsion is critically important to the vehicle, and we felt that we, SpaceX, had to build that engine ourselves.

Mr. ROGERS. The gentleman's time is expired.

I thank the gentlelady for her answer.

Now that Mr. Lamborn is back, he is recognized for 5 minutes for the next series of questions.

Mr. LAMBORN. Thank you, Mr. Chairman.

Ms. Shotwell, I am aware that your company is concerned that the EELV launch capability contract will provide possibly an unfair advantage to your competitor, ULA. But, like ULA, your company does have other government contracts. In fact, your company receives money from NASA for the Falcon 9, Version 1.1, I believe.

Ms. SHOTWELL. We have a contract with NASA to fly that. Yes.

Mr. LAMBORN. Just real quickly as I go along here, what would be the amount of that contract?

Ms. SHOTWELL. The contract for the Jason-3 mission this summer I believe was $63 million.

Mr. LAMBORN. And that is your only contract with NASA?

Ms. SHOTWELL. We just received a contract from NASA to launch the test payload in 2017 or 2018. And I actually don't know the value of that contract. I am guessing—and I will follow up with the committee—on the order of $75 million for that.

In addition, I do have a contract with NASA for cargo resupply, which is Falcon 9 and the Dragon spacecraft mission, to serve the International Space Station with cargo both up and down.

Mr. LAMBORN. And how much is that for?

Ms. SHOTWELL. It was $1.6 billion initially for 12 flights, and we were recently awarded 3 additional missions. On the average of about $150 million per mission.

Mr. LAMBORN. So, with that in mind and just to put everything in context, how do we define "fairness"? And I would like to hear from each of you on that.

I mean, obviously, it sounds like you both are doing a great job of getting the applicable agencies to trust you to provide certain goods and services.

Ms. SHOTWELL. I appreciate the question, actually. This is a very important topic.

So ULA, through the EELV launch capabilities contract, receives this amount of money every year whether they launch or not. Their fixed costs are covered. My fixed costs are only covered because of what I charge on a per-mission basis. So if I am not launching, my fixed costs are not covered. So they are very different, very different, mechanisms to contract.

With no competition, which ULA has enjoyed since 2006, it doesn't matter whether you have a part that is firm-fixed price and a part that is not firm-fixed price that costs less. But when there is competition, they can sell their launch vehicles for the marginal cost of that launch vehicle because their fixed costs are already paid for by the Department of Defense.

Mr. LAMBORN. Thank you.

Mr. Bruno, how would you respond to that question?

Mr. BRUNO. Certainly. But, first, I think I have to untangle some of the numbers we just heard to make the context of the answer clear.

So we, in fact, do not charge $400 million for an average lift. Our Atlas 401, which is roughly equivalent to a Falcon 9.1 within the block buy, costs $164 million, on average, for a launch service.

We have an entire fleet of launch vehicles, unlike other providers that fly, essentially, one bird. The average lift of all of that within our 36-core block buy is $225 million.

This is a 30 percent reduction as we entered into the block buy than from prior years, as we have been working our costs down. In fact, the most recent GAO report recognized the $4.4 billion that the block buy and ELC contract saved the government.

Within the recent cycle of Better Buying Power practices, this is fully one-quarter of all of the savings achieved by the Department. So there is a consistent trajectory of reduced costs. Four hundred [million] dollars is not a number that I recognize. These are the actual numbers.

At the end of the block buy, the price of that 401, which is equivalent to a Falcon 9.1, will be more like $140 million for the next incremental buy.

The Delta Heavy is a different class of vehicle than the Falcon Heavy will be. One of the things that we have as a technical capability that other providers do not have is a high-energy upper stage.

So while performance may be roughly equivalent to LEO [low Earth orbit], to the most challenging orbits, the geosynchronous orbit, and the high-elliptical orbits there is still a performance delta that I urge the government to be considerate of as we make

sure we have competition for the entire spectrum of national security lifts.

Let me also explain the RD–180. We have an RD–180 underneath the Atlas because the government asked us to. At the end of the Cold War, there was significant concern about Soviet rocket scientists ending up in places like North Korea. And so we were asked to find cooperative opportunities to keep those people employed in a productive way.

Additionally, the RD–180 represents advanced technology in rocket engines that did not exist in the United States then and still does not exist today. That technology will come to the United States when we develop our new American rocket engines. It constitutes a significantly higher performance in the advancement of the technology.

That is why——

Mr. ROGERS. The gentleman's time is expired.

The chair now recognizes the gentlelady from California, Ms. Sanchez, for 5 minutes for any questions she may have.

Ms. SANCHEZ. Thank you, Mr. Chairman.

The more I learn, the more confused I get. I just would mention that a few years ago I was over with the French counterpart of these two companies. And they were telling me that their launch costs about $200 million equivalent, and they said they weren't worried about UAL, but could I get rid of SpaceX because they were going to drive them out of business. So I see why we have kind of a confrontation going on here.

Mr. Bruno, I understand the reason that you have given for the use of the Russian RD–180 engine. I am one of those persons that works consistently in NATO and is very worried about what is happening with Russia, and I think that it is high time that we develop our own engine here or have it or, in the case of SpaceX, I guess we have developed it.

Somebody told me that it was going to be $1 [billion] or $2 billion additional government moneys invested into building this new engine. Is that around the right realm?

Mr. BRUNO. No. That is not correct. Let me help to explain. So the typical cost of developing a new liquid rocket engine is, in fact, around a billion dollars, with somewhat more money to incorporate it into a rocket. The American rocket engine that we have embarked upon with Blue Origin and, also, our backup with Aerojet Rocketdyne is largely privately funded.

Ms. SANCHEZ. So the United States isn't putting very much money into developing this? Because I am being told by my staff that General Mitchell said it is about $1.5 billion that the government is investing into this engine development. I don't want to get caught up. But is that true or false?

Mr. BRUNO. That is false.

Ms. SANCHEZ. So I will have to go back to General Mitchell, then, to see why he said that.

Let me go to Ms. Shotwell for a minute, and then I might come back to you, Mr. Bruno. I am just trying understand this.

I have been very interested in having competition and new entrant certification process for a long time. And I understand the

major requirement for new entrant certification was that you perform three launches successfully. Am I correct about that?

Ms. SHOTWELL. That is correct.

Ms. SANCHEZ. Now, SpaceX, I believe, completed those by January 6 of last year, of 2014. Is that correct?

Ms. SHOTWELL. That is correct.

Ms. SANCHEZ. And, since then, you have completed a total of 11 more consecutive successful launches with the Falcon 9 rocket.

So is your sense that your rocket has demonstrated reliability?

Ms. SHOTWELL. Absolutely. The Falcon 9 has demonstrated incredible reliability. We are 100 percent primary mission success with the earlier version of Falcon 9 as well as this upgraded version of Falcon 9.

I want to clarify a little bit. The path that we chose for certification required three flights, plus data, plus engineering review boards, which are basically design reviews of every subsystem, plus audits of our launch site, our quality systems, our management systems, and our systems engineering.

So I just wanted to be clear that it was more than just the three flights. It was the three flights plus all the additional activity.

Ms. SANCHEZ. But it is pretty much the same rocket each time?

Ms. SHOTWELL. Largely the same rocket. We don't fly a fairing when we fly a Dragon capsule to the International Space Station, but it is fundamentally the same first stage, with the exception of recoverability and reusability pieces. But, fundamentally, the same first stage.

Ms. SANCHEZ. Then I understand that ULA has about 14 different configurations of the vehicle.

So can you tell us, have all of these flown more than three times to demonstrate reliability? Mr. Bruno.

Mr. BRUNO. No. They have not all flown more than three times. So we have 16 configurations, 10 for the Atlas, 4 for the Delta IV, and 1 for the Delta II. The number of flights across that family is varied, and I don't off the top of my head have the exact scorecard for each one.

Ms. SANCHEZ. How much of each went.

Mr. BRUNO. But I will submit that for the record.

[The information referred to can be found in the Appendix on page 125.]

Ms. SANCHEZ. That would be great. I would appreciate that. Okay.

For right now, that is the questions that I have. I have a lot more after everything you said, but maybe somebody else will get to them. Thank you.

Mr. ROGERS. I thank the gentlelady.

The chair now recognizes the gentleman from Alabama, Mr. Brooks, for 5 minutes.

Mr. BROOKS. Thank you, Mr. Chairman.

Of course, with all these questions, there is often going to be some degree of overlap.

Mr. Bruno, how many launches has ULA done?

Mr. BRUNO. 94.

Mr. BROOKS. How many has it tried?

Mr. BRUNO. 94.

Mr. BROOKS. 100 percent success record?

Mr. BRUNO. Yes.

Mr. BROOKS. As you have noticed in the media over the last couple years with respect to various launch efforts by various companies, there have been failures.

If there were a failure of the kind of launch that ULA does, what is the cost? What is the damage, the loss?

Mr. BRUNO. Typically, it would be in the billions. So launch is, on average, 10 to 15 percent of the life-cycle cost of a national security space mission.

Mr. BROOKS. You said how much?

Mr. BRUNO. Billions of dollars.

Mr. BROOKS. Billions of dollars for one lost launch?

Mr. BRUNO. Yes.

Mr. BROOKS. Ms. Shotwell, last year Mr. Elon Musk testified to the Senate Appropriations Committee that, "No competition will be fair, full, and open so long as the Air Force continues to utilize contract line items to fuel ULA's fixed costs to maintain its launch capability."

As you are aware, the Air Force currently has the EELV launch capability, ELC, contract in place to meet government requirements. As I understand the situation, the Air Force plans for competition later this year.

Do you think these competitions will be fair or unfair and why?

Ms. SHOTWELL. Well, it depends on how the Air Force decides to determine how much of the ELC should be allocated to any competed mission. I can't say in advance of reading the request for proposal, but I do anticipate a draft in the next month or so.

Mr. BROOKS. Mr. Bruno, do you have an opinion?

Mr. BRUNO. I do. I have greater faith in the Air Force acquisition corps than my counterpart at SpaceX. I am convinced that they will find a way to create a level and even playing field and create real competition.

Mr. BROOKS. All right. Next question.

Ms. Shotwell, the Air Force has told us that whoever wins a competition will get a portion of the ELC funding. If SpaceX wins, my understanding is that you will get a portion of that planned funding.

Is this correct? And is that fair or unfair?

Ms. SHOTWELL. That is not my understanding at all. We have never sought nor accepted ELC funding.

Mr. BROOKS. Okay.

Ms. SHOTWELL. I hope I understand your question.

Mr. BROOKS. Well, I am reading it as written. So that is the best I can do right now.

Ms. SHOTWELL. Okay. All right.

Mr. BROOKS. Mr. Bruno, is the ELC contract a subsidy, as SpaceX often refers to it? Please describe the role of this contract.

Mr. BRUNO. No. It is not a subsidy. As I have said before, it covers costs that all launch providers have: pads, labs, day-of-launch operations, fuel and propellents, the infrastructure that supports them. The Air Force has simply chosen to contract for that separately from the production element.

Mr. BROOKS. Ms. Shotwell, I am going to give another shot at a different question, but please bear in mind that each of us Congressmen have staff, both committee and office, that put these things together to assist us. Hopefully, this one you will be better able to follow.

Quote, "Ms. Shotwell, I am aware that SpaceX was surprised that its Falcon 9, Version 1.1, was not certified by the Air Force at the end of 2014, despite the fact that weekly teleconferences were conducted by senior SpaceX leadership, such as yourself or Mr. Musk, with Lieutenant General Sam Greaves of the Air Force Space and Missile Center.

"Were all the elements of the cooperative research and development agreement that was signed by the Air Force and SpaceX completed by the end of 2014?"

Ms. SHOTWELL. Before I answer the question, I do want to note that SpaceX and the Air Force are working very closely. They are working very hard and we are working very hard, shoulder to shoulder, to get this vehicle certified to help fix this assured access to space issue. So let's make sure that that is very clear.

The surprise that we had in December was that the mode that we were operating in with respect to dealing with open items, it looked like we were going to be able to resolve open items after certification—some open items after certification. I think the Air Force believed in December that they did not want to certify with any open items. And so kind of the practice that we had been following did not—basically, did not bear out.

However, we have a great understanding with the Air Force right now. We continue to work on certification. And I would like to be clear. The certification process that we are undergoing right now, which SpaceX is going through, we are not being paid by the Air Force to go through, and ULA had a very different and a much easier certification process when they were new with their rockets.

So we are working very closely with the Air Force on the certification. And the certification fundamentally addresses all of the issues that one would address right up until a flight-readiness review, which occurs just a week or so before launch.

So not only are we, by going through this certification process, being certified as a provider or maybe even the launch vehicle design, but, fundamentally, we are being certified as if we were going to be flying in a week or two.

And, normally, when you do an Air Force contract, you receive a contract and then you fly that mission 2 or 3 years later. So all I am trying to say is it is an incredibly rigorous certification process.

Mr. BROOKS. I see my time is expired. Let me conclude with this one remark.

Mr. Bruno, United Launch Alliance, thank you for your perfect record in servicing our country.

And, Ms. Shotwell and SpaceX, thank you for your company's willingness to engage in a very risky endeavor in space.

Mr. ROGERS. Thank the gentleman.

The chair now recognizes the gentleman Mr. Bridenstine for 5 minutes.

Mr. BRIDENSTINE. Thank you, Mr. Chairman.

Mr. Bruno, just a question regarding the Delta retirement process. Do you have a timeline for that?

Mr. BRUNO. Yes. I expect to retire it in the 2018 to 2019 timeframe after we have accomplished the commitments we already have.

Mr. BRIDENSTINE. So when you think about the limitation on the RD–180, how does that affect your calculus on when to retire the Delta program? Because, ultimately, if there is going to be a competition, you will need the Delta program beyond 2018, 2019.

Mr. BRUNO. Delta is inherently more expensive than Atlas and is simply not competitive in an open marketplace.

Mr. BRIDENSTINE. And I am just—out of curiosity, when there is this limitation out there and the limitation is waiverable and there may be uncertainty based on that, how does this effect you, as a company, trying to make capital expenditures and plan for the future? Does it change the way you do business?

Mr. BRUNO. It does. The investment for our new American rocket engine and our Next Generation Launch System will largely be private.

Private investment does not like uncertainty. And so this issue around 1608 and the availability of the RD–180 is making it difficult for us to close with our investors on that arrangement.

Mr. BRIDENSTINE. You mentioned that the Delta IV Heavy has a different capability from the Falcon Heavy.

So how is that relevant if it is going to be retired after 2018, 2019?

Mr. BRUNO. I will maintain the Delta IV Heavy as long as the NRO requires it. I have made that commitment to the NRO and to the Air Force.

When we have the final version of our Next Generation Launch System, it will, in fact, have 30 percent more capability than a Delta Heavy has today and at a substantially lower cost. At that point, I expect the Air Force and the NRO will find a graceful path to migrate to that platform.

Mr. BRIDENSTINE. You mentioned that the BE–4 engine is methane and that the AR–1 engine is kerosene. My understanding is, when you build a new rocket—or you build a new engine or you have a new engine, you need to build an entirely new rocket around that engine.

What are the engineering implications of which direction you end up going? Is there a difference in timeframe and those kind of things?

Mr. BRUNO. There is a difference in timeframe, but it is primarily because the methane engine started 3 years earlier than the kerosene engine did.

Methane is a lower density fuel. And so the tanks on the first stage would need to be larger. The kerosene engine we are developing will also be longer in length and have different interfaces. So, for both, there will be pad changes that need to be made as well.

Mr. BRIDENSTINE. When do you expect the next-generation rocket to be ready for testing and, ultimately, usability?

Mr. BRUNO. If all goes as planned, we would have the next-generation rocket first flying no earlier than 2019, which would support a certification in 2022 or 2023.

Mr. BRIDENSTINE. And for both of you, could you give me an estimate, what percentage of your launches are driven by the private sector commercial enterprise, the satellite industry, for example, you know, commercial telecommunication satellites? And not just telecommunication, whether—whatever satellites there may be. What percentage is from commercial?

Ms. SHOTWELL. Sixty percent of SpaceX launches are commercial.

Mr. BRIDENSTINE. Okay.

Mr. BRUNO. Just under 20 percent for us today.

Mr. BRIDENSTINE. Is there a reason that it is about 20 percent and not more, not higher?

Mr. BRUNO. Our primary core market in mission has been for national security space.

Mr. BRIDENSTINE. Okay. And then the final question for both of you would be—I have got about 55 seconds left, so you guys can divide that among yourselves—as far as infrastructure requirements, both of you are going to need infrastructure for launch capabilities. Can you share with this panel what those requirements might be as we think about the future?

Ms. SHOTWELL. As a responsible launch service provider, we basically build our own launch pads. We maintain our own launch pads. We maintain all our infrastructure, and all of the costs of that are rolled into the per-mission price for each launch. So it is covered.

Mr. BRIDENSTINE. Okay.

Mr. BRUNO. Ditto.

Mr. BRIDENSTINE. Roger that.

Mr. Chairman, I yield back.

Mr. ROGERS. I thank the gentleman.

I just want to ask some cleanup questions and then we will dismiss this panel. And trust me, I can keep you all here for 2 hours talking about the stuff on my mind.

You just mentioned that you would keep the Delta Heavy in place, as long as—that the NRO requires or the government requires. But you have also said publicly, and I would to go back to the RD–180 and the problems it generates, that if we don't fix the 1608 language problem in the NDAA 2015 budget, that you may not be able to compete for some of the missions upcoming and then the Delta program may go away. Is that accurate?

Mr. BRUNO. Yes, it is.

Mr. ROGERS. All right. And before I go any further, let me ask Ms. Shotwell this: He has already talked about getting rid of the Delta IV. If he were to stop the Delta IV, are there any missions that it carries out that you could not carry out?

Ms. SHOTWELL. No. Falcon 9 and Falcon Heavy could carry out all the missions——

Mr. ROGERS. Anything that the Delta IV does.

Ms. SHOTWELL. That is correct. As a matter of fact, the comment that the Falcon Heavy is less capable than the Delta IV heavy is patently untrue.

Mr. ROGERS. Well, my point is, so we would go from him having a monopoly to you having a monopoly if he stops with Delta IV. Is there anyone else to compete with you for those missions?

Ms. SHOTWELL. I don't understand why ULA can't focus and determine how to make the Delta IV more competitive.

Mr. ROGERS. That is not my question. One thing at a time. If he stops the Delta IV rocket launches, is there anybody else that can—and you have already said you can do anything it can do, is there anybody else that can compete with you for those missions?

Ms. SHOTWELL. I have not seen Delta IV prices, so if they stop Delta IV, I guess we would compete with the Atlas, hopefully with an American engine.

Mr. ROGERS. No, I am just saying—forget the Atlas. Let's say the Atlas is gone. I am fixing to go there with him. If the Delta IV is no longer making launches, and you have already said you can do anything it can do, is there anybody else in the marketplace that could compete with you for the mission work that it would leave?

Ms. SHOTWELL. There are international launch service providers that could——

Mr. ROGERS. Who?

Ms. SHOTWELL. Ariane 5 or Arianespace, and the Proton Launch Vehicle through ILS [International Launch Services].

Mr. ROGERS. And you think that they would be competing for those launches?

Ms. SHOTWELL. Well, I don't think the National Security Committee——

Mr. ROGERS. I don't think so either, that is my point. You would have a monopoly is where I am going with this, and I just want you to acknowledge it. You would have a monopoly on that work. But, now I am going to leave you and go back to him.

If this RD–180 problem is not solved, which I hope we are going to solve this year, you have made a statement that you may not be able to compete and the Atlas program would go away; is that right?

Mr. BRUNO. Yes.

Mr. ROGERS. So, you have already said that the Delta IV is going away in 2018. You are saying that we could lose the Atlas, but you promised you will never let the Delta IV Heavy go away as long as the NRO needs it. Now, if those two things happen that I just described, that we lose the Delta IV and the Atlas program goes away, how much would it cost for a Delta IV to lift, heavy-lift launch?

Mr. BRUNO. Substantially more than it costs now.

Mr. ROGERS. What does it cost now?

Mr. BRUNO. So, Delta IV, depending on the configuration, costs between $400 million and $600 million——

Mr. ROGERS. What would it cost if you no longer have the other infrastructure?

Mr. BRUNO. Oh, it could be upwards of $1 billion.

Mr. ROGERS. Okay. Is that an acceptable number, do you think?

Mr. BRUNO. No.

Mr. ROGERS. Do you think that we would ever pay you that much money to launch?

Mr. BRUNO. I do not.

Mr. ROGERS. I think you are correct.

Now, let me go to you. You do not have the heavy-lift capability right now; is that correct?

Ms. SHOTWELL. That is correct. We will demonstrate that later this year, the plan.

Mr. ROGERS. And let me get you on this now.

Ms. SHOTWELL. That is okay. I expected it.

Mr. ROGERS. I love your optimism, but you said in April of 2014, quote, "We will launch the Falcon Heavy from here—from this pad—early next year." We are in early next year; in fact, we are at the end of early next year. When do you think you will be able to test that Heavy Falcon lift—the Falcon Heavy lift?

Ms. SHOTWELL. So I will try to be quick. I know——

Mr. ROGERS. No, we are all about you right now. I want to hear this.

Ms. SHOTWELL. Okay. Thank you. I appreciate that.

So first of all, we did deemphasize the Falcon Heavy development after I made that remark, because we wanted to focus on the single-stick or the single-core Falcon 9. It was a choice that we could make, largely because the customers that we have for the Heavy were really going to start in mid-2016. So, we had more time than we originally thought. We did have a contracted mission through the Air Force, the STP–2 mission and that was originally going to fly in December of 2015. However, thankfully, my customer moved that flight out, which gave me more time to both focus on the Falcon 9 and its reliability, of which we have done a great job of flying that with 100 percent mission success, and then I could delay the Falcon Heavy.

Mr. ROGERS. Yeah. Well I just want you to understand—and I am not picking on you, because, Blue Origin has got all kind of optimistic promises out there, as does Aerojet—is that the name of them?—Aerojet Rocketdyne. But here is another thing that Elon Musk said in April of 2011, quote, "First launch from our Cape Canaveral launch complex is planned for late 2013 or 2014."

So, you all have made statements before about having this heavy-launch capability before now and it hadn't happened yet. You said earlier today that you think you are going to have this launch later this year and be certified by 2018; is that correct?

Ms. SHOTWELL. Yes.

Mr. ROGERS. That is very optimistic. Would you agree that the certification process historically has been a 2- to 3-year process?

Ms. SHOTWELL. Actually, we started the certification process——

Mr. ROGERS. For the Heavy, the Falcon Heavy?

Ms. SHOTWELL. We started the certification process for Falcon 9, basically got going, in April of 2014, and we are going to finish in about June—by June of 2015. So, I believe—and by the way, the Air Force has really participated and leaned forward heavily on this—with lots of emphasis, I believe that the Heavy can be certified in 14 to 16 months.

Mr. ROGERS. You are optimistic. I hope you hang around for the next panel, because have you heard of the Mitchell Commission? They have a much more dim view of the timeline. And I say all this because I am not picking on either one of you, but I am very concerned, about this possible window, that we don't have heavy-lift capability. I just am. We are at war right now, and as you may look around, the world is getting a lot more dangerous. We don't know what is about to happen. We have to have these NRO platforms up

in the air. And we can't pay you $1 billion to do it. So, we can't let that happen.

And, I can't wait for you to be certified on your intermediate launches as well as your heavy-lift launches. And frankly, I hope you get another company in there competing with you all. But, I just want you to understand from our perspective, we are going to keep some kind of heavy-lift capacity until you are certified, going on. That is in our Nation's interest. You may not like the fact that we are going to try to figure out a way to keep his Atlas launches going so that we can keep the cost down for those heavy launches, but I think it is in our Nation's interest. So, please, hurry and get that Falcon 9 Heavy working and certified, and I will be a happy camper.

Last thing I want to ask and then I will shut up. But I tell you, I may try to arrange a meeting with Mr. Cooper, a sit down with the two of you all, in a room and talk about some of these things when we have got more time.

But the last thing I did want to ask, because this concerns me, and that is, Ms. Shotwell, does your company oppose Defense Contract Audit Agency [DCAA] standards as well as providing the necessary detailed costs in processing information to government oversight?

Ms. SHOTWELL. So, we have DCAA auditors doing manufacturing audits for us right now, and we have provided the Air Force and other government customers with our costs, and our costs have been audited. Our rates have certainly been audited.

Mr. ROGERS. So, as we go forward and you compete for government launches, you have got no problem with these DCAA audits?

Ms. SHOTWELL. No, we have DCAA auditors in the plant right now.

Mr. ROGERS. That is what I wanted to hear.

Mr. ROGERS. Chair now recognizes the gentleman from Tennessee for much smarter questions.

Mr. COOPER. Thank you, Mr. Chairman.

This question is actually Ms. Sanchez's. She asked me to ask it on her behalf. It is to Mr. Bruno, and it is, do you need any government funding investment for your plan B, which is replacing the RD–180 engine for Atlas?

Mr. BRUNO. I do not require government funding; however, there are wise investments the government can make, in reducing the technology risk of this new and advanced technology we are introducing, and I will not say no to help.

Mr. COOPER. Well, new and advanced technology, but you would basically be duplicating what you have been reselling from the Russians for 30 years.

Mr. BRUNO. We will, but we will be doing it in a different size class with different materials in advanced and more modern manufacturing techniques.

Mr. COOPER. Because they still have a 5-year license hold on the technology.

Mr. BRUNO. They have a 5-year license hold on the design of the RD–180, not on the fundamental technology I am referring to, which is an oxygen-rich, staged-combustion process.

Mr. COOPER. Okay. Thank you, Mr. Chairman. I look forward to the next panel.

Mr. ROGERS. I do too.

Thank you all very much. This has been enlightening. And I do hope you will hang around for this next panel because it is going to be an important part of this process as well. So with that, this panel is dismissed and I call up the second panel.

I would now like to welcome our expert witnesses for the second panel. Thank you all for coming to testify today and be with us. We have the Honorable Katrina McFarland, Assistant Secretary of Defense for Acquisition; Dr. William LaPlante—apparently you must not be honorable. Nobody put that in front of your name. I am just joking. You are a very honorable man—Assistant Secretary of the Air Force for Acquisition; we also have General John Hyten, Commander of U.S. Air Force Space Command; and Major General "Mitch" Mitchell, United States Air Force, retired. General Mitchell is representing himself today, but he was the chair of the Air Force chartered study to risk mitigation for the EELV program concerning U.S. reliance on the Russian RD–180 engine.

And I would also like to recognize a special guest with us today. General, it is clear that you have got somebody with us that is much better than you.

General HYTEN. That is for sure.

Mr. ROGERS. You married up, brother. But you brought the big guns with you. If you get in trouble, I will just ask her what the answer is.

General HYTEN. She is much smarter than me too.

Mr. ROGERS. All right. So, Ms. McFarland, I will start with you. Your entire statements will be submitted for the record. If you could take 3 minutes to kind of summarize it, and we are going to do the same thing for all of you, 3 minutes each and then we will get into the Q and A and hopefully some more discussion type of an environment.

But anyway, Ms. McFarland, you are recognized for 3 minutes to summarize your statement.

STATEMENT OF HON. KATRINA G. MCFARLAND, ASSISTANT SECRETARY OF DEFENSE FOR ACQUISITION, DEPARTMENT OF DEFENSE

Secretary MCFARLAND. Thank you, Chairman Rogers, Ranking Member Cooper, and distinguished members of the committee. I appreciate the opportunity to appear today before this subcommittee.

The Department's highest priority for space launch is assured access to space. That requires two highly reliable engine launch systems as a fail-safe method to allow for continued access should one suffer a fleet grounding event. If we do not have an alternative launch system, all our overhead space operations that provide capabilities such as global awareness, communications, strategic missile warnings and indications, and position, navigation, and timing information are at risk.

We are dependent upon assured access to space as the enabler of space operations that we rely on for national security. We can recognize, however, that the assured access to space must come at

an affordable price, and that is why we intend to pursue affordability and a healthy industrial base by incentivizing innovation through an orderly transition to competition via certified new entrants. I state orderly transition, as moving to competition must not occur at the reduction or expense of mission assurance. We lost sight of mission assurance in the 1990s and that led to a string of launch failures, where more than $5 billion worth of hardware and three national security payloads were lost. We can't afford to repeat that.

When speaking of new entrants, it is important to understand that certification is a cornerstone of our mission assurance process. We have invested heavily through the Air Force in providing a means for certification to new entrants, and it appears to be paying off as our first new entrant, in this case SpaceX, according to the Air Force as the certificating authority should be certified this year.

My last emphasis will be on our commitment to end use by our providers on the Russian RD–180 engines as we pursue our competition of competitive launch services. The Air Force has been working with industry and subject matter experts since last year early to find an alternative solution. We are concerned about the current fiscal year 2015 NDAA section 1608 language. It may interfere with our ability to transition in an orderly and efficient manner to two domestically produced affordable and effective certified launch systems in a competition that can sustain our full launch manifest requirements. As it is written, it may result in a trade of one monopoly to another.

We are committed to reintroducing competition into the EELV program and ending the use of the RD–180 as quickly and as safely as possible. Space launch is an inherently unforgiving, high-risk endeavor, which our approach to mission assurance has effectively mitigated for over 15 years. As we move forward into a more competitive environment, we will continue to maintain our robust mission-assurance standards because the cost of failure is simply too high.

Thank you, again, for this opportunity to appear before the subcommittee, and I turn it over now to my colleague.

Dr. LAPLANTE. Thank you, Ms. McFarland.

[The prepared statement of Secretary McFarland can be found in the Appendix on page 88.]

Mr. ROGERS. Mr. LaPlante is recognized.

STATEMENT OF DR. WILLIAM A. LAPLANTE, ASSISTANT SECRETARY OF THE AIR FORCE FOR ACQUISITION, DEPARTMENT OF DEFENSE

Dr. LAPLANTE. Yeah. Thank you, Chairman Rogers. Thank you Ranking Member Cooper and other members of this panel. I can just say right up front that this panel just today has already done a really important work in exposing and clarifying, I think, the challenges we have, particularly in the wrap-up there, Mr. Chairman. You got right to it. So, thank you for holding this hearing.

As we know, we have a lot of challenges here. You know, one word that has not yet come up but I want to emphasize is "sequester." So, we think about everything that is ahead of us, whether we

do public/private partnership, we also could have the "S" word to deal with.

So, let me go ahead and just give a summary of where I think things stand and then, in the interest of time, turn it over then to my colleague, General Hyten.

Obviously, this is a hard problem. I think you just heard this in the last meeting. I am an engineer. I like to talk about constraints and over-constrained problems. In many ways, this is an over-constrained problem, meaning we and the situation are given more constraints than are possible to achieve the outcome. So let's talk about this. Typically, when you have a problem like this, it is usually worthwhile, I found, to first start about the desired end state. It is actually pretty simple and easy to get everybody to agree to. The desired end state. Then what you do is you say where are we today? I think what you just heard was a pretty good summary of where we are today. I am going to give my version of that. But those are two kind of easy pieces. The next piece is the key: What is the way to get from here to there, the transition plan? That is what we are here, and that is what we are all about. And can we pull it off?

So, let's talk about the desired end state. We heard it. We have at least two independent launch vehicle families that can do the assured access to space for General Hyten's manifest. We heard that we need to do this with American propulsion, American technology. And we heard we need to do this competitively. We want competition. We want to bring the price down. That is our desired end state.

Where are we today? Well, we just heard. Let's talk about ULA. ULA has got the Atlas V and the situation with the RD–180. We heard the risk that is there. We heard the discussion and the language. We heard Tory Bruno say a number of his lowest five, okay. Then let's go to the next one, the Delta. We heard Tory Bruno say what we all know, which is at least 30 percent more expensive than the Atlas V, and we heard what he proposes to do about that, namely to shut down the line in 2018 so he can make his Atlas V more competitive, okay.

And then we heard SpaceX, which any day now, any month now or week now—we are shooting for June—who is going to be certified to do a lot of our manifest. And make no mistake, the national security of the United States will be improved the day SpaceX is certified. It is really, really important.

But so now, let's talk about a transition plan to get between where we are today to this desired end state. Well, I think what we just heard is that just talking about an engine in isolation and the government funding the engine and getting at what Congresswoman Sanchez was asking, about the amount of money, no, that is the amount of money that has to be spent. Let's say $1 billion, maybe plus. The question is by whom? How much of it is government? How much of it is private?

We heard just in the last session, very promising from both witnesses, and pride, about what private investment can do. I think if we want to spur innovation, we have a duty to the taxpayer to look at what it would be done to compete launches of service and see what teams come forward, including how much they would do

on their own and how much the government would pay. That is what is called a public/private partnership. We are moving out on that immediately right now. We were going the put a draft RFP [request for proposal] on the street next week—next month excuse me—to find out who is serious, what does this look like. At the same time, we are putting money, as per the legislation, against risk reduction this year to continue it on this type of engine technology, and we are going to move out.

So, that is the situation we are in and that is our approach to it. But, make no mistake, Mr. Chairman, you got to it near the end: We do have to ask ourselves what risk we have still doing that strategy and having all of those conditions. So, at that point I am going to just finish my opening remarks. Again, thank you for the hearing.

[The prepared statement of Secretary LaPlante can be found in the Appendix on page 94.]

Mr. ROGERS. Great. Thank you. General Hyten, you are recognized for 3 minutes.

STATEMENT OF GEN JOHN E. HYTEN, USAF, COMMANDER, U.S. AIR FORCE SPACE COMMAND

General HYTEN. Thank you, Mr. Chairman. Thank you Ranking Member Cooper, members of the committee. This really is an important subject. And I very much appreciate as a commander of Air Force Space Command that you allow us to come here today and talk about this problem. Because, it is a risk decision that we have to figure out as we go through. So, on behalf of the 38,000 men and women of Air Force Space Command deployed in 134 locations around the globe right now, I really thank you for this opportunity.

So, as the commander of Space Command, I have three priorities for our space-lift mission. The first priority and most important is to maintain assured access to space from at least two U.S.-based transportation vehicle families who can reliably launch national security payloads.

So, in my 34 years in the Air Force, I have twice experienced periods where our military lost assured access to space. The first was in January 1986 with the loss of the space shuttle *Challenger*. Because the shuttle was used for military satellite launches, we not only lost the lives of seven great Americans, but we lost our Nation's access to space at the same time. That impact was significant. It caused gaps, but it was limited because space was just becoming part of our military infrastructure at the time.

The second time it happened was in the late 1990s, when we had a string of launch failures caused by our lack of focus on mission assurance and basic engineering principles, that culminated in the failure of three huge Titan IVs: One with a DSP [Defense Support Program] missile warning satellite, one with a Milstar-protected satellite communications system, and one with a National Reconnaissance [Office] satellite.

Each of these failures cost this Nation over $1 billion, but more importantly, it denied our Nation critical warfighting capabilities that would be important as we approached 9/11. Today space is fundamental to every military operation on this planet, from humanitarian to full-combat operations and the loss of assured access

to space would be extremely damaging to national security. That is why it is my highest priority and it is the prime directive for my command.

The next priority is to insert competition into the launch business. There is no doubt that new entrants have the potential to improve assured access to space as well as drive down costs. That is important, but it has to be conducted in context with assured access to space.

The next priority is move as fast as we can to get away from rocket engines not built by the United States. Specifically, getting off the Russian RD–180 from the Atlas V. I fundamentally believe that every American rocket should be powered by an American engine. It is really that simple. So, keeping in mind the prime directive of assured access, the production of a new engine must be in partnership with industry to assure we have a rocket, or ideally rockets, which will be able to fly with any engine that we build. Right now, this is a concern of mine.

But my biggest concern in this new competitive environment with the future, and I thought the previous panel did a great job talking about that, is what happens when, God forbid, we have a launch failure and we must shut down a rocket for a year or two. With multiple companies operating under tight margins, how does the company that experienced that launch failure stay in business without the revenue stream that you heard talked about so much from a vigorous launch campaign?

Who makes the decision when we return to fly? Who makes the decision to put another $1 billion satellite on top of that? Who makes the decision that we have to have assured access to space and there we are going to do those things? The story of ELC is actually part of that story, and I will be glad to address that in questions, but all of these are difficult questions.

So, Mr. Chairman, I thank you for your support.

Ranking Member Cooper, I thank you for your support, and I look forward to your questions as we go forward.

[The prepared statement of General Hyten can be found in the Appendix on page 104.]

Mr. ROGERS. Thank the gentleman. General, you are recognized.

STATEMENT OF MAJ GEN HOWARD J. "MITCH" MITCHELL, USAF (RET.), CHAIRMAN, USAF–CHARTERED RD–180 AVAILABILITY RISK MITIGATION STUDY

General MITCHELL. Chairman Rogers, Ranking Member Cooper, and members of the committee, thank you very much and good evening. Thank you for the opportunity to discuss assured access to space, a critical component of our national security.

I chaired the RD–180 mitigation study last March and April. I testified on Congress, provided copies of the report. I would only say that the major recommendation from that was that the Nation should have the capability to have liquid hydrogen, solid rocket motors, and hydrocarbon propulsion systems available to rocket designers to optimize the designs, and that is still valid today.

The EELV program has been very successful. It was designed to meet the DOD national security space requirements and has done so remarkably well. The family of launch systems has met all the

requirements documented in the key performance parameters of the 1998 operational requirements document.

That being said, as has been discussed today, the program is the midst of a major restructure, if not properly resourced and carefully thought out, will add significant risk to assured access to space for national security, particularly, launches in the 2018 to 2022 timeframe. That may not result in a competitive environment, as has been discussed earlier. Depending on the interpretation of the RD–180 restrictive language, it could actually affect the 2015 to 2017 Phase A1 procurements that the Air Force plans, because we will be in a sole-source position as early as 2016.

If success orientated schedules for the contractors and the government are not met, the 2018 EELV program will look like the following: No Delta IVs, except the Delta IV Heavy at an extraordinary cost; no Atlas Vs; no certified Falcon 9 Heavy, that is yet to be submitted for that certification process to begin; no Next Generation Launch System [NGLS] yet, as Mr. Bruno said, it won't be on until 2022 or 2023.

Only Falcon 9, version 1.1, which launches the lower end of the mission model, and the Delta IV Heavy would be available for national security missions. The result would be that national security flying on the Atlas V, that are currently in that middle range, would have to fly on a Delta IV Heavy or they would have to wait for either NGLS or SpaceX Falcon 9 Heavy to show up. That would be an untenable situation.

This potential 2018 program would result in two monopolies, one for the heavy mission, ULA, one for everything else, SpaceX. Obviously, this is not the desired end state for competition, but is certainly a plausible outcome based on the risk profiles. The only way to preserve competition and avoid this situation is to allow the use of RD–180 engines until a transition plan to new launch system is defined and adequately resourced.

I recommend a plan be put in place led by the Air Force to do that. And I will close with a comment from a colleague of mine who said, "Currently, no stakeholder has a credible plan that closes. Each stakeholder has a different endgame solution, and each stakeholder's current non-closing game plan has 'and then a miracle happens' as the last element of the plan. And all of those miracles are different."

I appreciate the opportunity to discuss this and look forward to your questions.

[The prepared statement of General Mitchell can be found in the Appendix on page 114.]

Mr. ROGERS. Great. Thank you. All of you made reference to the importance that we clean up this 1608 language problem, and you just heard General Mitchell made a real sense of urgency about it.

So, I want to start with this: You heard earlier—we heard Mr. Bruno, in the earlier panel—I guess all of you listened to the first panel—make references to what will happen if he doesn't get a replacement engine for the RD–180 soon, get that language cleaned up. Well, if he doesn't get a replacement engine or isn't able to use the engines that we have paid for, that could create a potential that we would only have the Delta IV Heavy for the NRO launches

that are essential to our national security. Does everybody agree with that?

Record will show everybody said yes.

All right. You heard the eternal optimism of Ms. Shotwell, that she is going to have her Falcon 9 Heavy able to launch later this year and certified by 2018. And let me start with General Mitchell. Do you think that is a realistic timeline?

General MITCHELL. Sir, I think when you talk the Falcon 9 Heavy, it is realistic for them to start the process. The question on finishing the process has got a couple aspects to it: One is, do they get enough launches in? And that is determined by them. As they do their statement of intent, they will say whether they are going to do three launches or six launches. There is several options. The process to go through to get certified will then take some time.

Mr. ROGERS. But before you go to the certification, let's stay on the launches. They are going to have to prove this technology——

General MITCHELL. Yes, sir.

Mr. ROGERS [continuing]. Which is going to take some launches. You know this business. What is a realistic timeline that you think that that could be done by that company?

General MITCHELL. Well, from what I understand, their manifest, they are in the process of building the Falcon 9 Heavy now, the first one. It would be at least a year, year and a half before they could launch all three of those, perhaps 2 years. And that is only one part of those certifications.

Mr. ROGERS. And that is if it works?

General MITCHELL. Yes, sir. That is success orientated.

Mr. ROGERS. There is 27 rockets that is going to be put in there and there is all kind of issues about whether it would work. But let's assume it works. You are saying a year to 2 years before they can test——

General MITCHELL. Before the——

Mr. ROGERS. No, no, not certification.

General MITCHELL. Just the launches.

Mr. ROGERS. Just to prove the launches work and all the rockets go in the same direction.

General MITCHELL. Yes, sir.

Mr. ROGERS. Which is the desired goal. So now, 18 months from now, they have successfully proven the technology works. How long will the certification process take? Because as I understand it from you, it starts at that point.

General MITCHELL. Yes, sir.

Mr. ROGERS. You heard Ms. Shotwell say they have already started the certification process. I don't think you can start the certification process until you prove the technology works.

General MITCHELL. Right. So let's be clear, sir. There are some steps in this process. First, there is a statement of intent that says I want to get this rocket certified.

Mr. ROGERS. Okay. That is what she started.

General MITCHELL. Right. When they put that statement in, then they say how many launches they are going to do, as part of that certification process, and depending on how many launches they do, depends on what depth of technical expertise you apply to look at their design. Then, they do an agreement as to how that certifi-

cation is going to be done. It takes some time after the statement of intent to negotiate what the rules of engagement are going to be.

Then it takes typically, I would say, because it is a redo of the company, you don't have to go back and look at their quality and a lot of their manufacturing processes, but you do have to look at the product. So, it probably won't take 2 years, but I would be surprised if it took less than 18 months, because a Falcon 9 Heavy is going to have to meet some very stringent requirements, the hardest one being a direct inject to geosynchronous orbit for a 14,500-pound payload that requires a 3-hour coast mission for an upper stage, and that upper stage today does not exist.

So, it is not just getting a heavy. It is getting a heavy that can perform the DOD missions. The first heavies are going to be at experiment. The STP–2 mission, they have got a couple of commercial launches, but none of those launches are going to be as stressful as the heaviest of the DOD requirements.

Mr. ROGERS. Okay. So——

General MITCHELL. I don't think you are going to get a system certified until 2018 or beyond.

Mr. ROGERS. Okay. She, Ms. Shotwell believes that she will have that entire process complete by 2018. Are you saying that is doable?

General MITCHELL. They could get there by 2018 if everything is successful.

Mr. ROGERS. If everything is successful.

General MITCHELL. No earlier than 2018.

Mr. ROGERS. Is that optimistic or is it practically realistic?

General MITCHELL. I would say it is optimistic, sir.

Mr. ROGERS. What do you think is a realistic timeline, based on your experience with this process, which is extensive?

General MITCHELL. If they have no failures of the Falcon Heavy, then they can get there probably in 2 years, 24 months after, so it would be the middle of 2019.

Mr. ROGERS. Okay.

General MITCHELL. If they have a failure, all bets are off. It depends on what it is and what it means for the redesign and everything else.

Mr. ROGERS. Okay. General Hyten, you heard me talk about this new technology and, again, as I said in the previous panel, I want to see this heavy, this Falcon 9 Heavy certified. But this is new, this whole approach of using 27 rockets. Tell me about what your thoughts are on that. How high a confidence level do you have that this new technology is going to work in the test that Ms. Shotwell talked about would be later this year?

General HYTEN. I will never deny the ingenuity of SpaceX to pull something off. Because what they have done in the last 4 years is really remarkable, how far they have come.

Mr. ROGERS. Right.

General HYTEN. So they have the ability to do that. But they are going to strap three Falcon 9s together, each with 9 engines on the bottom, so you will have 27 engines on the bottom to take that heavy capability up. And then they are going to have an upper stage because they are going to have to demonstrate how to get with an upper stage coasting to GEO [geosynchronous Earth orbit]

for a long period of time. That is a very stressful mission. They are going to have to come in to us with a certification proposal.

Mr. ROGERS. Have they submitted an intent?

General HYTEN. They have not submitted——

Mr. ROGERS. So, no process has even been started yet?

General HYTEN. Not on the Falcon 9 Heavy, no, sir. And so when they come in, they will tell us, one, three, nine, it won't be nine for a heavy because you will never get to there with nine. But probably one or three and then they are going to have to basically say we will submit the following data, the following design reviews, the following certification process. And if it is one, it is a longer process, if it is only one launch they have done, it is a longer process than it is with three, because we will see more of the multiple launches that go on.

So, I agree with General Mitchell in terms of it is very aggressive to get to 2018, but SpaceX has been amazing in their ability to deliver those capabilities. So, I will not say that it is impossible, but I think 2019 or 2020 is a more likely solution for a heavy capability.

Mr. ROGERS. Okay. Dr. LaPlante, same question: How realistic is it do you think, we will have an alternative to the Delta IV Heavy, from SpaceX, demonstrated and certified? What is the most realistic timeline, in your mind?

Dr. LAPLANTE. Well I think, again, what my previous two colleagues said is exactly what I have been hearing for the last 2 years, is more or less what these two gentlemen have said. And they have also said, you know, just that the challenge is success oriented, and so the likelihood of having all that done, all the certification done in the 2018 timeframe, normally I would say that is probably lower likelihood than you would expect.

But, the caveat I have to make is what General Hyten just made. I mean, SpaceX has done remarkable things. They have done remarkable things. And so, we are all in the jobs of trying—our job is not to be optimistic or pessimistic; it is to be accurate. And so I think it is an optimistic schedule. They may be able to pull it off, but you heard all the challenges.

I also want to add one other thing, Mr. Chairman. If you heard General Hyten and General Mitchell talking about, depends which approach they do in certification, for those just to know, we have essentially a user's guide. If you want to be a new certifier, you can go in and you can look, depending on what class of missions, which path you want to go. General Hyten just said, you could do it only with one launch but then you have to do a lot of other stuff to show us.

On the other hand, at the other extreme, you could do a lot of launches and show us very little because the proof is in the pudding, or go something in between. So they, SpaceX has to decide which approach they want to do and then put in place their statement of intent. That has not yet, at least on our side, happened.

Mr. ROGERS. Yeah. So, I am surprised, I thought that based on Ms. Shotwell's testimony, the certification process has already been initiated. But you say that is not accurate?

Dr. LAPLANTE. Not formally on our side. In the case of the Falcon 9, the formal process, depending on whether it is statement of

intent, we actually signed the CRADA [Cooperative Research and Development Agreement], which was the detailed agreement between the Air Force and SpaceX for certification in June of 2013. That is the detailed plan of how we, together, would do this. And so, that hasn't happened yet for Falcon, for the current vehicle. That is a key point.

Mr. ROGERS. Let many ask this question: If, in fact, it takes SpaceX, and I understand it is heavy lift, because that is where I am really concerned for our national security interest, if it takes them another 2 to 3 years to successfully test this technology, to the satisfaction of you that it works, and then the certification process takes 18 months, we could be looking at 2020 or 2021 or maybe even 2022 before the final certification process could be done. If everything doesn't go perfectly. Is that an accurate statement?

General MITCHELL. Sir, I would only add to that that once it is certified, then you have to be awarded a mission, and it is about 2 years after certification before you would actually launch a mission. Because you have to integrate that payload into it. So, you have got to take the end of certification, then you have to win a competition to actually fly a mission, and then you have to take about 2 years to integrate and make sure that it is going to be a mission success not just——

Mr. ROGERS. This is the last thing I will pester you all with, so everybody else gets a chance to ask questions. Is there, in your opinion—and this is for each one of you I am asking another question—a realistic probability that we could have a window of 1 to 3 or more years, where we will not have heavy-launch capacity or access to space in the absence of paying $1 billion or more for a launch, under the landscape, as you see it, laying ahead of us? Ms. McFarland.

Secretary MCFARLAND. Chairman, since I haven't had a chance here, I will definitely jump on that. Yes, that is our gravest concern.

Mr. ROGERS. Is that an acceptable national security risk, in your opinion?

Secretary MCFARLAND. No, sir, it is not.

Mr. ROGERS. Dr. LaPlante, same question.

Dr. LAPLANTE. No, not if we are going to have assured access to space with two independent lines. By definition, by policy of the country, that violates that.

Mr. ROGERS. But based on the testimony you have heard from the first panel and the witnesses here in this panel, the circumstance we are facing is not an acceptable national security risk, in your opinion?

Dr. LAPLANTE. My opinion, it adds significant risk to national security, and the policy—this is important—the policy of having two independent vehicles, if you will, and independent, as Tory Bruno and Gwynne Shotwell talked about it, access to space. It does not meet that.

Mr. ROGERS. General Hyten, same question.

General HYTEN. It is not acceptable risk, period.

Mr. ROGERS. Okay. General Mitchell.

General MITCHELL. I would only add that the Falcon 9 Heavy probably has a better chance of getting there before the NGLS or the Next Generation Launch System, which probably isn't going to, as Mr. Bruno said, be launching until 2022 or 2023. I think you will see a Falcon 9 Heavy launch before then but probably not before 2020.

Mr. ROGERS. Ms. McFarland, do you believe that if we fix this 1608 language problem, it would remedy the circumstance that you all just testified was unacceptable?

Secretary MCFARLAND. Chairman, I would be thrilled if you came and worked with us on anything that you would like to propose relative to helping us in this matter.

Mr. ROGERS. If the 1608 language was fixed so that we could use those additional 14 RD–180 engines, would it remedy the situation that you just all said was unacceptable?

Secretary MCFARLAND. Yes, sir.

Mr. ROGERS. That is all I want. Thank you very much.

The chair now recognizes the ranking member.

Mr. COOPER. Thank you, Mr. Chairman.

And I appreciate the terrific expertise of all the witnesses.

I am a little worried that in some of the chairman's questions we were like starting to borrow some trouble, and we have enough trouble already because we want to be honest about this. The greatest threat we face that threatens assured access to space is probably our own sequestration stupidity. Because that is a Pentagon-wide problem, and it is up to Congress to fix that. And I am grateful, it is my understanding, that some 67 of our Republican colleagues have now signed a letter saying they will not vote for a budget that is below the President's request for defense spending.

Because we have got to at least be at the President's level, because as General Dempsey said, that is the lower ragged edge of what we absolutely have to have. So, that is step one and that is the committee's responsibility. Step two, the chairman just got at, let's correct the mistake that we probably made in the 1608 language so that all 14 of the RD–180s can be used, because that would help close this possible window of vulnerability.

Okay. Then we get to more of the stuff we have been talking about in this hearing, which is we took the great words, "assured access to space," and we have effectively added some other things, for good reasons. Assured affordable, access to space. And competition is a way of achieving that but it is not the only way. I will get to that later. And then it has got to be assured, affordable American access to space because, you know, we are not against the Europeans but they have a rocket too, the Ariane 5, that can work for some stuff.

So, but if we delve deeper into these things, we really haven't brought up with RL–10 issue, the single point of vulnerability that we have today, in which that is really almost prehistoric technology compared even to the RD–180. So, there are a lot of issues here. But it seems to me that when the taxpayer is listening to this, they are thinking, well, competition is good, but that also could be viewed as redundancy. We are paying for extra capacity that we know we are not going to use, and in certain areas of life you want

redundancy, you want belt and suspenders. That is good. You want a seat belt and airbags.

But, you know, when I see entrepreneurs, and it is interesting now that both SpaceX and ULA are relying heavily on these remarkable individuals, who essentially compete against themselves. You know, their motto is probably, you know, "The difficult we do immediately; the impossible takes a little longer." Because already in many ways they have achieved what most mortals would have considered impossible.

So, this window of vulnerability that we may or may not be facing—and General Mitchell did an excellent job with his RD–180 mitigation report—there are ways of closing that gap. One of the ways that might be distasteful is to acknowledge that we have had 30 years to replace the RD–180 and we haven't done it yet, and buying a few more, which even in times of trouble with the Russians, they have been willing to sell us, is a way of closing that gap. And a darn affordable one, because the business plan of ULA previously has basically been reselling Russian technology. And that is an American company? Whoa. Definitions get a little squishy here.

So, there are ways to solve this problem. So I hope the sum message of this hearing is not that we can't do it in America, because we can do it in America. We will do it in America. We will get this done. And oftentimes, we argue over technique, and it is good to have this competition and occasional elbow. But, we are a can-do country and we will get this lift done.

And one thing that hasn't been mentioned is, it is my understanding that many of our satellites are being downsized. So, perhaps the heavy-lift capability isn't as necessary as it once was. So, we have got to get with the program here. And I think that the sum total of your testimony is, maybe we need to get the bureaucracy a little faster, because an automatic 2-year process, as I told one of the witnesses earlier, that was half of World War II and now we just use that much time.

And, you know, if we had to, in emergency, spend $1 billion, well, what did we spend in Afghanistan and Iraq, and what exactly did we accomplish? You see. You know, so putting things in perspective, we are a can-do, successful nation. We will get this done. And we have advantages that no other place on Earth has.

So, the overall message of this, let's not borrow too much trouble from the future. This will be done, and we will figure out a way to do it. And that, to me, is one of the most encouraging things that I could take from this hearing.

Thank you, Mr. Chairman.

Mr. ROGERS. I thank the gentleman.

Chair now recognizes Mr. Lamborn of Colorado for 5 minutes.

Mr. LAMBORN. Thank you, Mr. Chairman.

Thank you all for being here.

And General Hyten, greetings from Colorado Springs. I know people that work for you or associated with contractors helping you, and they certainly have a lot of respect for what you are doing, so thank you so much.

For any one of you, I have a question. Now, I was concerned because in a March 27 House Science Committee hearing, Garrett

Reisman or Reisman of SpaceX testified, quote, "With each flight, the Falcon 9 launch vehicle also continues to undergo improvements to safety, reliability, and performance," unquote. Does that mean that it is a moving target? That—I mean—General Hyten.

General HYTEN. Yes, sir. So the interesting thing about launch is that pretty much every launch that we fly, doesn't matter whether it is a ULA launch, an Atlas, a Delta, whether it is a SpaceX launch, a Falcon 9, there is almost always first-flight items on that launch. We continue to mature the technology. We continue to provide additional capability. We focus on that, and we have a very disciplined process for how we bring those things on.

The certification process incorporates all of those things coming in. It is not going to be an issue for us working through that. We know how to do that kind of business. We know how to bring new capabilities on. We will continue to do that with SpaceX just like we have done with ULA, sir.

Mr. LAMBORN. Would any of you add to that, or does that pretty much sum up what your thoughts are?

Secretary MCFARLAND. That is what we consider our state.

Mr. LAMBORN. Okay. All right. Thank you.

And secondly, General Hyten, at a February 25 hearing at the Senate Appropriations Subcommittee on Defense, the Secretary of the Air Force stated that, quote, "SpaceX has not really been part of our EELV program yet, right. They are trying to get certified to be part of it, but if you look back in time they have had various mishaps," unquote.

What was the Secretary of the Air Force getting at by that statement?

General HYTEN. So, the Secretary is pointing out, and we have had the same issues with launches, is that not every launch goes perfect. And so SpaceX has had some internal anomalies in the launches that they have done. Those are proprietary information, so I would be glad to share the details with you in a private setting, but I don't want to share them in a public setting. But we have also had the same things with Atlas launches. We have had the same thing with Delta launches.

And we go back and look at that. But the most important thing to remember is each one of those was a mission success. The actual rocket was successful as we went through. So, the Secretary was talking about issues with SpaceX in terms of anomalies that they have had. We continue to pursue those anomalies. We have worked those out with SpaceX. We have also done that with ULA. That is a normal way of working in the launch business. We will continue to do that with SpaceX.

The tricky part is that you can never extrapolate them into a national security space launch, because some of our requirements are very stringent and so when you ask the question, would the Falcon 9 have worked if you were launching this kind of rocket, it starts turning into a multidimensional helix where you just can't figure out all the variables and turn it into an answer that makes sense. But the good news is that every one of their launches have worked. It has been a mission success. We just have to work through the issues with them.

Mr. LAMBORN. I am just going to finish up with a very general question just to illuminate my understanding better. What is at risk? If you take one of these heavy launches, how much time is involved in putting the bus together and then how many dollars are involved, in a worst-case scenario? And I don't want to go into detail, and can't, on what capability we lose. That is huge also. But how much time do we lose, and how many dollars do we lose with one of these heavy launches?

Dr. LAPLANTE. You mean with the heavy-launch failure?

Mr. LAMBORN. Exactly.

Dr. LAPLANTE. Yes. Well, and as has been said by several of my colleagues here, of course, we are—launching is a means to an end. The important thing is what we are launching into space. That is what we actually care about. And those are at least $1 billion a pop. Sometimes more. You lose the capability, as General Hyten said, about what happened in the late 1990s. And just remind people the type of things we are putting into space are not just communications, but it is communications.

I mean, essentially, if you think of the nuclear triad we have, we have the bombers, we have the ICBMs [intercontinental ballistic missiles], and we have the submarines, the command and control of it, which we care about, but with the indications and warning of that, is what we put into space. It is what we assure and have been assured the country and the President for decades that we have a reliable deterrence system that he or she or the leadership will know if there is something happening in a timely way so they can make a decision. So this is serious, serious stuff.

So, you lose the money, you potentially lose the capability, and so it is a big deal. And then as General Hyten said, you know, the company—we have to be concerned if the company is going to be run out of business depending on the company.

Mr. LAMBORN. And lastly, I am running out of time, how many years are we talking about to duplicate it?

Secretary MCFARLAND. So, you have to rebuild the system that you launched, and some of those systems take 5, 6, 8, 12 years.

Mr. LAMBORN. Well, thank you so much. This is so critical. I appreciate your help.

Mr. ROGERS. Gentleman's time has expired.

Chair now recognizes the gentleman from Colorado, Mr. Coffman, for 5 minutes.

Mr. COFFMAN. Thank you, Mr. Chairman.

Ms. McFarland and Dr. LaPlante, given the importance associated with the payloads we are talking about here, I think is described by General Hyten, do you agree that any future launch contracts should put a premium on full certification based on demonstrated launch success?

Secretary MCFARLAND. Yes, sir, I do.

Mr. COFFMAN. Okay.

Dr. LAPLANTE. Yes, but what I also think we need to do, we need to challenge ourselves as to make sure we are doing it as efficiently as possible, and, you know, we need to look at the process to make sure of it. But yes, I do.

Mr. COFFMAN. General Hyten, anything?

General HYTEN. The certification process—this is the first time we have been through a certification process, Congressman. And so the first time you go through with something, the nature of a bureaucracy is to make sure that you have everything covered. And so we did that. When you look back in hindsight, and we have just had an independent team look back and we will have some reports come through the Secretary of the Air Force shortly, but when you look back, there is probably some things we can do to streamline that. That is what Dr. LaPlante is referring to. I think there are smart things we can do in the future. You always learn the first time you go through something.

Mr. COFFMAN. Major General Mitchell.

General MITCHELL. Yes. That is being looked at by General Larry Welch, who was a former chief of staff for the Air Force. He actually did two things, one for General Greaves in the certification of the Falcon 9 1.1 specifically, and then he is looking at the general overall process on part of that team that is supporting him in that look of can we improve the process without giving up mission assurance. And General Welch is very adamant about that because he goes back to the 1999 failures when he did the broad area review, and he has been engaged ever since then.

Mr. COFFMAN. Ms. McFarland and Dr. LaPlante, I think that everyone can agree that competition in any industry is a healthy dynamic that drives down cost and increases value to the U.S. Government. But, do you also agree that the foundation of any head-to-head competition between launch providers needs to be based on fair and open competition, taking into account any government-provided resources such as launch facilities, engineering services, or any other below-value government contribution?

Secretary MCFARLAND. Congressman, absolutely. When we go through competition in the future, we have to be very cognizant of what contributions are held where, and that actually is part of the competition process when you equate cost to cost.

Dr. LAPLANTE. Congressman, yes, Adam Smith is correct. Competition is good. But we have to do our level best when we are doing it to make sure you look at it from every angle and make sure it is a level playing field. That is our strategy, and so we always are doing that. We have to do that.

Mr. COFFMAN. Okay. Any other comments? Okay.

Thank you, Mr. Chairman. I yield back.

Mr. ROGERS. I thank the gentleman.

Chair now recognizes Mr. Bridenstine for 5 minutes.

Mr. BRIDENSTINE. General Hyten, you gave an estimate on when you think the Falcon 9 Heavy might be certified, and you said 2017 was maybe optimistic but you wouldn't bet against it necessarily?

General HYTEN. I said 2018.

Mr. BRIDENSTINE. 2018.

General HYTEN. And I would not bet against SpaceX. I think anybody that has bet against SpaceX in the last few years has lost. So, I think they are a very inventive company that has demonstrated mission success. But the heavy missions are very, very demanding. It is a whole new level of complexity that you are adding to the problem that they haven't faced yet in the missions that they have done. So, it is another step up. That is why, if you are

asking me, I think that is a risky proposition to get there. But, again, I would not put it past them.

Mr. BRIDENSTINE. So, we have heard, and I think a lot of people on this panel have expressed the concern, especially the chairman—and I appreciate it and certainly I understand it—that we have a risk as it relates to heavy launch. But, we have also heard, Mr. Bruno very clearly articulated that they are not going to retire the Delta IV Heavy, and we are hearing that the Falcon 9 Heavy could be certified by 2018, maybe optimistically, 2019, I would think, would be more, you know—we would be more sure of.

So, the reality is, we are really not at risk of losing a redundant launch capability; is that correct?

General HYTEN. The one modification I made to the analysis you went through would be, what General Mitchell pointed out, is that once they are certified, they are 2 years away from doing a mission.

So, the way you look at the problem is that—is when we look at every category of lift that we are talking about, we are really talking about a potential gap that we have to worry about—"gap" is probably not the best term. "Transition" is probably the best term—a transition period from 2018 to 2022, that we have to somehow work with Congress to figure out how we are going to transition, because when you get out to 2022, it is pretty easy to understand the competitive environment at heavy, intermediate, and small lift that can be out there in 2022. The challenge is how do you transition from 2018 to 2022? That is what we need to work with the Congress to do.

Mr. BRIDENSTINE. With the heavy-lift requirements of satellite communications, for example, it would seem like there is a large market here for commercial industry as well as for the military. When you think about the entire market for heavy lift, can you guys share maybe some—shed some light on what percentage is commercial and what percentage is military?

General MITCHELL. Yeah, I can speak to that. When you are talking the commercial satellites, you are not talking the heavy lift we are talking about. They don't need a Delta IV Heavy. They can do that with a smaller rocket. And——

Mr. BRIDENSTINE. Even to get to GEO?

General MITCHELL. Yes, sir. They go to a geotransfer orbit, and then from the geotransfer orbit they boost themselves up to their final location.

Mr. BRIDENSTINE. Okay.

General MITCHELL. So the Falcon 9 1.1, can handle that, some of the bigger ones. The Falcon 9 Heavy but, you know, you don't have to use all of its capability.

Mr. BRIDENSTINE. So, there is not a whole lot of opportunity to bring down the costs by relying on commercial——

General MITCHELL. No, sir. This is like the Titan IV was. We launched 41 Titan IVs. It is a very expensive rocket. It is a unique mission. It is very heavy. And the NRO payloads are the only ones that require that heavy lift capability today at the Delta IV Heavy category. And when we did the RD–180 study, we poked at that a little bit and we got back that that requirement will be in place until at least 2030.

Mr. BRIDENSTINE. Okay. For Dr. LaPlante, you brought up—and I think it is perfectly appropriate and I would like to echo it—that the challenge that we are living under right now is born of the sequester. And if you would highlight for us, because now we are looking at passing a budget, and the budget is going to have a number, a sequester number for DOD and then there is going to be OCO [overseas continency operations] dollars.

My question for you is, can you shed light for us, what are the implications for OCO dollars? Does that help you? Does that hurt you? I know the dollars are different. Can you maybe shed a little light on that?

Dr. LAPLANTE. Yeah, I will try to and then maybe also defer to Ms. McFarland. So, in the case of the space—of this space-launch issue, we have I believe the number in the President's budget for 2016 and beyond for the 5-year is somewhere a little short of $300 million. Part of that, we are going to know a lot more when we get these RFPs back because we are going to find out what is real in public/private partnership.

Of course, that $300 million is like everything else, going to be under the scrutiny with the sequester or if we end up having to increase it, if we find out that it has got to be $500 million. Now, can that be helped by OCO? I don't know how that could be. I am having trouble thinking of the color of money. But I will also ask Katrina to answer.

Secretary MCFARLAND. So, Congressman, the problem is that we currently budgeted in the President's budget for a competitive launch service, that was based on the use of Atlas Vs. Now you add the complexity of trying to enter in with a new launch system, the Next Generation Launch System, and then you try to find out what the public/private venture is that you can actually afford.

It was very interesting that the chairman pointed to the two industrial folks and they came back with no real response for what is the business case. And we have to provide a business case, because indeed, one of the things that you are poking at when you are trying to do a public/private venture is that you know you end up with something better than you started, not transferring from one monopoly to another as part of that.

So, indeed, I believe there is a concern here in sequestration: Can we afford it, and will we be able to put the money into the system for the long term that they see a business case that they can see money there to get, for us to be able to assure space launch.

Dr. LAPLANTE. Yeah. And just to add onto Ms. McFarland, in a case, an example, and this is maybe just a simple example is, do you have to guarantee a certain number of minimal launches for them to close their business case? And is there enough launches where you could have more than one person with a minimum guarantee? Things like that.

You were also asking very astute questions about what is the commercial marketplace for some of this, because that is part of the business case too, right? And that is why it was very important to hear from General Mitchell because his study—which by the way, is really called the Mitchell Commission, he just is too modest to call it that—looked at the market for these things and it is not what you might initially expect, it is particular with the heavies.

Secretary MCFARLAND. If I could add to that, the 2014 commercial—thank you. I am an engineer. The 2014 commercial space transportation forecast that came out has a flat line on what they anticipate the future brings in terms of commercial and NGO [non-governmental organization] and government. So, this business case is very interesting to us. They are all competing for this same size pie.

Mr. BRIDENSTINE. And if I may, Mr. Chairman, so let's pretend there was a third entrant. Would you say, that the market can't support that?

Dr. LAPLANTE. I would defer to General Mitchell.

General MITCHELL. So, I would say, I think it is going to be interesting to see how you support two. Three would be even more challenging. Because last year, as was reported by SpaceNews, there was 18 competitive commercial launches awarded. Of those 18, worldwide, of those 18, 9 were won by SpaceX and 9 were won by Arianespace. Nobody else won any; Proton's kind of grounded, they are not flying real well. And the reason it is so small is every country that has a capability vectors their satellite builders to their rocket.

So, there may be 50 launches worldwide but only 18 of those are going to be competed, last year as an example. And the document that Ms. McFarland refers to that 50 kind of stays stable and there is about 15 to 20 every year that is competitive. So, you don't have much to split up because Arianespace is going to win half of them typically, and their consortium will continue to subsidize them to make sure they win half of them so that they remain viable. So, you are just not going to get all of that market.

And so, the DOD tends to be around 10 to 12 missions a year. NASA has three or four that fall on this category. And when you add them up, there just is not a target-rich environment out there to go sell rockets. And even if you get a cheap rocket, that doesn't mean more people are going to build satellites just because of the launch vehicle is cheap. As Mr. Bruno said, it is 10 to 15, 20 percent of the cost of the stack. So, people aren't going to go build more satellites. They are going to do this in a business case.

Now, there are some out there that are talking about blotting out the sun with small satellites, and there is a couple of investments that are going on to do that. That is the same thing we heard in 1999, and that fell apart, which led us to kind of where we are in the EELV program now. They may be successful this time, but I guess we are a little bit jaded from the first experience to say let's go bank on all those commercial guys showing up again. So, I think it is going to be difficult to support three. It will be a challenge just to make two viable.

Mr. ROGERS. I thank the gentleman.

I just want to close up and get some things on the record. And I do want to pick up on that point though. What you just described is what worries me. And you heard me ask Ms. Shotwell that when the Delta IV goes offline in 2018 isn't she going to have a monopoly—and she didn't want to say it but we all knew the answer—that worries me, because of what you just described. The whole reason that ULA came into existence is Boeing and Lockheed couldn't make the business case to stay in the market so we basi-

cally created this partnership so that the national security interests were taken care of.

I love it when billionaires want to spend their own money to do cool things that help the country, but it's still a business. And you just described the very flat marketplace that either SpaceX or Blue Origin or whoever decides they want to pursue that, and then in a few years they go, you know, we are really not making any money. And we can't let this infrastructure go away because we still have national security demands.

So, I don't want it to look like at any time that the government is putting their finger on the scale to help anybody, except the government. And that is to make sure we have the national security infrastructure in place to take care of our security.

But having said that, I want to go back to General Hyten, that you talked about the transition period. You kind of summed up in there, that 2018 to 2022 period, that I was kind of trying to get to in my earlier questioning about this certification process. There is that period where we could have no assured access to space, which every one of you have said for the record, or at least the two of you, let me get you: Is that period of—acceptable to you of not having assured access to space period?

General HYTEN. We have to have it every year, every minute. That is critical to our national security.

Mr. ROGERS. And General Mitchell, I would say you would agree?

General MITCHELL. Yes, sir. As long as you refer to assured access to space in the policy statement that it is two providers. We will be able to have one provider. It is just going to cost more.

Mr. ROGERS. Yeah. And do you think we are going to give them $1 billion? With sequestration, it is not an option.

General MITCHELL. I agree with you, sir. All I can say is in the Titan era, we were spending about $500 to $550 million a launch in then-year dollars, which was in the 90s. I don't know what that would equate to today, but it is probably 3 quarters of a billion that we were spending back then to launch, and we launched 41 of them.

Mr. ROGERS. Yeah. Well, anyway. I think all of you have made it clear that not having assured access to space is not an option from our national security standpoint.

Now, the thing I want to kind of—the last thing I want to touch on is this replacement to the RD–180. And this is more for the record. I know it is late, but this is just such important stuff. My understanding is, there are two companies that are trying to build this engine at present to replace the RD–180, Blue Origin and Aerojet. Am I correct? Is there anybody else that any of you know of that may compete for this?

General MITCHELL. I would not refer to it as replacing the RD–180. I would refer to it as——

Mr. ROGERS. Building the American version.

General MITCHELL [continuing]. A heavy-lift American-made engine that is an oxygen-rich stage combustion. But they are not really to replace the RD–180. It is not like they are going to throw it under the Atlas body.

Mr. ROGERS. That is not the way I understand it. I think it is supposed to be thrown under the Atlas.

General MITCHELL. No, sir. The Blue Origin is a methane engine. It can't——

Mr. ROGERS. You are getting ahead of me now. The whole point is, as you heard Mr. Bruno testify, he is about to run out of these engines. Even if we fix the 1608, there is going to have to be an American-made engine to replace that mission. Now, you are getting technical in talking about how some of these folks would not be able to build an engine that would fit basically.

General MITCHELL. Yes, sir. You are going to have to change the package to whatever the engine is. You build the rocket around the engine. So, just try and, you know, jack up an Atlas, and say, I am going to take an RD–180 out and I am going to put something underneath it. Not going to happen.

Mr. ROGERS. Well, you are getting ahead of me. But let me ask this question then: Do you believe—and I will start with you, General Mitchell—that either of those two companies could build an American version of a rocket engine to replace the RD–180 within the next 3 years that would be certifiable that we could use?

General MITCHELL. Not within the next 3 years.

Mr. ROGERS. How about the next 5 years?

General MITCHELL. I would say it is 5 to 7.

Mr. ROGERS. Five to seven.

General MITCHELL. And I would say that an RD–180 class engine with that kind of thrust they could certainly do. But that is why I segregate from an RD–180 specifically because it is an 875,000-pound thrust engine.

Mr. ROGERS. Right.

General MITCHELL. So, when you are talking that class of engine, yes, they could build engines to do that but then they have to build a different rocket body to take advantage of those rockets.

Mr. ROGERS. And do you think that limited to just those two companies?

General MITCHELL. There is nobody out there right now, although——

Mr. ROGERS. Nobody else out there doing it?

General MITCHELL [continuing]. Although SpaceX is looking at building a thing called the Raptor engine, which is a million-and-a-half pound thrust, but they are very, very—they are way behind either Blue Origin or the AR–1 at this point in time. So——

Mr. ROGERS. And you say, in your opinion, those two companies at best we are looking at a 5- to 7-year timeline before they would be ready to launch something?

General MITCHELL. Yes, sir.

Mr. ROGERS. General Hyten, your opinion?

General HYTEN. Yes, sir. And I would reference Mr. Bruno's testimony earlier where he said that, even with the AR–1, he is going to have to extend the tank of the first stage of the Atlas V; and with the BE–4, Blue Origin engine, he would have to basically come up with a completely new tank, much larger in diameter because of the physics. So, either way you go with those engines, there is going to be a new rocket that is built around it. But I agree with the timeframe.

Dr. LAPLANTE. Yeah, I agree and the 5- to 7-year number, it is no coincidence that General Mitchell said it because that was really

the view of his commission. And almost everybody I respect in this community, the scientists and engineers, use that same timeframe. And that is not, by the way, bureaucracy; although, we certainly know how to do that. And it is not money. It is the engineering that it takes and the development is driving 5 to 7 years.

Mr. ROGERS. Ms. McFarland.

Secretary MCFARLAND. I really can't add anything further, Congressman. It is definitely a challenge to——

Mr. ROGERS. But my question is, do you concur it is a 5- to 7-year timeline?

Secretary MCFARLAND. I concur.

Mr. ROGERS. Okay. Now, let me—and I promise it is my last question. What I would like to see happen, and this is me, and I am not an engineer, I am not a rocket scientist or any of that stuff, but I would like to see us put out an RFP for an American-made engine that is our version of the RD–180 to try to stay in the same technology. Because, while I have heard Mr. Bruno's optimism about this methane that Blue Origin is talking about, it has been talked about for decades and nobody's been able to pull it off.

Now, Jeff Bezos may be able to do it. He is a really smart guy. SpaceX may come up with an option that is different. But, we know the technology, the kerosene-based technology from RD–180 works. So, I want to see us come up with our version of the RD–180, the American-made version, and stay within that same technology realm.

My question is this: Do you think that it is practical for us to put out an RFP to do what I just described and expect market competition to do that? And I would ask Ms. McFarland to respond.

Secretary MCFARLAND. Well, I will start, Chairman. The practical that you had in your question is most important. If you go back to my conversation about a public/private venture and a business case, the problem with trying to have us solicit and have an engine built, means somebody has to build a rocket around it. So, if I were to go out with a rocket, if I was to go out with a request for a rocket, that I would say ask to have someone take on as a business case to launch for us under services, that is a more practical approach.

Mr. ROGERS. But now, see, you moved away from my premise. The premise of my question is, this American version of the RD–180, which means it would fit the Atlas V. I don't want to build another rocket. That gets us down another pig trail that I don't want to go. I want to launch what we are launching now and not build a new rocket.

So, is it realistic, if we put in an RFP, to ask for the American version of the RD–180 to be built by the same technology that would fit an Atlas V, would we get market competition from the players in the universe that you are familiar with?

And I guess Dr. LaPlante wants to take that.

Dr. LAPLANTE. I will give it a shot in how we are thinking about it and see if this addresses your question.

So, you are asking—essentially the question is, when do we do the down select and pick exactly, you know, something like the RD–180 or not. And you could do that right now in how you issue the RFP, sure.

Well, our plan is not to do that. Our plan is to issue the RFP that is broader than that, and get as many, as I said earlier, it is four people under contract. So, let's see what comes in with an RD–180 like, in your words, perhaps with an Atlas. Let's see what comes in with the AR–1. Let's see what else comes in. We would like to get these guys under contract and see what is serious about the public/private partnership and then evaluate the technology, get them along and then we will down select it. You may be going right to where we end up.

It is a question of whether we restrict it now before issuing the RFP or later. Our approach is to do it later because, you know, it is funny, until you get people under contract, you kind of really don't—you don't get the real data and you don't get to see the real designs and you don't get to see and really test it out. And I believe we are responsible for the taxpayer to check that stuff out, and I don't think it is going to slow it down at all. And so, but that is kind of essentially our approach. But we will be happy to engage with you further as we develop this.

Mr. ROGERS. General Hyten.

General HYTEN. So, I will just echo what Dr. LaPlante said. As you look at the future, and you look at where we are moving into engine technology in the future, we also have to look at the law. And the law tells us we want to preserve competition, and we do not want an engine that is only available to one provider. And so, it is essential for us to comply with the law, and it also makes business sense to do it that way, is that we go out and find out what is available on the open market today. And that has got to be the first step. I think that was the intent of Congress in the Authorization Act that was passed, to make sure that we have that capability and that is the process we are going down.

Mr. ROGERS. If we did what you just described, we wouldn't have competition because there is only two players in the market, Blue Origin and Aerojet. And Blue Origin is talking about a methane engine. It would never fit the Delta V.

General HYTEN. Yes, sir.

Mr. ROGERS. I mean the Atlas V, I am sorry.

General HYTEN. Right. Yes. The Atlas V. The Authorization Act specifically says you can't build an engine that is only available for one provider. And so we have to make sure that we are in that. So, we want to look at what Blue Origin can do. We want to look at what they can do, but eventually we are going to have to make that decision. So, what Dr. LaPlante says I agree with completely. Eventually, we are going to have to make that decision.

Mr. ROGERS. I am following you now.

General.

General MITCHELL. I agree totally. The only thing I would say is, predicting is difficult business, particularly when it is about the future.

Mr. ROGERS. Yeah. Thank you.

Chair now recognizes ranking member for any final questions he may have.

Mr. COOPER. Thank you, Mr. Chairman. I have no more questions. I was just here to chaperon you.

Mr. ROGERS. That means give me the hook.

I would to close with this: We may have some—I know we have some written questions that we may need to submit to you all for the record and not keep you here any longer, and the same thing for our first panelists. Both are still here. So, if we submit written questions to you, we will get them to you within the next 10 days, and I would ask you to try to timely respond to those for the record.

With that, I thank you for your participation. This hearing is adjourned.

[Whereupon, at 6:28 p.m., the subcommittee was adjourned.]

A P P E N D I X

MARCH 17, 2015

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

MARCH 17, 2015

Opening Remarks
Honorable Mike Rogers
Chairman, Subcommittee on Strategic Forces
House Armed Services Committee

Hearing on Assuring Assured Access to Space

March 17, 2015

Good afternoon. I want to welcome everyone to the Strategic Forces Subcommittee's hearing on Assuring Assured Access to Space. We will be conducting 2 panels today.

In the first panel, we have 2 expert witnesses from industry, who represent our current and projected near-term providers of national security space launch in the Evolved Expendable Launch Vehicle program.

In our second panel, we have 3 senior government officials who have responsibilities over the EELV program, and 1 advisor to the government.

Testifying on Panel 1 is Mr. Tory Bruno, President and Chief Executive Officer of United Launch Alliance. And Ms. Gwynne Shotwell, President and Chief Operating Officer of Space Exploration Technologies Corporation.

We appreciate you both taking the time to be here today to offer your perspectives including the challenges and opportunities related to our national security space launch activities.

For Panel 2, we have

- The Honorable Katrina McFarland, Assistant Secretary of Defense for Acquisition
- Dr. William LaPlante, Assistant Secretary of the Air Force for Acquisition
- General John Hyten, USAF, Commander Air Force Space Command
- Major General Mitch Mitchell, United States Air Force (ret) - General Mitchell was the chairman of an Air Force-chartered study on risk mitigation for the EELV program concerning U.S. reliance on the Russian RD-180 rocket engine.

In this job as Chairman of the Subcommittee on Strategic Forces, I've come to more fully appreciate the importance of space to our country. It's one of the underpinnings of our national security.

Let me provide an example. If a foreign adversary was to launch an intercontinental ballistic missile at our country, our military would rapidly detect

this missile launch through our Space-Based Infrared System satellites, and the information would be provided to our highest national command authorities to appropriately respond. Such response would almost certainly be transmitted across space-based communications satellites to combatant commanders all over the world who would order our military forces to take action, and those troops would rely on space-based intelligence, surveillance, and reconnaissance capabilities and communications capabilities to perform their mission and return home.

These are extremely important capabilities that American lives may literally depend on. We can't have space capabilities like this without an effective launch program. This is literally rocket science.

So, one of my top priorities in this job is make sure that we have assured access to space, both now and in the future.

We've come a long way since the late 1990s, when we went through a span of 10 months and suffered five launch vehicles failures.

Since 2006, we've benefitted from an unparalleled record of success through the Air Force partnership with United Launch Alliance, with 78 successful launches in the Evolved Expendable Launch Vehicle program.

Most recently, this partnership also brought tremendous savings to the taxpayers, $4.4 billion according to the Air Force, as a result of a 36 rocket core block buy contract.

Now, we are once again, entering into a new phase for EELV. We are transitioning to a more competitive environment. Many steps have been taken by the Government, including Congress and the Department of Defense, to encourage this.

Congress provided funding that was dedicated to new entrants for two launches – SpaceX was awarded both of these contracts.

And, the Air Force has spent over $60 million and allocated more than 100 government employees to help certify SpaceX for the EELV program, which, it may do in the months ahead.

We look forward to competition in the EELV program, because that will achieve the best outcome for the benefit for the taxpayers and our warfighters.

Lastly, it's extremely important that we work to transition off of relying on Russian engines for national security launch purposes. The intention with the Fiscal Year 2015 National Defense Authorization Act was to provide a reasonable transition. The Section 1608 language, regarding a prohibition of procuring Russian rocket engines, included specific exceptions and waivers. We intended to

allow the use of Russian engines that we understood to be on contract through the period of time that we believed would allow for the development of a new U.S. engine.

My understanding is that the Department of Defense may not be interpreting it the same way. This remains an issue that we look forward to understanding better today.

Regarding the development of a new engine, I understand this will take time. But I believe in our U.S. industry, and I believe that once the men and women in the Department of Defense have the red tape cut away, we can do this expediently, effectively, and efficiently. We should take the lowest risk approach that is in accordance with the terms of Section 1604 of the FY15 NDAA.

Thank you again for being with us today regarding this important topic, and I look forward to your testimony.

I now recognize my friend and colleague, Ranking Member Cooper, for your opening statement.

Opening Statement of Rep. Jim Cooper
Ranking Member of Subcommittee on Strategic Forces
Hearing on "Assuring Assured Access to Space"
March 17, 2015

Mr. Chairman, thank you for calling this hearing. It is a pleasure to work with you on such important issues.

We are all, of course, for "assured access to space," the only questions are how best to achieve it. We have two panels of excellent witnesses today to help us better understand our options. It is particularly exciting to have, in the background, two of America's most famous billionaires, Elon Musk and Jeff Bezos, competing against each other with their own significant investments in space. The generosity and genius of both men is doing much to enhance research and development of critical technologies for the future.

I am hopeful that, in this hearing and in our deliberations leading up to markup of the 2016 NDAA, we can put politics and ideology aside and put the best interests of the United States of America first.

For example, I think it is in the best interests of America to allow all of the RD-180 rockets already purchased by ULA to be utilized. I know that there is a letter dated March 13, 2015 from Frank Kendall, the Undersecretary of Defense for ATL, questioning the applicability of Section 1608 of last year's NDAA to these rockets. I don't think anyone in Congress intended for such an interpretation to be made, so, rather than having lawyers fight it out, it is probably time for Congress to admit that it made a drafting error. I believe that the Pentagon should be able to legally use the inventory of RD-180 rockets already contracted for so that we do not risk having a window of vulnerability in the out years in any of our national defense space programs.

Thank you, Mr. Chairman, and I look forward to the testimony of the witnesses.

Testimony of
Mr. Salvatore T. "Tory" Bruno
President and Chief Executive Officer
United Launch Alliance, LLC

Subcommittee on Strategic Forces
Committee on Armed Services
U.S. House of Representatives

Chairman Rogers, Ranking Member Cooper and Members of the Subcommittee – thank you for the opportunity to appear today to discuss the Evolved Expendable Launch Vehicle (EELV) program and the future of space launch.

Space systems are an integral part of today's technology driven world. Space has become critical to our national security, economic prosperity, and scientific advancement.

As this committee knows well, space systems are vital to every aspect of national security and provide warfighters and policymakers with critical and timely information that often makes the difference between life and death. Modern weapon systems rely on space capabilities for command, control, and precision guidance. The nation's leaders rely on space systems for critical intelligence and control of strategic forces. On the tactical side, space is integral to military operations and provides an irreplaceable asymmetric advantage on the battlefield. In short, national security demands and expects space capabilities to be there when needed. However, U.S. space systems are also increasingly vulnerable to a variety of threats, both man-made and natural threats. Therefore, to ensure the nation has the capabilities it needs, assured access to space is, and should remain, a fundamental tenet of space policy.

To that end, my company, United Launch Alliance (ULA), has consistently delivered 100 percent mission success over 94 consecutive launches; with 81 successful launches for the EELV program since 2002. We are currently at a tempo of about one launch every month. Our record on reliability, readiness, and on-time schedule performance is unsurpassed. ULA's rockets have safely delivered nearly all of the U.S. national security space systems on orbit today. ULA's Atlas V and Delta IV rockets are the most powerful and most reliable in the

world. They are the only rockets that fully meet the needs of the national security community. We are very proud to be the nation's assured access provider.

While mission success and schedule reliability should always remain top priorities, space launch is entering a new more competitive era. We welcome the competition. I'm optimistic about the future of space launch and optimistic about what my company can do for the nation. Thank you for the opportunity to share my plans on what ULA is doing to transform its approach to launch and affordable assured access to space while maintaining our focus on mission success.

Our overarching goals are:

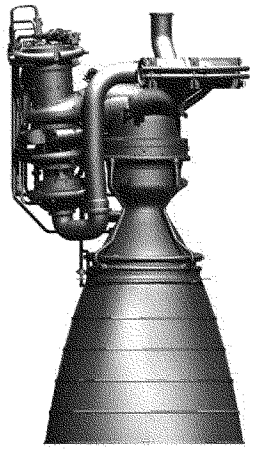
1. significantly reduce the cost of launch,
2. develop a new domestic rocket engine to replace the Russian RD-180 engine,
3. increase our launch capability.

ULA has been committed to and continues to reduce costs of launch not only for our critical National Security Space customers, but to our civil and commercial customers. The GAO recently released its annual report "Defense Acquisitions: Assessment of Selected Weapon Programs", March 2015 where it acknowledged the Air Force realized savings by the EELV Program of $4.4B due to the negotiation of a firm-fixed-price, multi-year procurement contract for launch services. ULA committed to deliver those savings without sacrificing the overall process reliability, insight and oversight requirements that these critical National Security Space assets demand, the flexibility that our national security demands to support critical operations throughout the globe and maintaining 100% mission success focus.

As ULA looks to the future acquisition environment and the space launch requirements, we have chosen to redefine our approach that will continue to reduce the cost of launch, increase overall system flexibility and provide for new capabilities to support space based architectures of the future. The centerpiece of our plan is a new launch vehicle, currently dubbed the Next Generation Launch System (NGLS), which we're targeting for first flight in 2019. The NGLS will have an American engine; it will be less expensive; and it will have greater capability than

our current fleet. NGLS is designed to meet both commercial requirements and the Air Force's EELV program requirements, and we will work closely with the government to obtain NGLS certification. We will be unveiling more details about the rocket in the coming months, but a key feature that I know is of interest is the new domestic first stage engine, the BE-4 from Blue Origin.

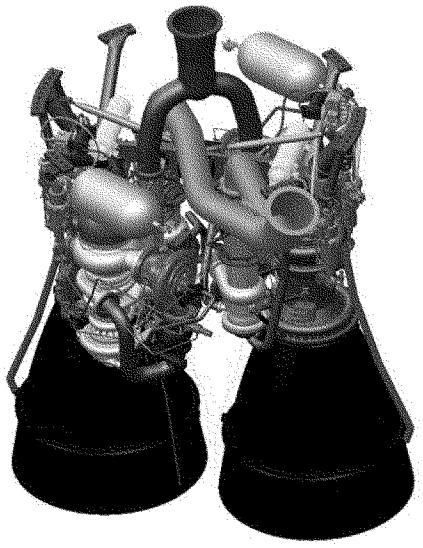
Last summer, we entered a strategic relationship with Blue Origin, founded by Amazon.com's Jeffrey Bezos, to develop the BE-4 liquid natural gas rocket engine. We partnered with Blue Origin for several reasons. The BE-4 engine's high-performance, low cost, and potential reusability made it very attractive. Also, given the urgency to transition from Russian supplied engines, Blue Origin's design was fairly mature since it was already 3 ½ years into development. Engine component testing is currently underway. The next major milestone will be testing of the turbo pumps and valves. Full-up engine testing is scheduled to begin in 2016. Finally, the BE-4 engine development is fully funded by industry. As a commercial development, we can move very aggressively toward completing the new engine.



Blue Origin BE-4 Engine (Source Blue Origin)

While we expect Blue Origin to succeed, we are also partnering with Aerojet Rocketdyne on a kerosene-based engine, the AR-1, as a backup plan. Aerojet Rocketdyne has a demonstrated

ability to develop and deliver new engine systems. We have full confidence in their technical abilities should the AR-1 be needed.



AR-1 Engine (Source: Aerojet Rocketdyne)

ULA and Aerojet Rocketdyne look forward to working with the U.S. Air Force to define the right level and appropriate contract mechanism to enable critical risk reduction investments to be made to advance the maturity of this propulsion alternative. We have asked our board to invest in this critical national capability.

While for any launch system propulsion has historically been the major cost driver, there are other elements ULA is addressing as part of the NGLS architecture. Another major element of cost in the launch business is infrastructure. Today, we have five launch sites and we intend to move toward having as few as two—one on each coast. We're conducting studies on which launch pads we'll use and what infrastructure is needed that will allow us to make a smooth transition, since we'll potentially have a period of overlap where all three rockets (Atlas, Delta, and NGLS) will be flying. Our goal is to design the infrastructure to radically shorten cycle

time between launches so two launch sites can take on the volume of what is currently done by five.

ULA is not just focusing on the hardware side of the launch system to reduce costs. Another element of the transformation is what we are calling a commercial pricing model. We will honor all our current contracting commitments, while reorganizing the company and begin to transition to more "commercial-like" contracts. This will allow ULA to become much more efficient and provide both government and commercial customers with a much less expensive launch service. ULA's future commercial pricing model, with a standard offering and custom pricing options, will provide the government the flexibility to add or reduce requirements to meet its specific needs for technical reliability, schedule certainty, oversight, and price goals.

Last summer, I was given the responsibility to lead ULA. What I found was a company and supplier base second to none in the world. We have a team that delivers what it promises. ULA and its suppliers have consistently done everything that their government customers have asked of them. We know what it takes to provide assured access to space and when we compete on a level playing field head to head – we win.

It's easy to forget, but 10 years ago many critical new satellite development programs were in serious trouble and way behind schedule. Several key constellations of older satellites on-orbit were operating well-beyond their expected life. National security space was hanging by a thread. The top priority then was to complete the spacecraft and make sure it was ready to launch. On the launch side, we had to be flexible, but always ready to receive the satellites. Once we hit the button the launch **had** to be successful. With fragile constellations on-orbit, a loss in capability from a launch failure would have far out-weighed the cost in dollars to replace the hardware. The Air Force's approach to launch taken over the past decade—which emphasized intense focus on mission success and readiness—was the right approach for that era. The capabilities we have on orbit today are the product of our collective focus on mission success. ULA and the EELV program are a tremendous success.

Looking forward, it is indeed time for a change in the approach to launch. I am optimistic about our plans for the future. We are eager to compete. We are ready to deliver what we're promising.

Thank you. I look forward to your questions.

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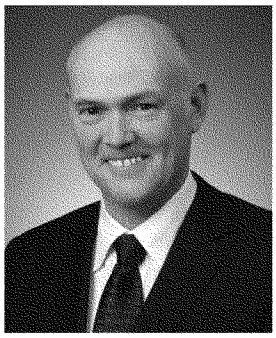
Salvatore T. "Tory" Bruno

President and Chief Executive Officer



Salvatore T. "Tory" Bruno is the president and chief executive officer for United Launch Alliance (ULA). In this role, Bruno serves as the principal strategic leader of the organization and oversees all business management and operations.

Prior to joining ULA, he served as the vice president and general manager of Lockheed Martin Strategic and Missile Defense Systems. The business is a leading provider of ballistic missile and ballistic missile defense systems, supporting U.S. Department of Defense customers, as well as the U.K. Royal Navy and Ministry of Defence. Programs included the Navy's Trident II D5 Fleet Ballistic Missile (FBM), the Air Force's Intercontinental Ballistic Missile (ICBM) Reentry Systems, and the Missile Defense Agency's Terminal High Area Altitude Defense (THAAD), Targets and Countermeasures and Common Exoatmospheric Kill Vehicle (EKV) Concept Definition. He also managed the corporation's responsibilities in Atomic Weapons Establishment (AWE) Management Limited, a joint venture that produces and safely maintains the U.K.'s nuclear weapons. He is a former member of the board of directors of Lockheed Martin U.K. Ltd.

Bruno joined Lockheed Martin in 1984. He previously served as vice president and general manager of FBM and ICBM, as vice president of the THAAD Missile, as vice president of Engineering, as chief engineer for Strategic Missile Programs, as program manager for FBM Rocket Propulsion and in engineering positions involving design and analysis for control systems of rockets and hypersonic reentry vehicles. He holds several patents.

He holds a bachelor's degree in mechanical engineering from the California Polytechnic State University, in San Luis Obispo, California, and has completed graduate courses and management programs at Harvard University, Santa Clara University, the Wye River Institute, San Jose State University and the Defense Acquisition University.

Bruno is a companion of the Naval Order of the United States, a member of the Navy League and a former member of the Board of Directors of the Silicon Valley Leadership Group. He served on the National Blue Ribbon Panel for Bettering Engineering & Science Education and as Chairman of the Diversity Council of Lockheed Martin Space Systems.

He is the author of two books that explore the organization of the medieval Knights Templar from the perspective of modern business management: "Templar Organization: The Management of Warrior Monasticism" and "Templar Incorporated." He is a recipient of the Order of Merit of the Sovereign Military Order of the Temple of Jerusalem.

United Launch Alliance
P.O. Box 3788 • Centennial, CO 80155-3788
www.ulalaunch.com

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COMMITTEE ON ARMED SERVICES
U.S. HOUSE OF REPRESENTATIVES

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Witness name: Salvatore T. "Tory" Bruno

Capacity in which appearing: (check one)

○ Individual

◉ Representative

If appearing in a representative capacity, name of the company, association or other entity being represented: United Launch Alliance, LLC

Federal Contract or Grant Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts) or grants (including subgrants) with the federal government, please provide the following information:

2015

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant

2014

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
NRO000-15-0006	NRO	134,869,453.00	NRO Integration Companion for EELV

2013

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
FA8811-13-C-0003	USAF	$4,077,550,793.57	Phase 1

Foreign Government Contract or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts or payments originating from a foreign government, please provide the following information:

2015

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment

2014

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment

2013

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment

STATEMENT OF
GWYNNE SHOTWELL
PRESIDENT & CHIEF OPERATING OFFICER
SPACE EXPLORATION TECHNOLOGIES CORP. (SPACEX)

BEFORE THE
COMMITTEE ON ARMED SERVICES
SUBCOMMITTEE ON STRATEGIC FORCES
U.S. HOUSE OF REPRESENATIVES

March 17, 2015

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

I greatly appreciate the opportunity to participate in this important hearing. SpaceX stands ready and able to provide access to space for the United States. Our mission, from day one, has been to leverage American innovation and technical know-how to provide the most reliable space launch systems in history. We are proud to have contributed—time and again—to providing a reliable and affordable ride to space for NASA and the world's most sophisticated commercial satellite manufacturers and operators. And we have now begun to provide launch services to a broader set of U.S. Government customers, including the United States Air Force. Notably, we successfully performed our first launch with the Air Force as a customer in early February. We use our all-American rockets – the Falcon 9 and, very shortly, the Falcon Heavy – to perform these missions. They are made in the United States by American workers with zero reliance on Russian raw materials, technologies or engineers.

The National Space Transportation Policy (NSTP) calls for two, independent launch systems capable of fulfilling the full spectrum of our national security launch needs. This is a sound and prudent policy. I will focus my testimony on a constructive approach to best honor this policy. Critically, honoring this policy should not include an extension of the timeframe under which the United States relies upon Russian rocket engines, nor should it include further financing Russia's military-industrial base. Given the state of world events, this is a dark path to even contemplate. National policy likewise should not include extending corporate welfare to U.S. companies in order to produce a new domestic rocket engine. There is a better path forward. To help the U.S. Air Force achieve assured access to space, SpaceX will provide an all-American launch system capable of fulfilling the full spectrum of our national security launch needs. And, for its part, ULA already has the launch systems to provide uninterrupted Evolved Expendable Launch Vehicle (EELV) services using its existing taxpayer-funded, domestic-engine powered Delta rockets and the Atlas V with those Russian engines that federal law already allows it to use. If ULA wants to transition to a new rocket, the United States taxpayer should not be required to fund it, and the Congress should not change federal law to allow more money to flow to Russia. Simply put, with the Delta and the Falcon lines, the United States already has two all-American rockets.

Since 1998, American taxpayers have spent more than $20 billion on the EELV Program, including nearly $2 billion on launch vehicle development and upgrades alone.[1] But we have not really gotten "assured access" to space. The Department of Defense has been forced to rely on a single, monopoly provider with ever-escalating prices. Its two vehicle systems share single points of failure – this is the opposite of "assured access" – and one of the vehicles is dependent upon a risky Russian supply chain subject to disruption, threats of discontinuation, and unilateral price hikes. In point of fact, the Nation is

[1] Department of Defense. "Selected Acquisition Report: Evolved Expendable Launch Vehicle (EELV) As of FY 2015 President's Budget." RCS: DD-A&T(Q&A)823-176. April 16, 2014.

currently flying only one heavy lift launch vehicle—a single point of failure for the largest and most critical of our national security payloads. And America has a launch program so expensive that untold numbers of new satellites that would have otherwise provided enhanced war-fighting capability were never developed, built or deployed. A capability not provided to the warfighter because of extremely high launch costs should be considered by this Committee to be a mission failure.

The EELV program is not fiscally healthy. It is now the largest single acquisition item in the unclassified Air Force space budget, comprising more than *53 percent* of all Air Force space procurement funding. In fact, the Air Force spends more on space launch today in the EELV Program than all of the other unclassified space programs combined. The GAO has year after year commented in depth on the problematic cost profile of this program.[2] In Fiscal Year 2015, this Congress was forced to appropriate in excess of $376 million per launch, while subsidizing ULA's fixed costs at more than $1 billion per year even if the company never launched a rocket.[3] Several recent cost analyses have determined the EELV Program will double in price over initial estimates to nearly $67 billion.[4] This sustained cost growth triggered multiple "critical" Nunn-McCurdy breaches, most recently in 2012 when the program exceeded 58 percent unit cost growth and subsequently was restructured to contemplate new competitors.[5] Indeed, a GAO report issued this month indicates that EELV's procurement cost increased *257 percent* from original program costs even though the total number of missions declined from 181 to 163, resulting in a unit cost growth of *270 percent* from $101.7M to $376.4M.[6]

Even as ULA has claimed to have achieved massive savings, the RAND Corporation reported just this year that: "EELV has extreme cost growth in four of the five metrics and has by far the largest estimated growth in dollars of [DOD's] space programs."[7] By contrast, SpaceX's Falcon 9 price for an EELV mission is under $100M—a $276 million per launch difference–and SpaceX seeks no annual subsidies to maintain our business. And, as the Air Force has stated repeatedly, SpaceX will be certified as an EELV provider no later than June of this year.[8]

Mr. Chairman, I appreciate this Committee's timely review of the EELV Program and the Nation's assured access to space policy. SpaceX fully understands the national security requirement to have two fully capable, dissimilar launch vehicle systems in order to assure access to space. The most rapid and cost-effective mechanism to achieve this capability is to expand competition, create proper incentives for industry to self-invest to meet customer requirements, eliminate American's reliance on Russian rocket engines as soon as possible, and end the practice of subsidizing launch services providers. To that end, I respectfully offer the following recommendations to this Committee:

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2 U.S. Government Accountability Office, "DOD Needs to Ensure New Acquisition Strategy is Based on Sufficient Information," September 2011, 10-12.

[3] Department of Defense, "Fiscal Year (FY) 2014 President's Budget Submission, Missile Procurement, Air Force." Apr. 2013. Vol. 1, 232.

[4] Department of Defense OUSD (AT&L) ARA/AM, "Selected Acquisition Report (SAR) Summary Tables," December 2012, 6; U.S. Government Accountability Office, "Defense and Civilian Agencies Request Significant Funding for Launch-Related Activities," September 2013, 2.

[5] U.S. Government Accountability Office, "Uncertainties in the Evolved Expendable Launch Vehicle Program Pose Management and Oversight Challenges," September 2008, 7; 20-21. U.S. Government Accountability Office, "Assessments of Major Weapon Programs," March 2013, 59.

[6] Government Accountability Office. "Defense Acquisitions: Assessments of Selected Weapons Programs." GAO-15-342SP. March 2015. 77.

7 RAND Corporation, "Air Force Major Defense Acquisition Program Cost Growth Is Driven by Three Space Programs and the F-35A," 2014, 26.

[8] Andrea Shalal, "U.S. Air Force secretary upbeat on SpaceX certification." *Reuters.* January 14, 2015. "James said it was not a question of 'if,' but 'when' the privately held company Space Exploration Technologies would be certified to compete to launch U.S. military satellites under the Evolved Expendable Launch Vehicle (EELV) program. The Air Force last week said it expected to complete the SpaceX certification by mid-2015 at the latest."

1) Maintain the limitation Congress passed in the FY2015 National Defense Authorization Act on the use of the Russian RD-180 rocket engines outside of the existing block buy contract, at a minimum. The United States Government should no longer finance the Russian missile industrial base with U.S. taxpayer dollars when American alternatives to the RD-180 engine exist today.

2) Achieve assured access through multiple providers with redundant, truly independent launch vehicle systems. Congress should continue to support real and continuous competition in the EELV Program, and not create an unfair competition by subsidizing one provider's efforts to develop new systems.

3) Eliminate payments—more properly called subsidies—under the EELV Launch Capability (ELC) contract line items that exclusively support the incumbent provider and properly account for such payments for any competitive solicitations in the interim to ensure a fair and level playing field, especially since these funds do not contribute to the true nature of assured access to space. The Department and this Committee have called for real, meaningful competition. That means eliminating the unfairness. All we seek is the right to compete in a fair competition. Just like reliance on the RD-180 engine, it is time for these subsidy payments to the incumbent to come to an end.

4) Structure any propulsion development effort to optimize public investment with a focus on propulsion technology development than can be used broadly rather than creating an engine that is relevant only to the incumbent already-subsidized provider. Any Government funds should be expended on ways that improve our propulsion industrial base and its ability to drive innovation, including technology demonstrations and upgrades to propulsion testing infrastructure.

I. SpaceX Today

SpaceX is the world's fastest-growing launch services provider. We are an American firm that designs, manufactures, and launches its rockets within the United States, with virtually no reliance on foreign vendors or suppliers and certainly no reliance for any major subsystem or component. SpaceX was founded in 2002 with the goal of dramatically improving the reliability, safety, and affordability of space transportation. We have made that goal a reality. Our Falcon 9 launch vehicle, which provides medium- to intermediate-lift capability, has a mission success record of 16 consecutive flights. The Falcon Heavy, an intermediate- to heavy-lift launch vehicle, will debut this year, with already contracted Air Force and numerous commercial flights soon to follow.[9] Both launch vehicles are powered by our all-American Merlin engines.

For more than a decade, SpaceX has developed reliable and affordable launch vehicle systems designed from inception to meet national security space (NSS) launch requirements as defined within the EELV Program. We are concluding formal New Entrant Certification for EELV Program missions by June of this year, if not before.

SpaceX has booked more than 50 launches valued at nearly $6 billion on the Falcon 9 and Falcon Heavy for a diverse and growing set of customers, including NASA, the Air Force, commercial satellite operators, and international governments. Most of these launches are set to be conducted before even the first competitive EELV mission will launch, firmly establishing our robust heritage. In fact, Falcon 9 will exceed the Delta IV family in flights to orbit by the end of next year. SpaceX is a profitable, robust

[9] SpaceX has Falcon Heavy launch contracts signed with the U.S. Air Force, Intelsat, Inmarsat, and ViaSat.

business; we invest these profits back into the company's manufacturing and launch infrastructure and into advanced research and development, including current and next-generation booster propulsion.

To date, SpaceX has achieved unprecedented reductions in the cost of launch and spacecraft development, all while achieving 100 percent primary mission success, scaling our production operations to be capable of producing 40 rocket cores and 400 rocket engines annually in 2016. We have aggressively developed next-generation rocket technology and are today the world's most prolific private producer of liquid fuel rocket engines. The Merlin rocket engine powering the Falcon family of launch vehicles is the only new American hydrocarbon rocket engine to be successfully developed and flown in the past 40 years. SpaceX has flown more than 160 Merlin engines on its missions, representing significantly greater flight heritage than any other rocket engine flying on U.S. launch vehicles today, including more than Atlas and Delta engines combined.

Meanwhile, we continue to push the envelope on rocket technology as we advance toward fully reusable launch vehicles, design the safest crew transportation system ever produced for American astronauts for our NASA customer, and test next-generation rocket engines. Critically, all of this innovation is occurring in the United States, and our launch vehicles (including engines and fairings) and spacecraft are made in America. We have never, nor will we ever, rely upon Russia for any element of the launch vehicle.

SpaceX serves the Nation's space program today by routinely resupplying cargo to and from the International Space Station (ISS) with our Dragon spacecraft, launching numerous Government satellites, and preparing to carry crew. We are single-handedly restoring America's competitive position in the global commercial space launch market, recapturing market share that the United States had surrendered to French, Russian, and Chinese competitors—in 2016, SpaceX will conduct more than half of the world's commercial satellite launches.

SpaceX maintains its manufacturing and engineering headquarters in Hawthorne, CA; a Rocket Development and Test Facility in McGregor, TX; and launch pads at Cape Canaveral Air Force Station (CCAFS), NASA Kennedy Space Center (KSC), Vandenberg Air Force Base (VAFB), and, soon, a commercial launch site at Brownsville, TX. We recently opened a satellite engineering and manufacturing facility in Seattle, WA. SpaceX maintains a nationwide network of more than 3,000 quality suppliers and partners, an investment in U.S. American industrial base when others are spending abroad. In fact, Mr. Chairman, a number of Alabama suppliers recently penned a public letter highlighting the importance of the commercial space sector to their ongoing operations.[10]

Recently, SpaceX announced that it had raised one billion dollars in a financing round with two new investors, Google and Fidelity. They join existing investors Founders Fund, Draper Fisher Jurvetson, Valor Equity Partners and Capricorn. This additional one billion dollars of private commercial investment will be used to support continued innovation in the areas of space transport, reusability, and satellite manufacturing.

II. SpaceX Reliability, Launch Operational Tempo, and Production Output

Mission success is foundational to SpaceX, as our flight history to date has demonstrated. The Falcon 9 is designed for the highest reliability starting at the architectural level. Because 91 percent of launch vehicle failures in the past two decades can be attributed to engine failures, avionics failures, or stage separation anomalies, the Falcon 9 and Falcon Heavy incorporate robust, fault-tolerant propulsion systems, avionics and controls systems with internal triplication and redundant harnessing, and a minimum number of

[10] Lee Roop. "Small Alabama aerospace companies urge Rep. Mo Brooks to support competition in industry." *Huntsville Times.* August 12, 2014. Available at: http://www.al.com/business/index.ssf/2014/08/small_alabama_aerospace_compan.html

separation events. With its nine-engine configuration, Falcon 9 features a unique engine-out capability, and is designed to permit the loss of up to two engines in flight without compromising the mission. The Falcon 9 is the only American rocket since the Saturn V with any engine-out capability; any other launch vehicle in the world, including those in the current EELV fleet, that encounters a major engine anomaly on ascent will almost certainly fail its mission.

Separately, SpaceX was the first private company in history to travel to and from the ISS. To do so, we first passed rigorous certification efforts by NASA to allow our Dragon spacecraft to berth with the ISS, a feat we have now successfully achieved six times. SpaceX has performed a number of missions for high-value commercial payloads as well, executing complex mission requirements. These include the launch and deployment of six satellites simultaneously for Orbcomm; the recent launch and deployment of the first two all-electric satellites to fly in space; and the successful launch—for the U.S. Air Force—of the Deep Space Climate Observatory (DSCOVR). SpaceX has accomplished a number of launches into very high geosynchronous orbit as well, requiring multiple second-stage engine burns.

Launch Vehicle Production

SpaceX's state-of-the-art headquarters and production center near Los Angeles, CA, spans nearly one million square feet. The headquarters contains the engineering team—design, manufacturing, and industrial engineering—and the production team and equipment for the Falcon launch system and Dragon spacecraft. Quality manufacturing is a core competency, and our ability to keep the majority of the supply chain in-house provides significant advantages, allowing SpaceX to avoid the pitfalls associated with single-source dependency for parts and giving us a competitive advantage in quality, cost and schedule control. More than 70 percent of each Falcon launch vehicle is manufactured or assembled at the SpaceX Hawthorne production facility.

With our existing facility, SpaceX is currently capable of producing 18 cores and 180 engines per year (a core is a booster with nine engines, similar to a Falcon 9 first stage). In 2015, we will be capable of producing 24 cores per year, and we are adding equipment to expand production capacity to be capable of producing 40 launch vehicle cores per year, as our manifest demands it.

Launch Site Operations

For launch capability, SpaceX currently maintains East Coast and West Coast launch sites at Federal Ranges, and is developing an additional private launch facility in South Texas to support our commercial launch service contracts. SpaceX is also reconfiguring Launch Complex 39A (LC-39A) at KSC to support Falcon 9 and Falcon Heavy launches, including manned missions for NASA by 2017.

This approach will, at no expense to the Government, add to the Nation's launch capability and reduce the risk of manifest congestion at SpaceX's existing launch sites at CCAFS and VAFB—the current Eastern and Western launch ranges used by NASA and national security space customers—allowing for a launch-on-need capability for the U.S. Government without conflict in priorities. Importantly, these launch infrastructure investments are being made without any burden on the taxpayer. By leveraging SpaceX's existing launch infrastructure and launch systems, the Government will not need to make any significant investments in new launch capability to support a new engine or launch vehicle.

SpaceX has demonstrated rapid, on-time launch as operational tempo increases this year to keep pace with customer requirements. Already in 2015, SpaceX has conducted three launches for four distinct customers in 50 days. We have an additional launch planned in the coming days for a commercial customer, and in early April we will launch another operational resupply mission to the International Space Station. These missions will be followed by a series of launches every month through the end of the year. Last year, SpaceX demonstrated a record turn-around time of 14-days between launches on our launch pad at Space Launch Complex 40 (SLC-40), CCAFS.

Test Site Operations
For test operations, SpaceX's 4,000 acre Rocket Development Facility in Central Texas includes 12 test stands that support engine component testing; design, qualification and acceptance testing of Merlin engines; structural testing of the first and second stages; and fully integrated stage testing for full mission durations. The state-of-the-art facility has remote and/or automatic controls and high-speed data acquisition systems, and post test data are available for analysis upon test completion. To date, more than 4,000 Merlin engine tests—including nearly 50 firings of the integrated first stage—have been conducted at the site's multiple test stands. Currently, an average of two static-fire engine tests is conducted there each day.

III. EELV New Entrant Certification

We have high confidence that the SpaceX Falcon 9 launch vehicle will be certified to launch national security space payloads no later than June of this year. As part of the certification process, we successfully executed three required certification launches during a five-month period between September 2013 and January 2014. Importantly, because all three missions were for commercial customers, they were flown at no cost to the taxpayer for the flights. In July 2014, five months after the third and final certification flight, the Air Force recognized all three flights as having met all mission requirements and qualified the flights under the EELV Certification Cooperative Research and Development Agreement (CRADA) executed with the Air Force.

It bears noting that the New Entrant Certification requirements that SpaceX must live up to vastly exceed the requirements that the Atlas V and Delta IV launch vehicles had to meet in 1998, prior to their ability to compete for and *be awarded* EELV launch service orders. In fact, Boeing and Lockheed were awarded multi-billion dollar contacts for 28 missions in 1998; Atlas and Delta would not fly for the first time until four years later, in 2002. Even today, most of ULA's Atlas and Delta configurations have either not flown or not achieved even the minimum number of launches to establish reliability—as the GAO reported, "only three [of ULA's] variants—the Atlas V 401, the Delta IV Medium, and the Delta IV Heavy—have launched seven times, proving production maturity according to an Aerospace Corporation measure developed for the program."[11]

Since completing our third certification flight, we have launched the Falcon 9 in this upgraded configuration 8 additional times for a total of 11 consecutive successes on this vehicle, excluding the first 5 successful flights of the Falcon 9 v1.0 launch vehicle. Under the CRADA, we continue working with our Air Force partner as we conclude the data and engineering analysis.

SpaceX has been committed from the start to supporting the warfighter and launching national security space payloads. We designed the Falcon 9 and the Falcon Heavy from the outset to meet the EELV design specifications, including the EELV Standard Interface Specification (SIS) and System Performance Requirements Document (SPRD), at no charge to the U.S. Air Force.

The certification process has benefitted both SpaceX and the government team. SpaceX recently contributed to the Broad Area Review of the New Entrant Certification Process that is expected to improve and streamline the process for future national security space New Entrant launch providers.

Above and beyond the baseline certification requirements, SpaceX has made a number of investments on its own that will enhance America's ability to access space, including:

[11] U.S. Government Accountability Office, "Assessments of Major Weapon Programs," March 2014, 63.

- Building and debuting a new launch facility at Vandenberg Air Force Base with a successful September 2013 Falcon 9 launch;
- Providing the Air Force with the ability to observe or receive data from our contracted commercial launch service activities;
- Securing and funding significant infrastructure upgrades of LC-39A to increase SpaceX's ability to meet a growing launch manifest and further reduce EELV manifest congestion; and
- Developing fully-commercial launch site in South Texas in order to reduce launch congestion for U.S. Government customers at the Federal Ranges.

IV. Assured Access to Space Policy

As previously discussed, despite Government efforts and many billions of dollars spent, the United States has not attained assured access to space. The existing policy, codified in federal law, requires that assured access policy and spending, at a minimum, achieve the following two objectives:

> (1) the availability of at least two space launch vehicles (or families of space launch vehicles) capable of delivering into space *any* payload designated by the Secretary of Defense or the Director of National Intelligence as a national security payload; and,
>
> (2) a robust space launch infrastructure and industrial base.[12] (emphasis added).

Contrary to these requirements, the Government does not today have two space launch vehicles capable of launching the full spectrum of national security payloads. Between the Atlas V and the Delta IV families operated by ULA, *only* the Delta IV has the heavy-lift capability required to launch the largest of the DOD's satellites. This means that if there are any anomalies that ground the Delta IV (as occurred most recently in October 2012), the Nation cannot launch any heavy satellites. *Even in its most powerful configuration, the Atlas V cannot fulfill this need.* While Boeing initially invested to meet the full-spectrum requirement in the EELV program, the Atlas vehicle sought and was provided a waiver.

SpaceX has self-invested the development of both the Falcon 9 and Falcon Heavy. Between these two systems, we will be in a position to support 100 percent of national security launch requirements. Coupled with the Delta family of rockets, for the first time in EELV Program history, the United States will have true assured access to space with two separate launch vehicle families, each of which can execute all mission requirements. This approach obviates the need for any additional Government investment in new propulsion systems, or long-term development efforts that will not result in renewed capability in the near-term. Further, such an approach eliminates the risks associated with continued reliance on the RD-180 engine.

Beyond the absence of two separate heavy-lift launch vehicles, there are single points of failure shared between the Delta and Atlas rocket families. As a direct result of the high cost of launch associated with the ULA family of vehicles, the Government funded the development of a common upper stage engine, the RL10-C, for both the Delta and Atlas vehicle families—to try to make them less expensive. While both families currently use variants of the RL-10 engine, the drive to a common engine has solidified the risk associated with a single point of failure, a risk the EELV Program was expressly created to avoid. As a result, an anomaly on either vehicle's upper stage likely would mean both would be grounded until the issue is resolved. This is a real and proven risk. Recently, such a grounding occurred, resulting in an eight month launch delay – again, the opposite of assured access.

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[12] 10 U.S.C § 2273 (b)

Finally, the fact that all Atlas V variants utilize the Russian-supplied RD-180 engine runs wholly counter to the notion of having assured access to space. Reliance on this non-secure foreign supply chain has been an acknowledged national security risk dating back more than a decade. Due to national security and non-proliferation concerns, every national space transportation policy has required that U.S. government payloads are launched on space launch vehicles manufactured in the U.S., unless explicitly exempted. Further, to avoid dependence on foreign-made, major critical components such as propulsion systems, which could jeopardize, delay or disrupt national security space launches, the EELV program *specifically required* that any propulsion systems produced in the Former Soviet Union (FSU) be converted to U.S. production within four years after contract.[13] This was never done.

Originally, U.S. production of the RD-180 was scheduled to begin in 2003; this deadline was later extended to 2008. In 2006, as the 2008 deadline to establish domestic co-production of the RD-180 loomed, a Congressionally-mandated review under the National Security Space Launch Requirements Panel identified reliance on the Russian RD-180 as a "major policy issue." Despite this warning, ULA announced in 2008 that it had made the decision to discontinue the required co-production program because, effectively, it could not justify the "business case" of developing this capability, and the Delta IV could provide "assured access to space."[14] This decision came after "hundreds of millions of dollars"[15] of spending, funds that would later be billed to the Government according to a DOD Cost Analysis Improvement Group report.

Later, in 2011, the GAO quoted the Launch Enterprise Transformation Study as identifying the RD-180 engine dependency as a "significant concern for policymakers."[16] In response, ULA repeated claims that it has the know-how to manufacture the RD-180.[17] While this implicitly acknowledged the geopolitical risk of continuing to rely on its Russian supply chain, it also turned out to be less than accurate. In any event, it would take years and likely cost around a billion dollars in additional taxpayer investments, since ULA and its subcontractors failed to fulfill the initial domestic co-production requirement, sought and received an extension, and then had the requirement removed.

In short, a monopoly environment has failed to provide assured access to space—in fact, a monopoly environment worked against the assured access policy. It contributed to the absence of assured access by eliminating the requirement for two heavy lift vehicles and the requirement for co-production of the RD-

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[13] William Perry. "Department of Defense Policy on the Use of Former Soviet Union Propulsion in Space Launch Vehicles. May 17, 1995. "The use of such FSU systems, components, or technology in U.S. launch vehicles used by DoD for national security missions shall be carried out so that access to space cannot be denied by the foreign supplier. . . FSU produced propulsions systems, components, or technology used in launch vehicles for national security missions must be converted to U.S. production within four years after contract award for Engineering and Manufacturing Development."

[14] In its statement, ULA said: "The decision was made to conclude the program, partly because of the commercial market downturn. The resulting lower launch rate did not provide a robust business case for building a U.S. production facility. Also, the standup of ULA means that we can offer our customers assured access through the ability to integrate Atlas V payloads onto Delta IV and vice versa. ULA will also continue to stockpile adequate inventory to service the Atlas manifest will into the future. . . If a serious supply interruption is ever experienced in the future, we know we can build the RD-180 engine in the United States." United Launch Alliance. "RD-180 Co-Production Successfully Concluded." September 2008. Available at: http://forum.nasaspaceflight.com/index.php?topic=14224.0

[15] Michael Gass, Statement before the Senate Defense Appropriations Committee. "Senate Appropriations Subcommittee on Defense Holds Hearing on National Security Space Launch Programs." March 5, 2014. U.S. Government Accountability Office, "Defense Space Activities: Continuation of Evolved Expendable Launch Vehicle Program's Progress to Date Subject to Some Uncertainty," June 2004, 8.

[16] Government Accountability Office. "Evolved Expendable Launch Vehicle: DOD Needs to Ensure New Acquisition Strategy Is Based on Sufficient Information." September 2011. 22.

[17] Ibid at 15.

180, prompting Government investment in single points of failure between the two vehicle systems. It is important to understand *why* the Government took these steps. First, it had no choice, at the time, as ULA was the only provider available. But, more importantly, the Government took these steps in an effort to reduce ULA's costs and prices. In other words, the high price of launching on "America's ride to space" effectively undermined the assured access to space imperative.

We recommend a change. Consistent with the initial goals of the EELV Program, real and continuous competition will ensure that in the event of a launch vehicle anomaly or national emergency, the U.S. still maintains its access to space with another independent launch vehicle capability. Indeed, an independent report by the MITRE Corporation in September 2012 affirmed that multiple providers will establish an "insurance for transition in case of performance failure."[18] Even without any anomalies, multiple providers with separate launch sites decrease manifest congestion at a time when DOD's launch needs are at their highest in years. The recently issued National Space Transportation Policy dictates that "competition among providers" is critical to "assure access to space for [the] United States Government."[19] Notably, the recent policy also removed the requirement that the Department of Defense continue subsidizing the fixed costs of United Launch Alliance through the ELC line item.[20]

V. The Problem of Russian Rocket Engines

As is now widely known, ULA uses the Russian RD-180 rocket engine to power the first stage of the Atlas V launch vehicle. The RD-180 is produced by NPO Energomash, a state-owned organization managed entirely by the Russian government, under the direct authority of Deputy Prime Minister Dmitry Rogozin, a close political ally to Vladimir Putin. Following Russia's invasion of Crimea and Ukraine, the United States Government issued sanctions against Mr. Rogozin and numerous others with direct connections to NPO Energomash.

In response, Rogozin threatened to discontinue supplying the RD-180 to the U.S. for military launches, and threatened to shut down U.S. GPS ground stations throughout Russia. Rogozin, who maintains a colorful Twitter account, taunted the United States, tweeting that the RD-180 was a "Russian broom for an American witch,"[21] a reference to American military and intelligence satellites; later, he suggested America should "delivers [sic] its astronauts to the ISS with a trampoline."[22] This, however, was not the first time—and it will likely not be the last time—that Russia has leveraged America's apparent dependence on the RD-180 as a bargaining chip in unrelated foreign policy disputes. In 2013, for example, the Russian Security Council threatened to cut off supply of this engine as the United States weighed in on Russia's contributions to the hostilities in Syria.[23] As for Rogozin, he issued a direct threat: "The US introduced sanctions against our space industry. God knows, we warned them: we respond to declarations w/ declarations, to actions w/ actions."[24]

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[18] Wydler, Chang, and Schultz, 17.
[19] The Executive Office of the President, "National Space Transportation Policy," November 2013, 3.
[20] Mike Gruss. "New Space Launch Policy Emphasizes Competition." *Space News*. November 22, 2013. "Specifically, the new policy language no longer explicitly requires the Defense Department to fund the annual fixed costs of launch services providers. The previous version of the policy, released in 2004, called for funding 'the annual fixed costs for both launch service providers,' referring to Lockheed Martin and Boeing."
[21] Dmitry Rogozin. Statement on Twitter. April 3, 2014.
[22] Alan Boyle. "Trampoline to Space? Russian Official Tells NASA to Take a Flying Leap." NBC News. Available at: http://www.nbcnews.com/storyline/ukraine-crisis/trampoline-space-russian-official-tells-nasa-take-flying-leap-n92616
[23] "Russian Rocket Engine Export Ban Could Halt US Space Program," *RT*, 27 Aug. 2013, Web.
[24] Dmitry Rogozin. Statement on Twitter. April 29, 2014.

To address the issue of Russian reliance for space launch—an obvious and substantial flaw in the Nation's assured access to space policy—Congress passed legislation last year to gradually phase-out the use of Russian rocket engines for Department of Defense launches. Congress' bipartisan approach expressly permitted the use of the RD-180 engine for those engines previously ordered under the current block buy with ULA, which includes missions that will fly out through roughly 2019 or 2020.

Recently, ULA has strained to suggest that continued imports of the RD-180 are critical to ensure national security and launch important military satellites—and they have requested "legislative relief" to enable them to buy more Russian engines. This is despite the obvious incongruity of relying on Vladimir Putin and his already-sanctioned inner circle to give the ultimate "go for launch" for U.S. satellites that will support American warfighters and the U.S. intelligence community in the field.

It is also in direct contradiction to testimony former ULA CEO Michael Gass gave to Congress last year. When asked a direct question about the risk of relying on Russian rocket engines, Mr. Gass stated expressly that there was no national security risk even if Russia discontinued the supply of the RD-180 immediately. Specifically, he stated that "[a]t the United Launch Alliance, we have another product that is fully compliant and ready to support any of the missions. So, for the nation, we are *not at any risk for supporting our national needs.* We've always kept our ability to not to be leveraged in case of any kind of supply interruptions"[25] (emphasis added).

Further, Roger Krone, the former president of Boeing Network and Space Systems, said last year, immediately following Rogozin's threat to cut off the RD-180 supply, that "[w]e believe we can deliver on the block buy with the engines we have"[26] and noted further that it was "fairly easy" to move payloads designated to fly on Atlas V to fly instead on the Delta IV. According to *InsideDefense*, "Krone noted that the manifest changes could be made without *any adjustments* to the terms of the block-buy contract" (emphasis added).[27]

Ultimately, not a single additional RD-180 is necessary to ensure American access to space. Two American-made launch vehicle families, the ULA Delta IV series of rockets, and the SpaceX Falcon rockets, have the capability to fulfill 100 percent of the Nation's launch requirements. As noted, even ULA has acknowledged that the Delta rockets can execute 100 percent of military launches—including those within the block buy, without a *single change* in the terms of that contract.

Ending the reliance on the RD-180 is good national security policy, as questions continue to be raised about the contracting propriety involved in the sale of the engines and the financial beneficiaries in Russia of U.S. taxpayer dollars. In November 2014, Reuters released the results of an investigative report into sales of RD-180 rocket engine to ULA. As noted, the RD-180 rocket engine is manufactured by NPO Energomash, a state-owned corporation headquartered in Khimki, Russia. These engines are sold through a series of brokers to an entity called RD Amross, which is itself half-owned by an entity called International Space Engines, itself 100 percent owned by NPO Energomash.[28] In effect, it would appear that NPO Energomash is selling the engines back to itself, before passing them on to ULA.

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[25] Michael Gass, Statement before the Senate Defense Appropriations Committee. "Senate Appropriations Subcommittee on Defense Holds Hearing on National Security Space Launch Programs." March 5, 2014.
[26] Amy Butler. "Boeing: No New Russian RD-180 Engines Needed For ULA Bulk Buy Deal." *Aviation Week.* May 13, 2014. http://aviationweek.com/space/boeing-no-new-russian-rd-180-engines-needed-ula-bulk-buy-deal
[27] InsideDefense.com. "Boeing Official: ULA Considering A Future Without Atlas V." May 14, 2014.
[28] Brian Grow, Stephen Grey, and Roman Anin. "Special Report: In Pentagon deal with Russians, big profit for tiny Florida firm." *Reuters* November 18, 2014. Available at: http://www.reuters.com/article/2014/11/18/us-russia-capitalism-rockets-special-rep-idUSKCN0J22BQ20141118 .

Reuters reports that after purchasing the RD-180 engines from NPO Energomash at $20.2 million per engine, RD Amross marks up each engine by $3.2 million prior to selling them to ULA for $23.4 million each. Over the course of the 29 engine contract through 2017, RD Amross will reap more than $93 million in profits. Reuters further reported on a 2011 Defense Contract Audit Agency (DCAA) report regarding RD Amross, and characterized DCAA's findings thusly: "Amross, the auditors concluded, was a middleman that did 'no or negligible' work. The audit characterized the…added costs as 'unallowable excessive pass-through charges.'"[29]

Beyond the connection with RD Amross, the Reuters investigation raised concerns about whom the flow of U.S. taxpayer funds was benefiting in Russia. Past media reports have revealed that NPO Energomash was experiencing persistent losses for years, directly due to the "mismanagement" by "unnamed former executives," and that the profits that were captured by "unnamed offshore intermediary companies," now understood in large part to be RD Amross.

Ultimately, Russian Deputy Prime Minister Dmitry Rogozin, has plainly indicated where some of the proceeds of the RD-180 sales to America go. Rogozin, who oversees all of Russia's space enterprise, recently consolidated under central state control, said publicly that the profit from sales of the RD-180 to ULA is "free money" that goes directly toward the modernization of Russia's missile sector.[30] In essence, these purchases are funding many of the very actions the U.S. Government is sanctioning Russia over, and likely contributing to Russia's ongoing violations of the Intermediate Nuclear Forces (INF) Treaty, about which this Committee has been rightly concerned.

ULA has announced in recent days that it will terminate its Delta IV rocket line—the one that uses an *American* engine, and its only vehicle that can execute the full spectrum of DOD launch requirements. Instead of flying payloads on an American vehicle, it would appear that ULA would prefer to use taxpayer money to "Buy Russian" and extend, rather than phase-out, America's dependence on this non-secure foreign supply chain for national security space launch.

As Chairman Rogers correctly has said: "You don't deal with a thug like Vladimir Putin by asking nicely. He breaks treaties, he invades countries and then stations his nuclear forces on their soil, and he cozies up to terrorist regimes like Assad's, North Korea's Kim Jong Un, and the mullahs in Tehran."[31] Simply put, assured access should not include an extension of the timeframe under which the United States relies upon Russian rocket engines, nor should it include further financing Russia's missile industrial base.

VI. From One Subsidy to Another?

Through the EELV Launch Capability, initially referred to as "assured access to space" payments, the U.S. Air Force and the National Reconnaissance Office (NRO) pay ULA approximately $1 billion per year through distinct cost-plus-incentive-fee contract line items. These payments cover most of ULA's fixed costs — for example, launch infrastructure, systems engineering and program management, launch operations, mission integration, base and range support costs, transportation costs, capital depreciation, and non-recurring engineering to name a few — for "up to eight launches" per year. These payments are

[29] Ibid.
[30] Dan Leone. "Notwithstanding Sanctions, ULA Standing By for RD-180 Deliveries through 2017." *Space News.* August 6, 2014. "Rogozin said, '[P]resently, the sale of engines [to the U.S.] benefits our engine-making enterprises in that they use the money for their own modernisation.' Rogozin added, according to the story, 'We need the most modern engines that produce more thrust. In order to design them, we need free money. This is why we are prepared to sell them.'" Available at: http://spacenews.com/41507notwithstanding-sanctions-ula-standing-by-for-rd-180-deliveries-through/#sthash.WDy66pzm.dpuf
[31] "Consequences for Russia's Arms Control Violations Act of 2014" introduced and sponsored by Rep. Mike Rogers.

in addition to the firm-fixed-price that ULA charges for EELV Launch Services (ELS) for each launch ordered through the block buy contract.[32]

Since 2006, when the EELV Program was transitioned to a sole-source procurement environment, the Government has made a number of taxpayer expenditures in an attempt to enhance the ULA launch vehicle systems. This spending includes:

- Hundreds of millions of dollars to upgrade the RS-68 engine on the Delta IV vehicles, an engine that was developed and flown on only one mission and for a vehicle that ULA has threatened to retire prematurely;
- Hundreds of millions of dollars creating a common RL-10 upper stage engine and a dual RL-10 upper stage engine configuration for the Atlas and Delta vehicle systems; and,
- Funding for new payload adaptors, launch site infrastructure, all or nearly all research and development, to the extent ULA conducted any.

ULA has announced in recent weeks that it plans to terminate all single core configurations of the Delta IV vehicles in 2018. To replace it, ULA has suggested it will develop a "Next Generation Launch System." While seeking authority to continue U.S. reliance on Russian rocket engines through the middle of the next decade, ULA is also requesting that the Government, at least in significant part, finance its new launch vehicle—effectively replacing the ELC subsidization from which it has benefited for the last decade, with a new form of subsidization where the taxpayer will foot the bill for a new rocket engine, new launch vehicle system, and new launch infrastructure.

Congress should reject this approach for a number of reasons; not the least of which is that it undermines assured access to space.

By prematurely taking all of the single core configurations of the Delta IV vehicle offline—rather than increase production, as it has expressly stated to Congress it could do without issue[33] to offset the Russian reliance and lower per unit prices through new economies of scale—ULA is attempting to create an environment to justify additional taxpayer outlays to support its business, needlessly. Because there is no "capability gap" today or in the near future, ULA is attempting to create one and force the consequences on the taxpayer.

Incidentally, this strategy reflects a reversal of ULA's previous "contingency plan" with the Department of Defense to assure access to space, which former ULA CEO Michael Gass undertook as the RD-180 supply became uncertain. *SpaceflightNow* reported that ULA had begun to ramp up production of the Delta vehicles in the days following Rogozin's threat to cut off supply: "[h]astening the pace of Delta 4 manufacturing could reduce its cost in the long run, perhaps bringing its price into parity with the Atlas 5, according to Gass. 'The premise right now in the price sheet is that Delta 4, by similar capability, is more [expensive] than Atlas, but those were prices based on a certain build rate,' Gass said. 'Now, we're going to accelerate the build rate, and the Delta prices will come down accordingly. How much? We've got to go negotiate how much.'"

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[32] U.S. Gov't Accountability Office, GAO-14-377R at 24, Space Launch Competition (Mar. 4, 2014).

[33] Stephen Clark. "With questions swirling, ULA hastens Delta 4 production." *SpaceflightNow*. May 19, 2014. "Gass told reporters Monday the decision to ramp up Delta 4 rocket production was part of a contingency plan adopted by ULA under the U.S. Defense Department's policy of assured access to space, which led to the development of the Atlas 5 and Delta 4 rocket families in the 1990s. . . 'The first thing we're doing is making sure we're implementing that contingency plan, which includes the acceleration of Delta 4 production, so some of that work is underway,' Gass said." Available at: http://spaceflightnow.com/news/n1405/19delta4/#.VQS5t47F_9Y

Congress should insist that ULA, as with any competitor, fully finance systems to meet customer requirements, to the extent it wishes to be a viable competitor in the national security launch market. SpaceX has already proven that a viable global commercial launch market exists and more than justifies contractor investment in new systems. The real benefit of competition is not only true assured access to space, but contractor-funded innovation to improve product reliability, enhance customer service, and meet customer needs.

The incumbent has raised concerns as to whether the Delta IV can adequately compete with SpaceX. We question this assertion, especially since the taxpayer has spent hundreds of millions of dollars improving the first stage engine on Delta IV in an effort to improve performance and reduce costs. Clearly, the most cost-effective way to achieve true assured access to space is to keep the Delta program online, eliminate the ELC subsidy, and expand competition for New Entrants. This approach requires not a single dollar of additional Government investment and will result in assured access immediately.

VII. Congressional Rocket Engine Development Program

As a general matter, SpaceX supports sound U.S. investment in liquid propulsion technology development and test stand infrastructure that will benefit the entire industrial base. However, we remain concerned about the Congressionally-funded engine development program, as currently constructed. Congressional direction in the FY2015 National Defense Authorization Act calls for a rocket engine that will ostensibly be "universal" and available to all prospective launch services providers. This approach carries the distinct risk of continuing a long line of Government programs that have spent billions of taxpayer dollars without ever producing a viable flying space system.

In theory, the idea of a universal engine is appealing. In practice, such an approach will be costly and non-responsive to the demands of the commercial and Government launch markets. For there to be a "common" engine, all launch vehicles would need the same interfaces, the same fuels, and the same structural capabilities. No U.S. launch vehicle operating today could accommodate a "standard" rocket engine without significant and extremely expensive modifications, including redesign of the entire stage and likely the development of an entirely new launch vehicle, erasing existing system heritage and requiring costly multi-year EELV certification prior to first flight. There is no guarantee that such a single-engine solution would be reliable, easily manufacturable, or cost-effective.

Though never really achieved, the primary goal of the EELV Program has always been assured access to space. When the program was first established, DOD officials chose two different launch vehicles with two different propulsion systems. This choice served a dual purpose: first, to encourage individual contractor innovation without hamstringing companies to a single formal design; and second, to guarantee that an anomaly in one rocket system would not compromise any other. This requirement of at least two independent systems was later codified. A "common" engine solution runs counter to this goal. Even the most reliable rocket engines have anomalies, so the need for redundancy is clear no matter how advanced any potential engine looks on paper. This point has been made abundantly clear in the EELV Program. While it has achieved a tremendous record of success, there have been notable propulsion issues with its certified launch vehicles. With multiple independent systems, the entire national security launch enterprise need not be halted in the event of an anomaly on one. This is a real risk, as was demonstrated by the October 2012 upper stage propulsion anomaly on the ULA Delta IV. The launch vehicle was grounded for months while the issue was investigated.

Reliance on the Russian RD-180 engine has rightly produced deep concern and a desire for an all-American path to space. However, spending billions of dollars and eliminating proven vehicle heritage without any viable market demand is not the prudent approach. Instead, the DOD should encourage the use of the multiple *existing and fully capable systems* that today utilize American propulsion systems.

Any Government development funds should encourage independent technological development by multiple providers to promote assured access and affordability.

VIII. SpaceX Propulsion Capability

The Merlin 1D rocket engine—which is designed and manufactured by SpaceX and powers the Falcon 9 first and second stages—is a human-rated engine with high structural margins and a highly reliable, redundant ignition system. A hold-before-release system verifying nominal operations of the first-stage engine suite before liftoff has been successfully demonstrated multiple times. Rigorous qualification and acceptance testing from the component to the vehicle system level are part of SpaceX's "test what you fly" approach, and the company uses liquid-fueled engines and non-pyrotechnic, resettable separation systems that allow testing of actual flight hardware before flight. As noted, SpaceX does not rely on any foreign companies for critical components or subsystems.

SpaceX has acquired considerable propulsion design, manufacturing, test, and ground systems experience. The company is currently on its fourth generation of booster engines, which have included the Kestrel, the Merlin 1A, the Merlin 1C, and the Merlin 1D. SpaceX has also developed and Draco and SuperDraco engines which provide in-space and abort propulsion capability for Dragon. Nine Merlin 1D engines power the first stage of every Falcon 9 vehicle, and an additional Merlin engine modified for vacuum operation propels the second stage. When it launches later this year, Falcon Heavy will be the most powerful rocket flown since the Saturn V. As noted, the Merlin engine has now successfully flown to space 160 times (with 110 on the Merlin 1D), reliably delivering multiple payloads for U.S, Government and commercial customers to complex orbits. Due to the engine's highly manufacturable design, SpaceX is now producing 4 Merlin 1D engines per week, with current production capacity to produce 10 engines per week—far more than any other private rocket engine producer in the world.

While Merlin 1D is not a one-to-one replacement engine for the RD-180, the nine Merlin 1D engines that form the power source for the Falcon 9 launch vehicle provide significantly more thrust at lift off than the baseline Atlas V rocket and offer enhanced reliability features like engine-out capability. More than this, because the Merlin engine is made in America, the Air Force and other Government customers will have insight into its reliability and production—this is not possible with the RD-180, which ULA currently accepts on faith from the Russian government.

Leveraging our design, fabrication, and testing experience on the Merlin engines, SpaceX has already begun self-funded development and testing on our next-generation Raptor engine. Raptor is a reusable LOX/methane staged-combustion engine designed for high performance, cost effectiveness, and long life in high production volume. The engine utilizes a full flow staged combustion cycle, promising the highest performance possible for a methane rocket engine, while also delivering long life through new SpaceX technologies and more benign turbine environments. Raptor will likely be the first methane rocket engine flown on orbital trajectories and beyond Earth missions by any entity in the world.

Raptor will represent a fundamental advancement in propulsion technology. This staged-combustion system will not only be the most powerful engine flying in the world today, but also extremely efficient and reliable. It will achieve commercial viability through notable risk- and cost-reducing improvements in metallurgy and producibility, as well as revolutionary technologies enabling long term reusability. All of these features are crucial in ensuring affordable assured access to space for the United States. Rather than turning to decades-old technology developed to support last-generation launch systems, Raptor will advance the state-of-the-art and ensure the US remains the global leader in rocket propulsion technology.

Importantly, SpaceX capability to support all NSS missions is independent of Raptor development; Falcon 9 and Falcon Heavy together exceed the DOD's requirements and will not require external development funds related to this engine.

IX. Contractor-funded Innovation

SpaceX continually self-funds the development of new technologies to improve the reliability of spaceflight and significantly reduce its costs. The Falcon 9 is a product of our past innovations. Among many other features, it utilizes the most efficient hydrocarbon propulsion system in history (Merlin) and is the only rocket flying today with advanced engine-out capability, all while being the lowest cost medium-to-intermediate lift launch vehicle in the world. To take the next step, rockets, like airplanes, must be reusable, and SpaceX has been working aggressively, on our own dime, to make that a reality.

Reusability is the single greatest challenge in spaceflight today. Every rocket in the world is discarded after each launch. This practice is akin to throwing away an airplane after every leg of a trip; it's simply not sustainable in the long-term. SpaceX developed two test platforms to prove that a vertical takeoff / vertical landing (VTVL) launch vehicle was possible. Our Grasshopper and subsequent F9R-Dev, the largest VTVL vehicles in history, conducted 13 test flights at our McGregor facility between 2012 and 2014. These groundbreaking and highly successful tests proved out the flight software, landing legs, and various other technologies necessary for a safe return to earth. SpaceX integrated these technologies into the Falcon 9.

In April 2014, we completed the world's first soft water-landing, when, after successfully delivering its Dragon spacecraft to orbit, a Falcon 9 first stage touched down at near-zero velocity in the Atlantic Ocean. We conducted a second successful soft-landing in July 2014, further proving that a launch vehicle could withstand the forces of reentry and safely touch down. Our next step, ahead of returning a stage to land later this year, is softly landing on an autonomous spaceport droneship. Just last month, SpaceX soft-landed a Falcon 9 in the ocean with near-perfect precision and near-zero velocity.

The EELV Program, with its continually rising costs, has been trapped in what Lieutenant General Ellen Pawlikowski and Deputy Assistant Secretary Douglas Loverro coined the "vicious circle of space acquisition."[34] Essentially, the high costs of launch meant that the DOD could only afford a handful of launches, which forces the development of larger, more expensive satellites to minimize the number of launches. This not only leads to massive budget overruns, but also dramatically reduces technology refresh rates, because many of the DOD's systems take so long to develop that they are outdated by the time they reach orbit. Reusability will break this cycle, by dramatically lowering launch costs. It will mean that more funds can be spent on innovating and deploying new satellite systems, enhancing warfighter capability.

The cost of launch today represents a massive opportunity cost; with innovative new systems—self-funded by industry—the Government will be better equipped to deploy new satellites to meet the military's changing needs around the globe. Reusability enables true operationally responsive capability such that in the event of a conflict, DOD could rapidly replace damaged satellites and establish new capabilities, even in a hostile environment. This is, in other words, the essence of assured access to space.

X. Ensuring Fair and Level Competition in the EELV Program: Eliminate ULA Subsidies

[34] Pawlikowski, Ellen, Doug Loverro, and Tom Cristler. "Disruptive Challenges, New Opportunities, and New Strategies." Strategic Studies Quarterly Spring (2012): 27-54. Available at: http://www.au.af.mil/au/ssq/2012/spring/pawlikowski.pdf

Competition is coming to the EELV Program, but the contractual environment that exists today favors a sole-source incumbent. To ensure that competition occurs on a fair and level playing field, the acquisition and contracting environment must change in order to reflect competitive procurement approach.

SpaceX appreciates that the Air Force is taking steps to reintroduce competition into the EELV Program. As the Air Force restructures the program to on-ramp New Entrants for competition in the intermediate term, and contemplates the format for full and open competition beginning with the FY2018 Phase 2 acquisition, a number of key issues must be addressed to ensure a fair and level competition.

ULA receives, on average, $1 billion annually primarily on a cost-plus basis to fund "facility and facility support costs, launch and range operations, mission integration, mission unique development and integration, subcontract support engineering, factory engineering, etc."[35] ULA receives these ELC subsidies whether they launch zero rockets or eight; if they launch more than eight times, they are paid additional subsidies. As was noted in DOD's recertification of the EELV program after its 2012 "critical" Nunn-McCurdy breach, cost-plus contracting and the ELC has funded "effectively idle personnel" at ULA for years.[36] Essentially, the Government supports all of ULA's fixed costs. Such funds are not provided to SpaceX, nor are they desired by SpaceX, and they are not contemplated to be offered to any other potential New Entrant.

ELC funding provides ULA with a major competitive advantage for national security missions, as well as civil and commercial missions. It distorts and conceals costs and pricing, as has been pointed out on multiple occasions by the GAO. ULA can marginally price launch services for commercial and civil customers because ELC funding allows ULA to maintain its operations and cover its fixed costs. Artificial reductions in launch vehicle core prices do not reflect true savings to the Government; they merely highlight that costs are shifted into the ELC. Ultimately, the taxpayer should not, under any rational circumstance, be funding 100 percent of the operational costs of any private company.

No competition will be fair, full, and open so long as the Air Force continues to utilize contract line items to fund ULA's fixed costs to maintain its ELC. There are reasonable ways to address this competitive inequity now. At minimum, the fixed cost funding must be accounted for in a meaningful way in competitions for EELV launches and must be completely offset in non-EELV competitions. This near-term approach should be leveraged as the ELC is phased-out no later than 2018, prior to the Phase 2 EELV Acquisition to ensure fair and level competition. Congress should conduct continuous oversight to ensure the elimination of the ELC.

In 2015, the conditions that may have justified the ELC subsidy payments at one time have materially changed in virtually every respect. For example, the quantity of national security space launch has increased significantly, which eliminates the need for continuous launch capability funding support and enables a transition to a fully-burdened launch services price offered by each competitor. Also, the EELV Program is emerging from its reliance on a single provider with a limited ability to compete on the open market, and transitioning to a model with potentially multiple certified providers. With respect to the commercial market, the market is robust and stable through 2030; these forecasts are predicated on rational market assumptions and analysis, not hypothetical future systems. There is no remaining rationale for maintaining the ELC.

SpaceX recognizes that a transition away from the ELC will take significant planning and time. In the intervening period, however, as the Air Force on-ramps New Entrants and allows those certified to

[35] "Department of Defense Fiscal Year (FY) 2014 President's Budget Submission, Missile Procurement, Air Force." Apr. 2013. Vol. 1, 230.
[36] Kendall, Frank. "Evolved Expendable Launch Vehicle Nunn-McCurdy Certification: Basis of Determination and Supporting Documentation." Memorandum to Congressional leadership. 12 Jul. 2012.

compete for missions identified to be ordered beginning in FY2015, the Air Force must require the incumbent provider to account for the derived financial and non-financial benefits it is afforded through the ELC payments it receives from the Government.

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Mr. Chairman, I appreciate your invitation to testify before the Committee today. SpaceX fully understands the national security requirement to have two fully capable, dissimilar launch vehicle systems in order to assure access to space. The most rapid and cost-effective way to achieve this capability is to expand competition, create proper incentives for industry to self-invest to meet customer requirements, eliminate American's reliance on Russian rocket engines as soon as possible, and end the practice of subsidizing launch services providers.

Gwynne Shotwell
President & COO

As President and COO of SpaceX, Gwynne Shotwell is responsible for day-to-day operations and for managing all customer and strategic relations to support company growth. She joined SpaceX in 2002 as Vice President of Business Development and built the Falcon vehicle family manifest to more than 70 launches, representing nearly $8 billion in revenue. Shotwell is a member of the SpaceX Board of Directors.

Prior to joining SpaceX, Shotwell spent more than 10 years at the Aerospace Corporation. There she held positions in Space Systems Engineering & Technology as well as Project Management. She was promoted to the role of Chief Engineer of an MLV-class satellite program, managed a landmark study for the Federal Aviation Administration on commercial space transportation, and completed an extensive analysis of space policy for NASA's future investment in space transportation. Shotwell was subsequently recruited to be Director of Microcosm's Space Systems Division, where she served on the executive committee and directed corporate business development.

In 2014, Shotwell was appointed to the United States Export Import Bank's Advisory Committee and the Federal Aviation Administration's Management Advisory Council. Shotwell has been awarded the World Technology Award for Individual Achievement in Space, has been inducted into the Women In Technology International Hall of Fame and was elected to the honorable grade of Fellow with the American Institute of Aeronautics and Astronautics.

SpaceX supports science, technology, engineering and math (STEM) programs locally near its offices as well as national engineering programs and competitions. Through leadership in both corporate and external programs, Shotwell has helped raise over $1 million for STEM education programs reaching thousands of students nationwide.

Shotwell received, with honors, her bachelor's and master's degrees from Northwestern University in Mechanical Engineering and Applied Mathematics, and currently serves on the Advisory Council for Northwestern's McCormick School of Engineering. She has authored dozens of papers on a variety of space related subjects.

DISCLOSURE FORM FOR WITNESSES
COMMITTEE ON ARMED SERVICES
U.S. HOUSE OF REPRESENTATIVES

INSTRUCTION TO WITNESSES: Rule 11, clause 2(g)(5), of the Rules of the U.S. House of Representatives for the 114th Congress requires nongovernmental witnesses appearing before House committees to include in their written statements a curriculum vitae and a disclosure of the amount and source of any federal contracts or grants (including subcontracts and subgrants), or contracts or payments originating with a foreign government, received during the current and two previous calendar years either by the witness or by an entity represented by the witness and related to the subject matter of the hearing. This form is intended to assist witnesses appearing before the House Committee on Armed Services in complying with the House rule. Please note that a copy of these statements, with appropriate redactions to protect the witness's personal privacy (including home address and phone number) will be made publicly available in electronic form not later than one day after the witness's appearance before the committee. Witnesses may list additional grants, contracts, or payments on additional sheets, if necessary.

Witness name: Gwynne Shotwell

Capacity in which appearing: (check one)

○ Individual

◉ Representative

If appearing in a representative capacity, name of the company, association or other entity being represented: Space Exploration Technologies Corp.

Federal Contract or Grant Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts) or grants (including subgrants) with the federal government, please provide the following information:

2015

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant

2014

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
FA8811-14-C-003	U.S. Air Force	$ 4,252,654	EELV Early Integration Studies
NNK14MA74C	NASA	$1,115,023,687	Commercial Crew Transportation Capability
	Subcontract to The Boeing Company	Undefinitized letter contract	Coupled loads analysis for TO-128
	Subcontract to Northrop Grumman Systems Corporation		Launch reservation agreement

2013

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
NNK13MA08C	NASA	$9,569,525	Certification Products Contract
NRO000-14-C-0049	NRO	$5,383,519	Leading Edge Integration

Foreign Government Contract or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts or payments originating from a foreign government, please provide the following information:

2015

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
LuxGovSat S.A.	Luxembourg	6,000,000.00	Launch Services

2014

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
National Applied Research Laboratory - National Space Orga	Taiwan	1,932,262.50	Launch Services
Qatar Satellite Company	Qatar	16,050,000.00	Launch Services

2013

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
Comision Nacional de Actividades Espaciales	Argentina	25,105,872.48	Launch Services

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STATEMENT OF

HON KATHARINA MCFARLAND

ASSISTANT SECRETARY OF DEFENSE
(ACQUISITION)

BEFORE THE

HOUSE COMMITTEE ON ARMED SERVICES

SUBCOMMITTEE ON STRATEGIC FORCES

ON

OPTIONS FOR ASSURING DOMESTIC SPACE ACCESS

MARCH 17, 2015

HOLD UNTIL RELEASED BY THE
U.S. HOUSE OF REPRESENTATIVES

Chairmen Rogers, Ranking Member Cooper, and distinguished members of the Committees, I appreciate the opportunity to appear before the subcommittee and testify about a critical national security issue: assuring the Department's access to space.

Introduction

Our defense space capabilities are central to our national security. This is amplified by 10 U.S.C. 2273, which requires the Department of Defense to sustain at least two space launch vehicles capable of delivering into space any national security payload, while also maintaining a robust space launch infrastructure and industrial base.

Our assured access to space provides national security decision-makers with unfettered global access and unprecedented advantages in national decision-making, military operations, strategic indications and warning, and homeland security. We cannot achieve this without an efficient and reliable space launch capability. The nation requires robust, resilient and affordable space transportation capabilities that enable and advance our space operations.

Mission Assurance

The Department recognized the importance of Mission Assurance for space launch following a string of Titan IV launch failures in the late 1990's during which more than $5B worth of hardware and three national security payloads were lost. The resultant focus on Mission Assurance ensured that the follow-on Evolved Expendable Launch Vehicle (EELV) program was able to provide 80 successful launches for national security payloads since 2002, an unprecedented record of success. The Department intends to retain this focus on Mission Assurance as we reintroduce competition and drive further affordability through New Entrants into the EELV program. In cooperation with each of these prospective New Entrants, the Air Force has implemented a multi-step certification process designed to ensure all new launch service providers meet the existing high U.S. Government levels of design and operational reliability prior to being awarded a National Security Space (NSS) launch service certification.

Reducing the Cost of Space Launch

The Air Force and the Office of the Secretary of Defense significantly restructured the EELV program in 2012 due to concerns over the escalating cost of domestic space launch. The Air Force and OSD reviewed the history of costs associated with the EELV program and

developed a strategy that employed economic order quantity procurement while reintroducing competition. The strategy was structured to allow for competition between the United Launch Alliance (ULA) and New Entrants as early as they can be certified. This resulted in the Air Force successfully negotiating and awarding ULA a contract for launch services, utilizing 36 EELV cores, over the period of five years. A core is generally one launch vehicle, with the exception of the Delta IV Heavy, which requires three cores. This contract award had two significant impacts: 1) it effectively stabilized significant portions of the U.S. launch industrial base and; 2) saved the DoD and taxpayers more than $4.4 billion dollars when compared to the FY12 President's Budget baseline.

Since restructuring the program, we have reversed the burgeoning cost of maintaining a domestic launch capability, without sacrificing the rigor required to maintain mission success. At the same time, the Department is encouraged by the potential for commercial competition to include capable and certified New Entrant launch providers in the years to come.

Competition

The Under Secretary of Defense for Acquisition, Technology & Logistics approved the Air Force's strategy to reintroduce competition into the EELV program in November 2012. Potential competitive launch service providers self- nominate via a Statement of Intent (SOI). The Air Force received the SOI from Space Exploration Technologies Corporation (SpaceX) in February 2012. The Air Force/SpaceX Cooperative Research and Development Agreement for the Falcon 9 v1.1 launch system New Entrant Assessment Certification Plan was signed in June 2013. The Air Force continues to apply significant resources to the certification process with completion of SpaceX certification projected in 2015.

To further enable competition, the Air Force has set aside higher-risk tolerant payloads for competition amongst potential EELV New Entrants. While this approach uses a separate non-EELV contract requiring less rigorous Mission Assurance, it effectively exposes New Entrants to the Government's Mission Assurance process and provides them operational experience that, once certified, makes them more effective in competing for future EELV-class NSS missions. Using this approach, the Air Force competitively procured launch services from SpaceX for its Space Test Program-2 mission and for the joint National Aeronautics and Space Administration (NASA) and National Oceanic and Atmospheric Administration (NOAA) Deep

Space Climate Observatory mission. The Space Test Program-2 mission is currently scheduled for launch in 2016. The Deep Space Climate Observatory mission successfully launched on 11 February 2015 on a Falcon 9 v1.1 launch vehicle.

In response to Section 1611 of the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015 (Pub.L. 113-291) (FY 15 NDAA), we brought forward two additional competitive EELV launches in the FY 16 President's Budget Request (PBR). The NSS manifest is dynamic, and we are still working to identify the payloads to be launched on those competitively-procured launch vehicles.

Use of the Russian RD-180 Rocket Engine

Approximately 18 years ago, we selected the Atlas V with the Russian RD-180 engine as a cost effective way to meet the National Space Transportation Policy of Assured Access to Space. In 1995, there were sound policy and cost saving reasons for the original decision to allow the incorporation of the RD-180 engine into a U.S. launch vehicle. One of the considerations explicitly addressed at the time of that decision -- and periodically since that time -- was the risk associated with using a non-U.S.-manufactured propulsion system for a critical national security capability. In compliance with Sections 1604 and 1608 of the FY 15 NDAA, we have reevaluated our use of the Russian manufactured RD-180 rocket engine.

The Department is committed to eliminating its use of Russian propulsion systems in the most efficient and affordable manner possible. As an initial step, the Department reprogrammed $40M to initiate engine risk reduction activities. This funding, when combined with the $220M added by Congress in FY 15 legislation will fund critical rocket propulsion work as directed in Section 1604 of FY 15 NDAA. The Department currently procures launch services rather than launch vehicle hardware, and is committed to working with industry on how to provide these services utilizing domestically-produced propulsions systems.

The current prohibition on use of Russian propulsion systems, Section 1608 of the FY15 NDAA, represents significant challenges to an orderly and cost effective transition to domestically-produced propulsion systems. Based on current 1608 language, the DoD believes ULA may exhaust the Atlas V RD-180 inventory it can use for NSS missions before the end of the decade. Additionally, ULA recently announced their plan to phase out medium/intermediate Delta IV variants after 2018. The medium and intermediate class payloads that these two

systems service represents the bulk of our launch manifest. Even assuming a New Entrant is certified in the near term, the Department is concerned that with the loss of Atlas V and medium/intermediate class Delta IV vehicle, we could be faced with a multi-year gap without at least two price competitive launch providers servicing medium to intermediate class missions.

Today the Department of Defense is not dependent or reliant on Russian technology to launch its critical space assets. The Delta IV launch vehicle has a domestically-produced propulsion system that is capable of lifting all NSS payloads, although it is not our most cost effective launch solution for classes other than heavy missions. Additionally, once certified, New Entrants are expected to be able to launch a large portion of the NSS manifest, thus increasing our domestic capabilities and providing opportunities for cost reductions. The ultimate goal is for the Department to have two or more commercially-viable launch service providers capable of launching the entire NSS manifest using domestically produced propulsion systems.

Conclusion

The goal of the Department in spacelift has been, and continues to be, maintaining Mission Assurance while leveraging the advantages of competition to make spacelift more affordable. We have accomplished this goal by implementing the principles of Better Buying Power, saving over $4.4B for the taxpayer since the FY12 President's Budget, and setting in motion a sound strategy to foster future competition. We will continue to stress the importance of Mission Assurance that has already resulted in 80 successful EELV launches in pursuit of affordable and reliable space access services.

The transition from the use of Russian manufactured propulsion systems has been and continues to be a difficult challenge. The Department will continue to work with Congress and our industry partners to create a cost-effective and technically viable plan to end the Department of Defense's use of Russian manufactured rocket propulsion systems.

Katrina G. McFarland

Assistant Secretary of Defense (Acquisition)

Katrina McFarland is the Assistant Secretary of Defense (Acquisition).

In this role, she is the principal adviser to the Secretary of Defense and the Under Secretary of Defense for Acquisition, Technology and Logistics on matters relating to acquisition.

Previously, she served as the President of the Defense Acquisition University (DAU) where she continued to build DAU's outstanding reputation as the DoD's primary learning institution while overseeing the development and expansion of acquisition curriculum and supporting learning opportunities for over 150,000 members of the Defense Acquisition Workforce. Under her leadership, DAU provided practitioner training, career management, and services to enable the acquisition, technology, logistics, and requirements community to make smart business decisions and deliver timely and affordable capabilities to the Warfighter. This included addressing the ever changing Defense Acquisition climate as required by the Under Secretary of Defense's (Acquisition, Technology and Logistics) "Better Buying Power" initiatives, and the recent National Defense Authorization Act directions and guidance.

Prior to joining DAU, Mrs. McFarland was the Director for Acquisition for the Missile Defense Agency (MDA)—a position she held since May 2006. As MDA's principal acquisition executive, Mrs. McFarland advised the Director of MDA on all acquisition, contracting and small business decisions. During her tenure, Mrs. McFarland's advice led to over $37 billion of sole source procurement activity being opened up to competition. Additionally, her successful efforts to centralize the acquisition of knowledge-based services enabled small businesses to compete for almost half of the MDA's knowledge based service, while reducing related procurement costs. Other core responsibilities included the development of process activities and program policy associated with the execution of the single integrated Ballistic Missile Defense System research, development and test program, and establishment of the Baseline Execution Review to ensure an integrated program execution of the BMDS occurred across the baselines of schedule, cost, performance, contracting, test and operational delivery.

Mrs. McFarland began her civil service career in 1986 as a general engineer at Headquarters Marine Corps where she was accredited as a Materials, Mechanical, Civil and Electronics Engineer. In 1990, she was hired by the Department of National Defense, Ottawa, Ontario, where she executed Procurement Head of Electronics duties. In 1992, Mrs. McFarland returned to the Marine Corps—this time, Marine Corps System Command—where she was responsible for the acquisition of the USMC Aviation and Ground Command and Control, radars/sensors, air defense, Combat ID and Cooperative Engagement Capability initiatives. She continued to serve the Corps through February 2005, when she concluded her duties as the Director, Battle Management and Air Defense Systems (BMADS).

Mrs. McFarland's accolades and accomplishments are far-reaching. She has received awards for her efforts in the joint arena of CEC, C2 and Theater Missile Defense integration and received recognition for her work from agencies including Government Computing News. Her articles have been published in the Military Operations Research Society, American Society for Computer Simulation, and the International Aeronautical Engineering Societies Proceedings. She has received the Presidential Meritorious Executive Rank Award for 2011, the Secretary of Defense Medal for Meritorious Civilian Service Award, the Department of the Navy, United States Marine Corps, Commendation Medal for Meritorious Civilian Service, DAWIA Level-III-certified in program management, has a professional engineer license and has attained her PMP certification.

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DEPARTMENT OF THE AIR FORCE

PRESENTATION TO THE
SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

SUBJECT: Joint Space Launch

STATEMENT OF: Dr William LaPlante
Assistant Secretary of the Air Force (Acquisition)

March 17, 2015

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HOUSE ARMED SERVICES COMMITTEE
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Introduction

Chairman Rogers, Ranking Member Cooper and distinguished Members of the Subcommittee, it is an honor to appear before this Subcommittee to discuss the Air Force's strategy to end our nation's reliance on the Russian-made RD-180 rocket engine and how we plan to introduce more competition along the way. As General Hyten stated, our military satellites have been a key element of warfighting for over 30 years. The Evolved Expendable Launch Vehicle has been a critical part of this enduring capability by safely delivering those satellites to their intended orbits. Indeed, the EELV program has an unprecedented record of success over all eighty of its launches, supporting all aspects of our nation's military operations, on land, air, and sea. Having said this, we fully support eliminating our reliance on the RD-180 rocket engine, but this will not come without significant technological challenges. Simply replacing the RD-180 with a new engine is not the answer. We know from our prior experience in developing rockets throughout the past several decades that a rocket engine and its associated launch vehicle must be designed concurrently. In essence, we build the rocket around the engine. Technical challenges that must be addressed include vibrations from the engine that ripple throughout the vehicle during its travel, potentially damaging the satellite; ensuring the launch vehicle structure can withstand these ripples and loads without breaking; optimizing fuel storage and flow for the

engine's performance characteristics; and one of the greatest challenges, combustion stability of a high-performance engine.

The Air Force must tackle these technical challenges to eliminate our use of the RD-180. Further complicating this effort, we will also attempt to maximize competition in an environment where the inventory of our current provider's most cost competitive launch vehicle is limited. The question then becomes how do we as a nation most effectively apply the necessary resources required to surmount these challenges.

Restrictive Language

As a result of the 1 February 2014 invasion of Ukraine by Russia, the FY15 National Defense Authorization Act (NDAA) prohibits the use of the Russian-made RD-180 rocket engine. Further, the act directs the Secretary of Defense to develop a US-made rocket propulsion system no later than 2019. The Air Force agrees that we need to transition off of the RD-180 as quickly as possible, however, the objective of 2019 is very aggressive, and it does not result in what is ultimately required, a launch vehicle and the supporting infrastructure so the Air Force can order launch services from industry. To echo the words of Secretary James, it truly is rocket science. Based on historical rocket engine development timelines, developing a new engine from scratch has taken six to eight years and

then another two years to integrate the engine into a launch vehicle. There have been engine development programs that were completed in about five years, but those systems were upgrades based on existing engines.

The act also prohibits the Secretary of Defense from awarding or renewing an EELV contract if it is performed using Russian-made engines. Of course, there is an exception for the current 36-core contract with United Launch Alliance as well as an exemption if the Secretary certifies, upon advice from the General Counsel of the Department of Defense, that the Russian engine was either fully paid for prior to 1 February 2014 or included in a legally binding commitment to fully pay prior to 1 February 2014.

While the intent of this exception language may have been to provide sufficient use of RD-180 engines on order to bridge the gap until a new engine and vehicle were ready, it appears that only a small number of engines actually meet the statutory language, based on the documentation provided to the Department. This prohibition therefore severely limits market driven competition due to the loss of the Atlas V as the most price competitive, certified launch vehicle. Without relief from this language, coupled with ULA's recent decision to retire the non-price competitive Delta medium-class launch vehicle, we will no longer meet our long standing assured access to space policy, where we attempt, to the maximum extent practicable, to have two paths to space for each of our satellites. Just as

importantly, we will likely be forced to trade one sole-source provider for another. One of the Air Force's top priorities has been to reinvigorate competition in the launch arena, and the restriction delays meaningful competition until we reach our ultimate goal of two domestic, commercially competitive launch service providers able to support the entire National Security Space manifest.

Four-Step Transition Approach

We are refining a four-step approach to meet this goal, and the $220 million addition in the FY15 NDAA for a new rocket propulsion system will help to transition off of RD-180. As General Hyten mentioned, we must maintain mission success and assured access to space for our national security space assets by ensuring this effort results in a launch system. Industry feedback from our August 2014 request for information assisted in our development of the four-step approach to accomplish this, and we will continue to refine this approach as we gain further insight from expertise across government, academia, and industry.

The approach involves shared investment with industry towards the ultimate goal of two or more domestic launch service providers in innovative public-private partnerships, selected through competition, and able to support the entire NSS manifest. As a start, we released a second targeted request for information last month which will help the Air Force shape this investment approach. We also

anticipate receiving initial approval for the acquisition strategy in the coming weeks. Additionally, we will provide a report on the strategy to Congress in June of this year.

The first step will be to complete technology maturation and risk reduction activities for the most challenging, highest risk aspects to developing a rocket propulsion system. This is already underway, using the FY14 and FY15 funds to accelerate investments in NASA's Advanced Booster Engineering Demonstration and Risk Reduction program and our own Air Force Research Laboratories' hydrocarbon boost project. The results of this technology maturation will be made available to industry and are intended to advance the early stages of rocket propulsion development and reduce risk. It is in this first step that the Air Force is reducing risk on the most pressing challenge, which is combustion stability in a high-performance engine. Engines of this caliber, which have not been fully developed in the US, can literally explode during test and operations, destroying critical test infrastructure as well. We are ready to make a broad area announcement that will call on industry and academia to assist in developing software tools for modeling combustion stability, advances in heat-resistant coatings, and fuel injection components, the results of which will be made available to industry to the maximum extent possible.

In the second step, we will be reaching out this spring to industry through a shared investment approach to partner in their rocket propulsion system solutions starting with the remaining FY15 funds. Based on our market research and previous requests for information, we have a strategy in place to structure this public-private partnership that is dependent on the level of maturity of the prospective rocket engines. To the maximum extent practicable, rocket propulsion systems developed from these investments will be open to any launch provider for use in their launch systems.

In the third step, the Air Force will invest starting with the FY16 funds in industry's launch solutions, based on advances made in rocket engine development programs from step two. This will result in fully developed launch systems powered by US-made propulsion systems. The goal of step three is to have two or more US-produced commercially competitive launch systems that meet NSS requirements and are also available for commercial use. As much as possible, we will work certification efforts in parallel when applicable during the development efforts in steps two and three.

In our final step in this approach, the Air Force will hold a full and open competition for launches that will occur between 2020 and 2024. The initial awards will use existing systems and then transition to the newly-developed systems once they are fully certified. The key to the success of this strategy is our

ability to use Atlas, Delta, and the soon to be certified Falcon 9v1.1 during this demonstration period. This will result in using all new launch systems powered by American-made rocket engines that would be capitalizing on the competitive commercial viability of the launch system to help offset the overhead of capability.

Conclusion

In conclusion, I hope I have been able to convey to you some of the challenges and complexities in developing launch systems, including rocket engines. Additionally, I'm confident the four-step approach I've outlined today will result in an American-made launch system that meets the needs of our nation and ends our use of the Russian-made RD-180. Also, I would like to reiterate the implications associated with the language in the NDAA and how that both limits the Air Force's ability to compete as many launch missions as possible during this transition and limits our nation's assured access to space. And lastly, I would be remiss if I did not emphasize the tremendous success the EELV program has had and continues to have for our nation. We are committed to making EELV even more resilient and ushering in a new era of competition and continued assured access to space.

We thank the Subcommittee for their support and look forward to coming back to you with reports on our progress.

BIOGRAPHY

UNITED STATES AIR FORCE

DR. WILLIAM A. LAPLANTE

Dr. William A. LaPlante is the Assistant Secretary of the Air Force (Acquisition), Washington, D.C. He is the Air Force's Service Acquisition Executive, responsible for all Air Force research, development and acquisition activities. Dr. LaPlante oversees a research and development, test, production and modernization program portfolio of over $32 billion annually. He is also responsible for development and execution of policies and procedures in support of the operation and improvement of the Air Force's acquisition system.

Dr. LaPlante has more than 29 years of experience in defense technology including positions at the MITRE Corporation and the Johns Hopkins University Applied Physics Laboratory. He has also served on the Defense Science Board (DSB), U.S. Strategic Command Senior Advisory Group and Naval Research Advisory Committee. He has also taught as an adjunct lecturer in the Department of Mechanical Engineering at the Catholic University of America.

Prior to entering public service in 2013, Dr. LaPlante was the Missile Defense Portfolio Director for the MITRE Corporation. In this role, Dr. LaPlante led a technical team providing analytic and system engineering expertise across the Missile Defense Agency portfolio of ballistic missile defense systems. Previously, he was the Department Head for Global Engagement at the Johns Hopkins University Applied Physics Laboratory (JHU/APL) where he was responsible for all of APL's work supporting offensive military capabilities. Dr. LaPlante was a member of APL's Executive Council and served on many other Laboratory leadership initiatives. His earlier APL work included Associate Department Head of the National Security Technology Department and Program Area Manager for the Strategic Submarine Security Program.

Dr. LaPlante has also served on numerous prestigious scientific boards. He was appointed to the Defense Science Board (DSB) in 2010 where he co-chaired a study on Enhancing the Adaptability of U.S. Military Forces and participated in studies on technology and innovation enablers, missile defense, cyber resiliency and contractor logistics. Dr. LaPlante chaired a Commander, USSTRATCOM Strategic Advisory Group study on nuclear planning factors and participated in various studies sponsored by the National Academy of Sciences, the Naval Research Advisory Committee, USSTRATCOM and the Office of the Secretary of Defense (Acquisition, Technology and Logistics).

EDUCATION

1985 Bachelor of Science degree in engineering physics, University of Illinois
1988 Master of Science degree in applied physics, Johns Hopkins University
1998 Doctorate in mechanical engineering, Catholic University of America

CAREER CHRONOLOGY

1. 1985, Began career at Johns Hopkins University Applied Physics Laboratory, Laurel, Md.
2. 1993 - 1998, Chief Scientist and Technical Director for several large at-sea submarine security experiments, Johns Hopkins University Applied Physics Laboratory, Laurel, Md.
3. 1998 - 2001, Program Area Manager for the Strategic Submarine (SSBN) Security Program, Johns Hopkins University Applied Physics Laboratory, Laurel, Md.
4. 2001 - 2003, Business Area Executive for Undersea Warfare and Associate Department Head, National Security Technology Department (Undersea Warfare, Homeland Security and Biomedicine), Johns Hopkins University Applied Physics Laboratory, Laurel, Md.
5. 2003 - 2011, Department Head, Global Engagement Department, Johns Hopkins University Applied Physics Laboratory, Laurel, Md.
6. 2011 - 2013, Missile Defense Portfolio Director, MITRE Corporation, McLean, Va.
7. 2013 - 2014, Principal Deputy Assistant Secretary of the Air Force (Acquisition), Washington, D.C.
8. 2014 - present, Assistant Secretary of the Air Force (Acquisition), Washington, D.C.

OTHER ACHIEVEMENTS

Defense Science Board Member
USSTRATCOM Strategic Advisory Group Member
Lecturer, Department of Mechanical Engineering, Catholic University of America

(Current as of March 2014)

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SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

DEPARTMENT OF THE AIR FORCE

PRESENTATION TO THE
SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

SUBJECT: Joint Space Launch

STATEMENT OF: General John E. Hyten
Commander, Air Force Space Command

March 17, 2015

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SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

Introduction

Chairman Rogers, Ranking Member Cooper, and distinguished Members of the Subcommittee, it is an honor to appear before this Subcommittee to discuss assured access to space and the dedicated men and women of Air Force Space Command (AFSPC) who provide foundational space capabilities to this Nation. These capabilities provide mission-critical global access, persistence, and awareness for our national security, which are vital to the global community and the world economy. They play a critical role in our Nation's ability to deter aggression and are essential across the entire range of civil and military operations; from humanitarian and disaster relief through major combat. Space assets have been a key element of warfighting for over 30 years, providing a unique vantage to observe activity around the globe, relay terrestrial communications, and provide precision position navigation and timing information on which warfighters and the global economy depends. Space launch itself is a critical national capability enabling not just military, but civil and commercial space programs, contributing to the United States economic success.

The challenge before us is to ensure space services continue to be available at the time and place of our choosing in an increasingly challenging space domain. The first step in this process is to assure our ability to provide safe, reliable, and available access to space for national security payloads. Assured access to space is our prime directive, our highest priority. It is also an extremely expensive enterprise. Foundational to this priority is taking into account risk management, affordability, and competition among providers. We must preserve assured access while driving down costs.

In recent years, we have established an unprecedented launch success record by placing an uncompromising premium on mission assurance. Such strict processes and standards were

developed in response to major failures in the late 1990s. I remember those failures, and I remember how we took our eyes off the ball, off the critical standards we must follow to ensure every single launch has the highest probability for success. These standards, which have helped ensure no major failures in national security launches since 1999, helped inform our new entrant certification process. We will continue to maintain a high standard for mission assurance principles in order to do all that is humanly possible and fiscally responsible to guard against launch failure. Launch is rocket science. The satellites on top of each and every rocket we launch represent hundreds of millions, even billions, of taxpayers' dollars; and, perhaps even more importantly, provide our warfighters unprecedented asymmetric advantages on the battlefield. We have developed a very good formula for mission success. We cannot afford to lose it.

Assured Access to Space

Assured access to space is AFSPC's highest priority; it is essential we sustain a reliable capability to deliver national security satellites to space. The Evolved Expendable Launch Vehicle (EELV) team continues an unprecedented string of successful national security space (NSS) launches. In 2014, the Atlas V and Delta IV launch vehicles executed 13 launches, nine of which supported NSS missions, extending the record of EELV total launch successes to 78 as of March 2015. These launch vehicles carry our most precious spacecraft into orbit including global navigation and timing, missile warning, communications, weather, and intelligence spacecraft.

In addition to building on the unprecedented string of launches, the launch enterprise team executed two launches in a span of only four days on the same coast, a never-before-seen turnaround. Furthermore, the team also executed two launches in seven days, but from different

coasts. The launch enterprise and EELV team remain focused on ensuring 100 percent mission success, one launch at a time.

Within the context of assured access to space, the Command's launch priorities are to eliminate the use of the Russian RD-180 rocket engine, and to reintroduce competition into the EELV program using the mission assurance process that has made the EELV program successful. This commitment is exemplified by the dedicated professionals at the Space and Missile Systems Center, under the command of Lieutenant General Sam Greaves, who have worked tirelessly to develop a plan to transition off the RD-180 without sacrificing assured access to space and mission assurance, and to certify new entrants into the space launch enterprise. I want to assure the members of this distinguished subcommittee of our continued commitment to transparency and due diligence as we move forward with these important activities.

Launch Competition

Since 2006, to safely launch our capabilities we have relied on a single industrial partner whose mission success is beyond question. This was necessary when there was a critical need for robust launch vehicle performance and limited business opportunities; however, the market is now growing in commercial space. U.S. commercial companies want to invest in, and compete for, government contracts. The U.S. Government now has an opportunity to leverage the commercial launch market more than we have in the past in order to drive price points on the NSS launch solution that would be more competitive for commercial launch. We are absolutely committed to support competition and a healthy space industrial base. In order to sustain an affordable assured access to space, we must have a healthy industrial base. There are good reasons for exacting standards and rigorous certification; however, we must continue to welcome

new partners into this arena. The Air Force is committed to getting new entrants certified as quickly as possible.

Finally, it is important to note that the Secretary of the Air Force has directed a review of our new entrant certification process by an independent team to capture lessons learned so we can enhance competition for launch services. I strongly support the Secretary's initiative to streamline the current certification process and make it more efficient, while protecting mission assurance.

New Engine Development

Russian aggression in Ukraine is a cause for great international concern and creates uncertainty in our future ability to rely on the Russian made RD-180 rocket engine that powers United Launch Alliance's Atlas V launch vehicle. While the RD-180 is a fine engine, uncertainty regarding its future availability highlighted the need to consider other options for assured access to space. The United States should not be dependent on another nation, particularly Russia, to assure our national security access to space. Upon the completion of an RD-180 Risk Mitigation Study directed by the Secretary of Defense, it became clear that a prolonged interruption would result in increased risk for our national security space posture due to unavoidable delays. Under the direction of Congress, we are collaborating with private partners to invest in industry solutions for U.S.-made rocket propulsion systems. We have developed a strategy to eliminate the use of the RD-180 and reintroduce competition for National Security Space launch. The strategy starts with investment in U.S.-based rocket engine technology.

In December 2014, the FY15 National Defense Authorization Act approved $220 million for a new rocket propulsion system to help transition from the Russian RD-180. Air Force Space

Command fully supports domestic launch capabilities. However, we must maintain mission success and assured access to space for our NSS assets by ensuring this effort results in a launch system. With the FY15 congressional add, we plan to invest in the first two steps of a four step process to attain domestic, commercially viable launch system providers. The initial investment of roughly $60 million will go towards improving U.S. hydrocarbon boost capability with NASA, national labs, universities, and industry. The remaining FY15 funds will be used to start the investment in the development of rocket propulsion systems. Starting with the funds in the FY16 budget, we intend to expand the investment into the corresponding launch systems, leveraging investments in Rocket Propulsion Systems started with the FY15 funds. Finally, we will onramp the launch providers, in which we invested and once certified, to achieve price competition. The ultimate goal is to have at least two domestic, commercially viable launch system providers that also meet all our nation's NSS launch requirements.

A sustained focus on rocket propulsion technology and the required launch systems allows the United States to operate in a broader trade space, helping to mitigate disruptive events affecting external supply lines. Also, launch systems developed with domestic engines will revitalize the launch and rocket propulsion industrial base, end reliance on a foreign supplier, and aid the competitive outlook for the entire domestic launch industry. This will be a multi-year effort and require significant congressional support to maintain adequate funding in future years.

Conclusion

Our Nation's strength in space is built on a foundation of a healthy space launch capability and Air Force Space Command plays a critical role. We are committed to sustaining the highest levels of mission assurance, and our ultimate objective is to safely and reliably launch

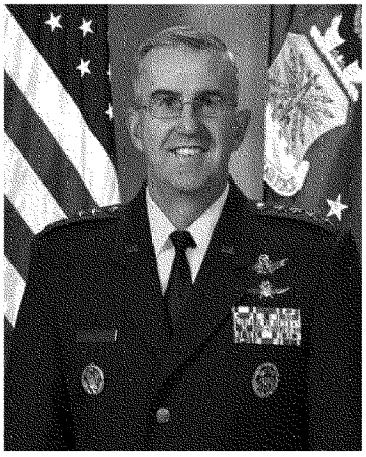
national security payloads on a schedule determined by the needs of the national security space enterprise.

We have an incredible track record of success and strive to maintain this record. I would like to thank the Subcommittee for their support and look forward to our continued partnership to provide resilient, capable, and affordable space capabilities for the Joint Force and the Nation.

BIOGRAPHY

UNITED STATES AIR FORCE

GENERAL JOHN E. HYTEN



Gen. John E. Hyten is Commander, Air Force Space Command, Peterson Air Force Base, Colorado. He is responsible for organizing, equipping, training and maintaining mission-ready space and cyberspace forces and capabilities for North American Aerospace Defense Command, U.S. Strategic Command and other combatant commands around the world. General Hyten oversees Air Force network operations; manages a global network of satellite command and control, communications, missile warning and space launch facilities; and is responsible for space system development and acquisition. The command comprises approximately 40,000 space and cyberspace professionals assigned to 134 locations worldwide. General Hyten also directs and coordinates the activities of the headquarters staff.

General Hyten attended Harvard University on an Air Force Reserve Officer Training Corps scholarship, graduated in 1981 with a bachelor's degree in engineering and applied sciences and was commissioned a second lieutenant. General Hyten's career includes assignments in a variety of space acquisition and operations positions. He served in senior engineering positions on both Air Force and Army anti-satellite weapon system programs.

The general's staff assignments include tours with the Air Force Secretariat, the Air Staff, the Joint Staff and the Commander's Action Group at Headquarters Air Force Space Command as Director. He served as mission director in Cheyenne Mountain and was the last active-duty commander of the 6th Space Operations Squadron at Offutt AFB, Nebraska. In 2006, he deployed to Southwest Asia as Director of Space Forces for operations Enduring Freedom and Iraqi Freedom. General Hyten commanded the 595th Space Group and the 50th Space Wing at Schriever AFB, Colo. Prior to assuming command of Air Force Space Command, he served as the Vice Commander, Air Force Space Command.

EDUCATION

1981 Bachelor's degree in engineering and applied sciences, Harvard University, Cambridge, Mass.
1985 Master of Business Administration degree, Auburn University, Montgomery, Ala.
1985 Distinguished graduate, Squadron Officer School, Maxwell AFB, Ala.
1994 Distinguished graduate, Air Command and Staff College, Maxwell AFB, Ala.
1999 National Defense Fellow, University of Illinois, Champaign, Ill.
2011 Senior Managers in Government Course, Harvard University, Cambridge, Mass

ASSIGNMENTS

1. November 1981 - December 1985, Configuration Management Officer and Chief, Configuration

Management Division, Automated Systems Program Office, Gunter AFB, Ala.
2. December 1985 - July 1989, Chief, Software Development Branch; and Chief, Engineering and Acquisition Division, Space Defense Programs Office, Los Angeles AFB, Calif.
3. August 1989 - July 1990, Special Adviser to the U.S. Army, Kinetic Energy Anti-Satellite Program Office, U.S. Army Strategic Defense Command, Huntsville, Ala.
4. July 1990 - August 1991, Deputy for Engineering, Strategic Defense Initiatives Program Office, Los Angeles AFB, Calif.
5. August 1991 - May 1992, Executive Speechwriter and Systems Analyst, Assistant Secretary of the Air Force (Acquisition), the Pentagon, Washington, D.C.
6. May 1992 - July 1993, Program Element Monitor, Advanced Technology Programs, Assistant Secretary of the Air Force (Acquisition), the Pentagon, Washington, D.C.
7. July 1993 - June 1994, Student, Air Command and Staff College, Maxwell AFB, Ala.
8. July 1994 - June 1996, Mission Director, Space Operations Officer, and Chief, Command Center Training, U.S. Space Command, Cheyenne Mountain Air Force Station, Colo.
9. August 1996 - August 1998, Commander, 6th Space Operations Squadron, Offutt AFB, Neb.
10. August 1998 - June 1999, National Defense Fellow, University of Illinois, Champaign
11. June 1999 - June 2001, Operations Officer, and Chief, Space Branch, Defense and Space Operations Division, Deputy Director for Operations (Current Readiness and Capabilities), J3, Joint Staff, the Pentagon, Washington, D.C.
12. June 2001 - June 2003, Chief, Space Control Division, Directorate for Space Operations and Integration, Deputy Chief of Staff for Air and Space Operations, Headquarters U.S. Air Force, Washington, D.C.
13. June 2003 - July 2004, Director, Commander's Action Group, Headquarters Air Force Space Command, Peterson AFB, Colo.
14. July 2004 - April 2005, Commander, 595th Space Group, Schriever AFB, Colo.
15. April 2005 - May 2007, Commander, 50th Space Wing, Schriever AFB, Colo. (May 2006 - October 2006, Director of Space Forces, U.S. Central Command Air Forces, Southwest Asia)
16. May 2007- September 2009, Director of Requirements, Headquarters Air Force Space Command, Peterson AFB, Colo.
17. September 2009 - February 2010, Director, Cyber and Space Operations, Directorate of Operations. Deputy Chief of Staff for Operations, Plans and Requirements, Headquarters U.S. Air Force, Washington, D.C.
18. February 2010 - August 2010, Director, Space Acquisition, Office of the Under Secretary of the Air Force, the Pentagon, Washington, D.C.
19. September 2010 - May 2012, Director, Space Programs, Office of the Assistant Secretary of the Air Force for Acquisition, Washington, D.C.
20. May 2012 - Aug 2014, Vice Commander, Air Force Space Command, Peterson AFB, Colo.
21. Aug 2014 – present, Commander, Air Force Space Command, Peterson AFB, Colo.

SUMMARY OF JOINT ASSIGNMENTS
1. July 1994 - June 1996, Mission Director, Space Operations Officer, and Chief, Command Center Training, U.S. Space Command, Cheyenne Mountain Air Force Station, CO., as a major
2. June 1999 - June 2001, Operations Officer, and Chief, Space Branch, Defense and Space Operations Division, Deputy Director for Operations (Current Readiness and Capabilities), J3, Joint Staff, the Pentagon, Washington, D.C., as a lieutenant colonel

BADGES
Master Space Operations Badge
Master Cyberspace Operator Badge

MAJOR AWARDS AND DECORATIONS
Distinguished Service Medal
Legion of Merit with oak leaf cluster
Defense Meritorious Service Medal with two oak leaf clusters
Meritorious Service Medal with four oak leaf clusters
Air Force Commendation Medal
Army Commendation Medal
Joint Staff Achievement Medal
Air Force Achievement Medal

OTHER ACHIEVEMENTS
1991 Recipient of the William Jump Award for Excellence within the Federal Government
1998 Recipient of a Laurels Award, Aviation Week and Space Technology Magazine

2009 Gen. Jerome F. O'Malley Distinguished Space Leadership Award

PUBLICATIONS
"*A Sea of Peace or a Theater of War: Dealing with the Inevitable Conflict in Space*," The Program in Arms Control, Disarmament, and International Security Occasional Paper, University of Illinois, 2000
"*A Sea of Peace or a Theater of War*," Air and Space Power Journal, Air University Press, 2002
"*Moral and Ethical Decisions Regarding Space Warfare*," with Dr. Robert Uy, Air and Space Power Journal, Air University Press, 2004

EFFECTIVE DATES OF PROMOTION
Second Lieutenant Aug. 23, 1981
First Lieutenant Aug. 23, 1983
Captain Aug. 23, 1985
Major May 1, 1993
Lieutenant Colonel Jan. 1, 1997
Colonel June 1, 2002
Brigadier General Oct. 1, 2007
Major General Nov. 10, 2010
Lieutenant General May 18, 2012
General Aug. 15, 2014

(Current as of August 2014)

Major General Howard "Mitch" J. Mitchell (USAF, Retired)
Testimony to the House Armed Services Subcommittee on Strategic Forces
Hearing on "Assured Access to Space"
March 17, 2015

Chairman Rogers, thank you and good morning. Members of the committee, good morning, and thank you for the opportunity to discuss Assured Access to Space, a critical component of our National Security.

I will discuss my views of the current state and strategy for the Evolved Expendable Launch Vehicle (EELV), including challenges, opportunities, risks and perspectives related to our national security space launch activities. These are my personal observations and do not represent either The Aerospace Corporation's position or the position of any member of the RD-180 Mitigation Study team.

Let me begin by saying I have been involved in the evolution of the Assured Access to Space policy since the phrase was coined in late 1983 by the Honorable Edward C. Aldridge, who, at the time was dual-hatted as the Under Secretary of the Air Force and Director of the National Reconnaissance Office (NRO). His concern was that the Nation needed to have Assured Access to Space to mitigate the risk of the "Shuttle only" policy in place since the late 1970s. The concept was to procure ten Commercial Expendable Launch Vehicle (CELV) that could be used in the event of a Shuttle problem. The program started with a study phase in 1984 and led to a contract award to Martin Marietta in 1985 for what became known as the Titan IV.

I have been involved with the EELV program since its inception in 1994. In fact, I was responsible for implementing the Congressionally directed, Space Launch Modernization Plan, led by Lt. Gen. Thomas S. Moorman, Jr., then the Vice Commander of Air Force Space Command. In the November 2006 High Frontier Journal (Volume 3, Number 1), he wrote an article entitled "Framing the Assured Access Debate: A Brief History of Air Force Space Launch"; an excerpt from that article follows; "One of the first things the study group examined was the "differing views and interests in this area" and the underlying causes that had led to "an inability to maintain consensus within the executive branch." These differing interests and perspectives are summarized below:

• The defense space sector was most interested in cost-effective, medium-class launches for its force enhancement payloads, while seeing future needs for improved operability, dependability, and responsiveness.

• The intelligence space sector's top concern was a reliable heavy lift capability for its large and expensive payloads.
• The civil space sector focused on safe, reliable human spaceflight to assemble the Space Station and on the need to reduce the costs of space transportation by pursuing a reusable space launch system.
• The commercial space sector was synergistic with the defense space sector because both were interested in lower prices and dependable launch schedules, and both saw limited opportunities to expand the launch market.

I would contend that as we discuss Assured Access to Space today differing interests and perspectives still exist, albeit slightly modified in the NASA case since the Space Station now exists and the Space Shuttle has been retired.

I also chaired the RD-180 Mitigation Study in March and April of 2014 under a Terms of Reference signed by the Assistant Secretary of the Air Force (Acquisition). A version of the briefing was released to the Committee and to the contractors that supported the study, so I will not go into detail today. I would only say that the major recommendation, to have Liquid Hydrogen, Solid Rocket Motor and Hydrocarbon propulsion systems available to rocket designers, is still valid.

However, much has changed since I completed the RD-180 Mitigation Study:
• The Congress approved a $40 million FY14 reprogramming action to increase funding for technology maturation.
• The Congress allocated $220 in FY15 to accelerate rocket propulsion system development with a target demonstration date of fiscal year 2019
• The Congress included language in the FY15 NDAA that restricted the purchase of RD-180 engines to those that are already on contract.
• SpaceX's Falcon 9 v1.1 is expected to be certified as an EELV New Entrant in the June 2015 timeframe.
• ULA has announced a partnership with Blue Origin to produce a new launch vehicle using the Blue Origin BE-4 engine.
• ULA has announced that they are also pursuing the Aerojet Rocketdyne AR-1 engine and will make a decision between the AR-1 and the BE-4 in late 2016.
• ULA has announced that they will discontinue producing the Delta IV Medium the Delta IV Medium-Plus with launches of those vehicles ending in the 2018/2019 timeframe. Thus ending the original Assured Access to Space capability of two families of launch systems, Atlas V and Delta IV.
• ULA has also announced that they will continue producing and launching the Delta IV Heavy as long as National Security Space missions require them.
• Additionally, ULA announced they will study reducing the number of current

EELV launch pads from four to two in the Next Generation Launch System (NGLS) timeframe.
• The SECAF tasked AFSPC/CC to conduct a review of the EELV New Entrant Certification process and General (Ret) Larry Welch, Former Air Force Chief of Staff is leading that effort.
• The DoD IG conducted an audit to determine whether the Air Force implemented the recommendations in the RD-180 Availability Risk Mitigation Study.
• SpaceX is expected to submit a revised Statement of Intent (SOI) for the Falcon 9 Heavy to enter into the EELV New Entrant Certification process later this year but has not yet done so.

With that as the background let me now discuss my views of the current state and strategy for the Evolved Expendable Launch Vehicle (EELV), including challenges, opportunities, risks and perspectives related to our national security space launch activities.

The EELV has been the most successful launch system in history with an outstanding record of mission successes -- only the Delta IV Heavy Demo (no payload) and a 2007 Atlas V have failed to place their payloads in the correct orbit at the required time (on the Atlas launch the mission was declared to be successful). Additionally, the EELV family of launch systems has met all the requirements documented in the Key Performance Parameters (KPP) of the 1998 Operational Requirements Document (ORD).

That being said the EELV program is in the midst of major restructure, that if not properly resourced and carefully thought through (from both an acquisition and operations perspective), will add significant risk to Assured Access to Space for National Security Space missions in the 2020 timeframe and may not result in a competitive environment. Depending on the interpretation of the RD-180 restrictive language even the current Phase 1a EELV competitions could become sole source procurements.

If the success oriented schedules of the contractors and Government are not met the 2020 EELV program could look like the following:

• No Delta IV Medium or Delta IV Medium-Plus launch vehicles– ULA's current plan
• No Atlas Vs due to restrictions on the use of RD-180s – Congressional language
• No certified Falcon 9 Heavy -- Potential as a revised Statement of Intent to enter the EELV New Entrant Certification process has not been submitted.

• No Next Generation Launch System (NGLS) -- NGLS engine is under development and, as I see it, has a high risk schedule. It is the ULA plan but not available until 2022/2023.
• Only Falcon 9 v1.1 and Delta IV Heavy available to launch the National Security Space missions
    • The result would be that NSS missions currently flying on Atlas V, that are too large for Falcon 9 v1.1, would have to fly on Delta IV Heavy or be delayed until a Falcon 9 Heavy or NGLS becomes available. If they fly on a Delta IV Heavy the cost will increase substantially.

This potential 2020 EELV program would result in two "monopolies" - one for the Heavy missions (ULA) and one for everything else (SpaceX). Obviously this is not the desired end state for competition but is certainly a plausible outcome based on the risk profiles of the current and planned activities.

Given this potential outcome the Government needs to take ownership and 1) define the desired end-state for Assured Access to Space for National Security Space missions, 2) take action to get on the path to achieve that end-state, and 3) adequately resource the plan to ensure this critical component of our National Security is in a healthy state. I recommend that a Space Launch Modernization Plan like effort, led by a senior Government official, be conducted with all the stakeholders participating to assess the risks of the current and planned activities and make recommendations to the Administration and the Congress on how to mitigate them so that the Nation does not have an end state as described above.

As a colleague and friend stated to me "Currently no stakeholder has a credible plan that 'closes.' Each stakeholder has a different endgame solution, and each stakeholder's current 'non-closing' game plan has 'and then a miracle happens' as the last element of their plan....and ALL the miracles are different."

BIOGRAPHY

UNITED STATES AIR FORCE

MAJOR GENERAL HOWARD J. "MITCH" MITCHELL

Retired August 01, 2003

Maj. Gen. Howard J. "Mitch" Mitchell is director of operations, Headquarters Air Force Space Command, Peterson Air Force Base, Colo. He is responsible for overseeing the development of policy and guidance to conduct the command's space and intercontinental ballistic missile operational missions.

The general entered the Air Force in 1973 upon graduation from the U.S. Air Force Academy. He has served in various missile operation and acquisition positions, from squadron level to the Air Staff. He has been a program director on two major acquisition programs and served as director of communications and director of launch in the National Reconnaissance Office. The general was first to direct the National Security Space Architect program. He also served as special assistant to the assistant secretary of defense for command, control, communications and intelligence, and was the Defense Department liaison to the Commission to Assess U.S. National Security Space Management and Organization with the Office of the Secretary of Defense in Washington, D.C.

EDUCATION

1973 Bachelor of science degree in engineering mechanics, U.S. Air Force Academy, Colorado Springs, Colo.
1977 Master of science degree in mechanical engineering, University of Michigan, Ann Arbor
1978 Squadron Officer School, Maxwell Air Force Base, Ala.
1980 Master of business administration degree, University of North Dakota, Grand Forks
1983 Air Command and Staff College, Maxwell Air Force Base, Ala.
1985 Air War College, by seminar
1986 Defense Systems Management College, Fort Belvoir, Va.
1989 Master of arts degree in national security affairs, Naval War College, Newport, R.I.
1989 Master of arts degree in international relations, Salve Regina College, Newport, R.I.
1997 Capstone, National Defense University, Fort Lesley J. McNair, Washington, D.C.
1999 Seminar XXI, Massachusetts Institute of Technology, Washington, D.C.

ASSIGNMENTS

1. November 1973 - July 1976, deputy missile combat crew commander, later, senior instructor deputy combat crew commander, 321st Strategic Missile Wing, Grand Forks AFB, N.D.
2. July 1976 - August 1977, Air Force Institute of Technology graduate student, University of Michigan, Ann Arbor
3. August 1977 - August 1982, manager of mechanical systems, later, chief, Spacecraft Operations Branch, later, chief of satellite and launch vehicle integration, Defense Meteorological Satellite Program, Headquarters Space Division, Los Angeles Air Force Station, Calif.

4. August 1982 - June 1983, student, Air Command and Staff College, Maxwell AFB, Ala.
5. June 1983 - June 1984, space shuttle acquisition manager, Directorate of Space Systems, and Command, Control and Communications, Deputy Chief of Staff for Research, Development and Acquisition, Headquarters U.S. Air Force, Washington, D.C.
6. June 1984 - June 1986, chief, Legislative Liaison Space Branch, Directorate of Legislative Liaison, Office of the Secretary of the Air Force, Washington, D.C.
7. June 1986 - December 1986, student, Defense Systems Management College, Fort Belvoir, Va.
8. December 1986 - June 1988, director of special activities, Deputy Chief of Staff for Systems, Headquarters Air Force Systems Command, Andrews AFB, Md.
9. June 1988 - June 1989, graduate student, Naval War College, Newport, R.I.
10. June 1989 - December 1990, deputy director of engineering, B-2 Systems Program Office, Headquarters Aeronautical Systems Division, Wright-Patterson AFB, Ohio
11. December 1990 - July 1992, program director, Small Intercontinental Ballistic Missile System Program Office, Ballistic Missile Organization, Norton AFB, Calif.
12. July 1992 - February 1994, program director, Air Force Ballistic Missile Defense Systems Program Office, Headquarters Space and Missiles System Center, Los Angeles AFB, Calif.
13. February 1994 - July 1995, director of developmental planning, Headquarters Space and Missile Systems Center, Los Angeles AFB, Calif.
14. July 1995 - August 1998, director, Office of Space Systems, Office of the Assistant Secretary of the Air Force for Space; director of communications systems acquisition and operations; and director, Office of Space Launch, National Reconnaissance Office, Washington, D.C.
15. September 1998 - September 2000, director, National Security Space Architect, Office of the Assistant Secretary of Defense for Command, Control, Communications and Intelligence, Alexandria, Va., and the Office of the Deputy Director of Central Intelligence for Community Management, Langley, Va.
16. September 2000 - March 2001, special assistant to the assistant secretary of defense for command, control, communications and intelligence, and Defense Department liaison, Commission to Assess U.S. National Security Space Management and Organization, Office of the Secretary of Defense, Washington, D.C.
17. March 2001 - present, director of operations, Headquarters Air Force Space Command, Peterson AFB, Colo.

BADGES
Master Space Badge
Master Acquisition Badge
Master Communications Badge
Senior Missile Badge

MAJOR AWARDS AND DECORATIONS
Defense Distinguished Service Medal with oak leaf cluster
Defense Superior Service Medal
Legion of Merit
Meritorious Service Medal with three oak leaf clusters
Air Force Commendation Medal with two oak leaf clusters
Air Force Achievement Medal

OTHER ACHIEVEMENTS
Combat Crew Readiness Medal
Outstanding program director, Gen. Bernard Schriever Chapter, Air Force Association
Gold Medal for Distinguished Service, National Reconnaissance Office
National Intelligence Distinguished Service Medal

EFFECTIVE DATES OF PROMOTION
Second Lieutenant Jun 6, 1973
First Lieutenant Jun 6, 1975
Captain Jun 6, 1977
Major Nov 1, 1982
Lieutenant Colonel May 1, 1987
Colonel Apr 1, 1991
Brigadier General Feb 1, 1997
Major General Jun 1, 2000

(Current as of May 2001)

DISCLOSURE FORM FOR WITNESSES
COMMITTEE ON ARMED SERVICES
U.S. HOUSE OF REPRESENTATIVES

INSTRUCTION TO WITNESSES: Rule 11, clause 2(g)(5), of the Rules of the U.S. House of Representatives for the 114th Congress requires nongovernmental witnesses appearing before House committees to include in their written statements a curriculum vitae and a disclosure of the amount and source of any federal contracts or grants (including subcontracts and subgrants), or contracts or payments originating with a foreign government, received during the current and two previous calendar years either by the witness or by an entity represented by the witness and related to the subject matter of the hearing. This form is intended to assist witnesses appearing before the House Committee on Armed Services in complying with the House rule. Please note that a copy of these statements, with appropriate redactions to protect the witness's personal privacy (including home address and phone number) will be made publicly available in electronic form not later than one day after the witness's appearance before the committee. Witnesses may list additional grants, contracts, or payments on additional sheets, if necessary.

Witness name: Howard John Mitchell

Capacity in which appearing: (check one)

(•) Individual

( ) Representative

If appearing in a representative capacity, name of the company, association or other entity being represented: N/A

Federal Contract or Grant Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts) or grants (including subgrants) with the federal government, please provide the following information:

2015

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
NONE	NONE	NONE	NONE

2014

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
NONE	NONE	NONE	NONE

2013

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
NONE	NONE	NONE	NONE

Foreign Government Contract or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts or payments originating from a foreign government, please provide the following information:

2015

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
NONE	NONE	NONE	NONE

2014

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
NONE	NONE	NONE	NONE

2013

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
NONE	NONE	NONE	NONE

WITNESS RESPONSES TO QUESTIONS ASKED DURING THE HEARING

MARCH 17, 2015

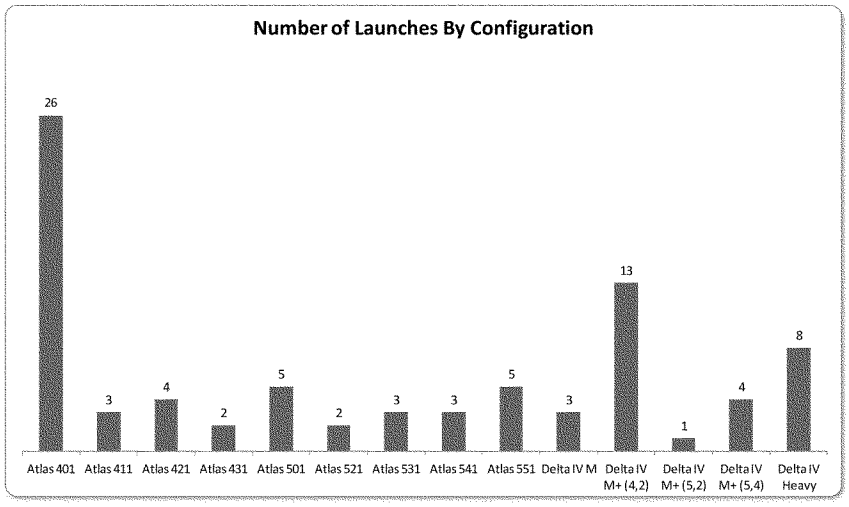
RESPONSE TO QUESTION SUBMITTED BY MS. SANCHEZ

Mr. BRUNO. ULA has successfully launched 95 times since inception in December 2006. ULA has offered multiple configurations to best serve our customers on the Delta IV, Atlas V and Delta II vehicles. The Delta IV and Atlas V vehicles have successfully flown 82 times, dating back to before the inception of ULA.

For Atlas V, ULA flies a 4-Series (4M payload fairing) and a 5-Series (5M payload fairing). These two configuration classes have launched successfully 35 and 18 times respectively. The core vehicle and upper stage are the same for every vehicle configuration with the exception of payload fairing size and number of solids, which varies based on customer requirements.

For Delta IV, ULA also flies a 4-Series (4M payload fairing) and a 5-Series (5M payload fairing). For these configuration classes, ULA provides additional solid rocket boosters if required. The Delta IV Intermediate booster stage is the same with the fairing size, upper stage size and number of solids varying to support customer requirements. In addition for Delta IV Intermediate, ULA flies the Delta IV Heavy.

ULA has demonstrated reliability through its configuration classes. The specific configuration is dependent on solid rocket boosters. The exact configuration is based on customer need. Below, please find the missions flown by ULA for each configuration. [See page 17.]



QUESTIONS SUBMITTED BY MEMBERS POST HEARING

MARCH 17, 2015

QUESTIONS SUBMITTED BY MR. ROGERS

Mr. ROGERS. Mr. Bruno, why are you planning to phase out the intermediate (single stick) Delta IV launch vehicle?

Mr. BRUNO. The Delta IV Medium-class is entirely redundant to the Atlas V-class in terms of its performance.

We have maintained these two systems all this time in order to satisfy the country's need for assured access, which is to say two independent systems so that in the event that there might be a failure or a flaw in one system there would still be a second system to be able to launch our critical National Security assets.

In this new environment where the policy has changed, to assured access through the existence of two providers I will now retire the Delta Medium-class of space launch vehicles when we have completed our current requirements within the manifest.

The last scheduled Delta IV Medium mission is WGS–10 in CY'19. This is part of the Evolved Expendable Launch Vehicle (EELV) Phase 1 procurement. In response to the Phase 1 Acquisition strategy signed by USD(AT&L) with a total USG requirement for 50 cores, of which 36 were to be procured using a block buy approach and the remaining 14 cores would be made available for competition, ULA committed to its Atlas V industrial base for 29 cores and Delta IV industrial base for 21 cores. The Delta IV cores were specifically for the requirements identified in the block buy (Phase 1) and the Atlas V cores were to support Phase 1 and 1A missions. This commitment has provided DOD with the over $4B of savings recently identified by the GAO in its annual assessment of DOD Acquisition Programs, dated March 2015. Since it is at least a 36-month lead time (from order to launch) for Delta IV hardware, coupled with the non-competitive prices associated with Delta IV, ULA will not be offering Delta IV single core vehicles to support Phase 1A or 2 mission procurements.

Mr. ROGERS. Ms. Shotwell, you were recently quoted in the media stating that SpaceX is working on a higher-thrust engine. Please provide details on the associated planned hardware and software changes in the engine and launch vehicle. Will this be the new baseline launch vehicle configuration going forward, and when is the first launch planned for?

Ms. SHOTWELL. SpaceX is planning to fully optimize the Merlin 1D engines on future flights of the Falcon 9 rocket. This optimization will enhance the existing Merlin 1D engine, which has a 100% success record on 13 consecutive missions and currently operates at approximately 85 percent of its thrust capability, and will qualify the engine to 100 percent thrust. The engine is in qualification at this time. SpaceX is currently planning the first launch of this vehicle for a commercial customer later this year. SpaceX would be pleased to provide the Committee with proprietary, detailed information about the Falcon 9 launch system directly.

Mr. ROGERS. Do you plan to fund an entirely new launch vehicle and all new infrastructure? Do you know what it will, or could, cost the taxpayer? What are the risks of this approach, and how does this compare with a path that replaces the RD–180 and leverages existing launch vehicle and infrastructure investments?

Secretary MCFARLAND. The Department currently procures launch services rather than launch vehicle hardware for the Evolved Expendable Launch Vehicle (EELV) program requirements, and is committed to working with industry on how to continue providing these services utilizing domestically-produced propulsions systems. Our strategy is to competitively invest with industry, to develop launch capabilities able to support National Security Space (NSS) requirements. The ultimate objective is access to two domestic commercially viable launch service providers utilizing domestically produced propulsion systems in accordance with statutory requirements and National Space Transportation Policy.

Based on our initial review, we do not know today the level of USG investment required, but prior program experience suggests it will be less than the cost of a government run standalone engine development program. The Department has released a Request for Proposal to industry that solicits innovative solutions to a performance based set of requirements. We expect these solutions may range from new launch vehicles and infrastructure to evolution of existing launch vehicles and infra-

structure. The Department will assess cost, schedule and technical elements of these commercially based solutions and incorporate them into a multi-step acquisition approach that will result in new or evolved systems meeting all of our NSS launch requirements.

The risk to this shared investment approach is whether industry chooses to participate. Industry must perceive that a viable business case exists and be properly incentivized to develop capabilities for new launch vehicles and infrastructure investment that meet the demands of the commercial satellite market and NSS needs.

The Department is committed to transitioning off the RD–180 but a Government led program that is limited to replacing this engine would not necessarily result in a new launch capability. Further, it may run counter to promoting competition in the launch service provider market for NSS requirements.

Mr. ROGERS. Can the DOD rely on the domestic commercial launch provider market to the meet the national security requirements for assured access to space? What are the risks of this approach?

Secretary MCFARLAND. The Department does not believe it can rely on the commercial satellite market alone to drive domestic launch service providers to develop or offer systems that meet all of our National Security Space (NSS) launch and assured access to space requirements. As the Department's launch rate tapers down over the next decade, launch service providers may decide to maintain viability by tailoring their solutions to the commercial satellite market, a market which is expected to remain relatively stable at least through 2023. As this market typically consists of smaller spacecraft launching into less demanding orbits, unique NSS requirements could be viewed as niche markets with their own specific business cases that, without government investment, could go unaddressed.

Moving forward, our strategy is to invest in launch capabilities that enable at least two domestic commercially viable launch service providers capable of supporting NSS requirements. The Department's challenge, and the risk of relying on the commercial market, is making sure NSS requirements are not excluded as domestic commercial capabilities are developed. The industry must perceive that a viable business case exists so they are incentivized to develop capabilities that are crucial to meeting NSS requirements and the demands of the commercial satellite market.

Mr. ROGERS. Why is the EELV Launch Capability arrangement in place, and how does this benefit the U.S. Government? Is the DOD still evaluating the appropriate contracting structure in the future, in terms of launch services, capabilities, and infrastructure, to maintain assured access to space and have fair competition?

Secretary MCFARLAND. The Evolved Expendable Launch Vehicle (EELV) Launch Capability (ELC) construct with United Launch Alliance was put in place in 2006 to preserve the industrial base at a time when there was not sufficient commercial launch market to do so. The ELC line item in the current EELV FA8811–13–C–0003 contract continues to provide the Department substantial benefits in both launch readiness and operational flexibility when navigating the dynamic DOD, Intelligence Community and Civil and Commercial manifest.

As New Entrants enter into the market and the EELV program transitions into a competitive environment, the Department is evaluating the appropriate method for consideration of launch readiness infrastructure costs.

Mr. ROGERS. Do you plan to fund an entirely new launch vehicle and all new infrastructure? Do you know what it will, or could, cost the taxpayer? What are the risks of this approach, and how does this compare with a path that replaces the RD–180 and leverages existing launch vehicle and infrastructure investments?

Dr. LAPLANTE. The Air Force plans to transition off the Russian supplied RD–180 via a launch service approach which may or may not result in a new launch vehicle and all new infrastructure. The Air Force released a Request for Information (RFI) in August 2014 to solicit industry inputs on propulsion and launch systems. The overwhelming conclusion from the RFI responses is that a solution at the propulsion level does not necessarily result in a launch vehicle solution capable of meeting the National Security Space (NSS) requirements. The Air Force plans to leverage the commercial market with the goal of two (or more) domestic launch service providers in innovative public/private partnerships, selected through competition, and able to support the entire NSS manifest.

Part of the plan is shared investment of the development to support the entire NSS manifest, and the level of shared investment is still to be determined with industry through RFI and Request for Proposal (RFP) responses; thus we do not have the exact costs for each solution at this time.

No path is without risk, and engine development by 2019 is risky but may be achievable. However, the path we have laid out reduces risk by leveraging industry's on-going engine development capabilities. Conversely, solely replacing the RD–

180 increases the risk that a launch service is not ultimately secured or the secured launch service is not ultimately competitive. An engine alone will not launch us into space, as the engine must still be integrated and tested in a rocket. It is near impossible to exactly replicate an existing engine or the performance features of an existing engine due to different manufacturing facilities, manufacturing processes, and material sources, likely resulting in engine with weight and thrust differences. Any engine changes will drive launch vehicle changes. Launch systems are customarily designed around the engine as the lowest risk approach. Furthermore, simply replacing the RD–180 engine in an attempt to minimize launch vehicle changes will likely result in a launch system that is not competitive, as the launch industry has fundamentally changed over the past decade. Therefore, we have to make sure we partner with industry, and that our shared investment with launch providers is a workable and cost-effective approach.

Mr. ROGERS. Can the DOD rely on the domestic commercial launch provider market to the meet the national security requirements for assured access to space? What are the risks of this approach?

Dr. LAPLANTE. Yes, DOD can rely on the domestic commercial launch provider market to meet the national security requirements for assured access to space as long as there are two or more commercially viable providers. Federal Aviation Administration Commercial Space Transportation Committee forecasts and Year in Review reports indicate a stable competitive commercial market. However, this is only a projection. A risk in relying on the domestic market is that it could enter a downturn and launch providers may not remain viable. With DOD as their sole customer, domestic providers would have to increase prices to make their business cases close.

Mr. ROGERS. Why is the EELV Launch Capability arrangement in place, and how does this benefit the U.S. Government? Is the DOD still evaluating the appropriate contracting structure in the future, in terms of launch services, capabilities, and infrastructure, to maintain assured access to space and have fair competition?

Dr. LAPLANTE. The EELV Launch Capability (ELC) arrangement was put in place in 2006 to ensure the launch providers could launch when the satellites were ready, thus preserving our nation's assured access to space IAW statute and the National Space Transportation Policy. During this time, many satellites in development were experiencing delays, and ELC offered a way to directly negotiate and manage the critical launch overhead and infrastructure costs independent of fluctuating launch schedules and ops tempo since we had to pay the costs anyway. ELC maintains operational flexibility to adjust the launch manifest in response to NSS requirements. ELC was and is required to maintain this flexibility and the readiness of critical personnel that possess unique and advanced technical skills to process and launch our most complex missions.

Yes, the DOD is still evaluating the appropriate contracting structure for future launch services. The goal of Phase 2 is for the Air Force to be able to competitively award launch services to meet NSS mission needs (FY18–FY22 procurements for FY20–FY24 launches) to the maximum extent possible. A final decision has not been made on how launch capability activities will be handled in Phase 2. As we work towards developing a successful overarching strategy, the need for some sort of ELC will be evaluated with the need to maintain mission success, assured access to space, fair competition, and affordability.

Mr. ROGERS. General Hyten, SpaceX has recently made statements about a higher-thrust engine. What does the USAF know about the planned changes to the engine and launch vehicle?

General HYTEN. SpaceX presented an overview of its planned "full-thrust" Falcon 9 launch system to NASA's Launch Services Program (LSP) on 7 April 2015, with the Air Force in attendance. However, SpaceX has not formally submitted the changes desired to be accepted under certification for the "full-thrust" system to the Air Force.

Mr. ROGERS. How will this affect certification?

General HYTEN. The Air Force will determine if the "full thrust" Falcon 9 is a "new configuration", as defined in the New Entrant Certification Guide (NECG). Higher thrust alone doesn't automatically mean it is a new configuration, but other vehicle system changes that accompany that (structures, dimensions, flight profile, etc.) could result in a new configuration determination for the vehicle or launch system. If certification activities are necessary, they would focus largely on the hardware and performance portions of the launch system since the Falcon 9 v1.1 certification will have already covered company engineering and manufacturing processes (unless those processes have been modified as well).

Mr. ROGERS. Will the Air Force be certifying the existing Falcon 9 version 1.1 and/or the new higher thrust capability?

General HYTEN. Yes. The Air Force is currently wrapping up certification of the Falcon 9 v1.1, and anticipates some level of verification effort to begin for the higher thrust system once SpaceX provides formal notification of changes.

Mr. ROGERS. Do you plan to fund an entirely new launch vehicle and all new infrastructure?

General HYTEN. We plan to transition off the Russian supplied RD–180 via a launch service approach which may or may not result in a new launch vehicle and all new infrastructure. Engine development alone does not improve our assured access to space posture because significant launch vehicle development may be required to use a new engine, even if the engine is designed as a replacement. However, investing at the launch system level does improve assured access to space by harnessing the commercial providers' investments to develop launch system(s), including the engine if required, that are commercially viable but can also launch all national security payloads. Therefore, our recommended plan to transition off the RD–180 is to invest with industry partners to develop domestic, commercially viable launch systems that also assure access to space for all national security payloads, and to competitively procure launch services using those systems.

Mr. ROGERS. Do you know what it will, or could, cost the taxpayer?

General HYTEN. We are working with industry to understand their business cases for developing commercially viable launch systems, so we do not have the costs for each solution at this time.

Mr. ROGERS. What are the risks of this approach, and how does this compare with a path that replaces the RD–180 and leverages existing launch vehicle and infrastructure investments?

General HYTEN. If we were to develop an engine solution for a single launch vehicle (i.e., to replace the RD–180 on the Atlas V), a competition could be accomplished at the engine level but the resulting engine would favor some launch systems over others. This approach would be seen as competitive for the engine developers but anti-competitive for the launch service providers. Also, any new engine replacement for any existing launch vehicle is still technically risky for two reasons. First, the baseline technical risk for developing a high-performance rocket engine is high. Second, even a new version of the RD–180 engine for an Atlas V launch vehicle may require structural changes to the launch vehicle due to the different forces and vibration imparted on the launch vehicle by the new engine. From a schedule risk perspective, it has historically taken ~8 years to develop a new engine, so there is a likelihood that a new engine, if started now or currently in early development, would not be completed by 2019.

Mr. ROGERS. Can the DOD rely on the domestic commercial launch provider market to the meet the national security requirements for assured access to space?

General HYTEN. The DOD can rely on the domestic commercial launch provider market to meet National Security Space (NSS) requirements if there are two or more commercially viable providers. This will require the DOD to partner with providers to jointly develop a commercial launch service that can also meet NSS launch needs.

Mr. ROGERS. What are the risks of this approach?

General HYTEN. The risk to this approach is that it requires U.S. providers to capture enough commercial and civil launch contracts to remain viable. If there are not enough commercial and civil launches available or if the launch system, once developed, is not competitive enough to win commercial and civil launch contracts, launch providers may not remain viable businesses. In this case, not only would the competitive supply be reduced, the DOD may be forced to procure launch services from those providers at a higher cost to assure access to space for our NSS payloads.

Mr. ROGERS. Why is the EELV Launch Capability arrangement in place, and how does this benefit the U.S. Government?

General HYTEN. The EELV Launch Capability (ELC) arrangement was put in place in 2006 to ensure the launch providers could launch when the space vehicles were ready, thus preserving our nation's assured access to space in accordance with the National Space Transportation Policy. It was also created to stabilize the industrial base during a time of reduced numbers of launches. The other risk is in the event of a launch failure and one provider is unable to fly for an extended period of time. Who makes the decision to return to fly and how does one company stay in business with the lack of revenue during the down time? We do not know the answers to these questions yet. Especially since there has been only one provider currently that can meet the entire National Security Space (NSS) manifest, ELC was and is used to stabilize the engineering workforce throughout dramatically changing launch manifest to include NASA and commercial launches. The ELC part of the USAF Phase 1 contract continues to provide the Department of Defense the required operational flexibility to meet its NSS requirements without Request for

Equitable Adjustment (REAs) or schedule penalties as a result of launch slips due to satellite vehicle acquisition issues, first time integration delays, or anomaly resolution timelines. The scope of the launch capability includes all work associated with supporting launch infrastructure maintenance and sustainment, program management, systems engineering and the Government's independent mission assurance process and launch site operations. Finally, the Phase 1 Block Buy contract ELCs portion is a significant part of the earned $4.4B in cost savings from the FY12 PB.

Mr. ROGERS. Is the DOD still evaluating the appropriate contracting structure in the future, in terms of launch services, capabilities, and infrastructure, to maintain assured access to space and have fair competition?

General HYTEN. Yes, the DOD is still evaluating the appropriate contracting structure for future launch services. The DOD is weighing the needs for mission success, assured access to space, fair competitions, affordability, and is working to develop a successful overarching strategy that fulfills requirements in each of those areas.

Mr. ROGERS. Can the DOD rely on the domestic commercial launch provider market to the meet the national security requirements for assured access to space? What are the risks of this approach?

General MITCHELL. Yes the DOD could rely on domestic commercial launch providers to meet National Security Space (NSS) requirements but due to the associated risks I do not think they should.

While commercial satellite operators and the NSS community both desire to have reliable launch systems at a competitive cost point with certainty of schedule they differ in their approaches to managing the risk inherent in space launch.

The commercial operators manage launch risk thorough a combination of insurance, self-insurance (buying "spare" satellites ahead of need), designing satellite so they can be manifested on multiple launch systems (foreign and domestic) and having contractual milestones that allow them to change launch systems if the launch provider does not meet them.

The NSS community does not insure, does not procure satellites ahead of need, can only manifest on domestic launch systems by law and, since launch system options are limited, do not design all satellites to be able to be launched on all launch providers, and has not used the same type contractual clauses as commercial satellite operators. So given these limitation the NSS community manages risk by employing a mission assurance process that is much more in depth and "intrusive" than commercial satellite operators. The NSS mission assurance approach has proven to be extremely effective since the turn of the Century. The current provider has adjusted to the government processes even though the strict terms of the contracts were for launch services and not hardware. It is not clear whether commercially competitive offerors would take the same approach to accommodating the government's mission assurance processes.

The bottom line is that National Security is about ASSURING CAPABILITY for the National Command Authorities, the Warfighter and the Intelligence Community and commercial space is about INSURING their revenue stream. The NSS Community needs to be able to apply its mission assurance standards on its launch providers as long as the current laws, policies and approaches to procuring satellites and launching satellites on schedule with no spares and no insurance is in place.

QUESTIONS SUBMITTED BY MR. COFFMAN

Mr. COFFMAN. SpaceX's support of competition in the launch markets is appreciated. Please explain SpaceX's objection to permitting future purchases of RD–180 engines to allow for an orderly transition to an all-U.S. alternative, given that Delta IV is not a commercially cost-competitive vehicle, even when produced at rate?

Ms. SHOTWELL. SpaceX appreciates the support of Congress and the Air Force for reintroducing meaningful competition into the EELV Program as a means to lower costs, provide true assured access to space, and stimulate continuous innovation that will enhance the U.S. industrial base. The issue of Russian engines is not related to competition—it is squarely related to the assured access to space policy. Reliance on the RD–180 engine for national security space launch is not consistent with assured access to space and that sending hundreds of millions of dollars to Russia's industrial base is not necessary when America has multiple options today. As a result, Congress passed legislation, with broad bipartisan support, to phase out such reliance and leverage existing and future capability. An "orderly transition" to an alternative is available immediately—with increased utilization of the Delta and Falcon family of rockets. The decision to discontinue the Delta Medium rests neither with SpaceX nor with Congress, but with ULA. Whether or not a provider has a

competitive offering is not an issue for Congress to resolve on behalf of that provider; instead, that provider should take steps to place itself in a competitive position. Competition will be truly enhanced to the extent that the Launch Capability subsidy (approximately $1 billion annually) paid to ULA is fully accounted for in head-to-head competitions and/or eliminated.

Mr. COFFMAN. SpaceX boasts development of a commercial launch site "soon" at Brownsville, TX. Please define the milestones and final operational date for this site.

Ms. SHOTWELL. SpaceX currently plans to have the launch site in South Texas completed in late 2016, and operational in 2017, when the first launch is scheduled to occur from this launch site. SpaceX is not relying on any federal funds for this launch site.

Mr. COFFMAN. Most U.S. Government payloads require performance in excess of the Falcon 9 V1.1. How does SpaceX plan to support these missions?

Ms. SHOTWELL. Falcon 9 can execute roughly 60 percent of national security space launches today. SpaceX has self-funded the development, qualification, and initial launch of the Falcon Heavy—set to occur later this year. Falcon 9 and Falcon Heavy, in just two configurations, will be able to execute 100 percent of EELV missions. The Falcon Heavy will be certified well in advance of any competitions for missions that would require its capability.

Mr. COFFMAN. SpaceX current launch has been delayed due to an evaluation of helium bottles. SpaceX has had multiple missions impacted by helium leaks. What has been done to address this specific issue?

General HYTEN. SpaceX has not had multiple missions impacted by helium leaks. During a pre-launch test of a single mission, SpaceX experienced a single helium bottle failure which resulted in a helium leak. Working with the Air Force, SpaceX has implemented changes and enhanced test methods regarding helium bottles, and has successfully flown the Falcon 9 a number of times since the issue was detected during the pre-launch test. The Air Force and SpaceX continue to work collaboratively on New Entrant certification, which will address any identified risks and implement USG and SpaceX agreed-to risk handling plans to mitigate the risks.

Mr. COFFMAN. Would SpaceX benefit from the mission assurance experience that resides in the U.S. Government?

General HYTEN. Yes. SpaceX has already benefited from the U.S. Government (USG) mission assurance experience with respect to this issue. The USG team was instrumental in identification of a potential root cause for an F9–010 issue, and recommended the recently performed follow-on testing. Additionally, the USG team recommended implementation of additional inspection acceptance criteria that are now being applied by SpaceX.

Mr. COFFMAN. How will SpaceX work with the U.S. Government to ensure that systemic issues do not impact future NSS missions?

General HYTEN. SpaceX and the USG team are currently engaged in the new entrant certification process designed to evaluate the Falcon 9 version 1.1 launch vehicle and identify potential risks to National Security Space missions. As part of this process, all identified risks or systemic issues require development and implementation of USG and SpaceX agreed-to risk handling plans to mitigate the risks.

Mr. COFFMAN. Is the U.S. Government or Aerospace Corporation participating in the helium bottle anomalies?

General HYTEN. Yes, the USG and Aerospace Corporation team has been participating in the helium bottle anomaly as part of the new entrant certification process. As noted above, the USG and Aerospace Corporation team was instrumental in identification of a potential root cause of the helium bottle anomaly and the subsequent development of the follow-on inspection acceptance criteria.

QUESTIONS SUBMITTED BY MR. BROOKS

Mr. BROOKS. Has SpaceX received any sole-sourced missions from the Air Force, NASA or any other U.S. Department or Agency? If so, please explain?

Ms. SHOTWELL. The DSCOVR and STP–2 missions were designated as Evolved Expendable Launch Vehicle (EELV) New Entrant missions, and were contracted under the U.S. Air Force IDIQ contract called Orbital/Suborbital Program (OSP–3), which is managed out of Kirtland Air Force Base. The OSP–3 program is a competed contract vehicle. The Air Force selected SpaceX, Orbital-ATK, with its Minotaur family, and Lockheed Martin's Athena vehicle as eligible competitors for launches under this program. The Air Force released the OSP–3 Request for Proposals (RFP) under solicitation FA8818–12–R–2006 on May 11, 2012 for the IDIQ and for two task orders to be ordered under the IDIQ: DSCOVR and STP–2. Accord-

ing to Aviation Week (Dec. 10, 2012), Orbital offered a bid, as did SpaceX. SpaceX successfully launched the DSCOVR satellite on a Falcon 9 in February 2015; STP–2 is currently scheduled for launch in 2016 on a Falcon Heavy.

Mr. BROOKS. SpaceX claimed in its testimony that with the Falcon 9 Heavy, it has the capability to perform all missions in the national mission model. In 2014, SpaceX stated "With the Falcon 9 and the Falcon Heavy, SpaceX will be able to execute 100 percent of the DOD's launch requirements with two launch vehicle configurations." Please describe the performance capability (in lbs) of Falcon 9 Heavy direct inject to Geosynchronous Orbit. How will the upper stage handle the long on-orbit coast required for this mission? What is the longest coast performed to date by the upper stage?

Ms. SHOTWELL. The baseline Falcon Heavy is capable of launching just over 18,000lbm direct to Geostationary orbit using a three upper stage burn mission profile. The mission profile includes a five hour and 14 minute long coast between the second and third burn. While the longest coast SpaceX has performed to date is only three hours, development of a "long coast kit" is planned for Falcon Heavy to enable the direct to GEO mission profile with low risk. The mass budgeted for this long coast kit is not to exceed 3000lbm, resulting in Falcon Heavy performance greater than 15,000lbm direct to GEO. This capability exceeds the most strenuous capability required by the Air Force of 13,770lbm direct to GEO thus allowing Falcon 9 and Falcon Heavy to address 100% of the DOD's launch requirements.

Mr. BROOKS. SpaceX stated in 2014 their Falcon 9 heavy "while being the most powerful launch vehicle in the world—twice the capability of the Delta IV Heavy." Please clarify this statement in regards to the National Security Space. What is the Falcon Heavy lift capability for National Security Space Geosynchronous Orbit missions?

Ms. SHOTWELL. Falcon Heavy lift capability for national security space geosynchronous transfer orbit (GTO) is 41,570 lb (18,856 kg).

Mr. BROOKS. SpaceX stated that the Falcon Heavy was delayed due to internal priorities. Given that SpaceX has stated that its overall goal is to get to Mars and other planets, what confidence can SpaceX provide to National Security Space customers that their priorities will not be delayed due to SpaceX internal decisions.

Ms. SHOTWELL. SpaceX and the Air Force have been focused on EELV certification of the Falcon 9 launch vehicle. We anticipate certification no later than June 2015. SpaceX has submitted its EELV certification statement of intent for the Falcon Heavy. Critically, our top priority is providing the most reliable launch services in the world to our customers. SpaceX's commitment to national security space launch is evidenced by the self- funded effort to date associated with meeting EELV requirements, including launch vehicle certification, and the development of vehicles capable of performing all EELV missions. SpaceX will fulfill contractual obligations for national security space launch customers, as with our NASA and commercial customers. SpaceX regularly conducts U.S. Government missions, including several U.S. Government missions this year, for both NASA and the U.S. Air Force. Falcon Heavy is under contract for launch in 2016 for the U.S Air Force, as well as a number of commercial customers. As a result, SpaceX is manufacturing, qualifying, and demonstrating the vehicle prior to these launch dates.

Mr. BROOKS. Given that SpaceX has delayed the Falcon Heavy due to internal priorities. Please provide the key milestones and specific dates between now and the launch date of Falcon Heavy.

Ms. SHOTWELL. Fabrication and qualification of the Falcon Heavy is currently underway. Reconfiguration of Launch Complex 39–A to support Falcon 9 and Falcon Heavy launches will be completed in the summer of 2015, and SpaceX will perform a Wet Dress Rehearsal of the Falcon Heavy in the fall. The self-funded demonstration flight of the Falcon Heavy is currently scheduled to occur late in 2015.

Mr. BROOKS. SpaceX has repeatedly claimed to have self-funded its launch infrastructure at both the Cape and Vandenberg and by mid-2015, SpaceX will have two launch pads in Florida for geostationary orbit missions. When does SpaceX intend to have two launch pads in Florida for geostationary orbit missions?

Ms. SHOTWELL. To date, SpaceX has self-funded its launch infrastructure. Currently, SpaceX maintains operational pads at Cape Canaveral Air Force Station (CCAFS) at Launch Complex 40 (LC–40) and Vandenberg Air Force Base (VAFB) at Space Launch Complex 4E (SLC–4E). This summer, SpaceX will complete work on Launch Complex-39A (LC–39A) within NASA Kennedy Space Center (KSC) to support Falcon 9 and Falcon Heavy launches. SpaceX expects to complete work on a fully commercial launch site in South Texas by the end of 2016, to support launches in 2017. Each of the Florida and Texas pads will be able to support launches to geostationary orbits.

Mr. BROOKS. SpaceX has made claims to bringing back the commercial launch market to the U.S. SpaceX also stated in 2014 that there is no conflict between U.S. Government National Security or NASA missions because "SpaceX prioritizes DOD and NASA missions over commercial missions." How have SpaceX's commercial customers de-conflicted their need for launches based on this policy?

Ms. SHOTWELL. SpaceX has recaptured a substantial share of the commercial launch market—more than 50 percent of the world's competed launches next year. Notably, prior to SpaceX's entry into the commercial market, U.S. market share had dwindled to zero percent. Our chief competitors in the commercial arena have been Russian and European. There is no conflict between U.S. Government missions and commercial missions. SpaceX maintains a clear manifest policy that is part of each of our commercial contracts, which prioritizes U.S. Government missions. Moreover, SpaceX's Air Force and NASA Cargo Resupply Services (CRS) contracts are rated either DO, DX, or in support of the International Space Station (ISS), meaning that SpaceX has a contractual legal right to prioritize these launches ahead of commercial missions, as necessary. SpaceX has invested internal funds in the development of additional launch infrastructure (i.e. the South Texas launch site) to eliminate manifest congestion and any schedule conflicts at the Federal Ranges.

Mr. BROOKS. SpaceX has repeatedly made claims of their Heavy debut. In a 2011 press release SpaceX said they would launch the Falcon Heavy in early 2013. Ms. Shotwell was quoted in 2014 claiming the Heavy would launch in March 2015, and during your recent testimony you stated "we did deemphasize the Falcon Heavy development after I made that remark because we wanted to focus on the single stick or the single core Falcon 9." What year and month will the Falcon Heavy launch? How many launches of the Heavy in 2015? Is one of them self-funded, like SpaceX indicated in 2014?

Ms. SHOTWELL. SpaceX has timed Falcon Heavy development and demonstration to precede our contractual obligations for the operational launch of the vehicle. The first launch contract for Falcon Heavy—for STP–2, an Air Force mission—was pushed back as a result of a delay with the Government's COSMIC–2 payload. Accordingly, SpaceX was in a position to move back our self-funded demonstration flight of the Falcon Heavy, while focusing on EELV certification of the Falcon 9 launch vehicle and other matters. SpaceX anticipates flying this demonstration flight in 2015. We have additional commercial Falcon Heavy flights under contract in 2016.

Mr. BROOKS. SpaceX stated that it does not need any subsidies from the U.S. Government. To confirm, SpaceX, and its management, believes that the U.S. Government should not subsidize companies or use taxpayer money to provide subsidies that do not benefit all participants of an industry?

Ms. SHOTWELL. The Government should not subsidize the fixed costs or business overhead of any one provider in a competitive procurement. As General Hyten recently testified before this Committee, such subsidies make it impossible to hold a fair competition, stating: "I don't think you can have fair competition with that contract in place. There'll have to be a change."

Mr. BROOKS. What condition is the booster in after recovery? The booster must fly at hypersonic velocities through its own Merlin exhaust, then again prior to landing. Please describe how the booster will be treated after exposure to this very harsh environment. Also please describe what refurbishment actions are included when recovering a booster? What reviews will SpaceX conduct to ensure readiness of the booster?

Ms. SHOTWELL. SpaceX has not recovered a booster at this time; once we successfully perform recovery on an upcoming flight, we will analyze the booster and engines. We will then be able to fully ascertain its condition and next steps for refurbishment.

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