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HEARING  
ON  
NATIONAL DEFENSE AUTHORIZATION ACT  
FOR FISCAL YEAR 2020  
AND  
OVERSIGHT OF PREVIOUSLY AUTHORIZED  
PROGRAMS  
BEFORE THE  
COMMITTEE ON ARMED SERVICES  
HOUSE OF REPRESENTATIVES  
ONE HUNDRED SIXTEENTH CONGRESS  
FIRST SESSION  
SUBCOMMITTEE ON STRATEGIC FORCES HEARING  
ON  
**FISCAL YEAR 2020 PRIORITIES  
FOR MISSILE DEFENSE AND  
MISSILE DEFEAT PROGRAMS**  
HEARING HELD  
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**FISCAL YEAR 2020 PRIORITIES FOR MISSILE DEFENSE  
AND MISSILE DEFEAT PROGRAMS**

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HOUSE OF REPRESENTATIVES,  
COMMITTEE ON ARMED SERVICES,  
SUBCOMMITTEE ON STRATEGIC FORCES,  
*Washington, DC, Wednesday, May 8, 2019.*

The subcommittee met, pursuant to call, at 2:14 p.m., in room 2118, Rayburn House Office Building, Hon. Jim Cooper (chairman of the subcommittee) presiding.

**OPENING STATEMENT OF HON. JIM COOPER, A REPRESENTATIVE FROM TENNESSEE, CHAIRMAN, SUBCOMMITTEE ON STRATEGIC FORCES**

Mr. COOPER. The subcommittee will come to order.

The hearing today is to receive testimony on the 2020 budget request for missile defense and to discuss the implementation of the 2019 Missile Defense Review.

I appreciate all the witnesses being here. I will ask unanimous consent that your full testimony can be submitted for the record, so I hope you will summarize in about 5 minutes. I know that is going to be a challenge, because just General Greaves alone was 42 pages, so it is a bigger challenge for him than for the others.

But we are honored to have Mr. Behler here, General O'Shaughnessy, Dr. Anderson, Lieutenant General Greaves, and Vice Admiral Kriete. Did I pronounce that correctly?

Admiral KRIETE. Kriete.

Mr. COOPER. Kriete. Excuse me.

Thank you all for coming today to provide your views.

I would like to single out General Greaves because it is my understanding this is your last hearing, at least on the House side. So I want to express my deep appreciation to you, not only as a general officer in the Air Force, but as a personal friend; your fantastic 37 years of service to the Nation. We appreciate the high quality of your work and your extraordinary service. So I am sorry this will be your last hearing, but you are always welcome to come back and visit us any time you would like. But thank you, General.

General GREAVES. Mr. Chairman, thank you. Those are very kind words. It has been an honor. Thanks.

Mr. COOPER. Our ranking member—

Mr. TURNER. Sorry, I am not used to the hearing beginning without me. We all just came from votes, so it is not as if we didn't have a direct line.

Mr. COOPER. Well, you have perfect timing. Perfect timing.

Mr. TURNER. Great. So you are passing it to me?

Mr. COOPER. Yes. The ranking member, Mr. Turner, for his remarks.

[The prepared statement of Mr. Cooper can be found in the Appendix on page 25.]

**STATEMENT OF HON. MICHAEL R. TURNER, A REPRESENTATIVE FROM OHIO, RANKING MEMBER, SUBCOMMITTEE ON STRATEGIC FORCES**

Mr. TURNER. Well, thank you all. I appreciate your expertise and your work. Obviously, with missile defense, we don't have a margin of error. And your work to try to give us the technological edge to be able to protect the American population is incredibly important. We have been through a lot of starts, stops, and shifts into what our mix would be in order to look to protect the continental United States. And I greatly appreciate that you have been part of that overall discussion.

I think the Missile Defense Review does start addressing some of our emerging missile threats. The budget request for Missile Defense Agency [MDA] is actually lower, though, about \$1 billion than fiscal year 2019, which is about 10 percent of MDA's budget. So it startles, I think, all of us on how the administration thinks it can address these increasing missile threats, including hypersonic, at the same time that we have that decrease.

Second, in space-based sensing, last year, on a bipartisan basis and bicameral basis, in recognition of the threat of hypersonic weapons being developed by Russia and China, Congress increased funding to an MDA program that would have provided a space-based sensing capability. We need that capability to detect and track hypersonic threats coming to the U.S. homeland.

This year, that program is zeroed out and does not appear anywhere in the President's budget. Instead, this program appears as MDA's number one priority on its unfunded priorities list. And I look forward to hearing from General Greaves about his perspectives on the future of this capability. And I also note that the commander of the United States Strategic Command mentioned this program as an area of concern in his letter to the committee on unfunded mandates.

Lastly, over the past year, the ground-based midcourse defense system has experienced numerous significant issues that are adequately addressed in the budget submission.

An issue with the redesigned kill vehicle has caused at least a 2-year delay in its fielding. I want to say that again, because I keep hearing some of the comments on the response to this as it is going to have minimal impact or we are dealing with the issue or we think we found a path forward. It is at least a 2-year delay in fielding, that is because we don't really actually yet even have the answer as to what the solution is going to be, that is what the projections are. I am obviously very concerned, when I look at missile defense as having no margin of error, that that error also should not be significant slips.

This means we will not be able to get all of the ground-based interceptors emplaced in Fort Greely by 2023. Additionally, the Department has significantly decreased funding for the multi-object kill vehicle, reducing funding to keep the program on life support

through low-level technology maturation efforts. The Department has once again failed to make a designation on an east coast missile defense site, which Congress has carried supportive language on the NDAA [National Defense Authorization Act] in its passage since fiscal year 2013.

Working with my colleague Elise Stefanik, we have called on the Department to publicly announce location of such a site. The environmental impact statement is complete, and it is imperative that the agency lean forward on the emerging missile capabilities of our adversaries that serve to threaten our homeland and move forward on designating the site to enhance our homeland missile defense capability.

Another aspect as to why this is important is you have three communities that are vying for this. Two need to be let go. Two need to be able to be told that they can stand down and that their communities and their chambers of commerce and everybody else who is working to advocate for their community needs to understand that actually a decision has been made because you have completed all the data work necessary for that decision, it just needs to be announced.

Now, on two occasions, Acting Secretary of Defense Shanahan has committed on the record to fulfilling Congress' intent on this important matter. On March 26, in an open hearing of our full committee on the fiscal year 2020 national budget, the Acting Secretary stated to Congresswoman Stefanik that we can count on him sharing the site designation with our committee. Again, then on May 1, before a House Appropriations Defense Subcommittee hearing on DOD's [Department of Defense's] budget request, the Acting Secretary promised Congressman Tim Ryan, in an answer on the site selection within hours of the hearing's conclusion. He actually said, I will give you an answer today. Well, that day has passed. To my knowledge, this promise has not yet been fulfilled either. And so now is the time for the Department to make good on its commitments.

The GMD [Ground-based Midcourse Defense] program is at a central element of missile defense. It is the only pure homeland defense element of our missile defense architecture. But with multiple delays, failures, and willful disregard of congressional intent, I am left worrying about the fate of homeland missile defense of the future.

There is no doubt the missile defense—that missile threats are increasing quantitatively and qualitatively. More countries have ballistic missiles. All of those missiles are increasing in their integration of countermeasures to evade our current missile defense capability. But this budget submission, the reduction of MDA's budget and the inability of the enterprise to fulfill basic congressional intent all increased the uncertainty that we can meet these challenges in the future.

I look forward to all the witness testimony. Thank you.

Mr. COOPER. I thank the ranking member.

Before we hear from the witnesses, let me remind all subcommittee members that there will be a classified hearing after this that is extremely important to attend, so I hope that your schedules will allow you to be there.

As I mentioned earlier, your testimony is submitted for the record. So if you would summarize, starting with Mr. Behler.

**STATEMENT OF ROBERT F. BEHLER, DIRECTOR, OPERATIONAL TEST AND EVALUATION, OFFICE OF THE SECRETARY OF DEFENSE**

Mr. BEHLER. Thank you, Chairman Cooper, Ranking Member Turner, and distinguished members of the subcommittee. I am honored to be here, along with the other distinguished panel witnesses here, to discuss missile defense testing and my independent assessment of the Ballistic Missile Defense System as the Director of Operational Test and Evaluation [DOT&E].

On March 25 of this year, I witnessed the Missile Defense Agency's most operationally realistic flight test of the ground-based intercept midcourse defense system, which is designed to protect the U.S. homeland against an ICBM [intercontinental ballistic missile] attack.

During that test, the salvo of two ground interceptors were employed against an ICBM target that was launched 5,000 miles away. Preliminary indications are that the system worked as designed and intercepted the target. My office was heavily involved in designing this test, reflecting the strong relationship between DOT&E and the Missile Defense Agency.

Testing conducted to date demonstrates that the Ground-based Midcourse Defense system is capable of defending the U.S. homeland from small numbers of intermediate-range missiles and ICBM threats with simple countermeasures when BMDS [Ballistic Missile Defense System] employs its full architecture of sensors and its command and control system.

Testing also demonstrates the capability to defend U.S. Indo-Pacific Command, U.S. European Command, and U.S. Central Command from short-range ballistic missiles and from small numbers of medium- and intermediate-range ballistic missiles.

Missile defense system flight testing is constrained by many, many factors. Most notably, range safety considerations and cost. Independently accredited modeling and simulation instantiated by flight test data is necessary to adequately assess the effectiveness of the missile defense system in complex realistic scenarios.

The following key challenges effectiveness—it affects the missile defense capabilities and my ability to assess its capabilities. First, the need for accredited modeling and simulation to adequately assess the BMDS effectiveness. Susceptibility of BMDS to cyberattacks. Third, reliability and sustainment. Fourth, interoperability and automated engagement deconfliction. And fifth, discrimination of threat reentry vehicles.

In closing, I would like to echo the chairman's comments: General Greaves transitioning out of the Air Force after a very distinguished military career. I pause to commend General Greaves for his steadfast leadership of the Missile Defense Agency and how professionally he has coordinated with me and my staff during his tenure.

I thank the subcommittee for your attention and look forward to your questions.



[The prepared statement of Mr. Behler can be found in the Appendix on page 26.]

Mr. COOPER. Thank you.  
General O'Shaughnessy.

**STATEMENT OF GEN TERENCE J. O'SHAUGHNESSY, USAF,  
COMMANDER, UNITED STATES NORTHERN COMMAND**

General O'SHAUGHNESSY. Thank you, Chairman Cooper, and Ranking Member Turner, and distinguished members of the subcommittee. I am truly honored to appear today as the commander of the United States Northern Command [USNORTHCOM] and North American Aerospace Defense Command [NORAD]. And while I am honored to be here with all of my colleagues, I too want to recognize Lieutenant General Sam Greaves and all the members of MDA for their incredible support to the warfighter. Both now and looking into the future, I know we are in good hands with a great partner.

And I will keep my remarks brief to allow more time for your questions, but I do want to start by thanking you for the opportunity to testify today.

As a warfighter responsible for defending the homeland from attack, I am truly grateful for the steadfast support of this subcommittee. That support is vital as revisionist powers of Russia and China have given every indication that their own security strategies are based on holding the United States at risk with both conventional and nuclear weapons. And they have signaled that we must anticipate attacks against our civilian and defense infrastructure in the event of a conflict. And as a result, it is clear to me that the homeland is not a sanctuary.

USNORTHCOM and NORAD's mission to deter our adversaries is clearly dependent on our ability to detect and defeat potential threats to the homeland. And to help pace our adversaries, we must take prudent steps now to ensure our next-generation defensive capabilities, to include a space-based sensing layer, are not late to need. We must also act now to improve our ability to see and defeat the advanced long-range cruise missiles already fielded by our adversaries.

And I am grateful to the subcommittee for your strong support of USNORTHCOM and NORAD priorities along these line of effort. And no matter the threat, the men and women of USNORTHCOM and NORAD are deeply committed to defending our nations. And I am honored to represent them today.

Gentlemen, we have the watch. And thank you, and I look forward to your questions.

[The prepared statement of General O'Shaughnessy can be found in the Appendix on page 38.]

Mr. COOPER. Thank you.  
Dr. Anderson.

**STATEMENT OF JAMES H. ANDERSON, ASSISTANT SECRETARY  
OF DEFENSE FOR STRATEGY, PLANS AND CAPABILITIES,  
U.S. DEPARTMENT OF DEFENSE**

Secretary ANDERSON. Chairman Cooper, Ranking Member Turner, and members of the committee, thank you for the opportunity

to testify on the Department's missile defense policy, posture, and budget. The MDR [Missile Defense Review] articulates a comprehensive approach to address the missile threat through strength and deterrence and active missile defense systems for both homeland and regional defense.

Over the past decade, North Korea and Iran have accelerated efforts to develop and field missiles capable of threatening U.S. strategic interests. North Korea possesses a range of systems, including road-mobile intercontinental ballistic missiles, solid propellant medium-range ballistic missiles, and submarine-launched ballistic missiles.

For its part, Iran already possesses the largest stockpile of regional missile systems in the Middle East. Iran continues to improve its missile capabilities and develop space launch vehicles which provide knowledge to develop an intercontinental-range ballistic missile if they decide to pursue that path.

We also see the reemergence of long-term strategic competition by revisionist powers in Russia and China. Russia and China are expanding and modernizing a wide range of offensive missile capabilities.

As highlighted in the MDR, a comprehensive layer of defense is needed to address today's complex threats. Within the MDR framework, the key roles for missile defense include protecting the United States homeland, our forces abroad, and allies and partners; diminishing the benefits of adversary coercive threats and attacks; assuring allies and partners that we will stand by our security commitments; preserving our freedom of action to conduct military operations; and hedging against future unanticipated missile threats.

Let me now turn to missile defense capabilities, posture, and budget that flow from our policy in the MDR to counter these threats. Regarding the first priority to protect the United States homeland today, the United States is protected by the Ground-based Midcourse Defense, GMD, system. The budget requests \$1.8 billion for the system, which includes a number of improvements, such as adding 20 ground-based interceptors in Alaska, bringing the total to 64, continuing development of the Redesignated Kill Vehicle for improved reliability, and continuing to build a new missile field at Fort Greely, Alaska.

The budget also requests funding to field new discrimination radars in Alaska and Hawaii and extend operations for a sea-based X-band radar.

To address the regional missile threat, our efforts focused on an integrated air and missile defense to defend U.S. forces abroad, allies, and partners against missile threats from any source. We are strengthening our regional missile defense posture by funding several programs. For instance, we are enhancing the Aegis Ballistic Missile Defense System by procuring the Standard Missile-3 [SM-3], Block IB and Block IIA missile and integrated SPY-6 radar.

The Department will also procure additional Terminal High-Altitude Area Defense, THAAD, interceptors, Patriot interceptors, and Army Indirect Fire Protection Capability command and control system.

In addition to improving our legacy systems, the 2019 MDR calls for pursuing a range of technologies and examining advanced concepts and breakthrough technologies. We are requesting funding for additional sensors; integrated Space-based Kill Assessment into the Ballistic Missile Defense System; operating and sustaining the Space Tracking and Surveillance System; developing defenses against hypersonic missiles; testing the SM-3 Block IIA capability against an ICBM-class target; kinetic boost phase intercept using a tactical air platform; technology maturation initiatives, including initiating a neutral particle beam technology demonstration program; and a study of space-based interceptors.

The MDR stresses the importance of working with allies and partners and encouraging them to invest in their own air and missile defense capabilities that are interoperable with U.S. capabilities. Interoperable integrated air and missile defense systems can take advantage of cost sharing and help distribute the burden of the common defense.

In closing, our missile defense investments and priorities focus on concepts and advanced technologies to ensure the continuing effectiveness of our missile defenses against capabilities of potential adversaries. By so doing, we will strengthen our ability to protect the homeland, enhance deterrence, stabilize crises, and better control escalation, protect and assure allies and partners, and hedge against future threats.

Thank you again for the opportunity to testify. I look forward to your questions.

[The prepared statement of Secretary Anderson can be found in the Appendix on page 55.]

Mr. COOPER. Thank you.

General Greaves.

**STATEMENT OF LT GEN SAMUEL A. GREAVES, USAF,  
DIRECTOR, MISSILE DEFENSE AGENCY**

General GREAVES. Chairman Cooper, Ranking Member Turner, distinguished members of the subcommittee, good afternoon, and thank you for this opportunity to testify on the Missile Defense Agency's budget request for fiscal year 2020.

I first wish to thank the subcommittee for its continued support of this very important mission area. I would also like to thank the thousands of men and women across government and industry who tirelessly work every single day in support of our Nation's Ballistic Missile Defense System. Without question, they are the source of our strength and one of the reasons the Armed Forces of the United States remain unparalleled in the world.

Our budget request of \$9.4 billion, which supports the President's commitment to sustain, expand, and improve the performance and reliability of the Nation's missile defense systems and reflects what was broadly articulated in the 2019 Missile Defense Review.

This funding request will continue development, rigorous testing, and fielding of reliable, increasingly capable, and advanced defenses for the protection of the United States, our deployed forces, allies, and partners against current and projected missile threats.

The Agency is also taking significant steps in improving the cybersecurity posture of the ballistic missile defense operational and developmental systems in defending against emerging cyber threats. We will continue to work closely with the Director of Operational Test and Evaluation and the combatant commanders in such things as persistent cyber operations testing to enhance our cyber defense posture.

On GMD. Program plans for the Ground-based Midcourse Defense system included the continued construction of 22 missile silos at Fort Greely, Alaska, and the procurement of an additional 20 ground-based interceptors for homeland defense upon completion of the Redesigned Kill Vehicle development program. However, during the Redesigned Kill Vehicle program's design phase, I assessed that we were unable to meet a key set of critical entrance criteria for our critical design review, the result of which is a projected delay in the program of up to 2 years.

On sensors. With the addition of the long-range discriminating radar, the homeland defense radar in Hawaii, and in the future, the Pacific radar, we will have in place a diverse sensor architecture in the Pacific to provide and improve a persistent midcourse tracking and discrimination capability against future threats.

The combination of high speed, maneuverability, and relatively low altitude of some of the emerging advanced offensive capabilities makes them challenging threats for our missile defense systems. A space sensor layer is needed because we cannot populate the Earth and the oceans with enough terrestrial radars to meet this need to track these threats.

The birth-to-death tracking that space sensors can provide when integrated with terrestrial sensors will make it possible to maintain custody of missile threats from launch through intercept, regardless of launch location.

On regional defenses. For regional defense, we are increasing a number of Terminal High-Altitude Area Defense interceptors and Standard Missile-3 Block IBs and Block IIAs, investing in the modernization and upgrade to enhance our Aegis Ballistic Missile Defense capabilities.

Additionally, through incremental upgrades to our command and control battle management and communication system, we will continue to integrate homeland and regional missile defense capabilities, improving the global missile defense battle management tools of the combatant commanders.

Finally, projected missile threats include new ballistic missile systems, advanced cruise missiles, and hypersonic missile capabilities that are now being actively tested by other nations.

We continue to advance the state of the art for scaling electric laser power and pursue competing technologies to reduce their development risk. Such efforts as distributed gain, diode-pumped alkali lasers, and fiber combining laser technology have the potential to meet missile defense requirements.

With this budget, we would also fund software modifications to the Ballistic Missile Defense System and further define the architecture for future hypersonic defense demonstrations.

Mr. Chairman, Ranking Member Turner, members of the subcommittee, in closing, our fiscal year 2020 budget funds missile de-

fense development efforts, including several critical capabilities required by the warfighter.

We will continue to increase the liability as well as the capability and capacity of fielded homeland and regional missile defense systems and make measured investments in advanced technology to counter the adversary missile threat.

Thank you once again, and I look forward to your questions.

[The prepared statement of General Greaves can be found in the Appendix on page 61.]

Mr. COOPER. Thank you, General.

Vice Admiral Kriete.

**STATEMENT OF VADM DAVID KRIETE, USN, DEPUTY  
COMMANDER, UNITED STATES STRATEGIC COMMAND**

Admiral KRIETE. Chairman Cooper, Ranking Member Turner, and distinguished committee members, good afternoon. I am honored to appear before you today on behalf of General John Hyten, the commander of U.S. Strategic Command [USSTRATCOM], and the 162,000 Americans who are accomplishing our missions every day.

As the warfighter advocate for missile defense, it is my privilege to sit alongside our missile defense partners, General O'Shaughnessy, Mr. Behler, Mr. Anderson, and Lieutenant General Greaves, because we cannot do our missions alone. The defense of our Nation against missile threats is certainly a team effort, requiring each of us sitting before you today to work together in defense of the homeland, our allies, and our partners.

I want to begin by thanking this committee for your enduring support to national defense. The stability afforded through this year's on-time budget came at a critical time for us, and I cannot overstate the enormous impact it has had on improving our force readiness and modernization efforts.

I would also like to express my gratitude to the subcommittee for broadening the strategic deterrence discussion and bringing this issue back to the forefront of our national dialogue.

Today we are here to discuss missile defense. Although this is one single mission from the broad portfolio assigned to USSTRATCOM, missile defense remains a central tenet of our overall strategic deterrence mission.

As stated in the National Security Strategy, the United States has a robust and credible layered missile defense system, which when paired with offensive capabilities, this combination sends a strong message allowing us to deny benefits and impose costs against any potential adversary. Although we rely on nuclear capabilities to deter near-peer strategic threats, missile defense endures as a critical component of comprehensive, strategic, and tailored regional deterrence strategies.

Today, the United States, our allies, and partners face potential adversaries who are investing in additional capacity and new technology specifically designed to defeat current missile defense systems. If left unaddressed, this expanding missile threat could embolden our adversaries into mistakenly believing that they can coerce us, inhibit our freedom of action, or undermine our security alliances.

So out of necessity and prudence, we must adapt to the new threats as well. We must adapt faster than our adversaries to ensure we never fail at our highest priority. Above all else, we will provide strategic deterrence.

In order to stay ahead of these threats, we must field adaptable systems capable of meeting the changing security environment. Our missile defense approach must integrate active missile defenses to intercept adversary missiles, passive defenses to mitigate their effects, and options during a conflict to neutralize missile threats prior to launch.

There will not be a silver bullet or a single exquisite capability that will provide a perfect solution, so we must be vigilant in our efforts to outpace emerging threats and not cede our current advantage. We must also do so in a cost-effective manner.

Thank you very much for the opportunity to be here today, and I look forward to your questions.

[The prepared statement of Admiral Kriete can be found in the Appendix on page 106.]

Mr. COOPER. I thank the witnesses for their testimony.

I would like to ask unanimous consent that nonsubcommittee members also be able to ask questions at the end of the questioning. And I would like to hold all members, myself included, to the 5-minute rule so that we can get to the classified session in a more rapid manner.

Hearing no objection, nonsubcommittee members will be able to ask questions as well.

If I had to summarize all the testimony, I would say that the single most important line, at least the most surprising line to the average citizen, would be from General O'Shaughnessy when he said on page 10 that he views the Arctic as the front line of defense for North America, for U.S. and Canada.

I think most Americans would be surprised by that. Can you elaborate?

General O'SHAUGHNESSY. Chairman, thanks for highlighting that. And we do view as the threat that we see today both of the cruise missile threat, the bomber threat, and ultimately potentially the hypersonic threat as it continues to be developed, that we have a capability gap developing if we don't take action now. We see that as an avenue of approach that, clearly, if you were, for example, putting yourself in the Russian position, that if you were going to attack North America, that would be the avenue that you would likely choose.

As such, we are advocating for increased domain awareness, increased ability to operate in that environment, and ultimately to make sure that we stay ahead of the threats that we feel are coming from that direction.

Mr. COOPER. The ranking member quite properly mentioned the missing funding for space-based sensors. Can anybody explain where that funding will come from?

Secretary ANDERSON. So I would be happy to start on that. It is true in the MDA budget there is not requested funding, although it does appear on the unfunded list. Space sensor efforts related do appear, however, in the Space Development Agency's budget. As you know, the Space Development Agency is just getting started.

It has hired a director, has a small staff, but there are certain lines in that requested budget related to space sensor efforts.

And those—for example, there is a proliferated low Earth orbit [pLEO] sensor technology, \$20 million for that. There is what is known as the data transport layer architecture standards, there is \$15 million for that. There is ground integration for pLEO as well, another \$30 million, as well as a space-based discrimination study, \$15 million.

So there is money, but it is in a different place this year. And the big reason for that is, over the past year, there has been kind of a change in the Department's approach in terms of thinking about where to put future satellites, and the essential shift, and perhaps General Greaves can elaborate, is moving from kind of a midlevel orbit to the low Earth orbit and having a more distributed architecture leveraging work that both the Air Force has done and DARPA [Defense Advanced Research Projects Agency] has done in a distributed approach. So that is where we are headed going forward.

Mr. COOPER. Thank you.

Mr. Behler mentioned that we face a deficit in cross training or joint training for our THAAD and Patriot cruise so that we can operate in a truly layered defense, because there won't be very good layers if they are not communicating with each other.

Mr. BEHLER. That is exactly right. I said that in my written testimony. And we found that when we want to look at deconfliction using THAAD and Patriot, the training is not there, and we have no automated way of doing deconfliction. So training is really important, I think, for the soldiers operating these systems.

Mr. COOPER. Thank you. And, Mr. Behler, can you explain why the recent and thankfully successful test cost \$300 million?

Mr. BEHLER. Well, I can attempt to, sir. There is a lot of assets being used there. We launched—I am sorry, Missile Defense launched three ICBMs that crossed five different ranges. Range safety is a big cost associated with that, making sure it is all clear, all the assets required to keep it clear. And the missiles themselves, the interceptor, the ground-based interceptors, they cost upwards to \$80- to \$90 million apiece also. We launched two of those. So if you add all that up, I think the biggest cost is range safety.

Mr. COOPER. Finally, Admiral Kriete, General Hyten in his testimony, which you delivered very well, urges us to take more risk, to be more entrepreneurial. Can you explain that statement?

Admiral KRIETE. Yes. Thank you, Chairman Cooper. General Hyten has remarked on many occasions about the urgent need for us as a department to be able to go faster, to set requirements to develop capabilities, put them in the field of our warfighters faster than we have been doing in recent years. And it is really all based on the threat. And as we see, particularly in this missile defense area, the range of missile capabilities that are being developed by a number of our adversaries both in increased capability and capacity in ways that are used to either coerce or provide aggressive means to our adversaries, they are doing that at a pace that makes it more and more challenging for us to stay ahead of it.

Make no mistake, as the combatant commander responsible for coordinating missile defense, General Hyten firmly believes that we

are ahead of the threat today. But they are closing the gap quickly, and that is why we need to go fast.

Mr. COOPER. Thank you. My time has expired.

The ranking member.

Mr. TURNER. Well, thank you.

To each of you, as you recall, 10 years ago missile defense was viewed as provocative, that it costs too much and that it wasn't going to work. Through your work and the accomplishments of Israel and the actual application that they have had to deploy, the conversation has changed. No longer do people look at it as provocative. They actually know that it doesn't cost too much. It saves lives. It actually reduces the risk. It deescalates, and, in fact, it works. But in some instances, we still have a tremendous amount of work to do. I want to thank you for the work that you are doing.

General Greaves, you were in my office, though, and we were talking about the issue of structure, how do we make all of these things work. And there is a lot of talk about Space Force, Space Corps, Space Command. And one of the concerns that you were discussing was how all these fit together. And you gave an excellent description of how the Space Development Agency might assist and not compete with the Missile Defense Agency. I thought you might share that for us here.

General GREAVES. Thank you, Congressman Turner. Getting right to the answer of the question, is the way I would look at this entire mission area is what is the mission? The mission is missile defense, the mission is hypersonic defense, the mission is defense against dim targets and other challenging targets. So the answer to that is not a specific element, such as a satellite or a radar or a ship. The answer is an integrated architecture that is layered as in resilient, that can respond to the threat and meet the threat.

So the current Ballistic Missile Defense System is composed, as you know, of ground radars, it is composed of such elements as the space-based infrared system that the Air Force flies, it is composed of the Navy ships, it is composed of the THAAD system. And those are all elements, but they are only important because they feed into an integrated command and control ballistic missile defense architecture that then picks out specific interceptors to go execute the mission.

So why do I not feel that the Space Development Agency is competing with missile defense? Because the mission of missile defense resides within the Missile Defense Agency. The ability to take disparate sensors and capabilities from wherever they may occur, whether they are organic or nontraditional missile defense sensors, and integrate them, that is what is important, into the architecture is what makes it very powerful. And that is how I would answer the question, sir.

Mr. TURNER. General, as you know, the east coast missile defense site, as it is called, even though two of the sites that are being considered are in the Midwest, not the east coast, was congressionally mandated for the beginning of the assessment process. The Missile Defense Review states that no work will be done on this site until there is actually a maturation of the threat. I don't think anybody is arguing with that. We are, though, very concerned about the designation of the site. It was congressionally



mandated, the work is done. If you tell the sites, then obviously as I have indicated, two communities would be released, wouldn't require that you move forward.

Is there anything that happened—is there any prejudice to you that—because when you and I were having this conversation, it didn't seem like there was any. Is there any prejudice to you to complete that designation, as long as it is clear that we are not proceeding until the threat is mature?

General GREAVES. Congressman, I will say, first of all, that I am not the decision maker. However, since you have asked the question, I have made the recommendation to proceed with that, and it is being debated and deliberated within the Department up through the SECDEF's [Secretary of Defense's] level and other places. And my hope is that we come to a conclusion and make a decision.

Mr. TURNER. I appreciate both your recommendation in favor but also your answer, and I want to give my last minute to Elise Stefanik.

Ms. STEFANIK. Just a follow-up on this. I appreciate my colleague and friend Mr. Turner's focus on this. Our congressional intent was very clear. The environmental impact study was funded, was authorized by Congress. That has been completed. We had language in previous NDAA's that would require an announcement of the preferred site.

And to your point, General Greaves, about the decision-making process, the Secretary of Defense sat in this very committee room and said on record, under oath, that he intended and had no problem and would meet our request to voluntarily provide that information to Congress. Not only did he say that to me in answering my questions, but he also said that to Tim Ryan.

So our expectation, on the record, let me make it perfectly clear, is that our expectation that we will hear from the Secretary of Defense what the preferred site is.

Just to reiterate Mr. Turner's point, you have three communities who have worked incredibly hard to advocate on behalf of this. One of mine is Fort Drum, which I believe is the strongest community to be the preferred site. But we expect to hear that from the Department of Defense, and I look forward to hearing feedback today from the Department in response to this test—to my question or my comment.

I yield back.

Mr. COOPER. Mr. Carbajal.

Mr. CARBAJAL. Thank you, Mr. Chairman, and thank you to all the witnesses that are here today.

General Greaves, how many ground missile defense tests have been conducted to date? And how many and what percentage of these tests have been successful?

General GREAVES. Congressman, I should know the number; I do not at hand. The main message I leave you with is that I absolutely believe it is wrong to compare testing and test results done at the beginning of any developmental program with testing that is done as a product of learning from those failures and successes, but are done more recently. I see—I see—it disturbs me quite a bit.

I see straight math done on 10 launches and 3 failures. So, you know, you have got a 30 percent failure rate; math in public.

But I would ask you to look at the testing record of the Ballistic Missile Defense System since 2010, there were two failures back then, but what was done to recover from those failures to improve the system and test against ever more challenging targets and threats and the successes we have. The devil is in the details, and that is where I think we need to go, as opposed to looking at the straight math comparing testing done in 2005 to testing done in 2019. They are not similar at all.

Mr. CARBAJAL. Well, let me ask you a different way. You can't have it both ways. You can't have it—we can't look at it that way and then look at it that way.

Recently, a statement was made that our missile defense system would be 97 percent effective against North Korean missiles. Is that an accurate statement?

General GREAVES. Yes, it is. And I can discuss that further in a classified session.

Mr. CARBAJAL. Okay. When planning and developing these test scenarios, how do you ensure these tests are not using outdated threat representations?

General GREAVES. In this forum, I can say that all test scenarios begin with input from the intelligence community to assess what that threat is. And then we work very closely with the developmental testers and the operational testers to design the test. The objectives of the test, it is approved by—in an operational test as an example—approved by the operational testers to say these are the goals, these are the parameters, this is pass/fail, and then we go off and execute it. So it is as realistic as we can get it.

Mr. CARBAJAL. Thank you. Just going back, on one hand you are telling me that it is 97 percent effective; but on the other hand, you didn't give me any specifics about the percentage of tests, the success rate we have had. Is it 97 percent?

General GREAVES. It is 97 percent capable against the threat that we foresee. The testing, as I might say, we had failures early on, but the record since 2013, I believe has been, if not 100 percent successful, very successful. So on the record, sir, I can get you those numbers.

Mr. CARBAJAL. Thank you.

General O'Shaughnessy, if North Korea launched a missile or multiple missiles at the homeland today, would you be confident that the current GMD system would be successful in intercepting these attacks?

General O'SHAUGHNESSY. Sir, I am highly confident that we would be able to intercept a set attack from North Korea.

Mr. CARBAJAL. Thank you.

One major concern I have in regards to the GMD program is the lack of reporting and the availability of unclassified information on the GMD testing and development. There has been less transparency specifically on the testing front. This is a problem because it inhibits us from effectively conducting the oversight that is our responsibility.

It is my understanding that DOT&E used to provide unclassified reports on the GMD program, but this has not happened in recent

years. Mr. Behler and General Greaves, can you both commit to re-summing these practices in the future?

Mr. BEHLER. I think there is an issue of operational security that I am concerned with. I would be happy to, in the right venue, to talk about the classified details, the reliability rates. I have them with me now, we can talk about them when we go closed. But to publish an open document that talks about that kind of information, I feel as my responsibility to the American people, I am very uncomfortable putting that data out that is right now classified.

Mr. CARBAJAL. But you would put that in a classified setting for us?

Mr. BEHLER. Right. And as a matter of fact, I also published a classified annual report on missile defense, and that information is also in the document that I send you every year.

Mr. CARBAJAL. Thank you very much.

Mr. Chair, I yield back.

Mr. COOPER. Mr. Byrne.

Mr. BYRNE. Thank you, Mr. Chairman.

General Greaves, once again, thank you for your service to our country. I think you would agree that a key piece to the future of sensor architecture, specifically for hypersonic defense, is deployment of a space sensor, but I didn't see it, and perhaps I just didn't read it right, in the President's budget submission for 2020 that MDA was requesting any funds for that effort.

Did I miss something or is there somebody else that is going to do that, or can you enlighten me on that?

General GREAVES. Congressman, it was not missed. The decision was made to put that money, that funding into the Space Development Agency's budget. I think it was \$20 million to initiate that study.

Mr. BYRNE. So the Space Development Agency will do it.

General GREAVES [continuing]. To initiate that study. I will add that the Congress funded the Missile Defense Agency in fiscal year 2019 to continue work on the payload in a sensor capability. And what the Space Development Agency is initially working on is the spacecraft bus, the host for the sensor itself, as well as the overall architecture, you know, and the transport layer. That is not what we are doing. We are focused on the sensor capability to detect the target and pass on any information.

Mr. BYRNE. Okay. Thank you for that clarification. It is good.

Just sort of getting at it a little bit more generally, what are your greatest challenges of defending against hypersonic missiles at this point in time?

General GREAVES. Thank you, sir. Very good question. In my mind, it is their speed, it is their maneuverability, and the altitudes at which they fly, which are relatively low when compared to ballistic missile defense systems. So unlike the predictability of a ballistic threat which, essentially, comes from the point its originating to where it is going, we have to ensure that we maintain custody from the time it is launched to the time we intercept it. And with speed, maneuverability, and lower altitude, that becomes more challenging.

Mr. BYRNE. So what solutions have you identified? And how much would those solutions cost?

General GREAVES. We have identified that there are two distinct phases of mitigating that threat. The less preferable case for us is in the terminal phase, the last phase. The area where it is most susceptible is in the glide phase, and that is where we are focusing our attention. And we can talk more about that in the classified section.

Mr. BYRNE. Can you speak to the cost in a nonclassified setting?

General GREAVES. I prefer to wait.

Mr. BYRNE. Okay. I understand. Thank you.

Well, I just want to register my concern about where we are versus some of our adversaries on hypersonics. I know that you are well aware of that; you know far more about it than I do. But the more I learn about it, the more I am concerned about it. And I hope during the classified briefing you can give us a little more detail about it.

General GREAVES. Yes, sir. And I will leave you with this thought, that the hypersonic defense mission, the hypersonic concern, the hypersonic mission is either at the top or very near one or two in Dr. Griffin's priority list of areas we need to address, and it flows down from there.

Mr. BYRNE. Well, I am glad to hear that. Thank you.

I yield back, Mr. Chairman.

Mr. COOPER. Mr. Garamendi.

Mr. GARAMENDI. Thank you, Mr. Chairman.

I think most of my questions are going to wind up in the classified, so I will let them go. But I do have one that would be probably in the unclassified.

Iron Dome. Recently, two systems to be acquired by the Army. It seems to have been successful. There are 1,700 successful intercepts by the Iron Dome, about 90 percent success rate. The cost of it seems to be significantly less than our systems, something around \$40,000 a shot. I think the Patriot is about \$6 million a shot.

Mr. Behler, I see you are nodding your head, so that must be about right. I will just assume that it is right, given the nod of your head.

Mr. BEHLER. Well, I would not go to the bank on that number, but I think it is in that range. Yes, sir.

Mr. GARAMENDI. I count by 10.

The question here is how does this fit into our missile defense systems? And I guess, General Greaves and General O'Shaughnessy, with regard to the NORTHCOM, General Greaves with regard to the overall.

General GREAVES. Congressman Garamendi, I will first start by saying that the threat against which the Iron Dome is deployed is a very different threat, projectiles essentially in close-range missiles, than what Patriot or THAAD or the Ground-based Midcourse Defense.

When I talk about the successful GBI [ground-based interceptor] test that we just did, we are talking closing speeds of 22,000 miles an hour at various altitudes.

Mr. GARAMENDI. Understood.

General GREAVES. So the complexity of the threat has a significant factor—is a significant factor in the ultimate cost of the intercept system.

Mr. GARAMENDI. You used the word layered defense. It has been used by several of you here. And from Mr.—General O’Shaughnessy, specifically, is Iron Dome part of a layered defense for your mission? And then more generally, I guess that should be for Mr. Behler or Dr. Anderson for the general military purposes.

General O’SHAUGHNESSY. Sir, we absolutely do support the layered defense mentality. That is, I think as we look at the future against all threats, against ballistic missiles, against cruise missiles, and against the future hypersonic missiles, the end state needs to be a layered defense capability capacity throughout North America.

As we look at the particulars of the Iron Dome specifically, to Lieutenant General Greaves’ point, it is a slightly—it is a different nature of the threat there.

What I do absolutely agree with is we have to flip the cost curve. Right now, if you look at the cost per shot that we are taking against anywhere from ballistic missiles, cruise missiles, and eventually hypersonics, we are on the wrong end of that cost curve. So to your point, I absolutely support and agree that we do need to flip that cost curve so we can have a high rate of fire, a large magazine at a much lower cost if we are going to be able to truly defend North America.

Mr. GARAMENDI. Presumably, the Iron Dome is good for cruise missiles?

General O’SHAUGHNESSY. Sir, again, it depends on the specifics of the type of missiles that we are talking about. For example, we have some capability capacity within the National Capital Region that is similar in nature, but it is of a different nature of the threat that we would necessarily want to apply across all of North America.

Mr. GARAMENDI. Okay. In a larger context, with regard to the U.S. Army acquiring two batteries, I guess, Mr. Behler or Dr. Anderson, the utility of it there?

Secretary ANDERSON. So my understanding is the Army is requiring this as kind of an interim solution. It may end up being a permanent solution for them to be used in a deployed context, whether that be in the European theater or perhaps in the Indo-Pacific theater. It is—as your question suggested, it is a proven system, highly effective. And it is something that the Army has decided to at least start with as part of their ability to defend themselves.

And this is important because, as indicated in the Missile Defense Review, which does obviously talk about homeland defense, but it also talks about supporting our friends and allies and being able to preserve our freedom of movement abroad of U.S. forces. And in the particular context of the European theater and also the Indo-Pacific theater, now we face some pretty tall military challenges. And having an ability to protect ourselves from shorter range projectiles is very important, and that is part of this equation.

Mr. GARAMENDI. Mr. Behler, I will take it offline since we are out of time, and we have been held to 5 minutes. Thank you.

Mr. COOPER. Ms. Cheney.

Ms. CHENEY. Thank you very much, Mr. Chairman. And thank you to all of our witnesses.

General O'Shaughnessy, could you talk about whether or not you agree with some of the assessments we have seen, particularly from General Hyten, based on reports that China has got the capability now and they have numerous successful tests of hypersonic missiles? General Hyten has talked about our inability currently to have any defense that would deny an adversary the capability of employing such weapons against our country. Would you agree with that assessment?

General O'SHAUGHNESSY. Ma'am, I do agree with General Hyten's assessment.

Ms. CHENEY. And given that, would you agree that our strategic triad is currently the only form of defense that we have of deterrence against hypersonic threats from our adversaries?

General O'SHAUGHNESSY. Obviously, the triad is incredibly important. In respect to a threat that is advancing, making it very challenging, the defense against the triad gives us the ability of that assured use.

Ms. CHENEY. And is it your best military advice that the current triad is both adequate and necessary to defend against the threat of hypersonics?

General O'SHAUGHNESSY. Yes, ma'am. I am a strong advocate for the triad and keeping the triad as we see it today.

Ms. CHENEY. Thank you very much.

Let me ask, General Greaves, if you could talk a little bit about specifically why the space-based sensors are so important in terms of missile defense against hypersonics in particular.

General GREAVES. Yes, ma'am. I will start by saying that the nature of a ballistic threat is that, if I am sitting here, I throw a baseball in your direction, it goes in a straight line and it goes in a parabolic shape, unless I throw a fastball directly at you. The hypersonic threat operates at much lower altitude, starts off at a higher altitude, then uses that energy it gains to bleed it off to accomplish maneuver, as well as fly at or right above the atmosphere.

So unlike a ballistic threat where you can accept some gaps in your sensing capability, because you know if it starts here and it is aimed at your direction, it will end up in your direction, the ability to maneuver, which is dependent again on the boost vehicle that the hypersonic threat is using, and the energy that it is given, allows it to maneuver out of that space. And custody is absolutely critical, because we need to ensure we know where it is going, what it is doing, and the type of mitigation—mitigating defensive capability we need to deploy against it, whether it be kinetic, you know, or in the future, potentially directed energy or some other capabilities. So that is the major difference and that is what causes the concern.

The ability to sense the hypersonic threat because it is flying lower at or above the atmosphere, sometimes in the atmosphere, depending on where it is going, proposes specific challenges to over-

head sensors. We can talk more about that in the classified session. But we need an architecture which will maintain custody from birth to death of that very dynamic and challenging target. That, in essence, is what it is.

Ms. CHENEY. Thank you. And let me add my concern to the concern you have heard from I think just about everybody on the subcommittee on both sides, that this was zeroed out in the budget, and our commitment to making sure that we do everything we can to provide the resources necessary in that regard.

This is also for General Greaves. The 2019 Missile Defense Review talked about the need to consider all operational options, including offensive strikes, as part of our strategy for ballistic missile defense. I am wondering if you can address who is responsible across the Department and the combatant commanders with respect to policy and capability development to integrate these offensive strike capabilities to deny adversaries the ability to launch ballistic missiles against the United States.

General GREAVES. Yes, ma'am. I will begin with the policy end of it, and that is in Dr. Anderson's office led by Secretary Rood. And the remaining portions of that task is an integrated approach across the Department, beginning with the intelligence community supplying the requirements with the combatant commander, in the case of missile defense, the Strategic Command, after coordinating across all the combatant commanders, and to include General O'Shaughnessy.

And then within the acquisition portion of it, it could be led or would be led by agencies such as the Missile Defense Agency, working with the services. It is never one thing, for instance, that the Defense Agency does by itself; it is always in concert with the services. And supporting all of that is a rigorous and robust process that ensures interaction between, in my case, the Missile Defense Agency and each of the services, as well as each of the CCOMs [combatant commands] led by Vice Admiral Kriete and his team up at STRATCOM.

So it is an integrated approach, and I think that that is a very beneficial approach because it ensures that we receive various perspectives on what may or may not be the best approach, and then a decision maker, if it is an acquisition and if it is in my lane with my mouse on the decision authority, it is me. If it is initial production and on, it is Ms. Lord. And if it is research and engineering, it is Dr. Griffin. So we all know who the responsible entity is within the Department.

Ms. CHENEY. Thank you.

I will have some additional questions in the closed hearing, but I yield back. Thank you, Mr. Chairman.

Mr. COOPER. The gentlelady's time has expired.

Mr. Rogers.

Mr. ROGERS. Thank you, Mr. Chairman.

General Greaves, a DOD IG [Department of Defense Inspector General] report was issued in January of this year on DOD cybersecurity. And it stated that while some actions had been taken by DOD to improve its cybersecurity posture, you still had some challenges managing cybersecurity risks in your networks. And as I un-

derstand it, it was the contractor locations where they felt the most exposure.

What are your thoughts about that IG report?

General GREAVES. Thank you, Congressman. I thank the IG for the time they spent assessing our capabilities. During that process, I will be frank, I learned quite a bit between auditors and capability assessments, you know. An audit is very different from a capability assessment.

When an audit is done, unless all the boxes are checked, if there is one that is unchecked, then there is an assumption that there is a problem throughout the system.

What is important for the Ballistic Missile Defense System, and in this case it was the developmental architecture that we got, not the operational architecture. That is not the issue or the concern here.

We have a layered defense system which is actively monitored, not only within the agency but across the Department, up through the CIO [Chief Information Officer] within the Department. And for everything such as authentication of people who try to access the weapon system or the development part of the weapon system, those are strictly controlled.

So we had a very robust—I personally went down to see the IG staff, with my staff. We talked with them at length regarding their findings. And we are at the point now where they have responded to us that the issues that they identified are on their way to being resolved if we can sign off on a few things.

So it is a real threat. We have a layered defense system against that threat. It is not the operational system. It is the developmental system that they were concerned about. And I think the IG learned quite a bit about defense in depth as opposed to an audit.

Mr. ROGERS. Great.

That is all I have got. I yield back, Mr. Chairman.

Mr. COOPER. I thank the subcommittee members for their questions. I can tease the classified session by saying there will be an excellent home movie shown, so I know no one will want to miss that. So why don't we start that session at 3:20, upstairs in 2212.

This public portion of the hearing is adjourned.

[Whereupon, at 3:15 p.m., the subcommittee proceeded in closed session.]



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# **A P P E N D I X**

MAY 8, 2019

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**PREPARED STATEMENTS SUBMITTED FOR THE RECORD**

MAY 8, 2019

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**Statement of Hon. Jim Cooper**  
**Chairman, Subcommittee on Strategic Forces**  
**“Fiscal Year 2020 Priorities for Missile Defense and Missile Defeat Programs”**  
**May 8, 2019**

Good afternoon. The subcommittee will come to order.

The purpose of today’s hearing is to receive testimony on the 2020 budget request for missile defense, and discuss the implementation of the 2019 Missile Defense Review.

Here today to testify are Mr. Behler, General O’Shaughnessy, Dr. Anderson, Lieutenant General Greaves and Vice Admiral Kriete. Thank you for coming today to provide your views on these vital issues. At this time, I would like to take a moment to thank General Greaves, as from my understanding, this will be your last time testifying in front of this committee. I want to recognize your service to our nation over the past 37 years, and wish you the best in your retirement from the Air Force. We have enjoyed working with you not only on missile defense but are also grateful for your leadership in space acquisition.

We are investing \$13.6 billion in missile defense in FY20, and missile defense is an important capability for national security. As the witness’ testimonies note, missile threats to the United States are becoming more complex in both capability and quantity, and we must be able to detect newer threats from hypersonic and cruise missiles. North Korea’s return to missile testing late last week and Iran’s continued missile testing reinforce our need to continue making effective investments in improving our defenses against missile threats against the United States and our allies.

On that note, I would like to highlight a few areas of concern going into this hearing. Recent news regarding the delay to the Redesigned Kill Vehicle is worrisome, and the plans to procure this critical component without testing seem to be repeating past mistakes. Also, the Department’s apparent underfunding of a hypersonic space sensor, a capability that USSTRATCOM continues to place a high priority on and was directed in the FY19 NDAA, is puzzling when compared to the deployment timelines our adversaries are working towards on more advanced threats. I am sure we will go in depth on both of those issues through the course of this hearing.

Now, let me turn to my Ranking Member, Mr. Turner for his remarks.

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COMMITTEE ON ARMED SERVICES  
U.S. HOUSE OF REPRESENTATIVES**

**STATEMENT**

**BY**

**ROBERT F. BEHLER**

**DIRECTOR, OPERATIONAL TEST AND EVALUATION**

**OFFICE OF THE SECRETARY OF DEFENSE**

**BEFORE THE**

**HOUSE ARMED SERVICES COMMITTEE**

**STRATEGIC FORCES SUBCOMMITTEE**

**NOT FOR PUBLIC RELEASE  
UNTIL APPROVED BY THE  
COMMITTEE ON ARMED SERVICES  
U.S. HOUSE OF REPRESENTATIVES  
HASC – MAY 8, 2019**

**Robert F. Behler**  
**Director, Operational Test and Evaluation (DOT&E)**  
**Office of the Secretary of Defense**

Chairman Cooper, Ranking Member Turner, and distinguished Members of the Committee, I appreciate this opportunity to discuss missile defense testing and my assessment of the Ballistic Missile Defense System (BMDS).

**Test Activity**

On March 25, 2019 I witnessed the Missile Defense Agency (MDA) conduct its most operationally realistic flight test of the Ground-based Midcourse Defense (GMD) system, which is designed to protect the U.S. Homeland from an intercontinental ballistic missile (ICBM) attack. During this test, the MDA launched a salvo of two interceptors against an ICBM-range target. Although we have just begun to analyze the wealth of data from this test, all indications are that the system worked as designed and intercepted the target. My office was deeply involved with the design of this test, reflecting the strong relationship that exists between my independent office and the MDA. I appreciate Congress' continued support of this relationship. In addition to this most recent flight test, during Fiscal/Calendar Year 2018 the MDA executed or participated in six intercept flight tests, three data collection flight tests, six non-MDA ballistic missile events, five ground tests, and nine operational cybersecurity assessments. The MDA also conducted numerous wargames and exercises designed to enhance Combatant Command readiness and to increase Service member confidence in the deployed elements of the BMDS.

**Assessment of BMDS Capability**

Threat ballistic missile systems are becoming more capable, flexible, mobile, survivable, reliable, and accurate, while also increasing in range. North Korea is developing weapons of mass destruction and the means to deliver them to the U.S. Homeland by intermediate-range and intercontinental ballistic missiles. Regional actors have close-, short-, medium-, and intermediate-range ballistic missiles that threaten U.S. forces, allies, and partners. Combatant Commanders combine the capabilities of available BMDS weapon systems with a sensor/command and control architecture to defend against ballistic missile threats.

The GMD system has demonstrated capability to defend the U.S. Homeland from a small number of intermediate-range and intercontinental ballistic missile threats with simple countermeasures when the BMDS employs its full architecture of sensors and command and control. The Regional/Theater BMDS has demonstrated capability to defend the U.S. Indo-Pacific Command (USINDOPACOM), U.S. European Command (USEUCOM), and U.S. Central Command (USCENTCOM) areas of responsibility from short-range ballistic missile threats (less than 1,000 km range) and from small numbers of medium- and intermediate-range ballistic missile threats (1,000 to 4,000 km).

One instantiation of the Regional/Theater BMDS is the European Phased Adaptive Approach, or EPAA, designed to defend Europe from ballistic missile attack. EPAA includes an Aegis Ashore site in Romania, which became operational in 2015, and other



BMDS elements such as Command and Control, Battle Management, and Communications (C2BMC); forward-based radars; and Aegis Ballistic Missile Defense (BMD) ships. Aegis Ashore is a land-based version of Aegis BMD, with a surveillance and tracking radar and interceptor launch system to enable engagements against medium- and intermediate-range ballistic missiles with Standard Missile-3 (SM-3) interceptor missiles. The MDA plans to add a second Aegis Ashore site in Poland in 2020 following a period of significant construction delays. The MDA also plans to integrate the more capable SM-3 Block IIA missiles into Aegis Ashore, completing the third and final phase of the EPAA.

Both the land- and sea-based variants of Aegis BMD have demonstrated capability to defeat ballistic missiles in the midcourse phase of flight for many realistic operational scenarios.

In addition to Aegis BMD, the Regional/Theater BMDS includes the Terminal High-Altitude Area Defense (THAAD) and Patriot elements. THAAD has demonstrated capability to defeat short- to intermediate-range ballistic missiles. Patriot has demonstrated a capability to defeat many types of short- and medium-range tactical ballistic missiles. As the oldest and most mature missile defense program, Patriot has an extensive and robust test history, and a much larger inventory of interceptors than the other BMDS elements. Patriot is also the only element of the BMDS funded by the Army, not the MDA.

Both THAAD and Patriot interceptors have demonstrated high reliability, but their ground-based components suffer from problems that reduce overall system reliability. Interoperability testing involving multiple BMDS elements has shown that the training provided for THAAD and Patriot crews does not prepare them well for a conflict involving Aegis BMD, THAAD and Patriot elements operating together. Planned system-level testing such as Flight Test, Operational-03 (FTO-03), distributed ground tests, and FTO-05, which is currently unfunded, will feature multiple elements operating together, provide their Soldier operators with realistic training, and provide an opportunity to refine Tactics, Techniques, and Procedures.

#### **Test Adequacy and the Integrated Master Test Plan**

The MDA continues to execute a rigorous test planning process, documented in the Integrated Master Test Plan (IMTP), which the MDA Director and I both approve. The MDA continues to emphasize operational realism when planning for and conducting both ground and flight testing, and involves my office with each update of the IMTP. Lieutenant General Greaves has welcomed DOT&E involvement and advice throughout his tenure at MDA, and it has been a pleasure to work with him.

*U.S. Homeland Defense Testing:* Flight testing of the GMD system is constrained by a number of factors, including range safety considerations and cost. The GMD test conducted in March, for example, cost more than \$300 million. Hence, independently accredited models and simulations (M&S), anchored by flight test data, will be required

to assess the effectiveness of GMD across its full battlespace. Including the most recent flight test, the MDA plans to conduct a total of five GMD intercept flight tests from 2019 to 2025. These tests include objectives that address current data gaps, such as a multiple simultaneous threat engagement.

*Regional/Theater Defense Testing:* As with U.S. Homeland Defense, flight testing of regional/theater defense systems is constrained by range safety and cost considerations, which limits my ability to assess the effectiveness of these systems in realistic combat scenarios involving raids of multiple missiles, with multiple BMDS elements. The MDA and the Army have robust flight test programs for Aegis BMD, THAAD, and Patriot operating independently. Additional M&S capability, anchored by flight testing of Aegis BMD, THAAD, and Patriot systems operating together, will be needed to evaluate the effectiveness of these systems operating together under realistic combat conditions.

### **Key Challenges**

Five key challenges limit the effectiveness of the BMDS, and my ability to assess BMDS capability:

#### **1. Need for Accredited Modeling and Simulation (M&S) to Assess BMDS Effectiveness**

Operationally realistic flight testing is limited by the availability of test assets, a limited test infrastructure, the lack of lethality testing against newer threat designs, long target development timelines, range safety complexity, and high test costs. BMDS

ground testing and M&S comprise the only feasible solutions to mitigate these flight test limitations. I believe the development of such M&S capability should be a priority for the MDA, and I think General Greaves agrees. For DOT&E to use M&S-generated data to quantitatively evaluate a system's operational effectiveness, the M&S must be independently accredited. To assess BMDS-level capability in a realistic combat environment, these models must present a common threat scene, include all interceptors from each BMDS element, and faithfully portray the complex debris fields generated by successful intercepts. These debris fields tax the performance of missile defense radars as they try to sort out legitimate targets from debris.

The MDA and BMDS Operational Test Agency (OTA) made substantial progress in the M&S area in 2018, increasing the value of the ground test events. The MDA and BMDS OTA have agreed upon an accreditation process and a plan to remove or minimize limitations, and the MDA continues to incrementally address them. As currently planned and resourced, this effort will take several more years to complete.

## **2. Susceptibility of the BMDS to Cyber-attack**

Given the complexity and interdependence of the BMDS, cybersecurity and cyber resiliency are critical to the success of the BMDS mission. Under Lieutenant General Greaves' leadership, the MDA has prioritized cybersecurity, and the MDA continues to make progress characterizing the cybersecurity posture of fielded and soon-to-be fielded BMDS capabilities. The MDA began to implement more structured cybersecurity test

planning activities, and address some of the assessment shortfalls from previous years. Operationally realistic cybersecurity testing, conducted for the first time by the MDA in 2018, identified ways to improve THAAD, C2BMC, BMDS Overhead Persistent Infrared Architecture, and Army Navy/Transportable Radar Surveillance (AN/TPY-2) Forward-Based Mode network defense operations and capabilities in a cyber-contested environment.

Under General Greaves' leadership, the MDA, in coordination with DOT&E and the U.S. Northern Command, plans to initiate persistent cyber operations – which emulate actual cyber threats in a safe and controlled manner on currently fielded MDA systems and networks. DOT&E's Cybersecurity Assessment Program has demonstrated that persistent cyber operations are the most effective way to rapidly find and fix mission-critical cybersecurity vulnerabilities in operational systems across the Department.

Over the last year, the MDA continued efforts to draft a BMDS Cybersecurity and Resiliency Strategy in response to a DOT&E recommendation. This strategy is intended to define a general concept and roadmap for implementing cybersecurity and resilience across the BMDS, but it has not yet resulted in a standard approach being applied across the elements for software assurance and developmental and operational cybersecurity testing. Going forward, the MDA should tailor this concept to each element, providing specific information on how developmental cybersecurity testing will be executed to inform the design cycle, government acceptance, and operational testing.

### **3. Reliability and Sustainment**

The BMDS is a complex system using advanced technology with resultant reliability and sustainment challenges. From 2010 to 2014, the MDA had three consecutive GMD intercept flight test failures. These failures were caused by poor reliability of the existing GMD kill vehicles – the parts of the interceptors designed to impact and destroy the target warheads. These failures led to the initiation of the MDA's Redesigned Kill Vehicle (RKV) program, whose primary purpose is to improve GMD system reliability. The MDA recently discovered a significant problem with the RKV design during ground testing, and General Greaves wisely instituted a program pause. He does not plan to proceed with further development or testing until the MDA thoroughly investigates and mitigates the problem, and verifies the resultant fix through testing. General Greaves is not allowing GMD program history to repeat itself with respect to the RKV program, and I strongly support his course of action.

When ready, the MDA plans to conduct an interceptor-only flight test of the RKV followed by an intercept flight test against an intermediate-range ballistic missile target. The MDA anticipates deploying the RKV beginning in 2023 following a successful intercept test.

Aegis BMD has also experienced numerous problems during flight and ground testing since the start of Initial Operational Test and Evaluation flight testing of the SM-3 Block IB missile in 2013. High-fidelity ground testing could have discovered some of

the SM-3 flight test failure mechanisms prior to flight. In accordance with DOT&E's recommendation, the MDA is working to develop a robust failure reporting system and more robust ground tests of all missile components, sections, and all-up rounds using the same configuration as flown in flight tests (i.e., "test as you fly"). In addition to assisting with problem discovery, such high-fidelity ground testing will provide essential data for estimating missile reliability.

As I mentioned previously, both Patriot and THAAD programs have experienced reliability problems with their ground systems. The Army and the MDA should address these problems to ensure these systems can maintain a high state of readiness in combat.

#### **4. Interoperability and the Maturation of BMDS Coordination**

The BMDS can make more effective use of its limited inventory of interceptors if the BMDS elements coordinate with each other to assign each threat missile in a raid to an appropriate BMDS element. This de-conflicts and optimizes the use of interceptors to defeat raids of incoming threat missiles.

The BMDS is currently not capable of automatic de-confliction and training does not fully prepare system operators to conduct such de-confliction manually. Operators have reported a lack of multi-element training and documentation during all four previous BMDS system-level flight tests.

Additional system-level flight and ground tests are needed to demonstrate and improve element interoperability and to give warfighters the opportunity to refine their

Tactics, Techniques, and Procedures. In particular, the Army and the MDA need to continue to work together to integrate the Army's Patriot test program with the MDA's THAAD and Aegis BMD test programs.

#### **5. Discrimination of Threat Reentry Vehicles**

Identifying the threat reentry vehicle from all the other objects in a sensor's field of view remains a challenging technical problem. The MDA has a dedicated engineering project to improve discrimination, but significant challenges remain. I encourage the MDA to continue this project, to develop the M&S needed to accurately assess BMDS performance against the wide variety of possible countermeasures an adversary might employ, and to conduct flight testing involving countermeasures to anchor the M&S and demonstrate BMDS discrimination capabilities.

In closing, I want to note how much I appreciate General Greaves' contributions to the Missile Defense Agency, how well he has worked with me and my staff, and how much I will miss working with him when he retires, as he plans to do soon.

Thank you for your attention and I look forward to answering the Committee's questions.



**Robert F. Behler**  
**Director of Operational Test and Evaluation**

Robert F. Behler was sworn in as Director of Operational Test and Evaluation on December 11, 2017. A Presidential appointee confirmed by the United States Senate, he serves as the senior advisor to the Secretary of Defense on operational and live fire test and evaluation of Department of Defense weapon systems.

Prior to his appointment, he was the Chief Operating Officer and Deputy Director of the Carnegie Mellon University Software Engineering Institute (SEI), a Federally Funded Research and Development Center. SEI is a global leader in advancing software development and cybersecurity to solve the nation's toughest problems through focused research, development, and transition to the broader software engineering community.

Before joining the SEI, Mr. Behler was the President and CEO of SRC, Inc. (formerly the Syracuse Research Corporation). SRC is a not-for-profit research and development corporation with a for-profit manufacturing subsidiary that focuses on radar, electronic warfare and cybersecurity technologies. Prior to working at SRC, Mr. Behler was the General Manager and Senior Vice President of the MITRE Corp where he provided leadership to more than 2,500 technical staff in 65 worldwide locations. He joined MITRE from the Johns Hopkins University Applied Physics Laboratory where he was a General Manager for more than 350 scientists and engineers as they made significant contributions to critical Department of Defense (DOD) precision engagement challenges.

General Behler served 31 years in the United States Air Force, retiring as a Major General in 2003. During his military career, he was the Principal Adviser for Command and Control, Intelligence, Surveillance and Reconnaissance (C2ISR) to the Secretary and Chief of Staff of the U.S. Air Force (USAF). International assignments as a general officer included the Deputy Commander for NATO's Joint Headquarters North in Stavanger, Norway. He was the Director of the Senate Liaison Office for the USAF during the 104th congress. Mr. Behler also served as the assistant for strategic systems to the Director of Operational Test and Evaluation. As an experimental test pilot, he flew more than 65 aircraft types. Operationally he flew worldwide reconnaissance missions in the fastest aircraft in the world, the SR-71 Blackbird.

Mr. Behler is a Fellow of the Society of Experimental Test Pilots and an Associate Fellow of the American Institute of Aeronautics and Astronautics.

He is a graduate of the University of Oklahoma where he received a B.S. and M.S. in aerospace engineering, has a MBA from Marymount University and was a National Security Fellow at the JFK School of Government at Harvard University.

Mr. Behler has recently been on several National Research Council studies for the National Academy of Sciences including: "Critical Code," "Software Producibility, Achieving Effective Acquisition of Information Technology in the Department of Defense" and "Development Planning: A Strategic Approach to Future Air Force Capabilities."

**STATEMENT OF**  
**GENERAL TERRENCE J. O'SHAUGHNESSY, UNITED STATES AIR FORCE**  
**COMMANDER**  
**UNITED STATES NORTHERN COMMAND**  
**AND**  
**NORTH AMERICAN AEROSPACE DEFENSE COMMAND**



**BEFORE THE**  
**HOUSE ARMED SERVICES COMMITTEE**  
**SUBCOMMITTEE ON STRATEGIC FORCES**  
**8 MAY 2019**

Chairman Cooper, Ranking Member Turner, and distinguished members of the subcommittee, I am honored to appear today as the Commander of United States Northern Command (USNORTHCOM) and North American Aerospace Defense Command (NORAD)—two complementary but distinct commands.

USNORTHCOM is the Geographic Combatant Command laser-focused on defending our homeland from an increasingly assertive set of competitors who are committed to holding the United States at risk in multiple domains.

NORAD is the bi-national U.S.-Canadian command that deters, detects, and, if necessary, defeats air threats to the United States and Canada while also providing aerospace warning and maritime warning. The six decades of NORAD's unmatched experience and shared history are proving more vital than ever as we face the most complex security environment in generations. This unique and longstanding command serves as both a formidable deterrent to our adversaries and a clear symbol of the unbreakable bond between the United States and Canada.

USNORTHCOM and NORAD are driven by a single unyielding priority: defending the homeland from attack. Revisionist powers Russia and China have changed global strategic dynamics by fielding advanced long-range weapons systems and engaging in increasingly aggressive efforts to expand their global presence and influence, including in the approaches to the United States and Canada. Our competitors currently hold our citizens and national interests at risk, and we must anticipate attacks against our defense and civilian infrastructure in the event of a conflict. As a result, it is clear that the homeland is not a sanctuary.

For that reason, improving our ability to detect and defeat cruise missile attacks is among my highest priorities. Russia has made its strategic intentions clear by investing heavily in long-

range, low radar cross section cruise missiles that can be fired from aircraft or submarines against targets well inside the borders of the United States and Canada. To safeguard our citizens and critical infrastructure, and to preserve our ability to rapidly project power abroad, it will be necessary to take deliberate and focused measures to improve our cruise missile defenses.

These shifting global military and political dynamics will be with us for the foreseeable future. Our competitors have fielded weapons systems and employed new methods in a concerted effort to exploit perceived vulnerabilities and erode our strategic advantage. The successful defense of our homeland today relies more than ever on constant vigilance by USNORTHCOM and NORAD, tightly coupled with a reinvigorated emphasis on close integration with our fellow combatant commands, the intelligence community, and our allies and partners. Collectively, these dynamics reinforce the importance of nuclear deterrence to our national security, given that nuclear deterrence backstops all U.S. military operations and diplomacy across the globe.

The threats facing our nation are not hypothetical; our competitors' reach is now global, and they are conspicuously undermining international norms and standards of behavior while possessing the capability to strike targets in North America with both nuclear and advanced non-nuclear weapons launched from well beyond our territory. In light of this reality, the homeland defense mission is more essential than ever, and USNORTHCOM and NORAD must be energized, proactive, and determined to actively shape our strategic environment. Together with our Department of Defense (DOD), interagency, and international partners, we have taken active measures to ensure the homeland defense enterprise is globally integrated, well-exercised, and positioned to take quick, decisive action to protect our interests and preserve the ability to project

all of the elements of our national power. And, should deterrence fail, USNORTHCOM and NORAD stand always ready to defeat any threat to our nations.

### **Threat**

#### **Russia:**

Russia has posed a nuclear threat to North America for over half a century, but has only recently developed and deployed capabilities to threaten the homeland below the nuclear threshold. Russia continues to hone and flex its offensive cyber capabilities, and its new generation of advanced air- and sea-launched cruise missiles feature significantly greater standoff ranges and accuracy than their predecessors, allowing them to strike North America from well outside NORAD radar coverage.

Since 2015, Russia has employed its new air- and sea-launched cruise missiles against anti-regime targets in Syria, providing real-world training for Russian crews and demonstrating its growing precision-strike capabilities to the West. In a parallel effort, Russia has implemented a modernization program for its heavy bombers that will ensure their ability to perform nuclear and non-nuclear deterrence and strike missions in the coming decades.

Russian heavy bombers such as the Tu-95MS BEAR and Tu-160 BLACKJACK continue to conduct regular air patrols in the international airspace along the coastlines of other countries to underscore Russia's capabilities. Russian bomber crews are demonstrating increasing proficiency in their flight activities, developing a new generation of air crews capable of employing this highly visible implement of Russian deterrence and messaging in peacetime, crisis, and war.

Patrols by Russian military aircraft off the coasts of the United States and Canada have grown increasingly complex in recent years. NORAD fighter aircraft routinely intercept Russian military aviation missions inside the U.S. and Canadian Air Defense Identification Zones, and

there is no indication that Russian leadership intends to reduce the number of these missions in the near future.

In addition to its highly capable cruise missiles that enable its anti-ship and land-attack missions, Russia has introduced the Severodvinsk-class guided missile submarine, which is armed with advanced land-attack cruise missiles and is much quieter and more lethal than previous generations of Russian attack submarines. Russia's growing non-nuclear capabilities provide Moscow a range of options to dissuade an adversary from escalating and to terminate a conflict on terms favorable to Moscow, increasing the potential for miscalculation or opportunistic actions.

Russia has demonstrated a willingness to conduct disruptive cyberattacks and cyber-enabled influence operations against its competitors, as it demonstrated during the 2016 election cycle in the United States. In a crisis or conflict, we would expect Russia to conduct cyber operations against critical infrastructure in an attempt to compel de-escalation.

In the Arctic, Moscow is planning to deploy surface vessels armed with the modular KALIBR-NK cruise missile system that will offer highly precise land-attack capabilities and introduce a new cruise missile threat from our northern approaches. Separately, Moscow continues to bolster its military defenses in the Arctic with the deployment of a K-300P Bastion coastal defense cruise missile system on the New Siberian Islands, significantly increasing Russia's ability to defend and control a large stretch of the Northern Sea Route.

Finally, Russia is developing multiple weapon systems specifically designed to circumvent U.S. missile defenses and hold our homeland at risk. This includes the Intercontinental Ballistic Missile (ICBM)-delivered AVANGARD hypersonic glide vehicle, which was highlighted in a

speech by Vladimir Putin in March 2018 and is expected to become operational in the next few years, complicating our missile warning mission.

**China:**

China is pursuing a comprehensive military modernization program that includes a rapid expansion of its strategic nuclear capabilities while working to improve the survivability of its nuclear forces and increase their ability to ensure a credible second-strike capability. Over the last decade, China has supplemented its modest silo-based ICBM force with dozens of road-mobile ICBMs capable of delivering multiple independently targetable reentry vehicles that could significantly increase the number of survivable warheads available for a retaliatory strike. During that same timeframe, China operationalized its first class of ballistic missile submarines, adding a second leg to its strategic deterrent. China maintains its longstanding no-first-use nuclear policy, but its growing nuclear, conventional, and cyber capabilities are significant.

China's military strategy and ongoing People's Liberation Army (PLA) reforms reflect the abandonment of its historically land-centric mentality, as evidenced by emerging doctrinal references to strategies that would move potential conflicts away from Chinese territory, suggesting that PLA strategists envision an increasingly global role for their military.

On the economic front, China plans to invest heavily in infrastructure projects in Asia, Europe, Latin America and the Caribbean, and Africa through its Belt and Road Initiative in a major effort to develop stronger economic ties with other countries and shape their interests to align with China's, simultaneously seeking to deter confrontation or international criticism of China's approach to sensitive issues.

In the cyber domain, Chinese leaders view computer network operations as a low-cost deterrent that demonstrates capabilities and resolve to an adversary and allows them to manage

the escalation of a conflict by targeting critical military and civilian infrastructure. Ongoing military reforms are aimed at accelerating the incorporation of information systems that enable forces and commanders to carry out missions and tasks more effectively.

**Advanced Threat Technologies:**

Defending the United States and Canada against long-range weapons systems capable of striking targets in the homeland is a major focus of both USNORTHCOM and NORAD. Russian aircraft and submarines are now armed with long-range cruise missiles designed to evade radar detection, while both Russia and China are developing and testing maneuverable hypersonic glide vehicles. In the cyber domain, our adversaries continue their non-stop efforts to penetrate defense and civilian networks. Collectively, these advanced technologies could be capable of creating strategic effects with non-nuclear weapons, potentially affecting national decision making and limiting response options in both peacetime and crisis.

**North Korea:**

After decades of research and development activity marked more by failure than success, North Korea's ICBM program turned the corner in 2017 when North Korea successfully flight-tested multiple ICBMs capable of ranging the continental United States and detonated a thermonuclear device, increasing the destructive yield of its weapons by a factor of ten. Following these successes, Kim Jong Un declared the completion of his nuclear ICBM research and development program, implying the production and deployment of these systems would soon follow.

Kim Jong Un developed these strategic weapons to deter the U.S. from overthrowing his regime, and he almost certainly has plans to use them against our Homeland should a conflict erupt on the Peninsula. Meanwhile, North Korea's cyber capabilities continue to grow, as does



the country's willingness to employ them during peacetime, as North Korea demonstrated by its cyber attacks on Sony Pictures in 2014.

**Iran:**

Iran is not yet able to strike the United States with strategic weapons, and its leaders have declared a unilateral 2000 kilometer range restriction that limits its missile force to threatening only regional targets in the Near East. Iran's SIMORGH space launch vehicle has yet to successfully place a satellite in orbit, but its most recent launch in January 2019 demonstrated continued progress on long-range missile technologies. Although we have no information to indicate that Iran intends to test and deploy an ICBM, the SIMORGH would be capable of ICBM ranges if configured for that purpose, and progress on the vehicle could enable Iran to field an ICBM in as little as a few years if its leaders chose to pursue that objective.

However, Iran has the largest ballistic missile arsenal in the region and has expended significant resources on its space launch and civil nuclear capabilities that could enable it to develop a nuclear-armed ICBM relatively quickly if its leaders chose to do so. In the meantime, Iran retains the ability to conduct attacks abroad via covert operations, terrorist proxies, and its growing cyber capabilities. Iran considers disruptive and destructive cyberspace operations as a valid instrument of statecraft and a means of imposing costs on its adversaries, even during peacetime.

**Defending the Homeland**

Homeland defense is USNORTHCOM's essential mission and the number one priority of the DOD per the 2018 National Defense Strategy. In light of the complex and significant threats to our homeland, USNORTHCOM and NORAD take assertive, proactive measures each day to shape our strategic environment, deter aggression, and ensure that we are always ready to defeat

any adversary should deterrence fail. As the Commander of USNORTHCOM and NORAD, I view everything the commands do through the lens of homeland defense, and I am committed to ensuring that each of our missions help to deter adversaries, preserve decision space, and maintain the ability for our national leaders to project power and exert influence in the best interest of our nations.

In pursuit of their own perceived national and ideological interests, our competitors have developed advanced capabilities and demonstrated their intent to hold our homeland at risk in multiple domains and along numerous avenues of approach to North America. In light of that reality, we simply do not have the luxury of waiting for others to act before we formulate a response. Instead, USNORTHCOM and NORAD work constantly to shape our theater while making it obvious to potential adversaries that they will face overlapping dilemmas and extraordinary costs should they choose to challenge us. This active and continuous enterprise requires strong relationships and close coordination with our fellow combatant commands, the military Services, the U.S. Federal interagency community, and our international allies and partners.

The diverse threats arrayed against the United States and Canada challenge our defenses in a number of domains and along multiple avenues of approach. The men and women of USNORTHCOM and NORAD work around the clock to monitor those approaches and are ready to respond at a moment's notice should our adversaries chose to challenge our defenses.

**Ballistic Missile Defense:**

USNORTHCOM continues to prioritize our mission to defend the United States against potential intercontinental ballistic missile (ICBM) attacks from North Korea and Iran, should Iran develop that capability. I remain cautiously optimistic that North Korea can be convinced

that it is in their best interest to abandon its nuclear weapons and ICBM programs. In the meantime, I continue to emphasize the necessity of fielding improved discriminating radars, a more survivable sensor network, and improving the reliability and lethality of our interceptor fleet in order to remain well ahead of North Korea or Iran's capability to strike the defended area.

I am confident in the ability of the Ground-based Midcourse Defense System to defend the United States against ICBMs fired from North Korea or Iran, if Iran develops an ICBM, but that confidence is contingent on our continued pursuit of system-wide enhancements to outpace our adversaries' rapid technological advancements.

The success of the Ballistic Missile Defense mission is also dependent on strong cooperation between USNORTHCOM as the supported warfighting command and the technical experts of the Missile Defense Agency (MDA). The MDA Director, Lt Gen Sam Greaves, is an outstanding partner, and I am grateful to him and the entire MDA team for their dedicated support of this enormously complex, no-fail mission. I fully support MDA's plans to field the Long-Range Discrimination Radar, Homeland Defense Radar-Hawaii, and Pacific Radar, along with the Redesigned Kill Vehicle and a selectable 2- or 3- stage interceptor booster. Additionally, I believe we must pursue space-based sensors to detect and track advanced threats from Russia and China. Each of these improvements to our sensor network and interceptor fleet will help to ensure our ability to defend the United States against an ICBM attack now and into the foreseeable future.

To counter the rapid evolution of our adversaries' missile technologies, we will require advanced defensive technologies such as space-based sensors and directed-energy missile defeat technology in the near future. A space-based sensor network, in particular, will provide far

greater coverage, survivability, and persistence—all of which are necessary to maintaining confidence in our ability to deter, detect, and defeat missile threats to the homeland.

At present, the DOD is striking an effective balance between ensuring our ability to defend against current and near-term threats while simultaneously investing in the research and development of advanced technologies capable of defeating future threats. This vision for meeting anticipated requirements is strongly articulated in the recently published Missile Defense Review, and I fully support the plan for defending the homeland.

**Arctic Northern Approaches:**

It has become clear that defense of the homeland depends on our ability to detect and defeat threats operating both *in* the Arctic and passing *through* the Arctic. Russia's fielding of advanced, long-range cruise missiles capable of flying through the northern approaches and striking targets in the United States and Canada has emerged as the dominant military threat in the Arctic, while diminished sea ice and the potential for competition over resources present overlapping challenges in this strategically significant region. Meanwhile, China has declared that it is not content to remain a mere observer in the Arctic and has taken action to normalize its naval and commercial presence in the region in order to increase its access to lucrative resources and shipping routes.

I view the Arctic as the front line in the defense of the United States and Canada, and as the DOD Advocate for Arctic Capabilities and the Combatant Commander responsible for defending the approaches to the homeland, I constantly assess the changing environmental and strategic conditions throughout the region—across borders and operational boundaries—in an ongoing, active, and collaborative effort to mitigate the risks associated with increased civilian and military presence in the northern approaches to North America.

The effort to rapidly adapt to the evolving strategic landscape and associated challenges in the Arctic includes a deliberate and ongoing effort to fully assess our collective missions and associated requirements in the region. As one key example of those ongoing assessments, in 2018, USNORTHCOM planners conducted a Homeland Defense Mission Analysis for the Arctic Region. This comprehensive, classified assessment of our capability to operate in the far north revalidated a number of known capability gaps in the region and provided an updated overview of current and future requirements.

As confirmed by our Mission Analysis, civil and military operations in the Arctic are impeded by limited communications capability, harsh environmental conditions, and vast distances between population centers. Improving communications and domain awareness in the region are among my top priorities for the region, and the DOD and the military Services have demonstrated their support of those requirements through investment in programs such as the Multi User Objective System (MUOS)—a satellite-based communications network that significantly expands the ability of U.S. and Canadian assets to operate in the far north.

To detect and track potential airborne threats, to include Russian long-range bombers and cruise missiles, USNORTHCOM and NORAD both rely on radar systems such as the North Warning System (NWS), a network of aerospace surveillance radars in northern Canada. In August 2018, NORAD, working in close coordination with USNORTHCOM, the Canadian NORAD Region, and the U.S. Navy's Naval Air Warfare Center, conducted an operational assessment of the NWS against representative targets, and the data collected from the test will inform the design for the air domain defense of the United States and Canada for years to come.

**Air Domain:**

Variants of the advanced cruise missiles that could fly through our northern approaches also present a threat along our coasts. Russian Severodvinsk-class submarines are capable of firing low radar cross section cruise missiles against critical targets along our coasts. This emerging threat requires advanced capabilities to ensure surveillance, detection, identification, targeting, and destruction to protect the homeland and key strategic targets in the United States and Canada.

The Homeland Defense Design will be a phased approach to employ advanced detection and tracking technologies to defeat a cruise missile attack against the homeland. However, the rapidity of our competitors' development of advanced cruise missile technology demands a continued, aggressive, and focused commitment to ensure our ability to defeat a cruise missile attack.

**Conclusion**

Today and every day, the men and women of USNORTHCOM and NORAD are standing watch over our homeland. These dedicated professionals work around the clock surveilling our skies, monitoring our oceans, and ensuring that we are always ready to counter a staggering range of threats to our homeland, ranging from intercontinental ballistic missiles and long-range bombers to lethal opioids and cyberattacks. The strategic and technological innovation that will be required to defend our nation in the coming years depends entirely on the quality and experience of our people.

Today and always, our people are our strength, and I am proud to lead the outstanding Airmen, Sailors, Soldiers, Marines, and civilians of USNORTHCOM and NORAD. While the threats facing our nation can be daunting, I have absolute confidence in our ability to meet any

challenge and defeat any adversary because of the dedicated professionals I am honored to lead.

We Have the Watch.

### **General Terrence J. O'Shaughnessy**

General Terrence J. O'Shaughnessy is Commander, United States Northern Command and North American Aerospace Defense Command. USNORTHCOM partners to conduct homeland defense, civil support and security cooperation to defend and secure the United States and its interests. NORAD conducts aerospace warning, aerospace control and maritime warning in the defense of North America.

General O'Shaughnessy is a 1986 distinguished graduate of the U.S. Air Force Academy. He has commanded at the squadron, group, wing, NAF and MAJCOM levels, including the 57th Wing, Nellis Air Force Base, Nevada, the 35th Fighter Wing as Misawa Air Base, Japan, and the 613th Air and Space Operations Center, Hickam AFB, Hawaii. General O'Shaughnessy has served as the U.S. Pacific Command Director of Operations responsible for joint operations in a region encompassing more than half the globe and 36 nations. General O'Shaughnessy's joint experience also extends to his time as the Joint Staff J5 Deputy Director for Politico-Military Affairs for Asia where he shaped regional planning and policy in the Asia-Pacific and Central Asia regions, supporting the commanders of U.S. Pacific Command and U.S. Central Command. Prior to his current assignment, General O'Shaughnessy was Deputy Commander, United Nations Command Korea; Deputy Commander, U.S. Forces Korea; Commander, Air Component Command, Republic of Korea/U.S. Combined Forces Command; and Commander, 7th Air Force, Pacific Air Forces, Osan AB, South Korea and Commander, Pacific Air Forces and Air Component Commander for U.S. Pacific Command, Joint Base Pearl Harbor-Hickam, Hawaii.

General O'Shaughnessy is a command pilot with more than 3,000 hours in the F-16 Fighting Falcon, including 168 combat hours.

#### **EDUCATION**

1986 Distinguished graduate, Bachelor of Science, aeronautical engineering, U.S. Air Force Academy, Colorado Springs, Colo.  
 1992 Fighter Weapons Instructor Course, U.S. Air Force Fighter Weapons School, Nellis AFB, Nev.  
 1993 Squadron Officer School, Maxwell AFB, Ala.  
 1996 Master's degree in aeronautical science, Embry-Riddle Aeronautical University, Daytona Beach, Fla.  
 1998 Air Command and Staff College, Maxwell AFB, Ala.  
 2003 Industrial College of the Armed Forces, National Defense University, Fort Lesley J. McNair, Washington, D.C.  
 2003 Information Studies Concentration Program, National Defense University, Fort Lesley J. McNair, Washington, D.C.  
 2005 NATO Senior Officer Policy Course, NATO Defense College, Oberammergau, Germany  
 2007 Department of Defense Senior Managers Course in National Security, George Washington University, Washington, D.C.  
 2007 Air Force Enterprise Leadership Course, University of North Carolina at Chapel Hill  
 2009 Combined Air and Space Operations Senior Staff Course, Hurlburt Field, Fla.  
 2011 Joint Force Air Component Commander Course, Maxwell AFB, Ala.  
 2012 Joint Flag Officer Warfighter Course  
 2013 Joint Force Maritime Component Commander Course, Newport, R.I.  
 2015 National Defense University PINNACLE Course, Suffolk, Va.

#### **ASSIGNMENTS**

June 1986 - September 1987, student, undergraduate pilot training, Sheppard AFB, Texas  
 September 1987 - August 1988, student, T-38 lead-in fighter training and F-16 training, Holloman AFB, N.M., and Luke AFB, Ariz.  
 August 1988 - December 1991, F-16 aircraft commander and instructor pilot, Shaw AFB, S.C.  
 January 1992 - June 1992, student, F-16 Fighter Weapons School, Nellis AFB, Nev.  
 July 1992 - July 1993, weapons officer and flight commander, 35th Fighter Squadron, Kunsan AB, South Korea



July 1993 - July 1997, assistant operations officer and air-to-ground flight commander, F-16 Division, U.S. Air Force Fighter Weapons School, Nellis AFB, Nev.

July 1997 - June 1998, student, Air Command and Staff College, Maxwell AFB, Ala.

June 1998 - June 1999, Chief, Air Superiority Weapons Branch, Global Power Programs, Office of the Assistant Secretary of the Air Force for Acquisition, the Pentagon, Arlington, Va.

June 1999 - June 2000, Chief, Fighter Programs, Office of Legislative Liaison, Office of the Secretary of the Air Force, the Pentagon, Arlington, Va.

June 2000 - April 2001, operations officer, 555th Fighter Squadron, Aviano AB, Italy

April 2001 - July 2002, Commander, 510th Fighter Squadron, Aviano AB, Italy

August 2002 - June 2003, student, Industrial College of the Armed Forces, National Defense University, Fort Leslie J. McNair, Washington, D.C.

June 2003 - August 2004, Chief, Joint Plans and Operations, Supreme Headquarters Allied Powers Europe, Mons, Belgium

August 2004 - July 2005, senior special assistant to the Supreme Allied Commander Europe and Commander, U.S. European Command, Supreme Headquarters Allied Powers Europe, Mons, Belgium

July 2005 - December 2006, Commander, 57th Adversary Tactics Group, Nellis AFB, Nev.

January 2007 - August 2008, Commander, 35th Fighter Wing, Misawa AB, Japan

September 2008 - August 2009, Commander, 613th Air and Space Operations Center, Hickam AFB, Hawaii

August 2009 - July 2010, Vice Commander, 13th Air Force, Hickam AFB, Hawaii

July 2010 - April 2012, Commander, 57th Wing, Nellis AFB, Nev.

April 2012 - August 2013, Deputy Director for Politico-Military Affairs for Asia, Joint Staff, the Pentagon, Arlington, Va.

August 2013 - October 2014 - Director for Operations, Headquarters, United States Pacific Command, Camp H.M. Smith, Hawaii

December 2014 - July 2016, Deputy Commander, United Nations Command Korea; Deputy Commander, U.S. Forces Korea; Commander, Air Component Command, Republic of Korea/U.S. Combined Forces Command; and Commander, 7th Air Force, Pacific Air Forces, Osan AB, South Korea

July 2016 - May 2018, Commander, Pacific Air Forces; Air Component Commander for U.S. Pacific Command; and Executive Director, Pacific Air Combat Operations Staff, Joint Base Pearl Harbor-Hickam, Hawaii

May 2018 - present, Commander North American Aerospace Defense Command and United States Northern Command

#### **SUMMARY OF JOINT ASSIGNMENTS**

June 2003 - August 2004, Chief, Joint Plans and Operations, Supreme Headquarters Allied Powers Europe, Mons, Belgium, as a colonel

August 2004 - July 2005, senior special assistant to the Supreme Allied Commander Europe and Commander, U.S. European Command, Supreme Headquarters Allied Powers Europe, Mons, Belgium, as a colonel

April 2012 - August 2013, Deputy Director for Politico-Military Affairs for Asia, Joint Staff, the Pentagon, Arlington, Va. as a brigadier and major general.

August 2013 - October 2014, Director for Operations, Headquarters, United States Pacific Command, Camp H.M. Smith, Hawaii, as a major general

December 2014 - July 2016, Deputy Commander, United Nations Command Korea; Deputy Commander, U.S. Forces Korea; Commander, Air Component Command, Republic of Korea/U.S. Combined Forces Command; and Commander, 7th Air Force, Pacific Air Forces, Osan AB, South Korea, as a lieutenant general.

May 2018 - present, Commander, North American Aerospace Defense Command (NORAD) and United States Northern Command (USNORTHCOM). Colorado Springs, Colo, as a general.

#### **FLIGHT INFORMATION**

Rating: command pilot

Flight hours: more than 3,000

Aircraft flown: F-16, AT/T-38 and T-37

**MAJOR AWARDS AND DECORATIONS**

Distinguished Service Medal  
 Defense Superior Service Medal with three oak leaf clusters  
 Legion of Merit with three oak leaf clusters  
 Meritorious Service Medal with three oak leaf clusters  
 Air Medal with oak leaf cluster  
 Aerial Achievement Medal with oak leaf cluster  
 Air Force Commendation Medal with oak leaf cluster  
 Air Force Achievement Medal with two oak leaf clusters  
 Combat Readiness Medal  
 Armed Forces Expeditionary Medal  
 Kosovo Campaign Medal  
 Global War on Terrorism Service Medal  
 Korea Defense Service Medal  
 Humanitarian Service Medal

**EFFECTIVE DATES OF PROMOTION**

Second Lieutenant May 28, 1986  
 First Lieutenant May 28, 1988  
 Captain May 28, 1990  
 Major Sept. 1, 1997  
 Lieutenant Colonel May 1, 2000  
 Colonel Aug. 1, 2004  
 Brigadier General Nov. 2, 2009  
 Major General Aug. 2, 2013  
 Lieutenant General Dec. 19, 2014  
 General July 12, 2016

(Current as of May 2018)

**HASC – Strategic Forces Subcommittee Hearing on Missile Defense**

James Anderson, Assistant Secretary of Defense  
Strategy, Policy, and Capabilities  
May 8, 2019

Chairman Cooper, Ranking Member Turner, and Members of the Committee, thank you for the opportunity to testify on the Department's missile defense policy, posture, and budget.

The MDR articulates a comprehensive approach to address the missile threat through strengthened deterrence and active missile defense systems for both homeland and regional defense.

The FY 2020 budget requests \$12.0 billion for missile defense that includes: \$9.4 billion for the Missile Defense Agency; \$2.5 billion for the Army; and \$100 million for the Air Force. These funds support improving the current system and moving towards innovative concepts and advanced technologies.

**Threat**

Over the past decade, North Korea and Iran have accelerated efforts to develop and field missiles capable of threatening U.S. strategic interests. North Korea possesses a range of systems including road-mobile intercontinental-range ballistic missiles, solid-propellant medium-range ballistic missiles, and submarine-launched ballistic missiles.

For its part, Iran already possesses the largest stockpile of regional missile systems in the Middle East. Iran continues to improve its missile capabilities and develop space launch vehicles which provide knowledge to develop an intercontinental-range ballistic missile.

We also see the re-emergence of long-term, strategic competition by revisionist powers in Russia and China. Russia and China are expanding and modernizing a wide range of offensive missile capabilities. For example, they are fielding increasingly diverse missile systems, and integrating missiles into their coercive

threats and military plans. These plans support anti-access/area denial, or A2/AD strategies, which seek to deny the United States the ability to move forces freely in response to a regional conflict or crisis.

Russia is developing the hypersonic glide vehicle (HGV), which maneuvers outside of traditional trajectories and typically maneuvers in the atmosphere. China is also developing advanced technologies, such as maneuverable reentry vehicles in addition to HGVs.

#### **Missile Defense Roles, Policy, and Strategy**

As highlighted in the MDR, a comprehensive layered defense is needed to address today's complex threats.

Within the MDR framework, the key roles for missile defense include:

- Protecting the U.S. homeland, our forces abroad, and allies and partners;
- Diminishing the benefits of adversary coercive threats and attacks;
- Assuring allies and partners we will stand by our security commitments;
- Preserving our freedom of action to conduct military operations; and
- Hedging against future, unanticipated missile threats.

#### **U.S. Missile Defense Priorities, Programs, Budget, and Capabilities**

##### ***U.S. Homeland Defense***

Let me now turn to the missile defense capabilities, posture, and budget that flow from our policy in the MDR, to counter these threats. Regarding our first priority, to protect the U.S. homeland, today, the United States is protected by the Ground-based Midcourse Defense (GMD) system. The budget requests \$1.8 billion for this system, which includes a number of improvements such as:

- Adding 20 Ground-based Interceptors (GBI) in Alaska, bringing the total to 64;

- Continuing development of a Redesigned Kill Vehicle for improved reliability; and
- Continuing to build a new missile field at Fort Greely, Alaska.

The budget also requests funding to field new discrimination radars in Alaska and Hawaii, and extend operations for the sea-based X-band radar.

Further, the MDR recognizes the need for improving our capability to detect and defend against increasingly stealthy cruise missile threats. In response, we are bolstering our homeland defenses against such threats. Funds for homeland cruise missile defense in the FY 2020 budget request include \$301 million for the Wide-Area Surveillance system.

### ***Regional Defense***

To address the regional missile threat, our efforts focus on Integrated Air and Missile Defense (IAMD) to defend U.S. forces abroad, allies, and partners against missile threats from any source. We are strengthening our regional missile defense posture by funding several programs. For instance, we are enhancing the Aegis Ballistic Missile Defense system by procuring Standard Missile (SM-3), Block IB and Block IIA missiles and integrating the SPY-6 radar. The Department will also procure additional Terminal High-Altitude Area Defense (THAAD) interceptors, Patriot interceptors, and the Army Indirect Fire Protection Capability (IFPC) command and control system.

### ***Preparing for Emerging Offensive Missile Threats and Uncertainties***

In addition to improving our legacy systems, the 2019 MDR calls for pursuing a range of technologies and examining advanced concepts and breakthrough technologies. We are requesting funding for:

- Space-based sensors;

- Integrating Space-based Kill Assessment into the Ballistic Missile Defense System;
- Operating and sustaining the Space Tracking and Surveillance System;
- Developing defenses against hypersonic missiles, including near-term sensor and command and control upgrades;
- Testing a SM-3 Block IIA capability against an ICBM-class target to develop the capability to add a layer to our defense system;
- Kinetic boost phase intercept using a tactical air platform;
- Technology maturation initiatives include initiating a Neutral Particle Beam technology demonstration program and continuing High-Energy Laser development and scaling; and
- A study of space-based interceptors.

#### **Working with Allies and Partners**

The MDR stresses the importance of working with allies and partners and encouraging them to invest in their own air and missile defense capabilities that are interoperable with U.S. capabilities. Interoperable Integrated Air and Missile Defense (IAMD) systems can take advantage of cost-sharing and help distribute the burden of common defense.

The United States is committed to completing the deployment of European Phased Adaptive Approach (EPAA), the U.S. contribution to North Atlantic Treaty Organization (NATO) ballistic missile defense in Europe. EPAA has three phases intended to address the threat to NATO and Europe originating from Iran. Phases 1 and 2 are complete and included: the stationing of four multi-mission Aegis BMD-capable ships in Rota, Spain; positioning of a forward-based AN/TPY-2 radar in Turkey; and deploying the first operational

Aegis Ashore system in Romania. Deployment of Phase 3, an Aegis Ashore system in Poland, is underway.

In the Middle East, we are working with our Gulf partners who are acquiring U.S. missile defense systems and we continue to support Israel's efforts through the DoD-Israeli Ministry of Defense Memorandum of Understanding that began in FY 2019, requesting \$500 million for the Iron Dome, Arrow Weapon System and David's Sling programs.

In the Indo-Pacific region, Japan is an example of mutually beneficial burden sharing, co-developing with the United States, the SM-3 Block IIA. Japan also hosts two U.S. AN/TPY-2 X-Band radars that support U.S. homeland defense as well as both Japanese and U.S. regional missile defense operations. Japan also continues to make significant investments in its own missile defense capabilities, highlighted by its decision to acquire two Aegis Ashore systems.

#### **Conclusion**

Our missile defense investments and priorities focus on concepts and advanced technologies to ensure the continuing effectiveness of missile defenses against capabilities of potential adversaries. By doing so, we will strengthen our ability to protect the homeland; enhance deterrence, stabilize crises, and better control escalation; protect and assure allies and partners; and hedge against future threats. Thank you again for the opportunity to testify. I look forward to your questions.

**Dr. James H. Anderson**  
**Assistant Secretary of Defense for Strategy, Plans and Capabilities**

Dr. James H. Anderson was confirmed by the U.S. Senate on August 28, 2018 as Assistant Secretary of Defense for Strategy, Plans, and Capabilities. Dr. Anderson is responsible for advising the Secretary of Defense and the Under Secretary of Defense for Policy on national security and defense strategy; the forces and contingency plans necessary to implement defense strategy; nuclear deterrence and missile defense policy; and security cooperation plans and policies. Dr. Anderson ensures that the Department's program, budget, and posture decisions support and advance senior DoD leaders' strategic direction.

Prior to this appointment, Dr. James H. Anderson served three years as the Vice President for Academic Affairs at the Marine Corps University. In this capacity, he supervised academic programs that educate thousands of Marines annually. From 2012 to 2015, he was Dean of Academics and Deputy Director at the Marine Corps War College. From 2009 to 2012, he worked as Professor of International and Security Studies at the George C. Marshall Center for European Security Studies, where he directed the Program in Advanced Security Studies. Dr. Anderson served in the Office of the Secretary of Defense from 2001 to 2009, where he was Director of Middle East Policy in International Security Affairs, among other positions.

In addition to his Pentagon service, Dr. Anderson worked as an Associate at DFI International, a private consulting firm; a Research Fellow at The Heritage Foundation, a Washington think tank; and an Associate Professor of International Relations at Command and Staff College, Marine Corps University. He has also taught courses at National Defense University, George Washington University, Lasell College, and the University of Phoenix.

He is the co-author of *Leading Dynamic Seminars: A Practical Handbook for University Educators* (Palgrave Macmillan, 2013). He is the author of *America at Risk: The Citizen's Guide to Missile Defense* (Heritage Foundation, 1999), and has written numerous articles and op-eds on a wide range of national security topics.

Earlier in his career, Dr. Anderson served three years on active duty as an intelligence officer in the United States Marine Corps, and then became a reservist in the Individual Ready Reserve.

Dr. Anderson earned his Doctorate in International Relations and Masters of Arts in Law and Diplomacy from the Fletcher School, Tufts University. He graduated Magna Cum Laude from Amherst College with a Bachelor of Arts in Philosophy.

He is a recipient of the Department of the Army Superior Civilian Service Award (2012) and the Office of the Secretary of Defense Medal for Exceptional Public Service (2009).



Unclassified Statement of

**Lieutenant General Samuel A. Greaves, USAF**

**Director, Missile Defense Agency**

*Before the*

**House Armed Service Committee**

**Subcommittee on Strategic Forces**

**Wednesday, May 8, 2019**

*Embargoed Until Released by the  
House Armed Services Committee  
United States House of Representatives*

**Lieutenant General Samuel A. Greaves, USAF  
Director, Missile Defense Agency  
Before the  
House Armed Services Committee  
Subcommittee on Strategic Forces Subcommittee  
May 8, 2019**

Good afternoon, Chairman Cooper, Ranking Member Turner, distinguished Members of the subcommittee. I appreciate this opportunity to testify before you today on one of the President's highest defense priorities for Fiscal Year (FY) 2020.

The Missile Defense Agency (MDA) budget request of \$9.431 billion for FY 2020 will continue the development, rigorous testing and fielding of reliable, increasingly capable, and state-of-the-art defenses for the United States, our deployed forces, and the forces and territories of our allies and partners against current and projected missile threats. The Agency's priorities for missile defense development and fielding will remain as follows: 1) continue to focus on increasing system reliability and sustainment to build warfighter confidence; 2) increase engagement capability and capacity; and 3) address the advanced threat. We will continue to collaborate closely with the Warfighter and support the current and future needs of the Combatant Commanders and the Services. Specifically, we will work closer with them on the development, testing, deployment, and integration of interceptors, sensors, and the command and control, battle management and communications (C2BMC) system into a multi-domain system for the Ballistic Missile Defense System (BMDS).

First, I am pleased to report that we have nearly completed execution of the emergency appropriations requested in the FY 2018 Budget Amendment that provided funding to enhance the nation's missile defense and defeat capabilities. I once again want to express my appreciation to the Congress for its support in this process.

Additionally, we have made great progress since 2002 improving missile defense performance, affordability, and reliability. The *2019 Missile Defense Review* (MDR) underscores the evolving missile threat we face and that missile defense must remain a high priority investment in our National Defense Strategy. Indeed, the missile defense mission is expanding to include non-ballistic threats. Aligned with current national security and defense strategies, the MDR strengthens our posture as we continue to make progress in the development and fielding of a BMDS to defend the homeland, our deployed forces, and our allies and partners, and it supports the critical need to pursue new concepts and technologies to address tomorrow's threat. The MDR also underscores our continued pursuit of cooperative relations with allies and partners to field interoperable and effective regional missile defenses.

The current BMDS can defeat the current ballistic missile capabilities of our adversaries, but we require additional capacity and advanced capabilities to stay ahead of the evolving threat. The projected missile threat is complex and volatile, and it includes new ballistic missile systems, advanced cruise missiles, and hypersonic missile capabilities, which are now being actively tested by other nations. It is critical we continue to develop innovative and breakthrough technologies to outpace rogue state offensive missile capabilities against the U.S. homeland.

Evolving regional offensive missile systems can threaten U.S. forces abroad, allies, and international partners, and so we also must continue to modernize U.S. regional missile defenses. We have several new technology efforts to improve discrimination capabilities and deliver space sensors to improve the ability of the system to conduct kill assessment following engagements. MDA also is continuing efforts to develop scalable, efficient, and compact high-energy lasers for potential use against threat missiles in the boost phase of flight.

In light of these realities in the current security environment, MDA understands the importance of innovating, developing, and delivering new missile defense capabilities quickly, accelerating where possible missile defense acquisition timelines while adhering to sound acquisition principles. U.S. missile defenses must be responsive to existing and new threats and leverage new approaches to the homeland and regional defensive missions by delivering capabilities faster, learning from failures to make rapid adjustments, and swiftly adapting our systems once they are fielded.

Mr. Chairman, I would like to recognize the personnel at MDA as being among the most skilled and dedicated in the nation. Additionally, the nation's preeminent Federally Funded Research and Development Centers (FFRDCs) and University Affiliated Research Centers (UARCs) are integral partners providing technical depth, innovation, engineering excellence, and core competencies that are critical to providing capability and capacity to the warfighter in an expedited manner. Working together with our partners in the Services, allies, and industry, this highly capable workforce makes it possible to develop and deliver the effective and reliable defenses we need to counter the proliferating missile threat.

### **Missile Threat**

Nearly all of our adversaries are devising various means to complicate missile defense operations. Missile defense countermeasures continue to be developed and fielded. Increasingly threat missiles are displaying maneuver capabilities such as maneuvering reentry vehicles (MaRV). Future supersonic and hypersonic powered cruise missiles may be launched from aircraft or by large rocket boosters that have traditionally been associated with ballistic missiles. Hypersonic glide vehicles are being developed as a new type of ballistic missile payload. The

combination of high speed, maneuverability, and relatively low altitude makes them challenging targets for missile defense systems.

In 2016 and 2017, North Korea conducted over 40 launches of missile systems of all ranges; this included two new intercontinental-range ballistic missiles (ICBM). As configured, the Hwasong-14 ICBM can reach North America, and the Hwasong-15 ICBM can reach the Continental United States. Pyongyang flew two Hwasong-12 Intermediate-Range Ballistic Missiles (IRBMs) over Japan in 2017, placing the territory and population of our allies at potential risk from falling missile debris. The second of these tests demonstrated a capability to reach over 3,700 kilometers, which can range beyond Guam. North Korea twice flight-tested a solid-propellant Medium-Range Ballistic Missile (MRBM), which is capable of reaching Japan. This advancement is significant because solid-propellant missiles can be prepared for launch more rapidly than liquid-propellant systems, which challenges U.S. pre-launch counter missile operations. North Korea remains capable today of conducting additional missile launches and further strategic-weapon testing.

Iran has ambitious ballistic missile and space launch development programs and continues to attempt to increase the lethality of its ballistic missile force. Iran is fielding increased numbers of theater ballistic missiles and improving its existing inventory with MaRVs, submunition payloads, and multiple seekers that enable anti-ship missions. Iran's ballistic missiles are capable of striking targets throughout the region, ranging as far as southeastern Europe. Within the Middle East, Iran has conducted missile strikes on targets in Iraq and Syria. It continues to proliferate ballistic missiles to states and non-state groups, such as the Huthi rebels in Yemen. Iran's ongoing missile tests demonstrate its desire to increase the accuracy and effectiveness of its capabilities. Continued investments in its space launch vehicle program also

have been notable. Iran's July 2017 launch of a Simorgh space launch vehicle demonstrated technologies that are virtually identical and interchangeable with those used in ballistic missiles, in particular ICBMs.

### **Increasing System Reliability through Testing, Warfighter Collaboration, and Cybersecurity**

MDA continues to enhance the reliability and functionality of current missile defense systems, especially the performance of the Ground-based Midcourse Defense (GMD) Ground Based Interceptors (GBIs) and Aegis BMD Weapon System/Standard Missile (SM)-3, build the confidence of Warfighters in the BMDS, and reduce the number of interceptors needed to defeat in-flight ballistic missile threats.

#### ***System Reliability***

MDA executes a continuous program to improve system reliability and manage service life of BMDS components. For example, we have implemented a series of upgrades to increase the overall reliability of homeland missile defenses. Recent improvements to the GMD ground system architecture replaced a number of obsolete components and the original Command and Launch Equipment with a GMD Maintenance Manager, increased system redundancy, and enhanced cyber resiliency. The GMD program also has advanced GBI stockpile reliability. In prior years, two GBIs were removed from the fleet, inspected and tested to gain understanding of how GBIs age in the silos. Another GBI will be similarly tested this year. This testing will enable service life extension for the GBI fleet. MDA also pursues reliability improvements through our development activities. We measure availability and reliability data in the field and target improvements in the GBIs and GMD ground system development programs. A key delivery this year was the Ground System 7A.0.1 software, which eliminated cyber vulnerabilities and also

improved redundancy for the Warfighter. Key future reliability improvements include delivering interceptors with Redesigned Kill Vehicles (RKVs) and upgrading the GMD Communications Network and launch support equipment.

We also continue to improve the system and missile reliability of Aegis Ballistic Missile Defense (BMD). For example, improvements to the Aegis Weapon System with the Aegis Baseline (BL) 9.C2.0 (BMD 5.1) upgrade enhances reliability and improves cybersecurity. We conducted several successful ground and flight tests in FY 2018 of Aegis BL 9.C2.0 to demonstrate these enhancements.

We continue to improve the system reliability of the seven Terminal High Altitude Area Defense (THAAD) batteries that have been delivered to the Army's inventory, including those deployed to Guam and U.S. Forces Korea. Improvements to THAAD include software upgrades for the batteries and the Army's THAAD Institutional Training Base to improve cybersecurity and system performance against current and emerging threats. We conducted FTX-35 and numerous ground tests demonstrating improved reliability in the interoperability between and THAAD and the Patriot weapon systems.

#### ***Missile Defense Testing***

MDA continues to execute a robust and aggressive test program that conducts meaningful missile defense testing. These tests demonstrate BMDS capabilities and provide confidence to Combatant Commanders in the capabilities being delivered. We remain committed to “fly before you buy” through collaboration with independent testers within the Department -- the Director, Operational Test and Evaluation (DOT&E); Deputy Assistant Secretary of Defense, Developmental Test & Evaluation; Combatant Commands; the Joint Functional Component Command for Integrated Missile Defense; Service Operational Test Agencies (OTA); and the

Joint Interoperability Test Command -- to develop the Agency's strategic test program as documented in the Integrated Master Test Plan (IMTP). The IMTP provides a flight-, ground-, and cyber-test program, to include the rigorous modeling and simulation (M&S), systems engineering and validation, and verification and analysis necessary to demonstrate and deliver proven integrated capabilities against the evolving threat. Tests comprised of multiple shooters, sensors, and command and control assets, weapon system improved functionality, and evolving targets drive the increasing complexity of our test program. We are using more threat-representative targets, longer-range targets, and simultaneous target launches in our test events. In addition, we are increasing our cybersecurity and international testing to execute a robust, cost-effective test program.

Our system ground tests are the primary source for system performance data, and they test our capability across a wide range of threats and environments that flight tests cannot replicate affordably. MDA and the BMDS OTA Team are making significant progress accrediting the ground test M&S to support developmental and operational assessments. The BMDS OTA Team, which provides an independent operational assessment of the BMDS, relies heavily on the MDA ground test program to independently assess MDA's operational capability. Ground tests allow analysts to characterize BMDS performance under varying conditions, with unconstrained red and blue force limitations, and without the safety, fiscal, and hardware availability limitations of flight-testing. Additionally, with Warfighters on console, they are able to use ground tests to refine Tactics, Techniques, and Procedures. All ground test data are used to inform DOT&E BMDS capability assessments.

In addition to 17 element-level ground tests, we conducted six developmental and operational system-level ground tests from April 2018 to present. There are four additional



system-level ground tests scheduled for FY 2019 and 10 more planned for FY 2020. Since April 2018, we also conducted or participated in more than 25 multi-event exercises and wargames, which are critical to the reliability and performance assessments of the Combatant Commands and the intensive engineering efforts across the Agency.

In FY 2018, the Agency began development of a high-fidelity, all-digital, integrated BMDS simulation to support both developmental and operational BMDS assessments. This effort integrates the best high-fidelity, all-digital models from each BMDS element using an integrating framework that manages time and the distribution of stimulus and is progressing towards MDA's first use in Calendar Year (CY) 2021.

Beginning in FY 2019, we are undertaking an across-the-board re-architecture of the M&S used in ground tests to address current limitations. With incremental deliveries scheduled over the next five years, this effort will improve every aspect of ground test M&S, including accuracy, efficiency, capacity, and credibility. By streamlining the interfaces between models, we will improve the speed with which we can integrate the BMDS and reduce the likelihood of integration errors.

Flight testing provides data for M&S and demonstrates the end-to-end performance functions of the operational system that ground testing cannot address. One of the key attributes of each flight test is combining the system under test with the Warfighters who plan to operate the system in wartime under operationally realistic conditions. We also work closely with our allies to demonstrate the integration and interoperability of BMD capabilities prior to fielding. From April 2018 to present we have executed nine flight tests. For the remainder of FY 2019, we will conduct 10 additional flight tests. Recently, on March 25, 2019, we successfully executed the first salvo test using the GMD weapon system. We will conduct 14 flight tests in FY 2020, to

include additional Terminal High Altitude Area Defense (THAAD) and Patriot integration tests in support of the USFK JEON; a Ground-based Midcourse Defense (GM) Booster Vehicle Test (BVT) flight test of the 2-/3-stage selectable GBI; and the first Aegis BMD SM-3 Block IIA test against an ICBM-class target. The Agency is also conducting detailed planning to execute the second operational test of Regional/Theater Increment 5 air and missile defense system capabilities; it will be the largest air and missile defense live-fire test in history.

### *Cybersecurity*

MDA remains vigilant of the growing cyber threat and we continue to work aggressively to ensure the nation's missile defenses are hardened, resilient, and able to operate in a highly contested cyber threat environment. We are strengthening the cyber defensive posture of missile defense capabilities by ensuring the cybersecurity infrastructure has the latest upgrades. MDA remains focused on supporting the DoD Cybersecurity Campaign through implementation of the DoD Cybersecurity Discipline Implementation Plan -- Four Lines of Effort for: Strong Authentication, Hardening of Systems, Reducing the DoD Attack Surface, and Alignment to Cybersecurity Service Providers (CSSP) across all networks and, where applicable, BMDS weapon systems.

MDA defends its networks against the advanced persistent cyber threat through its Computer Emergency Response Team (CERT). This team provides 24/7 network monitoring and defense of over 24 thousand network devices and continues to expand its breadth of coverage. This has increased the number of recorded cyber events from 3.3 billion to 11 billion per month, leading to actionable defensive measures by three-fold in the past year alone. MDA has continuously supported DoD cyberspace efforts by providing timely MDA cyber situational awareness. To ensure MDA cyber defense posture and activities are synchronized with U.S.

Cyber Command priorities, MDA has supported as many as eight named operations at a time through active network defense measures and daily input to the Joint Force Headquarters, Department of Defense Information Cyber Tasking Order. Lastly, MDA collaborated with US Cyber Command, National Security Agency, as well as open source partners to gather and analyze more than 3.4 million threat indicators over the past year in order to characterize and identify cyber threats to MDA capabilities. MDA also has partnered with the Intelligence Community to identify threat indicators against BMDS elements and is taking action to mitigate known threats to the BMDS.

MDA has engaged with our defense industrial base (DIB) corporate partners to ensure cybersecurity is prioritized, addressed and enforced at all levels of MDA's highly complex supply chain. We continue to make strides in this arena, where our technology is largely generated and where our controlled unclassified information (CUI) resides. The government has contractual relationships with only the prime contractor and has limited knowledge and visibility with the remainder of the supply chain. Our first order of business is to have prime contractors minimize the flow down of information requiring protection. Realizing this is not an absolute solution, we have recently initiated collaborative efforts with industry on two pilot efforts to illuminate where CUI resides within the entire contract supply chain.

Not only are we focused on external threats to our enterprise, but MDA acknowledges the reality of the insider threat as one of the more pervasive threats to be addressed, and we have established and implemented an aggressive Agency Insider Threat Program. This allows us to monitor both internal and external data movement to ensure all unclassified and classified data is handled in accordance with applicable guidance and is also afforded the highest level of protection. We are continually evaluating our attack data and updating the MDA Emergency

Response Team procedures. Abnormalities or violations are quickly identified and thoroughly investigated by both MDA and DoD Insider Threat and Counter Intelligence.

This year MDA engaged in significant improvements in cyber resiliency, increasing the programs' ability to prevent, mitigate, and recover from cyber effects on mission capabilities. We extended defense coverage to the BMDS OPIR (Overhead Persistent InfraRed) Architecture (BOA) system and implemented additional C2BMC tools to create a diverse layered defense capability. MDA also upgraded cyber defense for sensors by adding monitoring tools. GMD is actively updating its monitoring tools, improving its cyber defensive capabilities, and training its cyber incident responders to address modern, sophisticated cyber threats. Extensive cyber testing involving C2BMC, sensors, and GMD was conducted in platform-level and system-of-systems integrated cyber tests pursuant to new platform and increment releases. C2BMC performed in 25 cyber related test events. MDA developed the cybersecurity test strategy, test plans, and coordination with external stakeholders such as DOT&E, National Security Agency (NSA) (Platform Resiliency & Mission Assurance division), Survivability/Lethality Analysis Directorate (a directorate of Army Research Lab), Army Threat Systems Management Office, and NSA's Cyber Protection Team, providing Red and Blue Team test experts. The increased cyber situational awareness, training, and improved cyber defense performance were demonstrated through significantly improved cyber test results. Cybersecurity requires team synergy balance capability with security requirements, Warfighters considering potential cyber effects with maintenance outages, and increased diligence of daily technicians and those responsible for cybersecurity programs. We will support the Combatant Commands in Persistent Cyber Operations testing in 2019, adding real-time daily test, fix, and cyclic test improvements to the BMDS cyber posture.

MDA is actively integrating cybersecurity and cyber resiliency requirements early into the acquisition life cycle to increase security and reduce overall cost. For example, we are upgrading C2BMC and the GMD ground systems software and hardware to enable enhanced cybersecurity protection capabilities. To better support our Combatant Commanders, in 2018 we successfully executed seven operational Adversarial Assessments and Cybersecurity Vulnerability & Penetration Assessment on BMDS systems culminating in an Adversarial Assessment during Ground Test Distributed-07b US European Command / US Central Command. This is a significant step in understanding the cybersecurity posture of the BMDS and the ability to defend against emerging cyber threats.

The MDA office of the Chief Information Officer executes several testing efforts across MDA systems on an annual basis. This cybersecurity testing includes all BMD elements, development labs, and test systems. In 2018, cyber testing included 26 cybersecurity controls validation tests, six vulnerability assessments, 46 software assurance code reviews, and 308 cybersecurity risk assessments. MDA also executes BMDS element- and system-level tests that support fielding of new capability to be included in the Operations Capacity Baseline. Per Section 1647 of the FY 2016 NDAA, MDA executes operational weapon system cyber-testing and develops risk mitigation strategies for the congressional report scheduled to be delivered first quarter FY 2020.

Our partnership with DOT&E to implement a rigorous Test and Assessment Program is focused on ensuring cybersecurity compliance, resiliency, and protection and has supported our comprehensive cybersecurity efforts since 2010. In 2018, the Agency took critical steps to improve the BMDS cybersecurity posture. We implemented a proactive approach to MDA Cybersecurity Test and Assessment to support development of assessment requirements, detailed

test designs, and executable schedules. To further harden the BMDS, we approved the MDA Standing Ground Rules to support Combatant Command Persistent Cyber Operations. Moreover, we executed seven operational Adversarial Assessments on the BMDS Weapon Systems, to include THAAD, the Army Navy/Transportable Radar Surveillance and Control Model-2 (AN/TPY-2) radar, and C2BMC, in addition to six Cybersecurity Vulnerability & Penetration Assessments. In FY 2019 and FY 2020, we will continue to plan cyber assessments on additional assets in the homeland defense architecture and an operational assessment of the EPAA Phase 3 architecture, to include Aegis Ashore-Poland. MDA is committed to implementing cybersecurity in all phases of development, integration, deployment and sustainment of the BMDS.

In FY 2018, MDA took a proactive approach to cybersecurity by modifying contracts, including system level specifications that include cyber resiliency requirements. The contract modifications address compliance, security engineering, design, development, assessments, testing, physical security and program security. The key to executing this strategy is the understanding of the linkage that cybersecurity has with system engineering and the acquisition processes. Incorporating cybersecurity into the systems engineering directorate aligns cybersecurity functions to the following other functions: software, modeling and simulation, future concepts, requirements, and system integration. This alignment ensures cybersecurity is embedded early and often in the systems engineering and development life cycles.

I am confident in our cybersecurity posture and our plans for additional cybersecurity improvements. Our innovative teams continue to refine processes and procedures in this fast-paced, ever-changing and unforgiving cyber environment. We intend to improve our cyber resiliency capabilities through increased cyber sensors, enhanced centralized visibility, and

increased cyber vigilance, all while preserving warfighter confidence in a critical national defense asset.

#### ***Left-Through-Right-of-Launch***

During the past year, MDA has been working with other elements of the Department on a comprehensive effort to create a more robust missile defeat strategy.. This integration will enable the United States to identify and exploit opportunities to detect, disrupt, and destroy threat missiles. Collaboration between the Intelligence Community, Combatant Commands, State Department, the Office of the Secretary of Defense (OSD) and Joint Chiefs of Staff, and MDA has resulted in the Department developing a ballistic missile left-through-right-of-launch (LTRI) framework that will enhance sharing of data, technologies and capabilities across warfighter, policy, intelligence, and acquisition organizations. It includes discovery and development of new technologies to facilitate integration, improved data-sharing between systems, alignment of programs, and creation of a multi-year test campaign to integrate future capabilities and close gaps. The LTRI framework, governed by an Integration Senior Strategy Group (ISSG) with representatives from more than 20 organizations, provides a forum for development of comprehensive strategies to defeat any ballistic missile threat to the homeland, regardless of origin.

#### **Increasing Engagement Capability and Capacity**

This budget request maintains operational missile defense capabilities for existing operational homeland and regional defense forces and will continue to increase interceptor inventory capacity and use existing technologies to improve sensors, battle management, fire control, and kill vehicle capabilities to address evolving threats.

### Homeland Defense

MDA remains committed to operating, sustaining, and expanding the nation's homeland missile defenses and requests \$1.83 billion in FY 2020 for the GMD program. The Agency will continue to demonstrate improved performance through flight- and ground-testing of homeland defenses, integrate additional capabilities by development of a suite of Advanced Discrimination Radars (ADR) that maximize the engagement space of regional and homeland missile defense, to include the Long Range Discrimination Radar (LRDR), Homeland Defense Radar- Hawaii (HDR-H), and Pacific Radar. These additional ADR sensors, coupled with the Redesigned Kill Vehicle development and enhanced C2BMC will expand the GBI engagement capabilities while simultaneously improving effectiveness. We will continue improving our sensors, C2BMC, GMD ground systems hardware/software upgrades, GMD Fire Control (GFC), and kill vehicle software to improve discrimination capabilities and overall system performance. We also will continue to improve confidence in our reliability through increased testing and analysis.

Over the life of the BMDS, the intercept flight tests of the nation's homeland defenses have increased in complexity with the employment of realistic test scenarios and the use of operational weapons, sensors and fielded software. With the March 25 successful intercept of an advanced ICBM-class target with countermeasures (FTG-11), the Department executed the first test involving a salvo engagement, involving two GBIs launched from the missile field at Vandenberg Air Force Based in California. All system elements functioned as designed. The ICBM-representative target was launched from the Reagan Test Site on the Kwajalein Atoll, Marshall Islands in the Broad Ocean Area in the Pacific over 4,000 miles away. Following detection by Air Force Space Based Infrared System satellites, early tracking information was passed through C2BMC to precision discrimination sensors deployed on Wake Island (AN/TPY-



2 radar) and in the Pacific Ocean (Sea-Based X-band radar). Northern Command operators then authorized and launched the two GBIs. Once they were separated from the GBI boosters and in position, the exo-atmospheric kill vehicles successfully engaged the target complex, resulting in an intercept of the lethal warhead, with the trailing GBI observing the intercept flash and debris scene then intercepting the next most lethal object.

FTG-11 provided the data necessary to assess the performance of the GMD system, the evaluation of which will occur over the coming weeks and months. An Aegis BMD (ABMD) ship in the ABMD 5.1 (Aegis Baseline 9.C2) configuration participated in this test by tracking the ICBM target and executing a simulated SM-3 Block IIA engagement of the target as risk reduction for the planned FY 2020 SM-3 Block IIA test against an ICBM target. In that test we will determine if this advanced capability could be an additional layer of defense in support of the GMD system. During the test Spacebased Kill Assessment satellites provided data required to assess successful intercepts. We also collected real-time data from F-35 aircraft/sensors participating in the test to assess quality of track data for integration into the BMDS architecture.

*Increasing GBI Capacity:* MDA currently has 44 operational GBIs and, in accordance with the FY 2018 Missile Defeat and Defense Enhancement initiative, plans to expand the fielded GBI fleet to 64 in response to the rapidly advancing North Korean threat. MDA is developing the capability to provide the Warfighter the option of using all three GBI booster stages or not igniting the third stage, which would provide performance similar to a 2-stage boost vehicle. This 2-stage booster capability will provide additional homeland defense battle-space capability by enabling shorter engagement times without the expense of a separate development program. This capability is planned to be tested in a non-intercept flight test, after which it will be integrated into all boost vehicle configurations.

*Redesigned Kill Vehicle:* As a follow-on to the existing GBI program, MDA initiated the fielding of an additional 20 GBIs, tipped with the RKV upon completion of the development program, at Fort Greely, Alaska (FGA). The RKV will address the evolving threat, enhance kill vehicle reliability, improve in-flight communications to better utilize off-board sensor data, and heighten Combatant Commanders' situational awareness via hit/kill assessment messages. Initial plans were to field GBIs with RKVs as early as 2023 within an acquisition strategy that is disciplined, gated, and milestone-driven. Using this strategy and with inputs from key stakeholders, I assessed the RKV program did not meet the entrance criteria for the Critical Design Review, resulting in a projected delay in the program of up to two years. Re-planned RKV test efforts include Ground-Based Midcourse Defense Flight Test GM-Boost Vehicle Test-02 (GM BVT-02), a non-intercept mission in support of 2- or 3-Stage selectable boost vehicle software that will provide additional engagement battlespace to the warfighter using a GBI launched from VAFB, California in FY 2020 and Flight Test GM-Controlled Test Vehicle-03+ (GM CTV-03+), a non-intercept mission to collect RKV flight environment data in FY 2022. The first intercept flight test utilizing the RKV is planned for FY 2023, and a second intercept flight test in FY 2024.

The effort to reach 64 deployed GBIs requires MDA to develop and produce the RKV, construct a new missile field (Missile Field 4) at Fort Greely, install 20 silos, and deliver an additional 20 GBIs tipped with RKVs. In addition, MDA will initiate a plan to ensure that no less than 64 GBIs are available to the Warfighter at all times. To accomplish this, MDA will add two silos to Missile Field I at FGA and purchase six additional boosters.

*Ground System Upgrades:* MDA continues to develop and field capability upgrades and technology modernization of key ground support and fire control system components. These

include upgrades to the GMD Launch Support System, Communications Network, and the In-Flight Interceptor Communication System Data Terminals. Additional upgrades include improvements to the GFC-Warfighter interface, 2-/3-stage selectable GBI battle management, discrimination improvements, enhancements to the kill vehicle Target Object Map, and On-Demand Communications for the RKV. Ground system modernization will continue to mitigate obsolescence issues, improve cyber resilience, increase GFC capacity for emerging threat complexity and raid size, reduce life-cycle cost, increase system reliability and operational availability, and simplify the insertion of future technologies.

*Defense Sensors:* We are investing in radars and developing advanced electro-optical sensors to achieve a diverse sensor architecture to provide highly accurate midcourse tracking, discrimination and battle damage assessment for homeland missile defense. We request \$194.3 million to sustain the COBRA DANE radar, the Upgraded Early Warning Radars (UEWR), and the AN/TPY-2 radar. The Services and Combatant Commands, with logistical support from MDA, operate a fleet of five AN/TPY-2 (Forward Based Mode) radars in Japan, Israel, Turkey, and U.S. Central Command in support of homeland and regional defense.

We request \$283.5 million to continue radar development, to include advanced discrimination algorithms for the AN/TPY-2 and Sea-Based X-band (SBX) radars to counter evolving threats. The improvements will develop and field integrated capabilities to improve the BMDS ability to identify lethal and non-lethal objects. In FY 2019, MDA will complete transition to production development activities for next-generation Gallium Nitride (GaN) Transmit/Receive Integrated Multichannel Modules to support the AN/TPY-2 obsolescence and sparing strategy and set the condition for enhanced performance in the future. MDA requests \$105.5 million for BMD Sensors testing activities for planning, analysis, and execution of

BMDS flight test events, including pre- and post-test efforts, such as Digital and Hardware-in-the-Loop Pre-Mission Tests and Post-Flight Reconstruction.

MDA requests \$128.2 million for the SBX radar. The SBX is an advanced mobile radar that provides precision midcourse tracking and discrimination capabilities. The SBX participates in flight tests to demonstrate discrimination and debris mitigation improvements. Our budget request includes funds to continue extended operations for defense of the homeland in the U.S. Indo-Pacific Command and U.S. Northern Command areas of responsibility.

We request \$136.4 million to continue development of the LRDR. The LRDR will provide persistent long-range midcourse discrimination, precision tracking and hit assessment to support the GMD capability against long-range missile threats from the Pacific theater. LRDR's improved discrimination capability in the Pacific architecture increases the defensive capacity of the homeland defense interceptor inventory by enabling conservation of GBIs. LRDR includes threat discrimination improvements to enhance BMDS effectiveness against the evolving threat. LRDR also supports other mission areas, including Space Situational Awareness. Initial fielding/deployment of the LRDR is planned for calendar year 2020. We are on-schedule for the Technical Capability Declaration in late 2021, leading to Warfighter Operational Acceptance in 2022.

The Department conducted a Sensors Analysis of Alternatives (AoA) to assess the most cost-effective options for enhanced sensor capability to increase GBI effectiveness against future complex threats. The Sensors AoA report highlighted the operational value of placing additional discrimination radars in the Pacific region. Based on the report's finding, MDA completed site surveys for the HDR-H in FY 2017. In FY 2018 we conducted source selection activities for the HDR-H and, last December, awarded this radar as the first delivery order on a fixed-price

indefinite delivery/indefinite quantity (IDIQ) contract. MDA is requesting \$274.7 million in FY 2020 for the HDR-H.

The Pacific Radar will leverage a forward position to maximize BMDS discrimination areas for both homeland and regional missile defense. MDA plans to competitively award the Pacific Radar as the second delivery order on the IDIQ contract. MDA is requesting \$6.7 million in FY 2020 for the Pacific Radar. Coupled with LRDR, both radars will close coverage gaps in the Pacific architecture, provide persistent long-range acquisition, midcourse discrimination, precision tracking, and hit assessment to support homeland defense against long-range missile threats.

Space provides the critical vantage point necessary to address rapidly advancing threats across multiple regions of interest and the only vantage point for global persistence to address Warfighter requirements. A space-based sensor layer consisting of two separate constellations, one for tracking and discriminating ballistic missiles and one for tracking dim ballistic targets and hypersonic missiles, would enable the United States to use interceptor inventory more efficiently and effectively to counter a broad array of threats. Integrated space and terrestrial sensors for tracking, discriminating, cueing and targeting ballistic missile threats can improve missile defense architecture performance and robustness.

We are requesting \$27.6 million for the Spacebased Kill Assessment (SKA) program. Using fast frame, infrared sensors, SKA will deliver a kill assessment capability for GMD defense of the homeland as part of an integrated post-intercept assessment solution requested in the FY 2014 NDAA. As MDA's pathfinder program to host military payloads on commercial/other satellites, SKA, which received the DoD's 2018 David Packard Award for Acquisition Excellence, proved that commercial/other hosting can deploy assets on orbit quickly

and at an appreciable cost savings. To increase the Department's overall experience with commercial hosting, MDA collected and shared its SKA lessons learned with several organizations, including the Defense Advanced Research Projects Agency (DARPA) and U. S. Air Force. SKA sensors are participating in a variety of MDA flight tests and engineering missions to better understand the full capabilities of the SKA network. For example, SKA participated and performed well in FTI-03, an Aegis BMD test, and FTG-11, the GMD salvo test. In FY 2020 we will focus on steps necessary to add the SKA system to the operational BMDS.

Also, we request \$35.9 million in FY 2020 for continued operation of the Space Tracking and Surveillance System (STSS) and the Missile Defense Space Center (MDSC). STSS satellites, launched in 2009, have exceeded their life expectancy and proven to be a good investment. These satellites operate in low Earth orbit and continue to collect valuable test data. The STSS program and MDSC support concept development activities for space sensor architecture studies and analyses to address advanced threats.

MDA is working with the Space Development Agency (SDA), DARPA, and the U.S. Air Force to conduct prototype concept design activities for a space-based missile tracking sensor system known as Hypersonic and Ballistic Tracking Space Sensor (HBTSS). HBTSS is one of several proposed missions within the DoD's Proliferated Low Earth Orbit (P-LEO) space architecture led by SDA. As part of an integrated multi-tier OPIR enterprise architecture, HBTSS would detect and track additional and emerging threats using persistent infrared sensors. MDA and the SDA are partnering with DARPA and Air Force Space Command (AFSPC) to ensure our nation's ability to detect and track evolving threats. MDA will coordinate and leverage DARPA's Blackjack program for advances in the areas of production-line satellite buses

and spacecraft autonomy approaches in parallel with the HBTSS risk-reduction efforts. MDA is partnering with AFSPC on integrated missile warning and missile defense requirements definition and will explore opportunities to partner with the Air Force on ground services, integration, launch, and operations. MDA is using STSS as a testbed for HBTSS, and MDA will continue to leverage the Enterprise Capabilities developed collaboratively within other Department and federal agencies. MDA will work with SDA to ensure that HBTSS is compatible with a potential P-LEO data and communications transport layer.

*Command and Control, Battle Management and Communications:* We request \$564.2 million in FY 2020 for C2BMC. C2BMC provides persistent acquisition, tracking, cueing, discrimination, and fire-control quality data to Aegis BMD, GMD, Terminal High Altitude Area Defense (THAAD), Patriot, and coalition partners to support homeland and regional missile defense. We continue to support Warfighter command and control and battle management needs across the globe by providing the Combatant Commander with the BMD planner, situational awareness tools, and battle management capability to support global BMD situational awareness, coalition operations, weapons release authority for homeland defense, and control and tasking of the forward-based AN/TPY-2 radars, LRDR radar, and the HDR-H radar. C2BMC operators and maintainers deploy forward in some of the world's hottest threat spots and continue to provide around-the-clock support to the local commanders.

In FY 2020, we will continue development of C2BMC Spiral 8.2-5, which provides system-level discrimination data, BMDS Overhead Persistent InfraRed (OPIR) Architecture (BOA) 7.0 to provide advance threat warning capability with space sensors and threat characterization solutions and support command and control integration of the LRDR into the BMDS by 2021. These efforts support a robust homeland defense capability and integration of

HDR-H into the BMDS by 2023. Spiral 8.2-5 also will include initial integration and testing of the new Army Integrated Air and Missile Defense Battle Command System. C2BMC will continue development of Spiral 8.2-7 to meet the BMDS Increment 7 requirements, including command and control of the HDR-H radar, SKA sensor operationalization and prototyping for robust Post Intercept Assessment supporting homeland defense, expansion of C2BMC space tracking capability, and additional system-level discrimination data integration and integrated threat characterization.

In 2018, we successfully fielded C2BMC Spiral 8.2-1 and BOA 5.1 to U.S. Northern Command and U.S. Indo-Pacific Command and C2BMC Spiral 8.2-3 to U.S. European Command and U.S. Central Command along with the BOA 6.1 to Northern, Indo-Pacific, European and Central Commands. For the USFK JEON, we fielded a C2BMC Spiral 8.2-1 User Node providing improved BMD situational awareness and communications for USFK.

We continue supporting incremental improvements to the BMDS to keep pace with emerging threats worldwide by investing in the development, integration, and testing of advanced algorithms to improve track and discrimination capabilities and enhance the use of space-based sensor data from sources such as the Space Based Infra-Red System (SBIRS), using the BMDS OPIR Architecture. C2BMC will continue to update hardware/software to increase cybersecurity. The Air Force and MDA also will execute the MDR's direction to deliver a joint report to Department stakeholders within six months of the release of the MDR on how to integrate the F-35, including its sensor suite, into the BMDS for homeland and regional defense.

#### Regional Defenses

There are hundreds of theater-range ballistic missiles deployed worldwide. Our FY 2020 budget request continues to resource and build integrated regional missile defenses that are



interoperable with systems deployed by international partners to protect deployed forces, allies and international partners against Short-Range Ballistic Missiles (SRBMs), MRBMs, and IRBMs.

***Aegis Ballistic Missile Defense***

Aegis BMD continues to be a key component of the nation's regional defense for our deployed forces, allies, partners and friends, and directly supports and expands our homeland defenses with long-range surveillance and tracking capability. The FY 2020 budget request of \$897.3 million supports continued advancement of the Aegis BMD system to counter growing and more complex threats, including improvements in system reliability and missile reliability as well as increases in Aegis BMD engagement capacity and lethality.

We continued to expand Aegis BMD capability and capacity through new construction deliveries and upgrades on 10 Aegis ships: Three new construction DDG-51 Flight IIA Arleigh Burke-class destroyers (DDGs) with Aegis Baseline (BL) 9.C2.0 (BMD 5.1) were commissioned into service in FY 2018 as well as six Aegis BMD 3.6 ship upgrades to Aegis BMD 4.1, two non-BMD-capable ship upgrades to Aegis BL 9.C2.0 (BMD 5.1) through the Aegis modernization program and two Aegis BL 9.C1.0 (BMD 5.0CU) ships to Aegis BL 9.C2.0 (BMD 5.1). These additions and upgrades bring, among other things, Engage-on-Remote capability, SM-3 Block IIA, cyber improvements, and enhanced reliability to the Aegis fleet.

MDA's ability to keep Aegis BL 9 ships and Aegis Ashore in relatively the same configuration and under configuration control through in-service upgrades aligns training and Tactics, Techniques, and Procedures for the U.S. Navy and ensures the highest level of BMD capability is resident and consistent across the in-service and deploying fleet. We are strongly committed to further enhancing capability of the Aegis BMD system and continue to improve the

Aegis Weapon System in alignment with Navy programs. In coordination with the U. S. Navy, we currently have 38 BMD-capable ships, which will rise to 41 by the end of FY 2019. Per direction in the MDR, the Navy and MDA will develop a plan to convert all Aegis destroyers to be fully missile defense capable within 10 years.

In 2018, we successfully conducted a number of ground and flight tests of Aegis BL 9.2.0 (with BMD 5.1 integrated), which introduces significant new capabilities in U.S. Navy Aegis destroyers in support of Department of Defense priorities to increase lethality and validate the EPAA Phase 3 architecture. Aegis BL 9.2.0 (BMD 5.1) was a joint MDA-U.S. Navy development effort. For the MDA, Aegis BL 9.2.0 (BMD 5.1) delivered Significant Object Reporting to the BMDS, BMD reliability enhancements, and Engage-on-Remote capability with the SM-3 Block IIA missile, significantly expanding Aegis BMD's defended area. In September 2018, Aegis BL 9.2.0 (BMD 5.1) achieved U.S. Navy certification and we have commenced fielding this capability on in-service Aegis destroyers (affordable software updates to current Aegis BL 9.1 DDGs), modernized Aegis DDGs, new construction DDGs, and Aegis Ashore Romania and, upon activation, Aegis Ashore-Poland.

MDA conducted an international live fire event in support of Japan's modernization efforts, Japan Flight Test Aegis Weapon System (JFTM)-5, that successfully verified the performance of the Aegis J6 (with BMD 5.0CU equivalent capability) weapon system functionality, guiding a SM-3 Block IB Threat Upgrade (TU) to a lethal intercept of a SRBM target. This test completed the certification of the J6 combat systems baseline and was an important milestone for Japan's use of the SM-3 Block IB TU missile. MDA also completed an important Sensor Integration Study with The Netherlands that will inform their future BMD

efforts, conducted Pacific Dragon 2018 with the Japanese and South Korean navies, and continued cooperation in the U.S.-European Maritime Theater Missile Defense Forum.

We also conducted Flight Test Aegis Weapon System (FTM)-45, which successfully verified the performance of the Aegis BL 9.C2.0 (BMD 5.1) weapon system and SM-3 Block IIA functionality, guiding a SM-3 Block IIA missile intercept of a MRBM target. This flight test also provided objective quality evidence to finalize a detailed Failure Review Board of missile anomalies experienced earlier in 2018 during FTM-29. Automated BMD kill assessment was also successfully evaluated after intercept.

Finally, we successfully conducted Flight Test Integrated (FTI)-03, an operational test demonstrating the Aegis Weapon System Engage-on-Remote capability to track and lethally intercept an IRBM target with an Aegis Ashore-launched SM-3 Block IIA interceptor in a European Phased Adaptive Approach Phase 3 link architecture. In this case, Aegis Ashore calculated fire control solutions using remote AN/TPY-2 radar data, and then transmitted guidance messages to the interceptor, which then accomplished a lethal intercept of the lethal object. The engagement leveraged a ground-, air-, and space-based sensor/command and control architecture linked by the BMDS C2BMC suite.

In FY 2020, we will continue our commitment to develop, test, and deliver global naval capability to the Warfighter and support defense of U.S. deployed forces and European NATO allies through delivery of EPAA Phase 3 missile defenses. The MDA requests a total of \$822.8 million in procurement for Aegis BMD. As part of the overall Aegis BMD procurement request, MDA is requesting \$459.8 million to procure 30 Aegis SM-3 Block 1B missiles and \$238.00 million to procure seven SM-3 Block IIAs, along with associated hardware and support costs. By the end of FY 2020, we plan to have 238 SM-3 Block 1Bs and 11 SM-3 Block IIAs in

inventory. Also part of the request, we are continuing to explore the opportunity to enter into a five-year SM-3 Block IB Multi-Year Procurement (MYP) contract for FY 2020 - FY 2024. MDA will continue to deliver both SM-3 Block IBs and SM-3 Block IIAs for deployment on land at the Aegis Ashore site in Romania and at sea on multi-mission Aegis ships with BMD capability. The procurement budget also requests \$125.0 million for Aegis BMD weapon systems equipment to support program of record requirements.

In FY 2020, as part of our overall Aegis BMD request, we are requesting \$198.1 million for the SM-3 Block IIA program. This includes final efforts to transition from development into production, continued integration of the SM-3 Block IIA into the BMDS, along with certification and deployment activities to deliver SM-3 Block IIA rounds to the U.S. Navy and in support of EPAA Phase 3.

We remain committed to the Aegis BMD development required to deliver the new construction DDG-51 Flight III Arleigh Burke-class destroyer with Aegis BL 10 (with BMD 6.0 integrated) and SPY-6 Air and Missile Defense Radar (AMDR). We will continue to align with the U.S. Navy to develop and deliver a comprehensive Integrated Air and Missile Defense capability against advanced threats in the Arleigh Burke-class Flight III Destroyers for a 2024 Initial Operational Capability. Aegis BMD 6.0 exploits AN/SPY-6 radar improvements to enhance Aegis combat effectiveness, to include advanced discrimination, significantly improved raid defense, and expanded engagement battlespace. This will provide advanced organic capability at longer ranges to Flight III DDGs as well as enable BMDS utilization of AN/SPY-6 data for remote engagements while also supplementing deployed assets with simultaneous multi-mission capabilities. AN/SPY-6 will enable U.S. Navy ships to have a greater standoff range from threat environments, providing greatly improved operational flexibility. Aegis BL 10

Weapon System will integrate BMD capability with the advanced AN/SPY-6 for remote engagements and increased raid capacity with simultaneous multi-mission capabilities.

We continue joint U.S. Navy and MDA development of Aegis BL 5.4 (with BMD 4.1.2 integration), which merges Aegis BL 5.3 and Aegis BMD BL 4.1 into a single computer program with multi-mission capability and updated Identification Friend or Foe processing, a significant tactical advancement for individual U.S. Navy ships. We are actively working with the U.S. Navy to certify and initiate fielding of this capability in FY 2020. MDA also continues collaboration efforts with the U.S. Navy on AN/SPY-1 radar antenna improvements that, when coupled with Aegis BL 5.4, will increase AN/SPY-1 radar detection range and sensitivity, improving discrimination, performance, and stand-off distance from threat environments.

In FY 2020, we will also incorporate new BMD threats in Aegis BMD 5.1 that are inherent in the SM-3 Block IIA Build 8 missile software. We will also improve raid performance in Aegis BMD 5.1 through Force Level Engagement and Sensor Coordination – Raid. In FY 2020, we will expand our capability and capacity through execution of 19 Aegis BMD weapon system installations: one Aegis BMD 3.6 to Aegis BMD 4.1 upgrade (enabling a follow-on upgrade to Aegis BL 5.4); three non-BMD capable ship upgrades to Aegis BL 9.C2.0 (BMD 5.1); eight Aegis BL 9.B/C2 (BMD 5.1) Software Upgrade Installs; two Aegis BL 9.C2 (BMD 5.1) Backfit Installs; five Aegis BL 5.4 (BMD 4.1) Installs.

*Sea Based Terminal:* A sea-based terminal capability is critical to defending high value units at sea as well as protecting air and sea ports of debarkation during mobilization. Adding an additional layer to Aegis BMD, we are using an incremental development approach integrated within the Aegis BL 9 architecture to develop and deliver a Sea Based Terminal (SBT) capability. By expanding the capability of the SM-6 missile and associated Aegis weapon

system changes, we are delivering capability to maritime forces to protect against anti-ship ballistic missiles and provide a layered defense for forces ashore.

SBT Increment 1 was fielded in 2018 after completing the final testing in 2017. SBT Increment 1 built upon an existing weapon system performance and leveraged the Navy's SM-6 Block I design to deliver an operationally effective capability. In 2019, we continue to explore opportunities to expand this capability to in-service Aegis Weapon Systems.

SBT Increment 2, which further improves our endo-atmospheric defensive capabilities, was certified in September 2018. The introduction of SM-6 Block 1A with modifications, which expands capability against SRBM threats, provides larger operating areas with higher performance against threats expected in the 2020 timeframe and will undergo testing in FY 2019 and FY 2020. The flight test program supporting the SBT Increment 2 program consists of three flight tests. The first test, FTM-31, is planned for late FY 2019. FTM-31, a Development Test with Commander, Operational Test & Evaluation Force participation, consists of two independent events, both of which support the SM-6 Dual II missile Engineering Change Proposal production cut-in approval and subsequent delivery to the fleet. FTM-31 Event 1 will demonstrate an Aegis BL 9.C2 engagement of a MRBM target with an SM-6 Dual II (BMD initialized) missile. FTM-31 Event 2 will demonstrate an SM-6 Dual II engagement of an Anti-Air Warfare target. The second and third tests, FTM-32 and FTM-33, are planned for FY 2020.

SBT Increment 3 is critical to meet emerging and more complex threats. SBT Increment 3 will expand on the current capabilities of the Aegis Weapon System and leverage SM-6 engineering efforts achieved to date. This engineering effort will provide increased engagement capability against advanced threats by building on capability provided by prior SBT Increments.

SBT Increment 3 System Requirements Review was completed in December 2018 and in FY 2019 will define a preliminary design to support delivery of full capability in FY 2024.

*Aegis Ashore-Poland:* We continue to support the EPAA as a major U.S. contribution to NATO's BMD capability, providing coverage and protection of NATO's European territory, populations, and forces against the increasing threat of ballistic missile proliferation in the Middle East. Currently, there is an operational Aegis Ashore site located in Romania and another under construction in Poland. NATO BMD architecture also includes the U.S. contributions of a forward-based AN/TPY-2 radar in Turkey, four BMD-capable Aegis destroyers homeported in Rota, Spain, SM-3 interceptors, and a command-and-control node at Ramstein Air Base, Germany.

In FY 2020, we will continue our commitment to develop, test, and deliver global naval capability to the Warfighter and support defense of our deployed forces and European NATO allies through supporting the operational readiness of EPAA Phase 2 and efforts to deliver Phase 3 to improve defensive coverage against medium- and intermediate-range threats, which includes delivery of the Aegis Ashore site in Poland. Aegis Ashore site construction in Poland began in FY 2016. That site will be equipped with the upgraded Aegis BL 9 weapon system with BMD 5.1 and a capability to launch SM-3 Block IIAs in support of EPAA Phase 3 Technical Capability Declaration (TCD). The Aegis Weapon System upgrades are further enhanced by spiral upgrades to C2BMC and AN/TPY-2 sensors, enabling Engage-on-Remote capability and extended defensive coverage for NATO Europe.

Delays due to an unsatisfactory construction progress at the Aegis Ashore site in Poland delayed the EPAA Phase 3 TCD, and Navy Acceptance and Operational Acceptance into CY 2020. Several factors contributed to these delays including underestimation of project

complexity, slow mobilization, and challenges with trade staffing. While there is risk associated with unsatisfactory construction progress at the Aegis Ashore-Poland site, quality of accepted work is good and the Poland project continues to track to delivery of EPAA Phase 3 Technical Capability Declaration and Navy and EUCOM acceptance in CY2020. MDA and the U.S. Army Corps of Engineers (USACE) continue to use all available tools to assist efforts toward completion of the construction. In an effort to maintain post-construction schedule, the MDA,/USACE/Industry team initiated the first of three industrial work packages in support of Aegis Weapon System (AWS) Installation and Check-Out (INCO) in March 2019 on a not to interfere basis with ongoing construction. These work packages, combined with construction contractor efforts lay the groundwork to commence INCO in completed individual spaces vice waiting for the completion of all joint occupancy requirements. This approach will reduce construction delay impacts and assist with maintaining the site's TCD date. MDA, USACE, and Department of Defense leadership remain engaged with the construction contractor at high levels to ensure proper emphasis is placed on project importance and execution. Company leadership continues to express their commitment to the project. The company's performance has improved with steady progress on the ground observed. The company's actions to prioritize preparations for weapon system installation and improve trade labor placement will aid greatly to keep the overall project on track for delivery in calendar year 2020.

The site in Romania is on schedule to be upgraded this summer. This upgrade provides increased coverage capability for the defense of Europe and partially mitigates the delay at the AA Poland site.

MDA FY 2020 budget request includes \$25.65 million in Defense Wide Procurement and \$38.4 million in Research, Development, Test & Evaluation (RDT&E) funds to address the



multiple actions required to field Aegis Ashore in Poland and continued operations of other Aegis Ashore sites. Given the construction delays and the requirement to be on-site for at least another year, MDA's FY 2020 budget request includes funding to complete combat system adaptation, integration, installation, and testing to ensure delivery of EPAA Phase 3 capability to the Warfighter. MDA and the Navy also will execute the MDR's direction to evaluate the viability of operationalizing the Aegis Ashore Missile Defense Test Complex (AAMDTC) at the Pacific Missile Range Facility in Hawaii and develop an emergency activation plan that would enable the SECDEF to operationalize AAMDTC within 30 days of the Secretary's decision to do so.

#### ***Terminal High Altitude Area Defense***

Terminal High Altitude Area Defense (THAAD) is a globally-transportable, ground-based missile defense system that is highly effective against short-, medium-, and limited intermediate-range ballistic missile threats inside and outside the atmosphere in the terminal phase of flight. THAAD provides unique, cost-effective, and rapidly deployable capability to the Combatant Commanders to deepen, extend, and complement BMDS homeland and regional defenses. THAAD has successfully intercepted threat representative ballistic missile targets in all 15 of its intercept attempts. In 2018, MDA completed fielding of the 7<sup>th</sup> THAAD Battery to the U.S. Army while continuing to provide maintenance and sustainment support and deliver interceptors to the inventories of both the United States and United Arab Emirates (UAE).

MDA requested \$99.8 million of Operations and Maintenance funding to support the maintenance and upkeep of all BMDS-unique items of the fielded U.S. THAAD batteries and for all THAAD training devices. In FY 2020, MDA will provide support to seven THAAD batteries, including the two forward batteries stationed in the U.S. Indo-Pacific Command

(USINDOPACOM) area of responsibility and is prepared to support the U.S. Army in any future deployments around the world.

MDA requested \$425.9 million to continue procurement of THAAD equipment, including 37 THAAD interceptors in FY 2020. By the end of FY 2020, MDA will deliver 85 additional THAAD interceptors to the U.S. Army, for a total of 351 interceptors delivered. Synchronized with the deliveries for U.S. inventory, MDA is on track to complete delivery of THAAD interceptors to the UAE in FY 2020 as planned.

On November 26, 2018, the Kingdom of Saudi Arabia (KSA) signed Letters of Offer and Acceptance (LOA) for THAAD, with a program value of \$13.4 billion. MDA will deliver seven batteries, 360 interceptors, and associated support services to the KSA. The U.S. government expects to award the contract for the first phase of the KSA THAAD effort in FY 2019, which will include acquisition of long-lead items and obsolescence efforts.

MDA requested \$302.8 million in FY 2020 for THAAD development efforts. We will continue development of multiple, independent THAAD software upgrades to address the evolving threat, improve the Warfighter's defense planning capabilities, and provide improved interoperability with other BMDS elements. THAAD FY 2020 development and integration efforts include activities in support of the USFK JEON. The US Army deployed THAAD in March 2017 to USINDOPACOM in support of the U.S. - Republic of Korea (ROK) Alliance. The USFK JEON requested improved integration of existing ballistic missile defense assets in theater. In FY 2020, MDA will support Army fielding of Electronic Protection / Objective Debris Mitigation enhancements and the THAAD Remoted Launcher capability, which allows the THAAD system to use flexible communication paths to the THAAD launchers to increase defended areas. In coordination with the Army's Program Executive Office for Missile & Space,

efforts will continue to complete the development and demonstration of the Patriot Launch on Remote (THAAD) capability in FY 2020. Integration of the Patriot Advanced Capability – 3 Missile Segment Enhancement (PAC-3 MSE) interceptor capability into the THAAD system will continue to be delivered in FY 2021. In coordination with Army and the Joint Staff, MDA will execute the MDR's direction to prepare a report that provides a current assessment of the required numbers of THAAD batteries to support needed worldwide THAAD deployments, including potential deployment timelines, and basing and deployment options.

Testing continues to reinforce the confidence of U.S. and FMS customers in the THAAD system's performance and interoperability with other air and ballistic missile defense systems. THAAD successfully executed Flight Test Other (FTX)-35 at White Sands Missile Range, New Mexico on April 6, 2018, using THAAD Software Build 3.0, which demonstrated interoperability between THAAD and Patriot by exchanging Link-16 messages over tactical data links while tracking a Close Range Ballistic Missile target. This effort also met the NDAA requirement for annual BMDS integration testing with Patriot. MDA requested \$25.1 million for Terminal Defense Testing in FY 2020. This includes THAAD support of Army's Lower Tier Project Office demonstration of Patriot Launch on Remote (THAAD) in two events as well as demonstration of THAAD's capability to intercept an IRBM in the next operational flight test, Flight Test Operational (FTO)-03.

MDA and the Military Departments continue to coordinate with OSD on the path forward for transfer of missile defense programs as directed in the FY 2018 NDAA. A draft Report to Congress has been updated based on feedback from the Services and is in OSD staffing.

### **Addressing the Advanced Threat**

We must make investments in advanced technology today to prepare for tomorrow's threats by improving system performance and effectiveness. This budget request will continue the development and technology risk reduction of breakthrough technologies for integration into the BMDS, including discrimination improvements, Multi-Object Kill Vehicle technology, hypersonic defense technology, and high-powered lasers that have potential use against threat missiles in the boost phase of flight. Scalable, efficient, and compact high-energy lasers could change future missile defense architectures. MDA is developing technology to improve reliability, enhance discrimination, and expand battle space in order to address gaps in the BMDS and dramatically drive down the cost of defending the homeland.

MDA requested \$303.5 million for Technology Maturation Initiatives to conduct ground and airborne demonstrations of advanced sensor systems and refine directed energy technologies for missile defense. The Agency is maturing the technologies to increase power and testing sensors.

We are operating aircraft outfitted with passive sensors to better understand threat tracking and how an airborne layer could augment the existing sensor network. In 2020, we will add tracking lasers to these aircraft to increase precision and range and determine how these compact lasers could further influence sensor design. In addition, we are developing advanced sensors and testing them from ground sites to improve discrimination accuracy and validate performance against targets of opportunity. What we learn from these ground and airborne tests could influence future space-based sensor systems.

We continue to advance the state of the art for scaling electric laser powers and pursue competing technologies to reduce development risk. Distributed gain, diode pumped alkali laser, and fiber combining laser technology have the potential to meet missile defense requirements. In

2020, we will concentrate on laser maturation and power scaling development at the national laboratories and work with industry and the Services to investigate other promising laser technologies. Based on the results of these and other tests, we will work closely with the Department to determine the best way to integrate directed energy and laser sensing into the missile defense system.

We are exploring technology for a Neutral Particle Beam system to engage threat systems. The neutral particle beam offers new kill options for the BMDS and adds another layer of protection for the homeland. We are building upon technologies developed in the 1990's and have defined a logical building block approach that will culminate in an on-orbit demonstrator. We are exploring advancements in neutral particle beam component technology to improve the cost-benefit and size, weight and power for an operational system by incrementally building a demonstrator system in a lab environment and executing sound systems engineering practices early in the program. Per the MDR, MDA will study a space-based missile intercept layer capable of boost-phase defense and provide a report to the Under Secretary of Defense (USD) for Research & Engineering (R&E) and the USD for Policy (P) within six months of the release of the MDR.

MDA requests \$13.6 million for the Multi-Object Kill Vehicle effort to establish the technology foundation for killing multiple lethal objects from a single interceptor. The more kill vehicles we can put on an interceptor, the greater the raid capacity of our Ground-based Midcourse Defense system. MOKV has the potential to significantly enhance homeland defense capabilities against the threat at a lower cost per engagement. MDA competitively awarded contracts to three major prime contractors in 2017 to reduce the technical risk for MOKV

product development. The MOKV Technology Risk Reduction effort will culminate with component demonstrations specific to the three industry concepts.

We request \$157.5 million in FY 2020 for the Hypersonic Defense effort to execute the systems engineering process, identify and mature full kill chain technology, provide analysis and assessment of target of opportunity events, and execute near term space sensor technology and multi-domain command and control capability upgrades to address defense from hypersonic threats. This effort will execute the Defense Science Board's and the MDR's recommendations to develop and deliver a set of material solutions to address and defeat hypersonic threats informed by a set of near-term technology demonstrations. An integrated set of enhancements will provide incremental capability measured by progress and knowledge points in the following areas: establishment of systems engineering needs and requirements to identify alternative material solutions; execution of a series of sensor technology demonstrations; modification of existing BMDS sensors and the C2BMC element for hypersonic threats; and definition of weapon concepts and investments in key technologies to enable a broad set of solutions, including kinetic and non-kinetic means. Per the MDR, MDA and Northern Command will prepare a plan to accelerate efforts to enhance missile defense tracking and discrimination sensors, to include addressing advanced missile defense threats. Also, MDA will provide a plan that will leverage work taking place at DARPA and the Air Force identifying resources, retesting, and personnel requirements necessary for defense against hypersonic threats to USD (R&E) and USD (P) within six months of the release of the MDR.

MDA requests \$20.7 million for the Advanced Research Program to continue capitalizing on the creativity and innovation of the nation's small business community and academia to enhance the BMDS. Advanced Research conducts innovative research and development with

small businesses, universities, and international partners to create and advance missile defense capabilities against current and future threats. We are fostering innovative research between U.S. and foreign universities of allied nations through international cooperative technology development projects.

We request \$14.2 million for the Advanced Concepts & Performance Assessment effort, which centralizes advanced technology concept modeling, simulation, and performance analysis. The program delivers independent assessments of government, university, and industry technology concepts that, along with systems engineering requirements, support acquisition strategy decisions and define our technology focus areas. The request will fund independent government assessments of industry sensor, directed energy, and interceptor technology concepts and mature related tracking, discrimination, and sensor fusion algorithms. Assessment activities also include development of Hypersonic Defense, Artificial Intelligence and Machine Learning Initiatives, and left-through-right-of-launch integration key technology areas. The concept definition and assessment methodology enables us to verify contractor technology solutions and evaluate promising concepts in future missile defense systems architectures.

### **International Cooperation**

The FY 2020 budget request includes funding for regional missile defense capabilities to protect deployed U.S. forces, reassure allies and partners, and build stronger regional security architectures. MDA is actively engaged with over 20 countries and international organizations and is expanding work with our international partners through joint analyses, cooperative research and development projects, co-production activities, deployment of BMD assets, and facilitating the acquisition of missile defense capabilities, including FMS.

MDA continues to encourage allied and partner investments in their own missile defense capabilities to create more effective regional security architectures that complement U.S. regional missile defense capabilities. The United States and Australia are conducting joint modeling and simulation activities looking at combined regional IAMD architectures. MDA is providing support to the United Kingdom as it conducts an analysis of requirements and potential radar options to fulfill a commitment to field a BMD radar to enhance the coverage and effectiveness of the NATO BMD system. We are engaged in multiple missile defense architecture analysis studies with our foreign partners to help them make missile defense acquisition decisions that also support interoperability with the United States. MDA also supports foreign military sales of the THAAD system, highlighted by the FMS case with the Kingdom of Saudi Arabia for seven THAAD batteries. We continue to execute the UAE FMS case and deliver interceptors for the UAE's two THAAD batteries, both of which have been delivered and have achieved Initial Operational Capability.

MDA is actively engaged with several nations across the globe to provide program information and cost data that may inform future decisions to procure missile defense capabilities, including Aegis BMD, THAAD, and BMD-capable sensors. We continue to discuss the 2016 regional Ballistic Missile Early Warning System architecture study results with the Gulf Cooperation Council nations. MDA also is assisting Japan in their pursuit of an FMS case for two Aegis Ashore installations.

MDA's work with the Israeli Missile Defense Organization is a testament to the strong missile defense partnership we maintain with Israel. MDA's FY 2020 request remains consistent with the funding Memorandum of Understanding that the United States and Israel signed in 2016, which would provide \$500 million for this effort. This budget continues MDA's



longstanding support of U.S.-Israeli Cooperative BMD Programs, to include the co-development and co-production of the David's Sling Weapon System and Upper Tier Interceptor and improvements to the Arrow Weapon System. The Department continues to support co-production efforts for the Iron Dome program to provide critical defense against short-range rockets and artillery. In FY 2020, our budget will also support several flight tests across the Israeli portfolio. These continued joint efforts provide Israel with a three-tiered defense to defend from ballistic missiles, rockets, and cruise missiles and ensure Israel maintains its qualitative military edge against its adversaries.

We continue to make progress with our Japanese counterparts on the SM-3 Block IIA, our largest co-development effort, which supports extended deterrence and establishes an important regional defense capability. We are committed to delivering the SM-3 Block IIA to meet global threat requirements and support Phase 3 of the European Phased Adaptive Approach. Our FY 2020 budget request also supports Allied participation in tests, exercises, and wargames, such as Formidable Shield- 2019 (FS-19). FS-19 is a multinational exercise that will build upon the FS-17 exercise, which included the first operational SM-3 intercept in the Atlantic.

## **Conclusion**

Mr. Chairman and Members of the Subcommittee, in closing, our FY 2020 budget funds comprehensive missile defense development efforts, including several critical capabilities required by the Warfighter. We will continue to increase the reliability as well as the capability and capacity of fielded homeland and regional missile defense systems and make measured investments in advanced technology to counter the adversary missile threat.

I also would like to broadly recognize the government/industry missile defense team and, more specifically, recognize the brave men and women who serve in our Armed Forces at home and abroad and who operate the BMDS. Our Nation is fortunate to have such a capable fighting force.

I appreciate your continued support for MDA and missile defense, and I look forward to answering the committee's questions. Thank you.

**Lieutenant General Samuel A. Greaves**

Lt. Gen. Samuel A. Greaves is the Director, Missile Defense Agency and advises the Under Secretary of Defense for Research and Engineering on Ballistic Missile Defense policy, requirements, priorities, systems, resources, and programs. MDA's mission is to develop, test, and field an integrated, layered, ballistic missile defense system to defend the United States, its deployed forces, allies and friends against all ranges of enemy ballistic missiles in all phases of flight. General Greaves directs the organization spanning 14 time zones with more than 9,000 military, civilian and contract personnel and he exercises management oversight for the BMDS per Department of Defense Directive 5134.09, to include program management of missile defense and BMD-related programs, BMDS resources and execution of a single research, development, test and evaluation program supporting the BMDS.

General Greaves was commissioned in 1982 through the Reserve Officer Training Corps program after he graduated from Cornell University. He has held a variety of assignments in operational, acquisition and staff units, including assignments at Headquarters Air Combat Command, the National Reconnaissance Office and on the Air Staff within the Directorate of Operational Requirements and the Air Force Colonel Matters Office. He commanded the 45th Launch Group at Patrick Air Force Base, Florida, the Launch and Range Systems Wing and Military Satellite Communications Systems Wing at Los Angeles AFB, California. The general also served as Vice Commander, Space and Missile Systems Center, Los Angeles AFB, California, and subsequently as Director, Strategic Plans, Programs and Analyses, Headquarters Air Force Space Command, Peterson AFB, Colorado. He was then assigned as the Deputy Director, Missile Defense Agency, Redstone Arsenal, Alabama. Prior to his current assignment, he was the Commander, Space and Missile Systems Center, Air Force Space Command, Los Angeles Air Force Base, California.

He has operational launch crew experience in the space shuttle, Titan, Atlas and Delta space-launch systems. He wears the Command Space Badge.

**EDUCATION**

1982 Bachelor of Science, electrical engineering, Cornell University, Ithaca, N.Y.  
 1984 Master of Science, computer science, West Coast University, Los Angeles, Calif.  
 1986 Squadron Officer School, Maxwell AFB, Ala.  
 1997 Distinguished graduate, Air Command and Staff College, Maxwell AFB, Ala.  
 1997 Undergraduate Space and Missile Training, Staff Course, Vandenberg AFB, Calif.  
 1999 Air War College, by correspondence, with distinction  
 2001 Master's degree in strategic studies, Air War College, Maxwell AFB, Ala.  
 2003 Program Managers Course, Defense Systems Management College, Fort Belvoir, Va.  
 2008 Executive Program Managers Course, Defense Systems Management College, Fort Belvoir, Va.  
 2010 NSP Executive Course, George Washington University, Washington, D.C.  
 2010 Systems Acquisition Management Course, Fort Belvoir, Va.  
 2011 Requirements Executive Overview Workshop, Peterson AFB, Colo.  
 2015 Cyberspace Operations Executive Course, Maxwell AFB, Ala.

**ASSIGNMENTS**

June 1982 - December 1984, space shuttle avionics engineer, Vandenberg AFB, Calif.  
 December 1984 - June 1986, avionics engineer, Space Shuttle Main Engines, Kennedy Space Center, Fla.  
 June 1986 - October 1987, Chief, Titan Inter-Range Operations, 6595th Aerospace Test Group, Vandenberg AFB, Calif.  
 October 1987 - March 1990, Titan Space Launch Systems Manager, 6595th Aerospace Test Group, Vandenberg AFB, Calif.  
 March 1990 - January 1992, Chief, Spacecraft Test and Launch Operations, SP-11 Program Office, Secretary of the Air Force Office of Special Projects, Los Angeles, Calif.

January 1992 - March 1994, Chief, Satellite Engineering, SP-11 Program Office, Secretary of the Air Force Office of Special Projects, Los Angeles, Calif.  
 March 1994 - August 1995, executive officer to the Director, Secretary of the Air Force Office of Special Projects, Los Angeles, Calif.  
 August 1995 - August 1996, National Space Systems Applications Manager, Directorate of Requirements, Headquarters Air Combat Command, Langley AFB, Va.  
 August 1996 - August 1997, student, Air Command and Staff College, Maxwell AFB, Ala.  
 August 1997 - June 1998, Chief, Surveillance and Reconnaissance Requirements, Space and Reconnaissance Division, Directorate of Operational Requirements, Deputy Chief of Staff for Air and Space Operations, Headquarters U.S. Air Force, Washington, D.C.  
 June 1998 - June 1999, executive officer to the Director of Operational Requirements, Deputy Chief of Staff for Air and Space Operations, Headquarters U.S. Air Force, Washington, D.C.  
 June 1999 - July 2000, Deputy Chief, Assignments Division, and Chief, Space, Missile, Acquisition and Technical Assignments, Air Force Colonel Matters Office, Headquarters U.S. Air Force, Washington, D.C.  
 July 2000 - June 2001, student, Air War College, Maxwell AFB, Ala.  
 June 2001 - July 2002, Commander, Air Force Communications Support Facility, White Sands Missile Range, N.M.  
 August 2002 - June 2004, Materiel Group Director, Air Force Satellite Control Network, Space and Missile Systems Center, Los Angeles AFB, Calif.  
 June 2004 - August 2006, Commander, 45th Launch Group, Cape Canaveral Air Force Station, Fla.  
 August 2006 - June 2008, Commander, Launch and Range Systems Wing, Los Angeles AFB, Calif.  
 June 2008 - August 2009, Commander, Military Satellite Communications Systems Wing, Los Angeles AFB, Calif.  
 August 2009 - February 2011, Vice Commander, Space and Missile Systems Center, Los Angeles AFB, Calif.  
 February 2011 - August 2012, Director, Strategic Plans, Programs and Analyses, Headquarters Air Force Space Command, Peterson AFB, Colo.  
 August 2012 - June 2014, Deputy Director, Missile Defense Agency, Redstone Arsenal, Ala.  
 June 2014 - May 2017, Commander, Space and Missile Systems Center and Program Executive Officer for Space, Los Angeles AFB, Calif.  
 June 2017 - present, Director, Missile Defense Agency, Fort Belvoir, Va.

#### **SUMMARY OF JOINT ASSIGNMENTS**

August 2012 - June 2014, Deputy Director, Missile Defense Agency, Redstone Arsenal, Ala., as a major general  
 June 2017 - present, Director, Missile Defense Agency, Ft. Belvoir, Va., as a lieutenant general

#### **OPERATIONAL INFORMATION**

Space Shuttle Missions: 51-C, 51-D, 51-B, 51-G, 51-F, 51-I, 51-J, 61-A, 61-B, 61-C, 51-L  
 Titan: 34B-66, 34D-15, II-G1, 34D-14, II-G2  
 Titan IV: B-30  
 Delta II: NASA MESSENGER, Swift, Deep Impact, GPS IIR-13/GPS IIR-14(M), MiTex, GPS IIR-15(M), GPS IIR-16 (M), GPS IIR-17 (M), GPS IIR-18 (M), GPS IIR-19(M)  
 Delta IV: Air Force Heavy Demo, GOES-N, DMSP-17, DSP-23 Atlas II/III: AC-167, NROL-1, AC-206  
 Atlas V: AMC-16, INMARSAT-IV, NASA MARS Reconnaissance Orbiter, Pluto New Horizons, ASTRA, WGS-1, NRO L-24, NRO L-28, WGS-2

#### **MAJOR AWARDS AND DECORATIONS**

Distinguished Service Medal  
 Defense Superior Service Medal  
 Legion of Merit with oak leaf cluster  
 Defense Meritorious Service Medal with two oak leaf clusters  
 Meritorious Service Medal with two oak leaf clusters  
 Air Force Commendation Medal with two oak leaf clusters  
 Air Force Achievement Medal

**OTHER ACHIEVEMENTS**

2008 Lt. Gen. John W. O'Neill Outstanding System Program Director Award  
2016 Gen. Bernard A. Schriever National Space Leadership Award  
2017 Peter B. Teets National Security Space Award  
2017 General Thomas D. White Space Award

**PROFESSIONAL CERTIFICATIONS**

1994 Program Management, Level III, Acquisition Professional Development Program  
1994 Research and Development, Level III, APDP  
1994 Test and Engineering, Level I, APDP

**EFFECTIVE DATES OF PROMOTION**

Second Lieutenant June 2, 1982  
First Lieutenant June 2, 1984  
Captain June 2, 1986  
Major July 1, 1994  
Lieutenant Colonel Feb. 1, 1999  
Colonel Aug. 1, 2003  
Brigadier General Dec. 9, 2008  
Major General July 13, 2012  
Lieutenant General June 19, 2014

(Current as of November 2018)

HOUSE ARMED SERVICES COMMITTEE

STATEMENT OF GENERAL JOHN E. HYTEN  
UNITED STATES STRATEGIC COMMAND  
PRESENTED BY VICE ADMIRAL DAVID M. KRIETE  
DEPUTY COMMANDER  
BEFORE THE HOUSE ARMED SERVICES  
STRATEGIC FORCES SUBCOMMITTEE  
ON FISCAL YEAR 2020 PRIORITIES FOR MISSILE DEFENSE  
8 MAY 2019

HOUSE ARMED SERVICES COMMITTEE

## INTRODUCTION

USSTRATCOM is a global warfighting command. My command priorities have not changed during my time as Commander. They remain: (1) above all else, provide strategic deterrence for the Nation and assurance of the same to our allies and partners, (2) if deterrence fails, be prepared to deliver a decisive response, and (3) do this with a combat-ready force. The 162,000 men and women who make up USSTRATCOM are resilient, equipped, and ready thanks to your continued support. Budget stability over the past year was extremely important and had a positive impact on both our modernization efforts and our overall readiness.

As part of the Joint Force, USSTRATCOM is responsible for Strategic Deterrence, Nuclear Operations, Global Strike, Space Operations, Joint Electromagnetic Spectrum Operations, Missile Defense, and Analysis & Targeting. To execute our assigned missions, the Soldiers, Sailors, Airmen, Marines, and civilians of the command operate globally across the land, sea, air, and space. Our forces and the strategic deterrence they provide underpin and enable all Joint Force operations and are the ultimate guarantors of national and allied security.

The foundation that enables our strategic deterrence is the triad: nuclear-armed Intercontinental Ballistic Missiles (ICBMs), Submarines, and Bombers. A powerful, ready triad remains the most effective way to deter adversaries from conducting strategic attacks against the United States and allies. Its credibility backstops all U.S. military operations and diplomacy around the globe and ensures that tensions – regardless of where or how they arise – do not escalate into large-scale war.

However, as all the elements of the triad age beyond their planned service life, we must continue to execute our planned modernization strategy to maintain an effective deterrent. We require a robust and ready nuclear arsenal for the foreseeable future. This will remain the case until the myriad of legacy and emerging nuclear threats are reduced or eliminated. Unfortunately, the opposite is occurring.

Deterrence is created by much more than the 1,550 New START treaty-accountable deployed nuclear weapons and 700 deployed strategic delivery platforms. Today, our mission to deter major power conflict dictates we field ready, capable, and lethal forces, tailored to adaptive adversaries. Continued success means integrating the full range of missions in all domains and without geographic boundaries. We are increasingly integrating our planning and Tier 1 exercises to remove seams between global and geographic combatant commands. We are pursuing approaches to enhance real world planning and execution of globally integrated fires to best deliver the most effective capabilities and effects when and where needed.

The United States must never put our ability to deter in jeopardy. Our missions, capabilities, and forces must continue to be an integral part of our overarching national security posture. Therefore, to continue to provide the security our Nation deserves, we must clearly identify the threats we face, develop

strategies to deter those threats, and ensure we have the required capabilities for decisive response if deterrence fails. Only with continued Congressional support, can this remain the case.

#### **GLOBAL SECURITY ENVIRONMENT**

The National Defense Strategy describes the increasingly complex global security environment in which we live. We characterize today's environment by the re-emergence of long-term, strategic competition between nations and overt challenges to the free and open international order. Although an era of great power competition is again a reality, that does not mean conflict is inevitable. It means we must continue investing in strength to preserve the peace.

It is increasingly apparent that China and Russia want to shape a world consistent with their authoritarian models – gaining veto power over global economic, diplomatic, and security decisions – seeking dominance within their perceived regional spheres of influence, and expanding their global reach.

For over two decades, China and Russia have studied the American way of warfare; observing first-hand how we train and fight. They now understand the advantages we gain from integrating capabilities across all domains to accomplish strategic objectives. To counter our dominance, China and Russia are actively seeking to exploit perceived vulnerabilities and are directly challenging us in areas of long-held strength. Their development of asymmetric capabilities across all-domains is not meant to challenge single aspects of our deterrence strategy; rather, their advancements in technology, strategy, tactics, and doctrine aim to invalidate our entire deterrence strategy.

#### **CHINA**

China continues to challenge the existing rules-based international order. It is advancing a comprehensive modernization program aimed at making the People's Liberation Army a world-class military. This program includes the continued development and deployment of a nuclear triad, combined with anti-access/area denial (A2/AD) and power projection operations. They are also pursuing advancements in offensive hypersonic strike weapons, advanced robotics, quantum computing, and artificial intelligence through a combination of research and development, forced transfer of intellectual property, and outright cyber theft.

Additionally, China's maturing military space capabilities in intelligence, surveillance, and reconnaissance, satellite communications, satellite navigation, meteorology, and robotic space exploration present growing challenges in space. With their focus on counter-space capabilities, China is pursuing a strategy of denying the United States the advantage of space-based systems during crises and conflicts.



Once locked away in intelligence channels, news outlets are beginning to note specific threats to our space systems. January marked 12 years since China publicly tested its direct-ascent system, in which it destroyed one of its own satellites and created thousands of pieces of debris. This 2007 test demonstrated to the world that China is capable of destroying any satellite in low earth orbit, including many of our intelligence and communications spacecraft. Today, China has an operational ground-based anti-satellite missile intended to target low-earth orbit satellites and are pursuing numerous other capabilities. These developments, coupled with China's lack of transparency on nuclear policies, force disposition, and weapons and their growing assertiveness to challenge the existing free and open international order undermines regional and global stability. Further, these actions seek to erode the U.S. standing in Asia.

#### **RUSSIA**

Russia continues to conduct malign activities that negatively impact U.S. interests. Their invasion and attempted annexation of the Crimean Peninsula, destabilizing eastern Ukraine, intervening on behalf of Syrian President Bashar al-Assad, and shaping the information environment to suit Russian interests, pose a major challenge to the United States and NATO. Russia's military doctrine emphasizes the potential coercive and military uses of nuclear weapons. It mistakenly assesses that the threat of nuclear escalation or actual first use of nuclear weapons would serve to "de-escalate" a conflict on terms favorable to Russia. These mistaken perceptions increase the prospect for dangerous miscalculation and escalation.

As far back as 2006, Russia committed to modernizing and adding new military capabilities to its nuclear forces and upgrading its strategic nuclear triad. Today, Russia has completed roughly 80 percent of their modernization goals. As part of this program, Russia is upgrading to modern road-mobile and silo-based ICBMs, increasing ballistic missile submarine reliability and stealth, fielding new Submarine Launched Ballistic Missiles (SLBMs), Submarine Launched Cruise Missiles (SLCMs), and modernizing its fleet of long-range strategic bombers, to carry nuclear and conventionally-armed air-launched cruise missiles. Russia is also developing and intends to deploy novel strategic nuclear weapons, like its nuclear-armed, nuclear-powered underwater unmanned vehicle and intercontinental-range cruise missile, which Russia seeks to keep outside of existing arms control agreements.

Russia is also pursuing nuclear-armed hypersonic missiles and nuclear-capable cruise missiles, which when coupled with their newest intercontinental range ballistic missiles, improves upon its capability to attack anywhere on the globe with little or no notice. Additionally, their production of a new fifth generation bomber expected within the decade will enhance their ability for long-range deployment.

Russia's material breach of the Intermediate-range Nuclear Forces Treaty also remains a significant concern, as demonstrated by their deployment of a treaty-violating system, the SSC-8 ground-

launched cruise missile, multiple battalions of which have been fielded as of late 2018, and illustrates Russia's broader pattern of malign behavior and willingness to disregard negotiated agreements when they believe it is in their interest. Finally, Russia has an active stockpile up to 2,000 Non-Strategic Nuclear Weapons (NSNWs), which are not accountable under the New START Treaty. These include air-to-surface missiles, short-range ballistic missiles, gravity bombs, and depth charges for medium-range bombers, tactical bombers, and naval aviation, as well as anti-ship, anti-submarine, and anti-aircraft missiles and torpedoes for surface ships and submarines, and Moscow's antiballistic missile system.

Russia's diverse and flexible NSNW capabilities facilitate a doctrine that envisions the potential coercive use of nuclear weapons. Combined with its large nuclear weapons infrastructure and ready production base, this underscores Moscow's commitment to having nuclear weapon underpin its security and commitment to maintaining its nuclear forces for the indefinite future. Their doctrine of coercive use further enhances their ability to challenge the United States and NATO across the full spectrum of political, diplomatic, military, and information warfare.

#### **NORTH KOREA AND IRAN**

North Korea and Iran remain threats but not to the same degree as China and Russia. Both North Korea and Iran retain large arsenals of short- and medium-range ballistic missiles and are threats to regional stability. North Korea has tested ICBM-class missiles designed to range the United States. However, the Department of Defense is working actively to reduce military tensions and remains in full support of our diplomats as they work to achieve the final, fully verified denuclearization of the DPRK. Iran remains the world's leading sponsor of terror and continues its malign influence and destabilizing activities across the region. None of these activities are helpful or supportive of peace and stability, and all introduce greater risk to an already complex and volatile environment. In both instances, we remain vigilant to the threats they pose to the United States, our allies and partners, and support the on-going international and whole-of-government approaches to reduce these threats peacefully.

#### **STRATEGIC DETERRENCE**

Strategic deterrence has underwritten our Nation's security and preserved our way of life since the end of World War II. While the fundamental principles of deterrence remain constant, the 21st Century landscape is profoundly different. We can no longer focus on countering a single adversary with traditional means. Peer adversaries are aggressively pursuing outright theft of intellectual property, demonstrating willingness to corrupt supply chains, and are exploiting rapid advancements in disruptive technologies in destabilizing ways. These actions provide China and Russia, in particular, advanced strategic capabilities to threaten the United States and marginalize our global influence. This requires us to rethink how we continue to deter new types of strategic attacks.

The mission of our Nation's strategic forces of the last 73 years endures: to deter major attacks against the United States and if necessary employ strategic forces to defeat an ever-changing adversary. Effective command and control, that supports global integration, is a necessary and critical element.

The 2018 National Defense Strategy states the Department of Defense (DoD) "will modernize the nuclear triad – including Nuclear Command, Control, and Communications (NC3), and supporting infrastructure." Thanks to Congressional support and timely budgets, we are making solid progress modernizing these weapon systems. However, to fully realize the capabilities of a modernized triad we require an NC3 architecture responsive to evolving threats and able to adapt to technology innovations. Speed is essential. We are beginning to move faster, but we are still not moving fast enough. Our most critical weapon systems must deliver on time or early. The Services are making progress and I appreciate their efforts, but we must continue to strive for more timely, affordable programs. We must recapture the ability of our nation to go fast, faster than all potential adversaries, in order to maintain an effective deterrent.

Going fast means that we return to the dynamic that made us the strongest most technologically advanced military in the world. Over my nearly 38 years of military service I have watched as we collectively developed an increasingly unhealthy expectation of removing all risk from everything we do. Admiral Hyman Rickover, the father of the Nuclear Navy once said, "Success teaches us nothing, only failure teaches." We seem to have forgotten this principle. Although success is the ultimate goal, we must accept some healthy failures along the way. Today, however, we seem to reward and promote people at all levels for never failing, subconsciously creating a collective mindset to maintain the status quo at all costs. The best way to never fail is to never try, or to try only when success is certain – which means we punish those who aggressively take risks. If we continue this trend, we will eventually fall behind our competition. In 1991, the United States had the only superpower-class military, and status quo at that time favored us greatly. We still have an advantage, but that advantage is shrinking. I appear before you today fully confident in our ability to preserve the peace and dominate any conflict. But without change – unless we recapture the ability to take intelligent risk – a future USSTRATCOM commander, a decade or so from now, may sit before you and not be able to make the same statement. This could put our whole nation at greater risk.

To emphasize that point – today, our forces are still dominant, the finest in the world, yet they are equipped with many of the exact same weapon systems fielded during the Cold War, including the triad and our NC3 capabilities. Moreover, our competitors are moving fast – particularly in the area of their strategic forces. Status quo no longer favors us; however, our underlying personnel, budgeting, and acquisition structures evolved since the end of the Cold War to preserve the status quo. This must change. We must counter this situation with ruthless determination to reward and promote thoughtful risk

management aimed at applying innovative technologies and new business practices. We must improve our ability to protect our nation's commercial sector where innovation thrives. We must move fast in space, in cyber, in all our strategic systems – to once again regain the advantage.

#### **NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS**

Our NC3 system is ready, reliable, and effective at meeting today's strategic deterrence requirements. However, to meet the evolving threat, advances in technology, and to prepare for a modernized triad we must update our NC3 system now. Our current legacy system reflects the needs of the Cold War, focused primarily on Soviet-era ballistic missile and bomber threats. The next generation NC3 architecture must maintain and even improve on the readiness and reliability of today while also dealing with the myriad of new threats from our potential adversaries. As we transition to a modern threat-based NC3 enterprise architecture and address the growing cyber, asymmetric, and kinetic challenges, we must ensure positive command and control of U.S. nuclear forces at all times, even under the enormous stress of a nuclear attack. Getting this right and doing so quickly is one of my top priorities.

The next generation NC3 architecture requires an innovative approach tightly linking mission needs, requirements, acquisition, and funding strategies to deliver capability on operational and threat-relevant timelines. We must transform the enterprise to operate with speed and agility, fully leveraging rapid prototyping and experimentation, to innovate and outpace the threat. We must continually change while maintaining predictability for the user. This is a challenging task and once defined must be consistently resourced.

The 2018 Nuclear Posture Review (NPR) identified a range of initiatives to ensure our NC3 capability remains survivable and effective in crisis. Among these initiatives is reforming NC3 governance due to the broad diffusion of authority and responsibility within the Department. On 03 Oct 2018, the Secretary of Defense designated the Deputy Secretary of Defense and Chairman of the Joint Chiefs of Staff accountable for all NC3 related activities. Under this new governance structure, the Commander of USSTRATCOM is the NC3 Enterprise Lead responsible for NC3 enterprise operations, requirements, and systems engineering and integration, while the Under Secretary of Defense for Acquisition and Sustainment (USD (A&S)) serves as NC3 Capability Portfolio Manager (CPM). We have codified NC3 governance roles and responsibilities, taken concrete steps to sustain the current NC3 architecture with selective modernization, and are moving forward to design and field the next generation NC3. This was a necessary step to place the authorities under one commander, and I am already moving forward in that role.

To execute these new responsibilities, we are well on our way to establishing the NC3 Enterprise Center (NEC) at USSTRATCOM and are on track to achieve initial operational capability this year. The NEC will improve mission effectiveness and efficiency while defining future NC3 capability requirements. The NEC will also establish core NC3 operational concepts as the basis for aligning the right mix of multi-domain capabilities necessary to execute the Nuclear Command and Control mission and achieve strategic deterrence objectives. Essential to this work, is the ability to direct enterprise-level systems engineering and integration activities. Working with the Director, Defense Information Systems Agency (DISA), the Joint Systems Engineering and Integration Office is now aligned to the NEC and receives operational direction and work prioritization from me.

To support the NEC, USD (A&S) as the NC3 CPM will oversee and advise on NC3 enterprise acquisition and resources. The NEC and USD (A&S) team will provide comprehensive enterprise-level understanding of operational risk, margin and investment priorities as we envision, design and field the next generation NC3 in partnership with our service and agency leads.

To ensure we remain aligned, responsive and relevant, the NC3 enterprise must have dedicated operational and intelligence resources to rapidly identify, understand, and anticipate current and future evolving threats to the NC3 enterprise. To satisfy this need and concurrently address Section 1655 of the FY 2018 National Defense Authorization Act (NDAA), PL 115-91, USSTRATCOM, in coordination with the Office of the Director for National Intelligence, is establishing an NC3 Intelligence Fusion Center within the USSTRATCOM Intelligence Directorate. This initiative will facilitate aligning operations with intelligence expertise to enhance future NC3 architecture security.

With the governance structure in place to address future needs, we will concurrently continue sustainment and operation of the existing NC3 enterprise. We have taken significant steps over the past year to improve service, agency, and nuclear command and control operations centers reporting to better understand operational risk and margin. This data will allow us to continue increasing the analytic rigor in our assessments and inform sustainment and modernization investment priorities.

In order to provide the Commander In Chief continuous communications and control of the nuclear forces, we are improving communications capabilities across all domains to ensure connectivity, enhanced conferencing, and decision support tools to the President. In the space domain, we continue to launch Advanced Extremely High Frequency (AEHF) satellites for integration into a combined Milstar/AEHF communications constellation. The AEHF satellites, using the eXtended Data Rate (XDR) waveform, coupled with requisite ground node and airborne platform Family of Advanced Beyond Line-of-Sight terminals (FAB-T) enable collaboration between the President and senior advisors under any circumstance and ensure connectivity with the nuclear forces.

In the air domain, the Air Force and Navy are executing an airborne platform Analysis-of-Alternatives for replacing existing E-4B National Airborne Operations Center, E-6B Airborne Command Post and Take Charge And Move Out (TACAMO), and C-32 Executive Transport fleets. Ongoing communications capability enhancements include Air Force programs to provide a Very Low Frequency (VLF) receiver for the B-2 bomber in 2020 and a replacement VLF receiver and AEHF-capable terminal for the B-52 bomber. These capabilities will provide resilient and robust worldwide connectivity lasting well into the next two decades.

Finally, in the land domain, the Air Force Global Aircrew Strategic Network Terminal program will deploy an AEHF terminal providing Air Force Wing Command Posts, Munitions Support Squadrons, and Mobile Support Teams with survivable ground-based communications to receive Presidential direction for relay to bomber, tanker and reconnaissance forces. This modernization initiative is essential to completing transition from legacy Milstar low data rate networks to AEHF extended data rate networks.

I am confident in the direction the Department has taken and the priority placed on modernization of the NC3 Enterprise as stated in the NPR. As the Enterprise lead, my command will aggressively move forward, ensuring a safe, secure, and reliable architecture is in place for years to come.

#### **THE NUCLEAR TRIAD**

Maintaining the planned modernization of our nuclear triad of ICBMs, SSBNs, and bombers with air delivered weapons remains the best approach to deterring potential adversaries and assuring our allies that we are committed to their security. Numerous reviews, including the 2018 NPR, validate the nuclear triad's importance in deterring Russia and China, providing operational flexibility, and dissuading other nations from pursuing their own nuclear weapon programs. With a credible and effective force and a supporting declaratory policy, our strategic competitors would be hard-pressed to believe they could attack the United States or our allies and achieve the benefits they seek.

A modernized triad provides both unique and complementary capabilities to address current threats and future uncertainty. Alert and always ready to respond, the ICBM force ensures no adversary, regardless of size, can be confident in the success of a preemptive attack. Our ICBMs create enormous targeting problems for our adversaries, requiring a massive raid that would be impossible to hide and would guarantee their own demise. With its range, payload, accuracy, and speed the ICBM is critical to our nation's deterrent strategy.

Our strategic bombers provide the President the most visible, flexible, adaptable, and recallable options to provide strategic deterrence. Should an emerging crisis arise, we can rapidly deploy our bombers to clearly communicate our resolve and commitment to our global security partners. With the

ability to provide a conventional or nuclear strike capability, the bomber force plays an indispensable role in our overall strategy.

Nuclear powered submarines with nuclear-armed ballistic missiles patrol the seas and provide a survivable response capable of holding targets at risk within hours. Their assured, survivable second-strike capability means that regardless of any attack, our adversaries will always face the possibility of a devastating response. The most survivable leg of the triad, it is also critical to our nation's strategic deterrent.

We continue to propose prudent investments in delivery system modernization programs across the triad. These modernization efforts improve our readiness, increase safety and security, and enhance our capabilities/credibility against the threats we face now and in the near future. Although some might consider these modernization plans expensive, I believe that America can afford survival. The only way to change our strategic deterrent is to convince our adversaries to reduce the threat. This is not occurring. China and Russia, in particular, are not only modernizing the traditional elements of their own triads, but are also building a myriad of additional nuclear capabilities to threaten the United States. Both nations employ and are modernizing silo-based ballistic missiles, submarines and bombers, and both are deploying large numbers of mobile ICBMs – which the US has chosen not to pursue. China and Russia are pursuing hypersonics as we are, but, in stark contrast, we have no plans to include them in our nuclear force structure. Russia is also building new intermediate range nuclear weapons, new cruise missiles, as well as new nuclear powered cruise missiles and torpedoes all to threaten the United States.

We continue to monitor and evaluate all these new threats. We did so in last year's NPR. In the NPR, we evaluated and discarded a course of action that would match and even exceed the capabilities of these adversaries. Our analysis showed that we could continue to deter any and all of these threats with a modernized triad augmented by a small number of low yield nuclear weapons deployed on our submarines and a measured sea launched cruise missile capability. Modernization of these capabilities is critical to our nation's defense. We don't have to match all the specific capabilities of our adversaries as long as our capabilities are robust enough to deter and if needed respond to any attack; this is why we need a triad augmented by some small numbers of supplemental capabilities. By pursuing these capabilities, we make sure that nuclear-armed adversaries do not falsely conclude there are reasonable benefits and acceptable costs to attacking the United States and our allies. Sustaining and modernizing the triad requires investment, but its contribution to peace and stability far outweigh the projected cost required to maintain a credible nuclear deterrent.

#### **LAND-BASED STRATEGIC DETERRENT**

The Minuteman III has served the country for over 45 years. Its high availability rate is testament to its robust design and the diligent efforts of the Airmen who operate and maintain the weapon system. The Air Force is committed, through such efforts as the Programmed Depot Maintenance and Airborne Launch Control System Replacement programs, to sustaining the Minuteman III ICBM through 2030. When the Minuteman III finally retires, it will have exceeded its initial 10-year service life by half a century. While still reliable, missile component and hardware attrition, coupled with the aging of 1960's era infrastructure, drive the requirement for a comprehensive weapon system replacement within the next decade. Further Minuteman III life extension is not cost effective nor will it provide a weapon system capable of adapting to advancing technology and changing adversary threats.

To maintain a viable land-based strategic deterrent capability, the Air Force must begin deploying the replacement Ground Based Strategic Deterrent (GBSD) by the late 2020s. We are working closely with the Air Force to ensure the GBSD is fully integrated into our modernized NC3 system and can adapt to an evolving and increasingly dynamic strategic environment. To ensure this, the Air Force is incorporating modularity and open system standards enabling future technology insertion. Additionally, to deliver GBSD on time and on budget, the Air Force is pursuing mature, low-risk technologies and working with other strategic partners to leverage investments that eliminate delays and reduce cost. When fielded, GBSD will be a capable and cost-effective ICBM able to deter potential adversaries and assure allies of our commitments to their security.

#### **SEA-BASED STRATEGIC DETERRENT**

The OHIO-class ballistic missile submarine's stout construction and pioneering maintenance program allowed it to be life extended from 30 to 42 years into the 2040s, making it the longest serving submarine in U.S. history. However, with no margin to extend the OHIO-class further, the COLUMBIA-class SSBN must field on time to avoid a deterrent capability gap in the triad. It is also essential that we maintain our technological advantage in this critical mission, and COLUMBIA will do just that. To this end, the Navy has elevated the COLUMBIA program to its top shipbuilding priority, leveraging other efforts and implementing advanced procurement to reduce risk and ensure it is ready for its first strategic deterrent patrol in 2031. We must continue to support our industrial partners and give appropriate prioritization to funding throughout the life of the program.

To avoid complex concurrent strategic weapon modernization programs, the Navy life extended the Trident II D5 ballistic missile to transition from OHIO to COLUMBIA. The Navy fielded the Trident II D5 over 25 years ago and is executing a life extension that will allow service into the early 2040s. In



the face of continuously evolving threats, we must begin the effort of designing a flexible and adaptable follow-on SLBM that allows rapid and cost effective modifications.

To ensure our nuclear posture is successful in deterring adversaries, the 2018 NPR directed near-term fielding of a small number low-yield ballistic missile (LYBM) warheads and pursuit of a modern nuclear-armed SLCM. These capabilities are necessary to our strategic deterrence mission and will serve to disabuse any adversary of the mistaken perception they can escalate their way to victory.

The LYBM has begun production and will serve to provide a timely counter to Russia's NSNWs, their doctrine of limited first-use in a large-scale conflict on Russian territory, and their perceived advantage in low-level nuclear conflict. The SLCM will help close deterrence gaps and provide a considerable degree of assurance to allies.

#### **AIR-BASED STRATEGIC DETERRENT**

The current bomber fleet and its associated weapon systems have already exceeded or are rapidly approaching the end of their intended service life. To preclude a strategic capability gap associated with these essential nuclear platforms, ongoing sustainment and planned modernization efforts must continue.

The B-52 remains the backbone of the strategic bomber force today and well into the future. It is the only platform capable of employing the nuclear AGM-86B Air-Launched Cruise Missile (ALCM) which provides a standoff capability while providing the President the flexibility to recall a strike if necessary. B-52s will remain in service until 2050. Until the B-52 is replaced, the Air Force will continue to upgrade the aircraft to ensure its long-term viability. Modernization of the 1950's-era engines, avionics, and weapons systems is essential for continued airborne strategic deterrence.

The B-2, the Nation's only penetrating bomber is also undergoing several critical modernization programs to maintain its survivability against advanced air defenses. Similar to the B-52, the B-2 recently received weapon systems and communication equipment updates to improve effectiveness and lethality.

The B-21 is the bomber of the future, ensuring we maintain a technical advantage against planned adversary advancements. Armed with both direct attack weapons to hold emerging targets at risk and cruise missiles to deny geographic sanctuaries to any adversary, the B-21 will deliver the right capabilities based upon the tactical situation. Like other modernization programs, it is critical the Air Force deliver the B-21 on time and on budget to assure we can meet deterrence objectives and global security commitments.

Complementing the Nation's strategic bomber force, the Long Range Standoff weapon (LRSO) will replace the aging ALCM and maintain a viable nuclear standoff capability that can hold targets at risk in an evolving threat environment.

Strategic bombers require reliable and robust tanker support to execute their strategic deterrence and nuclear operations missions. While the Air Force is committing significant resources to maintain the aging KC-135 tanker fleet, it is critical we deliver its replacement on time. The Air Force remains confident the KC-46 will deliver the required capabilities to support our strategic forces. It is imperative that KC-135 sustainment and KC-46 deliveries remain top priorities to ensure a credible air-delivered strategic deterrent.

Our NATO partners rely on the credible deterrent of deployed F-15, F-16, and PA-200 Dual Capable Aircraft (DCA) to provide regional assurance against aggression in Europe. The B61 nuclear gravity bombs deployed to NATO are over 30 years old and will be replaced by the life extended B61-12. By the mid-2020s, the F-35 will be available in Europe and capable of delivering the B61-12 into defended areas, maintaining the credibility of our deterrent capability and of the nuclear alliance. The on-time delivery of these capabilities and our continued commitment in support of NATO is a cornerstone of our deterrence and assurance objectives.

#### **NUCLEAR WEAPON STOCKPILE AND SUPPORTING INFRASTRUCTURE**

Today, our nuclear weapons are safe, secure, effective, reliable, and able to meet deterrence mission requirements. Much like the modernization efforts of our delivery systems, we must also take a hard look at the components that make up the warheads themselves. Ensuring the viability of the nuclear deterrent requires continued resourcing and sustained effort to address the increasing uncertainty and growing risk in our nuclear stockpile and enterprise.

The majority of weapons in today's stockpile have surpassed their intended design life, thereby accumulating increasing risk. The United States has reduced its stockpile by 25 percent since 2010, while some potential adversaries have increased their numbers of nuclear weapons and significantly modernized their nuclear capabilities. Potential adversaries are elevating strategic uncertainty with new capabilities, escalatory doctrines, and actions threatening our nuclear forces' effectiveness and credibility.

To address these challenges, the Nuclear Weapons Council (NWC) recently updated its long-range strategic plan to align with the National Security Strategy and the National Defense Strategy, and implement actions directed in the 2018 NPR. The strategic plan aligns the Department of Energy's National Nuclear Security Administration (NNSA) nuclear weapons modernization and infrastructure recapitalization activities with DoD nuclear delivery system replacement programs in support of deterrence and military requirements.

The NNSA recently celebrated important stockpile modernization milestones by completing the Navy's W76-1 ballistic warhead life extension program (LEP) and achieving first production of key components in the Air Force's B61-12 gravity weapon nuclear package. The Air Force and NNSA are

progressing with the LRSO missile and its associated W80-4 warhead to deliver required capabilities on schedule.

The next significant stockpile effort involves both Air Force and Navy ballistic missile warheads, the bulk of our deterrent force. While these weapons will not field until the 2030s, development activities need to start in earnest now in order to posture the enterprise for success. Starting now also provides expanded opportunities for the Navy and Air Force to collaborate and leverage investments to their mutual benefit.

None of the required stockpile surveillance, sustainment and modernization efforts will succeed without replacing key facilities and upgrading our aged nuclear infrastructure. Our present complex continues to accumulate serious risk due to atrophy and past lack of timely recapitalization. I visited all the design laboratories and production plants across the complex last year, and in too many cases the enterprise is operating at or near capacity or simply lacks the needed infrastructure. This results in little margin to execute planned work or respond adequately to an emergent technical issue. Options for future systems are constrained by design and production limitations. If not corrected with currently underway or planned investments, the complex's condition will place us at a strategic disadvantage.

The highest NNSA infrastructure priority is re-establishing a plutonium pit production and fabrication capacity to meet deterrent requirements. Our national requirement, supported by numerous studies and analyses, requires no fewer than 80 war-reserve pits per year by 2030. I support the NNSA plan to achieve this.

Additionally, critical infrastructure investments in uranium and tritium processing, lithium and non-nuclear component production, experimental facilities, and general supporting infrastructure are required. Shortcomings in these areas create operational risks to force readiness and our surge ability to respond to unforeseen technical issues or adversary advancements in their capabilities.

Along with recapitalizing our infrastructure, we must also recruit, train, and retain a qualified workforce to perform the highly specialized nuclear weapons work. The enterprise must enact a human resource strategy that identifies qualified candidates, fosters interest through internships or skilled trade programs, and clears them for classified work as quickly as possible. The critical nature of our nuclear deterrent mission should drive us to hire and retain the best workers our country has to offer.

#### **NUCLEAR WEAPONS SAFETY AND SECURITY**

The Nation's nuclear security standard is absolute denial of unauthorized access to nuclear weapons. We work closely with our Navy and Air Force partners to assess nuclear security requirements and adjust our force posture, training, and equipment to address any threat. While we continue to upgrade

and evolve our security capabilities, there are areas where additional investments are necessary to maintain the high standards this mission demands.

The proliferation, ease of use, and sophisticated capabilities of small, unmanned aircraft systems (sUAS) represent a growing threat to our deterrence operations. We rapidly fielded counter sUAS capabilities and are refining tactics, techniques, and procedures to address the developing threat. Focused leadership, vigilance, and dedicated investment are necessary to remain ahead of this threat.

With Congressional support, we recently achieved an important security milestone with the Air Force awarding a contract to replace our aged UH-1N helicopter fleet with the new MH-139. The new helicopter is a critical element in securing our vast ICBM complex and our security forces eagerly await its deployment. The first production unit is already well along the production line in Pennsylvania. With this program moving forward, we can now focus our efforts on replacing security vehicles and deploying advanced communication systems that will provide security personnel uninterrupted situational awareness anywhere they operate.

#### **21st CENTURY DETERRENCE**

21st century deterrence not only requires effective NC3, a modernized triad of nuclear ICBMs, SLBMs, and bombers with air delivered weapons, and an ability to design and produce modern and more effective nuclear weapons, it also requires conventional global strike, space control, control of the electromagnetic spectrum, and missile defense. When effectively integrated these capabilities provide the Joint Force the ability to respond to adversary actions in the domain, location and time of our choosing.

#### **CONVENTIONAL GLOBAL STRIKE**

Bombers are capable of carrying a variety of conventional and nuclear weapon types with diverse attributes contributing to the flexibility of the deterrent force. Additionally, bombers are integral to our international engagements and partnering through our Bomber Task Force (BTF) missions, and our demonstrated capability to conduct strike missions originating from the continental United States. BTF deployments to the Indo-Pacific and European theaters provide an opportunity to exercise and train with our allies and partners, demonstrate U.S. commitment and resolve, and deter potential adversaries.

The B-1 is the workhorse of the past 17 years of conventional fighting. The B-1 has had many successes in Iraq, Syria, and Afghanistan, while providing USSTRATCOM a credible conventional deterrent against global threats. As the threshold platform for the Long Range Anti-Ship Missile, the B-1 will remain a formidable asset for operations in the Pacific and across the globe. Similar to the B-52, the Air Force remains committed to maintaining the platform to ensure its continued operational effectiveness.

Strategic competitors are investing significant resources to develop offensive and defensive capabilities with the purpose of countering our entire deterrence strategy. To maintain peace, the United States must continue to invest in technological innovation and development of survivable, long-range strike systems able to hold time-sensitive and high-value targets at risk. Today, the only prompt long-range strike capabilities are ballistic missile systems armed with nuclear warheads. We need a conventional prompt global strike capability. This is the USSTRATCOM requirement. Conventional hypersonic strike weapons could meet this requirement and provide responsive, long-range, strike options against distant, defended, and/or time-critical threats when other forces are unavailable, denied access, or not preferred. While conventional hypersonic weapons are not a replacement for nuclear weapons, their unique attributes will increase traditional warfighting advantages and bolster conventional and strategic deterrence.

The DoD identified conventional hypersonic strike as a top research and development priority and is moving forward with a mix of land, sea, and air-launched weapon system options to hold high value, heavily defended and time critical targets at risk. This is a Department-wide, multi-Service, collaborative effort to provide operational capabilities as soon as possible. The Navy's Conventional Prompt Strike (CPS) program spearheads the initiative as the leading technology maturation effort allowing the Navy to field a submarine/ship launched intermediate-range CPS weapon system that can be leveraged into Air Force and Army efforts. The Air Force continues to explore both air-launched hypersonic boost-glide and cruise missile concepts for fielding on a variety of strike and bomber aircraft. The Army plans to incorporate hypersonic strike systems into their traditional long-range precision fires portfolio to expand the reach of surface-to-surface engagements. Each of these capabilities have the potential for early operational fielding within the next few years. This flexible mix of capabilities will provide Combatant Commanders persistent, visible and credible strike options without crossing the nuclear threshold.

#### **SPACE OPERATIONS**

For decades, the United States has enjoyed unimpeded freedom of action in space. This allows us to deliver space capabilities that include intelligence collection, missile warning, weather monitoring, satellite communications as well as precise positioning, navigation, and timing essential to joint forces operating globally with unmatched speed, agility and lethality. These same capabilities also contribute to our economy and support our quality of life.

The President has directed a renewed commitment to space. Our commitment extends to the integration of space capabilities across every domain in order to deliver an unmatched global advantage to the Joint Force. What remains unchanged is the fact that our principal competitors regard space as a

warfighting domain. While the United States prefers space to remain free of conflict, we are rapidly moving to meet and overcome challenges impeding our ability to access and freely operate in space. The best way to deter a war that starts in, or extends into space, is to be ready to fight and win.

As part of this effort, the President has given direction for a more cohesive, robust space warfighting organization. In December, upon the recommendation of the Secretary of Defense and the Joint Chiefs, the President directed the establishment of U.S. Space Command (USSPACECOM) as a unified combatant command to improve joint warfighting in the space domain. Moving expeditiously to a unified space command reflects the importance of warfighting in space to the Joint Force, the value of space-focused deterrence elements, and the critical need for space-related response options for the Nation. USSTRATCOM will maintain its focus on this critical mission area until authorities and responsibilities governing space operations fully, and successfully, transition to a new combatant command.

In addition to realizing a dedicated unified space command, we are moving forward on a priority effort executing tasks directed in Space Policy Directive-3. USSTRATCOM is closely partnering with the Department of Commerce (DoC) to transition some non-military aspects of Space Situational Awareness (SSA) data publication and space traffic management-related functions to DoC, while continuing to provide SSA data to support U.S. Government customers and to advance military-to-military relationships that support worldwide combined military operations.

USSTRATCOM's new SSA data sharing initiative, executed through the Joint Force Space Component, releases information about space objects not previously available outside of DoD channels, to enhance SSA data sharing, transparency, and spaceflight safety. This initiative is in line with national policy as part of a larger effort to preserve the safety of, and accessibility to space, so that our Nation, allies, and even the rest of the world, can continue to reap the benefits of space.

Exercises and wargames continue to refine how we coordinate today and how we will work together in the future. This year, Japan participated in the Schriever Wargame for the first time, joining Australia, Canada, France, Germany, New Zealand, and the United Kingdom. We also executed GLOBAL SENTINEL 2018, our fifth annual operational tabletop experiment for SSA, and increased its international participation to include Australia, Canada, the United Kingdom, France, Spain, Germany, Italy, Japan, and the Republic of Korea. Chile and Norway attended as observers.

USSTRATCOM continues to focus on cultivating a robust international engagement environment with several ongoing lines of effort. In doing so, we have generated significant momentum leading to a fully integrated partnership of nations dedicated to defending the peaceful use of space.

Improved partnership with allies is paramount for the safety and security of the space domain. As we continue our Combined Space Operations (CSpO) initiative with Australia, Canada, New Zealand, and the United Kingdom, we recently expanded it with the addition of France and Germany. In July 2018, the

Joint Space Operations Center (JSpOC) transitioned to a Combined Space Operations Center (CSpOC), now the centralized hub for operational space planning and tasking with distributed execution through contributing partners. This effort goes hand in hand with our recent update to Operation OLYMPIC DEFENDER to include international partners and define our operational relationships and associated authorities as we conduct combined operations in the space domain.

The National Space Defense Center (NSDC) continues to mature as our 24/7/365 operational center to protect and defend the space domain. The NSDC remains the focal point for unity of effort across DoD, the Intelligence Community, and the National Reconnaissance Office for information sharing and to rapidly detect, warn, characterize, attribute and defend against threats to our Nation's vital space systems.

Future satellite communications (SATCOM) systems remain key to our continued strategic posture in space. We must design and fund replacement systems and remain on schedule for smooth transition of operations to these new systems. We must expand international SATCOM partnerships, strengthen our industrial base response to acquisition challenges, and integrate commercial opportunities to evolve future satellite payloads towards commercial solutions wherever possible.

The inclusion of our allies is key to building a robust SATCOM network that leverages commercial integration, synchronization and sharing of resources. Multilateral agreements with Canada, Denmark, Luxembourg, Netherlands, and New Zealand provide funding for the operation of Wideband Global SATCOM (WGS). Consequently, the department shares bandwidth proportionally with our partner nations and allocates bandwidth based on the amount of their financial contribution. The growth of the WGS constellation continues as we launch WGS-10 in early 2019, and with newly-infused funding authorized in the FY 2018 NDAA, we plan to procure and launch additional WGS capacity.

Addressing the synchronization gap between terminals, ground infrastructure, and on-orbit satellite capacity remains a significant concern. The narrowband SATCOM legacy constellation is aging, and we must continue to make progress transitioning to the Mobile User Objective System, leveraging commercial capabilities where appropriate. The fielding of new AEHF Extended Data Rate (XDR) capable satellites continued with the launch of AEHF-4 in October 2018. That event, coupled with the anticipated launch of two more AEHF satellites in the next two years, will cover our near term protected communications equities.

USSTRATCOM, in conjunction with the Services, continues to pursue an enterprise approach to fighting SATCOM in a contested domain through the stand-up of the SATCOM Integrated Operations Environment (SIOE). The SIOE is designed to leverage key wideband, narrowband, protected band, and commercial SATCOM enterprise capabilities and expertise to improve our ability to mitigate and fight through SATCOM degraded environment. We will also aggressively pursue the integration of

commercial capabilities that have the ability to provide robust, resilient augmentation of our constellations for a very reasonable cost.

We must improve how we collectively organize, train, and equip ourselves for unfettered access to and freedom to operate in space, providing vital capabilities to joint and coalition forces in peacetime and across the spectrum of conflict. As potential adversaries continue to develop, test, and field more threats to our space systems, USSTRATCOM (and the future USSPACECOM) will benefit from increased focus on these key areas that enable us to deter aggression and protect our interests. We must go faster to stay ahead of potential adversaries, and USSTRATCOM is committed to ensuring sustained space operations with available forces during this transition period until USSPACECOM is ready to assume the lead role.

The President has also focused on the benefits of establishing a sixth branch of the military, the Space Force. The President and Vice President have been personally involved in developing this new Force and Acting Secretary of Defense Shanahan has worked across the Department to define the proposal. The Space Force will be a separate service within the Department of the Air Force. I support the creation of the Space Force within the Department of the Air Force. This will allow proper focus on the warfighting challenges, effective and aligned support to the new USSPACECOM, and given the threats and challenges in the domain, help to build an enduring “space-minded” culture in the department. This effort will not create or require a large, new support bureaucracy. Someday, the Space Force will be its own department, but this is not yet the right time. I thank the President and the Vice President for recognizing that space is a warfighting domain and proposing a fiscally responsible approach for the organizations needed to address these critical challenges. I encourage the Congress to support this proposal.

USSTRATCOM and the future USSPACECOM will directly benefit from the President’s intent to accelerate space acquisition timing. Current 10- to 15-year cycles from requirement to fielded capability are too long. Not only do we miss out on application of new technology and field equipment that is already obsolete on Day 1, but we also need a systemic change to counter potential adversaries with faster acquisition cycles. Commercial innovation has already adapted to exploit faster and faster technology discovery in commercial competition, and we must change to leverage these accelerating opportunities not only to defend our Joint Force in space, but also to protect commercial investments that sustain the global economy. USSTRATCOM (and the future USSPACECOM) look forward to leveraging the benefits of the new Space Force as our organizations focus on two things – defending the space domain and going fast.



#### **JOINT ELECTROMAGNETIC SPECTRUM OPERATIONS (JEMSO)**

The Electromagnetic Spectrum (EMS) is the one physical maneuver space shared by all forces in all domains. The EMS is central to the first strategic goal of organizing forces to achieve Joint Force commander objectives. The Joint Force operates in the EMS to achieve superiority at a time and place of our choosing. Our adversaries recognize the need to decisively achieve EMS control and have developed and organized their forces accordingly. In recognition, we must continue to pursue capabilities necessary to maintain EMS superiority. Achieving EMS superiority early in conflict is critical for effective U.S. operations in all domains.

USSTRATCOM, in coordination with DoD CIO/DISA, is actively pursuing development of an Electromagnetic Battle Management (EMBM) system to enable EMS superiority. We are supporting the EMS Operations governance study directed by the Joint Requirements Oversight Council and coordinating with other combatant commands on the development and implementation of JEMSO cells and tactics, techniques, and procedures. Additionally, we continue to engage Australia and North Atlantic Treaty Organization partners to ensure compatible JEMSO doctrine and concepts of operation, and to lay the groundwork for interoperable EMBM systems.

Section 1053 of the FY 2019 NDAA, PL 115-232, provides guidance to the Secretary of Defense on electronic warfare and JEMSO to improve our ability to advocate effectively for requirements. USSTRATCOM is working closely with the Acting Secretary and Services to implement measures of the act, the Electronic Warfare Executive Committee and the previously mandated cross-functional team to identify requirements and specific plans for addressing personnel, capability and capacity limitations in order to ensure effective implementation of DoD's Electronic Warfare Strategy.

#### **THE MISSILE DEFENSE REVIEW**

Conducted at the direction of the President, the 2019 Missile Defense Review (MDR) presents the Administration's missile defense policy and strategy. The MDR aligns with the National Security Strategy, the National Defense Strategy, and the 2018 NPR. The MDR reinforces the Administration's commitment to defending the United States and our deployed forces and allies from adversary missile attacks.

The United States and our allies and partners face potential adversaries who are increasing existing missile system capability and capacity; adding new and unprecedented types of armaments to their arsenals; and integrating offensive capability more thoroughly in their coercive threats, military strategy, and war planning. Left unaddressed, this expanding missile threat could embolden our adversaries into mistakenly believing they can coerce us, inhibit our freedom of action, or undermine our

security alliances. A concerted U.S. effort is required to expand and improve existing capabilities for both homeland and regional missile defense.

As stated in the National Security Strategy, the United States has a robust and credible layered missile defense system. When paired with offensive capabilities this combination sends a strong message allowing the United States to deny benefits and impose costs against any potential adversary. Although the United States relies on nuclear capability to dissuade near-peer strategic threats, missile defense endures as a critical component of comprehensive U.S. strategic and tailored regional deterrence strategies. Our regional missile defenses protect against missile attacks on deployed U.S. forces, allies, and partners; assists allies and partners in better defending themselves; preserves freedom of action; and counters adversary anti-access/area denial tactics. The United States is pursuing new concepts and technologies to ensure continuing effectiveness against advanced future threats, including space-based sensors and boost phase intercept. As we address future threats, we must account for the air and missile defense assets required to defend the homeland, while simultaneously improving our regional security architectures. In this effort, there is no one silver bullet, but several layered capabilities are in development.

#### **MISSILE DEFENSE**

The 2019 MDR sets the foundation for the next generation of missile defense efforts. Of importance to USSTRATCOM, it provides an opportunity to conduct focused reviews clarifying and optimizing missile defense roles and responsibilities across the Department. This includes opportunity to assign responsibility for integrating pre-launch attack operations with defenses to mitigate missile threats, ensuring warfighter involvement in our Departmental requirements and fielding processes, and assessing how to better use missile warning assets against emerging threats. All of these efforts focus on reviewing current systems and addressing advanced adversary capabilities such as hypersonic threats.

U.S. missile defense capabilities will be sized to provide continuing effective protection of the U.S. homeland against rogue states' offensive missile threats. The United States relies on nuclear deterrence to address the large and more sophisticated Russian and Chinese intercontinental ballistic missile capabilities, as well as to deter attacks from any source consistent with long-standing U.S. declaratory policy as re-affirmed in the 2018 NPR.

As the warfighter advocate for Missile Defense, it is imperative that we focus materiel developers on research, development, testing, and engineering against advanced threats. Rapidly transitioning ready systems with identified funding streams to the Services will free up needed resources for critical research and development efforts such as continued funding of next generation

space systems. Research and development is key to ensuring we keep pace with evolving adversary threats across all domains. Space systems provide valuable solutions to layered tracking and discrimination capability. A space tracking and discrimination constellation combined with next generation Overhead Persistent Infrared systems would provide significant improvements necessary to detect advanced threats. Future space-based sensors may be able to detect, track, and discriminate hypersonic glide vehicle and ballistic missile threats globally. These abilities cannot be fully achieved with the current or any future terrestrial-based radar architecture due to the constraints of geography and characteristics of future missile threats.

Boost phase intercept is also showing promise. Increasing the power and lethality of laser, neutral particle beam, and high power radio frequency systems for multi-mission applications, along with new fighter-delivered interceptors, can exponentially enhance our missile defenses.

#### **ASSURING ALLIES AND PARTNERS**

USSTRATCOM cannot accomplish its mission without integrating allies and partners. Allies are critical to responding to mutual threats, preserving our shared interests, and are the greatest asymmetric advantage the United States has over potential adversaries. The Command continues to expand and enhance the viability of our Nation's alliances and partnerships, setting conditions across the globe to deter our adversaries.

USSTRATCOM's engagements with allies and partners are critical in shaping the strategic environment, strengthening relationships, and building trust. In doing so, we are prepared to act in a combined manner to deliver a decisive response in crisis or during contingency operations.

During 2018, our Command conducted over 50 bilateral engagements with senior leaders from Australia, Brazil, Canada, Denmark, France, Germany, Great Britain, Iceland, Japan, Netherlands, Pakistan, the Republic of Korea, Taiwan, and Thailand.

Our 25-nation, multinational missile defense policy campaign of experimentation, NIMBLE TITAN (NT) 2018, concluded with a senior leader seminar held at the new NATO headquarters in Brussels, to include representatives from Europe, the Gulf States, the Indo-Pacific, and North America. The NT 2020 campaign is just beginning, and continues to show increased interest by partners and allies.

USSTRATCOM works closely with our allies and partners to enhance awareness within the space domain, increase the safety of spaceflight operations, and promote the responsible, peaceful, and safe use of space. During 2018, USSTRATCOM signed new national agreements with Brazil, Denmark, the Netherlands, New Zealand, and Thailand for sharing SSA services and data. Currently, USSTRATCOM has agreements with 18 nations, two intergovernmental organizations, and over 70 commercial satellite launchers, owners, and operators.

Our efforts in this area increase military interoperability, improve alliance capability and capacity, and integrate our critical defense missions. The Command's engagements assure allies and partners of the United States' extended deterrence commitments and reinforce non-proliferation goals and objectives.

## CONCLUSION

USSTRATCOM is a global warfighting command. Success in all of our missions depend on the Command's greatest strength – our people. The 162,000 men and women stationed around the globe, operating in all domains, undertake the active defense of our Nation every day. These Soldiers, Sailors, Airmen, Marines, and civilians are warfighters, dedicated to preserving the peace and when called upon, ready to dominate and win in conflict. Successful mission execution has the appearance of “business as usual” which belies the effort and impact of executing at the highest standard every day.

Today, our capabilities are safe, secure, and effective and our forces are combat-ready. With continued support of the programmed major investments, our forces will prevent nuclear war and ensure that regardless of how would-be adversaries might choose to attack the United States, we will always retain decisive response options, across the spectrum of conflict, for the President.

We are dominant today. However, advantages we have long-held are eroding, challenging the Command's ability to deter strategic attack, engage in active defense, assure our allies and partners, and fight and win in and across all domains if necessary. We cannot let this erosion continue. We must maintain our strategic advantage. We must take calculated, smart risks and move fast once again. With sustained Congressional support, USSTRATCOM will continue to effectively defend the nation.

Nuclear war cannot be won and must never be fought. Therefore, to prevent war we must be ready for war. We must maintain today's triad of nuclear forces, while simultaneously building the triad of tomorrow. We must integrate all domains and capabilities together to effectively deter in the 21st century. If we are successful, we will continue to live up to our motto, coined over 60 years ago. Peace is our Profession...

**Vice Admiral Dave Kriete**  
**Deputy Commander of U.S. Strategic Command**

Vice Adm. Dave Kriete is a native of Brooklyn, New York. He is a 1984 graduate of the United States Naval Academy where he majored in general engineering. He holds a master's in engineering management from Old Dominion University.

His flag assignments include command of Submarine Group 9 in Silverdale, Washington; deputy director of Plans and Policy, U.S. Strategic Command (USSTRATCOM), Offutt Air Force Base, Nebraska; and as deputy director, force employment at U.S. Fleet Forces Command (USFF). Most recently, he served as director, Strategic Capabilities Policy, National Security Council where he was responsible for presidential policy on all nuclear weapons related issues.

His operational assignments include command of USS Rhode Island (SSBN 740). He also served aboard USS Kentucky (SSBN 737), USS Flying Fish (SSN 673) and USS Finback (SSN 670).

His shore and staff assignments include chief of staff, Submarine Force Atlantic; Navy Staff, Undersea Warfare Division; Submarine Force Atlantic Tactical Readiness Team and prospective commanding officer instructor; Joint Staff Nuclear Operations Division; Atlantic Fleet Nuclear Propulsion Examining Board; and Submarine Force Atlantic Special Operations Division.

Kriete has had an integral role in the two most recent Nuclear Posture Reviews. He assumed the duties and responsibilities as deputy commander, United States Strategic Command in June 2018.



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**QUESTIONS SUBMITTED BY MEMBERS POST HEARING**

MAY 8, 2019

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## QUESTIONS SUBMITTED BY MR. COOPER

Mr. COOPER. Along with the DODIG findings on cyber vulnerabilities of government networks hosting BMDS data, DOT&E has historically been critical of MDA's willingness to test operational configurations of the BMDS against cyber threats. Can you please provide the committee a summary of how DOT&E is working with MDA to ensure both operational and developmental systems are being tested against cyber threats? Further, can you detail how implementing persistent cyber operations would be beneficial in ensuring our critical technology and infrastructure for missile defense is protected?

Mr. BEHLER. The Missile Defense Agency (MDA) is working on multiple, parallel fronts to characterize the cybersecurity posture of critical developmental and operational Ballistic Missile Defense System (BMDS) assets. DOT&E continues to participate in the planning of operational cybersecurity assessments and monitor test conduct to inform MDA efforts to improve BMDS cyber resilience. We intend to work with the MDA and USD(R&E)/DT&E to finalize an overarching cybersecurity assessment strategy that includes robust developmental test and evaluation to enable discovery and remediation of cybersecurity vulnerabilities prior to operational test and evaluation (OT&E), while ensuring that operational cybersecurity assessments inform critical fielding decisions. DOT&E is also championing a more deliberate and detailed element planning cycle to ensure that cybersecurity findings are applied to future engineering updates. DOT&E will work with USD(R&E)/DT&E and MDA to develop and implement a robust element-level cybersecurity DT&E plan to identify and mitigate vulnerabilities earlier. Currently, many vulnerabilities identified during cybersecurity OT&E should have been found in DT&E. BMDS mission assets and MDA networks remain subject to exploitation by adversarial threat actors. Persistent Cyber Operations (PCO) are a continuous means by which the MDA can characterize system vulnerabilities induced by the operational environment and train warfighters and net defenders against a cyber threat emulation that has the time to stealthily employ both physical and cyber means of exploitation. If employed properly, PCO will help improve the cyber resilience of critical BMDS mission assets and MDA networks against advanced cyber threats. Although the MDA has significantly increased the amount of cybersecurity OT&E conducted over the last two years, cybersecurity DT&E is lacking and the overall test activity remains constrained by short test windows, limited access to critical BMDS components, and test artificialities that a realistic cyber threat does not encounter. Robust cybersecurity DT&E and PCO help to remove these limitations. However, the PCO's human element alone is unable to scale to the magnitude of the cyber challenges. Therefore, a robust effort to develop autonomous tools to identify cyber vulnerabilities and patching should be pursued.

Mr. COOPER. Congress mandated that MDA conduct an SM-3 Block IIA intercept against an ICBM-range target by 2021, which is outside of the systems designed threat space. Since that mandate, the SM-3 IIA has experienced several flight test failures. Would you assess the system has been adequately tested against its designed-to threat? Would DOT&E assess the system to be "operationally suitable and effective" against IRBM threats based on the testing done to date?

Mr. BEHLER. Aegis Baseline 9.2 and the Standard Missile-3 (SM-3) Block IIA guided missile have not yet been adequately tested against the designed-to battlespace and threat set. To date, the weapon system and missile have successfully completed one end-to-end operational Engage on Remote (EOR) engagement in a flight test mission. EOR is fundamental to the system's ability to defend against a larger battlespace and threat set. A second end-to-end EOR engagement is planned for Flight Test, Operational-03 Event 2 and will qualitatively demonstrate the repeatability of that capability. System performance across the battlespace has not yet been assessed using accredited high-fidelity modeling and simulation (M&S) tools. A subset of the planned high-fidelity M&S runs will be delivered by June 2020, with the remainder being delivered by June 2021. Completion of these accredited M&S runs, coupled with additional flight testing, will enable DOT&E to make an assessment of operational effectiveness for this system against intermediate-range ballistic missiles (IRBMs). Additional flight testing and data from flight-like, high-fidelity ground testing of the missile in its production-representative configuration, will enable DOT&E to assess the operational suitability of the system against IRBM threats.

Mr. COOPER. Can you please provide the committee a summary of what the “Neutral Particle Beam” effort being initiated in PB20 is, and the underlying policy decisions that have been made, or will be made, about deploying this type of capability in space?

Secretary ANDERSON. The Neutral Particle Beam (NPB) is a technology demonstration effort to assess the feasibility of a space-based, directed-energy intercept layer. This effort would leverage past and current work on particle beam and related enabling technologies, as well as laser scaling, pointing, and stability to inform future decisions. The 2019 Missile Defense Review articulates the policy to pursue new missile defense concepts and technologies, including disruptive capabilities such as boost-phase intercept, to provide protection against evolving missile threats. The policy for any potential future decisions regarding space-based capabilities would be informed by factors such as technical maturity, threat, feasibility, and cost, as well as pertinent political-military considerations.

Mr. COOPER. Can you please provide the committee a summary of what the “Neutral Particle Beam” effort being initiated in PB20 is, and the underlying policy decisions that have been made, or will be made, about deploying this type of capability in space? To employ a Neutral Particle Beam in space, would you need a space sensor to provide data to that weapon? What are the estimated total costs for an operational system? What other technologies and/or solutions were looked for boost-phase defense prior to moving forward with the Neutral Particle Beam?

General GREAVES. Missile Defense Agency defers to Under Secretary of Defense for Research and Engineering (USD(R&E)).

Mr. COOPER. Congress mandated that MDA conduct an SM-3 Block IIA intercept against an ICBM-range target by 2021, which is outside of the systems designed threat space. Since that mandate, the SM-3 IIA has experienced several flight test failures. Would you assess the system has been adequately tested against its designed-to threat?

General GREAVES. The SM-3 Blk IIA has been adequately analyzed and tested against the designed-to threat. Analysis and testing included modeling and simulation, ground testing, and flight testing. Given the large number of threat and engagement variables the modeling and simulation testing is the primary means to verify performance against the designed-to threat set. Ground and flight testing provide the evidence necessary to anchor the models and simulation to predict performance in real world scenarios. All models used are accredited for the intended use of performance assessment. High fidelity missile performance models are accredited via comparison to independently coded government models. Following flight test, the data gathered is used in post flight reconstruction of the event utilizing both models supporting continued improvement in fidelity for the models. Specific to flight testing, the SM-3 Blk IIA has been successfully tested against Medium Range Ballistic Missile (MRBM) (FTM-45 in fiscal year 2019 (FY19)) and Intermediate Range Ballistic Missile (IRBM) (FTI-03 in FY19) threats in both organic and Engage-on-Remote (EoR) engagement scenarios. MDA’s President’s Budget 2020 Integrated Master Test Plan version 20.1 includes future flight tests for SM-3 Blk IIA against MRBM (FTM-30 in FY20), IRBM (FTO-03 in FY20) and ICBM (FTM-44 in FY20) that include additional complexity to further refine and validate the Aegis Weapon System/SM-3 Blk IIA performance capability. The flight test failure in Flight Test Aegis Weapons System-29 (FTM-29) on January 31, 2018 was traced back to a manufacturing flaw and improper firing sequence of the Arm Fire Device that has since been corrected and validated in FTM-45 on October 26, 2018 and again in Flight Test Integrated-03 (FTI-03) on December 11, 2018. The SM-3 Blk IIA flight test program was established to incrementally learn from test to test, with each test serving as a graduation exercise and risk mitigation for the next one. Starting with the Controlled Test Vehicle-01 flight test on June 6, 2015 that demonstrated the propulsion stack, and eventually progressing to the recent FTI-03 test demonstrating EoR in a simulated European Phased Adaptive Approach architecture, each test provided incremental refinement and validation of the Aegis Weapon System/SM-3 Blk IIA models. This learning extends not only for the successful intercept flights, but those with failed intercepts like FTM-29. Based on a continuously evolving and increasingly relevant threat, testing our systems at or beyond the limits of their designed specifications will serve to build confidence in the system to the warfighter.

Mr. COOPER. What would the concept for operation be for a “Neutral Particle Beam”?

Admiral KRIETE. The Neutral Particle Beam (NPB) is a promising technology with the potential to expand our layered defense abilities enabling early ascent/boost phase engagement opportunities. However NPB is very early in development. Formulation of a future CONOPs, is dependent on a better understanding of the capa-

bilities available when the technology is mature and employment size, weight and power requirements are known.

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#### QUESTIONS SUBMITTED BY MRS. DAVIS

Mrs. DAVIS. How close is MDA to maturing directed energy technology to where it is suitable and effective for missile defense? What are the deliverables in FY20 and in the FYDP?

Mr. BEHLER. All directed energy efforts being explored by the Missile Defense Agency (MDA) are in the basic technology maturation phase of development. Potential platforms for directed energy applications have not yet been determined, and there are no platform integration activities currently being pursued. The MDA's directed energy maturation is centered on scaling electrically-driven High Energy Laser (HEL) power by a factor of ten, to the megawatt class, which is the minimum required for effective missile defense. While chemical laser technology has demonstrated higher optical output power than electrically-driven lasers, chemical-based lasers were previously found to be larger, heavier, harder to operate, and had significantly more logistical challenges when deployed. The MDA is currently pursuing multiple technologies in parallel, both in industry and at national laboratories, with the common goal of increasing laser power with adequate beam control. The MDA's FY20 goal is to achieve 100 kilowatt-class performance in the laboratory with several selected approaches. The MDA's maturation strategy is to increase power levels to 300 kilowatts, then to 500 kilowatts, and then finally to megawatt-class power levels. MDA is coordinating its effort and its goals with OUSD(R&E) in a Department-wide laser scaling effort. OUSD(R&E) and MDA are pursuing four different electrically-driven high energy laser technologies, with the goals of increasing output optical power, increasing efficiency, and reducing size and weight. OUSD(R&E) anticipates that, with its projected funding level in concert with MDA, a 500 kilowatt optical power level laser could be reached in FY24. The MDA is also developing tracking and sensing technologies that use a low-power non-lethal laser. In FY20, two developers will pursue this advanced sensor with a precision tracking test anticipated by the end of FY21. Results of the test will inform future years' efforts on this sensor.

Mrs. DAVIS. MDA established a hypersonic defense program in fiscal year 2018 to develop and deliver a series of material solutions to defeat hypersonic threats. In the fiscal year 2020 President's Budget submission, MDA plans to spend over \$650 million over the next 5 years on hypersonic defense.

What are the challenges of defending against hypersonic missiles from a technological and organizational standpoint? What solutions has MDA identified that are needed to defend against hypersonic missiles and how much will they cost? Is it technically feasible? What deliverables are planned in the FYDP?

General GREAVES. Hypersonic threats fly at speeds and altitudes above traditional air defense systems and below the altitude of traditional missile defense systems, creating technical challenges for either system if they attempt to defeat the threat. Challenges for the missile defense system include threat maneuvers, low altitude, and hypersonic speeds that make the target unpredictable while also compressing the available battlespace. These characteristics impact all aspects of the missile defense system's operation, including threat detection, tracking, engagement planning, engagement, and assessment of the engagement's outcome. These challenges led MDA to identify required capabilities for hypersonic missile defense, including persistent tracking of an unpredictable threat, improved communications, fire control strategy changes (compared to ballistic threats), and very high interceptor agility in a harsh aerothermal environment. Since hypersonic threats fall between the traditional air defense mission of the services and the missile defense mission of the Missile Defense Agency (MDA), any solution will be coordinated accordingly. MDA is awarding multiple contracts for several HD component technology solutions to include: seeker technology; new propulsion techniques; guidance technologies in a high stress environment; sensor technologies and testing to support detection and tracking; and non-kinetic technology solutions to address the hypersonic threat. MDA is also utilizing its existing Small Business Innovation Research Program funds to identify and support aspects of the kill chain and weapon system design for expansion of hypersonic missile defense capabilities in the near-future (outside the Future Years Defense Program (FYDP)). The PB20 submission includes \$109.2 million across the FYDP to leverage and upgrade existing command and control systems and sensors for improved hypersonic tracking and reporting. The weapon system concept exploration precedes development of specific weapons solutions; MDA will

estimate costs for those solutions as part of the selection process. Deliverables planned across the FYDP include:

1. Engineering Enablers: System-level engineering products include future architecture definition, test and analysis infrastructure, requirements, interface definitions, ground/flight test assessments, and core lethality test results.
2. Command and Control, Battle Management and Communications (C2BMC) Upgrades: C2BMC upgrades include capabilities for hypersonic threats delivered in FY21 and FY23; other details classified.
3. Weapon Concept Definition and Risk Reduction: Deliverables include glide phase weapons system technology development and testing data that demonstrates technologies needed for a HD capability.
4. Radar Upgrades: Current BMDS sensor deliverables include Army Navy/Transportable Radar Surveillance and Control (AN/TPY-2) radar and Long Range Discrimination Radar (LRDR) software upgrades (FY23).
5. Sensor Technology Improvements: Improvements include development of new high resolution sensors and a state of the art testbed needed to demonstrate capabilities against hypersonic threats.
6. Partner Flight Test Participation: Data collected from two partner flight test events will support Weapons Concept Definition and Risk Reduction activities. In both events, MDA will collect data to shape future defensive capability and assess current capability to inform incremental missile defense updates.

Mrs. DAVIS. How close is MDA to maturing directed energy technology to where it is suitable and effective for missile defense? What are the deliverables in FY20 and in the FYDP? Does MDA's PB20 request include any funding to begin integrating into an airborne platform? At this stage, for each of the candidate technologies, can you tell us what the assumed platform would be (i.e. UAV, space, other)?

General GREAVES. *How close is MDA to maturing directed energy technology to where it is suitable and effective for missile defense?*

- All directed energy efforts being explored by the Missile Defense Agency (MDA) are in the basic technology maturation phase of development. MDA has developed knowledge points over the Future Years Defense Program to track technical progress supporting knowledge based decisions. Potential platforms for directed energy applications have not been determined, and there are no platform integration activities currently being pursued. Our strategy is synchronized with the Office of the Secretary of Defense Laser Roadmap.
- MDA's directed energy maturation is centered on scaling electrical-based high energy laser power by a factor of ten to the megawatt class that is required for effective missile defense. While chemical technology is more mature, chemical-based lasers were previously found to be larger, heavier, harder to operate, and had significantly more logistical challenges when deployed.

*What are the deliverables in FY20 and in the FYDP?*

- MDA is currently pursuing multiple technologies in parallel, both in Industry and at National Laboratories, with the common goal of increasing laser power with adequate beam control (i.e., MDA's Laser Component Technology and Beam Control program). The Fiscal Year (FY) 2020 goal is to achieve 100 kilowatt class performance in the laboratory. The maturation strategy is to increase power levels to 300 kilowatts, then 500 kilowatts, and finally megawatt class power levels. MDA anticipates that with the President's Budget 2020 (PB20) funding level, it will be approximately FY 2025 before the 500 kilowatt power level could be reached.
- MDA is also developing tracking and sensing technologies that use a low-power non-lethal laser. Electrical-based lasers are available today for use as low-power tracking devices. In FY 2020, two developers will pursue this advanced sensor with a precision tracking test anticipated by the end of FY 2021. Results of the test will inform future year efforts on this sensor.

*Does MDA's PB20 request include any funding to begin integrating into an airborne platform?*

- There is no funding in the 2020 President's Budget for any platform integration. The efforts will be focused on the critical technology maturation needs and scaling laser power to levels required.

*At this stage, for each of the candidate technologies, can you tell us what the assumed platform would be (i.e. UAV, space, other)?*

- Laser scaling work is platform agnostic. Sufficient laser power levels need to be demonstrated before investing in a specific platform.