S. HRG. 116–508, PT. 7

DEPARTMENT OF DEFENSE AUTHORIZATION FOR APPROPRIATIONS FOR FISCAL YEAR 2020 AND THE FUTURE YEARS DEFENSE PROGRAM

HEARINGS

BEFORE THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

ONE HUNDRED SIXTEENTH CONGRESS

FIRST SESSION

ON

S. 1790

TO AUTHORIZE APPROPRIATIONS FOR FISCAL YEAR 2020 FOR MILITARY ACTIVITIES OF THE DEPARTMENT OF DEFENSE, FOR MILITARY CONSTRUCTION, AND FOR DEFENSE ACTIVITIES OF THE DEPARTMENT OF ENERGY, TO PRESCRIBE MILITARY PERSONNEL STRENGTHS FOR SUCH FISCAL YEAR, AND FOR OTHER PURPOSES

PART 7
STRATEGIC FORCES

APRIL 3; MAY 1 AND 8, 2019

Printed for the use of the Committee on Armed Services

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Available via http://www.govinfo.gov/

U.S. GOVERNMENT PUBLISHING OFFICE

46–155 PDF WASHINGTON : 2024

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DEPARTMENT OF DEFENSE AUTHORIZATION FOR APPROPRIATIONS FOR FISCAL YEAR 2020 AND THE FUTURE YEARS DEFENSE PROGRAM

WEDNESDAY, APRIL 3, 2019

UNITED STATES SENATE,
SUBCOMMITTEE ON STRATEGIC FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

MISSILE DEFENSE POLICIES

The Subcommittee met, pursuant to notice, at 2:29 p.m. in room SR–222, Russell Senate Office Building, Senator Deb Fischer (Chairman of the Subcommittee) presiding.

Committee Members present: Senators Fischer, Rounds, Sullivan, Hawley, Heinrich, King, and Jones.

OPENING STATEMENT OF SENATOR DEB FISCHER

Senator FISCHER. The hearing will come to order. The Strategic Forces Subcommittee meets today to review the Administration's budget request for missile defense programs for the next fiscal year and to discuss the associated policies with our witnesses.

Testifying before us today we have the Honorable John Rood, Under Secretary of Defense for Policy; General Terrence J. O'Shaughnessy, Commander of the U.S. Northern Command and North American Aerospace Defense Command (NORAD); Lieutenant General Sam Greaves, Director of the Missile Defense Agency; and Lieutenant General James Dickinson, who commands the Army Space and Missile Defense Command, as well as the Army Forces Strategic Command and the Joint Functional Component Command for Integrated Missile Defense.

Last year we bid farewell to General O'Shaughnessy's predecessor, General Robinson, and I understand, General Greaves, that you will be following her into retirement. I want to thank you for your decades of service to this country that you have sacrificed so much for, you and your family. We wish you well. It has been a pleasure to work with you, sir.

I would like to thank the entire panel for being here today. We look forward to hearing from you.

First I would recognize our Ranking Member for any comments he would like to make.

Senator Heinrich?

STATEMENT OF SENATOR MARTIN HEINRICH

Senator HEINRICH. Thank you.

First I want to thank Senator Fischer for holding this hearing, and let me also thank today's witnesses for testifying. We very much appreciate the time that they took to prepare for today's hearing and for the work that they do every day for our country.

Now that we have the 2019 Missile Defense Review (MDR), it's important that we take this opportunity to review the fiscal year 2020 budget request to ensure that it's consistent with the MDR and that it provides sufficient resources so that our missile defense systems perform reliably and effectively.

We also need to continue to improve our sensor and discrimination capabilities so that we have a better picture of the ever-evolving threats, including hypersonic missiles.

We need to continue to conduct smart simulation and testing before we commit to buying new technologies.

While we continue to improve our Homeland defense systems, we should not take our eyes off the ball when it comes to protecting our deployed troops and reassuring our allies and partners. The demand for our combatant commanders for Aegis ships, Terminal High Altitude Area Defense (THAAD) and Patriot batteries remains high. We need to consider how we can best allocate these systems and effectively train the warfighters who operate them, and to provide the protection that is needed in today's demanding environment.

But what was most notable about the Missile Defense Review is what it didn't do, since it failed to recommend any new creative solutions for addressing the expensive shock doctrine that we currently face. Simply put, the cost curve is not in our favor.

The targets are extremely cheap, and our interceptors are extremely expensive, which means we need to more aggressively pursue new technologies and emphasize left-of-launch approaches.

The Missile Defense Review also avoided proposing any actions to defend against hypersonic missiles despite repeatedly acknowledging the threat. So I look forward to hearing about how we can, as a nation, move with a sense of urgency to best address that threat.

Again, thank you for coming today, and I look forward to this dialogue.

Senator FISCHER. Thank you, Senator Heinrich.

We now turn to our witnesses for their opening statements. I would remind you that your full statements will be made part of the record.

Secretary Rood, please.

STATEMENT OF HON. JOHN C. ROOD, UNDER SECRETARY OF DEFENSE FOR POLICY

Secretary ROOD. Senator Fischer, Madam Chairman, Senator Heinrich, other Members of the Committee, thank you for the opportunity to testify before you today on the Department's missile defense policy, posture, and budget.

The Missile Defense Review, or MDR, articulates a comprehensive approach to address the missile threat through strength and deterrence and active missile defense systems. It is based on a rec-

ognition that the threat environment is more dangerous and calls for a concerted U.S. effort to improve the existing capabilities for both Homeland and regional missile defense.

The fiscal year 2020 budget requests $12 billion for missile defense, which includes $9.4 billion for the Missile Defense Agency, as well as other funding for the Army and Air Force. These funds support improving the current system and moving towards innovative concepts and advanced technologies.

Now, today more than 20 states possess offensive missiles. Potential adversaries are developing sophisticated ballistic and cruise missile systems with increased speed, range, accuracy, and lethality.

Over the past decade, for example, North Korea and Iran have accelerated efforts to develop and field missiles capable of threatening United States strategic interests. While North Korea has not tested a nuclear-capable missile in over a year, it possesses a range of systems, including road-mobile Intercontinental Ballistic Missiles (ICBMs), solid-propellant medium-range ballistic missiles, and submarine-launched ballistic missiles.

Iran continues to improve its missile capabilities and develop space launch vehicles which provide knowledge to develop an intercontinental-range ballistic missile. Iran already possesses the largest stockpile of regional missiles in the Middle East and is now enhancing their precision.

We see the re-emergence of long-term competition with Russia and China. Both of those countries are expanding and modernizing a wide range of offensive missile capabilities. For example, they are fielding increasingly diverse missile systems and integrating those missiles into their coercive threats and military plans.

Russia is developing the hypersonic glide vehicle, which maneuvers outside traditional trajectories and typically maneuvers in the atmosphere, and China is also developing advanced technologies, such as maneuverable reentry vehicles, as well as hypersonic glide vehicles.

As highlighted in the Missile Defense Review, a comprehensive approach is needed to address today's complex threats. Our focus is on a layered defense, with adaptable systems to meet the changing environment.

Within the MDR framework, the key roles for missile defense include: one, protecting the U.S. Homeland, our forces abroad, our allies and partners; two, diminishing the benefits of adversary coercive threats and attacks; three, assuring allies and partners we will stand by our security commitments; four, assuring our freedom of action to conduct military operations; and lastly, hedging against future unanticipated threats.

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, the United States is protected by the ground-based missile defense system. The budget requests $1.8 billion for this system, which includes a number of improvements such as: 20 additional ground-based interceptors, bringing the total to 64; continuing development of the redesigned kill vehicle (RKV); 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 use of the sea-based X-band radar.

The MDR also recognizes the need for improving our capability to detect and defend against increasingly stealthy cruise missile threats. This includes a phased effort to enhance our ability to warn and defend against air-breathing threats and cue our air and missile defense systems against these threats. Funds for Homeland cruise missile defense in the 2020 budget request include $301 million for the wide-area surveillance system.

To address the regional missile threat, our efforts are focused on integrated air and missile defense to defend our forces, allies, and partners against missile threats from any source. General Greaves will talk about a number of the programs where we have requested funding and the budget request for them.

In addition to improving our legacy systems, the MDR calls for pursuing a range of technologies and examining advanced concepts and breakthrough technologies. We are requesting funding for: additional space-based sensors; integrating space-based kill assessment; operating and sustaining the space tracking and surveillance system; developing defenses against hypersonic missiles, including near-term sensor and command and control upgrades; testing an SM–3 Block IIA capability against an ICBM-class target; kinetic boost phase intercept using a tactical air platform; and technology maturation initiatives, including a neutral beam technology demonstration program and continuing High-Energy Laser development and scaling, as well as 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. The United States, for example, is committed to completing the deployment of European Phased Adaptive Approach. Phases 1 and 2 are complete and included: stationing ships in Rota, Spain; positioning a TPY–2 radar in Turkey; and deploying the first operational Aegis Ashore system in Romania. Deployment of Phase 3, in Poland, for an Aegis Ashore system is underway.

In the Middle East we are working with our Gulf partners. We are also working and supporting Israel's programs. In the Indo-Pacific region, Japan is perhaps the best example, where we have developed the SM–3 Block IIA together with that country.

So in conclusion, let me just say that our missile defense investments and priorities focus on the 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, better control escalation, protect and assure our allies, and hedge against future threats.

Thank you again for the opportunity to testify.

[The prepared statement of Mr. Rood follows:]

PREPARED STATEMENT BY SECRETARY JOHN ROOD

Chairman Fischer, Ranking Member Heinrich, 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. It is based on a recognition that the threat environment is more dangerous and calls for a concerted U.S. effort to improve existing capabilities for both Homeland and regional missile defense.

The fiscal year 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

Today, more than 20 States possess offensive missiles. Potential adversaries are developing sophisticated ballistic and cruise missile systems with increased speed, range, accuracy, and lethality.

Over the past decade, North Korea and Iran have accelerated efforts to develop and field missiles capable of threatening United States strategic interests. While North Korea has not tested nuclear-capable missiles in over a year, it possesses a range of systems including road-mobile intercontinental-range ballistic missiles, solid-propellant medium-range ballistic missiles, and submarine-launched ballistic missiles.

Iran continues to improve its missile capabilities and develop space launch vehicles which provide knowledge to develop an intercontinental-range ballistic missile. Iran already possesses the largest stockpile of regional missile systems in the Middle East. It is now enhancing their precision while developing cruise missiles and anti-ship ballistic missiles.

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 antiaccess/area denial, or A2/AD strategies, which seek to deny the United States the ability to move forces freely to limit or negate our ability to respond in a regional conflict or crisis.

Russia is also developing the hypersonic glide vehicle (HGV), which maneuvers outside of traditional trajectories and typically maneuvers in the atmosphere, (unlike traditional missiles on a predictable ballistic trajectory), and 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 approach is needed to address today's complex threats. Our focus is on a layered defense, with adaptable systems to meet the changing environment, enhanced ballistic and cruise missile defense integration for more robust capability, and pursuit of space-based capabilities and boost-phase intercept capabilities.

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 the threats I've highlighted. 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.

The MDR also recognizes the need for improving our capability to detect and defend against increasingly stealthy cruise missile threats. In response, we are bolstering our Homeland three defenses against such threats. This includes a phased effort to enhance our ability to warn and defend against air-breathing threats and cue our air and missile defense systems against these threats. Funds for Homeland cruise missile defense in the fiscal year 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:

- Additional 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 a 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 budget requests funding for the Joint Integrated Air and Missile Defense Organization (JIAMDO), some of which supports conducting evaluations and demonstrations of IAMD with regional allies and partners throughout the United States Indo-Pacific Command, United States European Command, and United States Central Command areas.

The United States also is committed to completing the deployment of European Phased Adaptive Approach (EPAA), the United States 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 United States missile defense systems and we continue to support Israel's efforts through the DOD–Israeli Ministry of Defense Memorandum of Understanding that began in fiscal year 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, codeveloping with the United States, the SM–3 Block IIA. Japan also hosts two U.S. AN/TPY–2 X–Band radars that are fully interoperable in a manner that supports both Japanese and United States 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.

Senator FISCHER. Thank you, Mr. Secretary.

General O'Shaughnessy, please.

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

General O'SHAUGHNESSY. Thank you, Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee. I am truly honored to appear today as the Commander of the United States Northern Command (NORTHCOM) and North American Aerospace Defense Command.

As a warfighter responsible for defending the Homeland from attack, I am truly grateful for the steady support we receive from Under Secretary Rood, General Greaves, and General Dickinson, and I appreciate the opportunity to appear with each of these great partners today. I also thank you, ma'am, for recognizing Sam Greaves' upcoming retirement and the great work that he's done for us.

USNORTHCOM is responsible for the ballistic missile defense of the United States, while NORAD has responsibility for cruise missile defense over the United States and Canada. In an era of rapidly evolving technology and renewed great power competition, the importance of USNORTHCOM and NORAD's mission to deter, detect, and defeat threats to the Homeland cannot be overstated.

Our adversaries have engaged in deliberate, focused efforts over a number of years to exploit our perceived gaps and erode many of the advantages previously afforded by our geography and technological superiority. As a result, it is clear that our Homeland is not a sanctuary.

Revisionist powers 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 conflict.

Russia has modernized its aviation and submarine fleets and fielded long-range cruise missiles designed to evade radar detection. Russia and China continue developing and testing hypersonic glide vehicles, and both have also established a noticeably stronger foothold in the Arctic along the northern approaches to the United States and Canada, well within the striking distance of both nations.

Meanwhile, North Korea's stockpile of nuclear weapons and ICBMs remain an immediate concern.

USNORTHCOM and NORAD's mission to deter our adversaries is dependent on our ability to detect and defeat potential threats to the Homeland, and I am grateful to the Subcommittee for your strong support of USNORTHCOM and NORAD priorities along those lines of effort. Improving our ability to see and defeat missile

threats to the Homeland is among my top priorities. Congressional support for fielding active electronically scanned array (AESA) radars for our aerospace control and warfighters and improving the capability and capacity of our missile defense sensors and interceptors clearly demonstrates our shared sense of urgency and resolve. In that same spirit, I ask for your continued support as we improve our defenses against new and emerging missile technologies.

We must take prudent steps now to ensure our next generation defense capabilities to include a space-based sensing layer are not late to need. That effort cannot start too soon given that our adversaries are already developing and testing advanced weapons specifically intended to avoid detection in order to hold targets in the Homeland at constant risk.

With these challenges firmly in mind, I sincerely appreciate the much-needed predictability and stability that came from an on-time budget in fiscal year 2019. I am also grateful for the subcommittee's ongoing efforts to ensure that we avoid the devastating impacts that a return to sequestration would bring to the Department of Defense (DOD) in fiscal year 2020.

USNORTHCOM and NORAD work every day with our partners to keep our citizens safe while confronting challenges emanating from multiple approaches and in all domains. I especially want to take this opportunity to express my gratitude to the amazing men and women in the National Guard who are great partners and critical to our ability to perform our missions.

The threat to the Homeland from both ballistic missiles and cruise missiles are significant and increasingly complex, but the airmen, soldiers, sailors, Marines, Coast Guardsmen and civilians of USNORTHCOM and NORAD are deeply committed to defending our nation, and I am honored to represent them today. We have the watch.

Thank you, and I look forward to your questions.

[The prepared statement of General O'Shaughnessy follows:]

PREPARED STATEMENT BY GENERAL TERRENCE J. O'SHAUGHNESSY

Chairman Fischer, Ranking Member Heinrich, 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 United States-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 long-standing 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. Should deterrence fail, USNORTHCOM and NORAD stand always ready to defeat any threat to our nations.

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. 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 United States 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 dur-

ing 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 United States 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 United States 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 dur-

ing 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 a 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, Lieutenant General Sam Greaves, is an outstanding partner, and I am grateful to him and the entire MDA team for their dedicated support of this enormously com-

plex, 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 United States 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 en-

sure 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.

Senator FISCHER. Thank you, sir.

General Greaves, welcome.

STATEMENT OF LIEUTENANT GENERAL SAMUEL A. GREAVES, USAF, DIRECTOR, MISSILE DEFENSE AGENCY

Lieutenant General GREAVES. Chairman Fischer, Ranking Member Heinrich, 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.

Madam Chairman, thank you for those very kind comments at the beginning of the hearing. It has been my distinct pleasure and true honor to serve within our United States Air Force these past 37 years.

As for the budget request, I am pleased to report that we have nearly completed execution of the missile defense enhancements funding we received in the fiscal year 2018 budget amendment that provided funding to enhance the Department's missile defeat and defense capabilities.

Once again, I would like to express my appreciation to this body for its support in this process. In fiscal year 2020 we will continue to leverage this funding to meet our nation's critical missile defense needs.

I would also like to thank the thousands of men and women across government and industry who work tirelessly every day in support of our nation's ballistic missile defense mission. 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 supports the President's commitment to sustain, expand, and improve 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 advanced defenses for the protection of the United States, our deployed forces, and our allies and partners against current and projected missile threats.

As part of our intensive engineering efforts, this past year the agency began development of a high-fidelity, all-digital, integrated ballistic missile defense system simulation capability to support both developmental and operational ballistic missile defense system assessments. This effort integrates the best high-fidelity, all-digital models from each of our ballistic missile defense system elements using an integrated framework which is progressing towards the Missile Defense Agency's first use in calendar year 2021 on the ground-based midcourse defense program.

Program plans include the continued construction of 22 missile silos at Fort Greeley, Alaska, and the procurement of an additional 20 ground-based interceptors for Homeland defense upon completion of the redesigned kill vehicle development program. The emplacement of the new interceptors will bring the total number of operational ground-based interceptors to 64.

Initial plans were to begin fielding those ground-based interceptors with redesigned kill vehicles in 2023. However, during the redesigned kill vehicle design phase, I assessed that we were unable to meet the critical entrance criteria for the critical design review, resulting in a projected delay in the program of up to 2 years.

Sensors. We continue to make investments in sensors to improve Homeland missile defense. The Department conducted the Sensors Analysis of Alternatives to assess the most cost-effective options for enhanced sensor capability to increase ground-based interceptor effectiveness, and highlighted the operational value of placing additional discrimination radars in the Pacific region.

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

The combination of high-speed maneuverability and relatively low altitude of some of the emerging advanced threats makes them challenging threats for missile defense systems. A space sensor layer is needed since we cannot populate the Earth and the oceans with terrestrial radars to meet this need. 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 location.

On the advanced threat, we must also prepare for future security challenges. Developing advanced missile defense technologies to address emerging threats will remain a top priority. The projected missile threats include new ballistic missile systems, advanced cruise missiles, and hypersonic missile capabilities that are now being actively tested by other nations.

With this budget, we will fund software modifications to the current ballistic missile defense system and further define the architecture for future hypersonic defense demonstrations.

The agency is taking significant steps in understanding the cybersecurity posture of the ballistic missile defense system and the ability to defend against emerging cyber threats.

Madam Chairman, Ranking Member Heinrich, and Members of the Subcommittee, in closing, our fiscal year 2020 budget funds comprehensive missile defense development efforts, including sev-

eral 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 defense systems and make measured investments in advanced technology to counter the adversarial threat.

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

[The prepared statement of General Greaves follows:]

PREPARED STATEMENT BY LIEUTENANT GENERAL SAMUEL A. GREAVES

Good morning, Chairman Fischer, Ranking Member Heinrich, distinguished Members of the subcommittee. I appreciate this opportunity to testify before you today on the Missile Defense Agency's budget request for fiscal year 2020.

The Missile Defense Agency (MDA) budget request of $9.431 billion for fiscal year 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 fiscal year 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.

Madam 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. prelaunch 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 reli-

ability 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 fiscal year 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 United States 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 fiscal year 2019 and 10 more planned for fiscal year 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 fiscal year 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 fiscal year 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 5 years, this effort will improve every as-

pect 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 fiscal year 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 fiscal year 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 U.S. 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 United States European Command / United States 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 fiscal year 2016 NDAA, MDA executes operational weapon system cyber-testing and develops risk mitigation strategies for the congressional report scheduled to be delivered first quarter fiscal year 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 fiscal year 2019 and fiscal year 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 fiscal year 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, require-

ments, 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 fiscal year 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 fiscal year 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 fiscal year 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 2 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 fiscal year 2020 and Flight Test GM–Controlled Test Vehicle-03+ (GM CTV–03+), a non-intercept mission to collect RKV flight environment data in fiscal year 2022. The first intercept flight test utilizing the RKV is planned for fiscal year 2023, and a second intercept flight test in fiscal year 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 1 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 United States 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 fiscal year 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 United States Indo-Pacific Command and United States 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 fiscal year 2017. In fiscal year 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 fiscal year 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 fiscal year 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 fiscal year 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 fiscal year 2020 we will focus on steps necessary to add the SKA system to the operational BMDS.

Also, we request $35.9 million in fiscal year 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 fiscal year 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 fiscal year 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 United States European Command and United States 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 6 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 fiscal year 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 fiscal year 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 fiscal year 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 fiscal year 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 United States-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 fiscal year 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 IB missiles and $238.00 million to procure seven SM–3 Block IIAs, along with associated hardware and support costs. By the end of fiscal year 2020, we plan to have 238 SM–3 Block IBs 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 fiscal year 2020—fiscal year 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 fiscal year 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 fiscal year 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 fiscal year 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 fiscal year 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 IA 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 fiscal year 2019 and fiscal year 2020. The flight test pro-

gram supporting the SBT Increment 2 program consists of three flight tests. The first test, FTM–31, is planned for late fiscal year 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 fiscal year 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 fiscal year 2019 will define a preliminary design to support delivery of full capability in fiscal year 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 United States 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 fiscal year 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 fiscal year 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 fiscal year 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 fiscal year

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 7th 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 fiscal year 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 fiscal year 2020. By the end of fiscal year 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 fiscal year 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 fiscal year 2019, which will include acquisition of long-lead items and obsolescence efforts.

MDA requested $302.8 million in fiscal year 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 fiscal year 2020 development and integration efforts include activities in support of the USFK JEON. The U.S. Army deployed THAAD in March 2017 to USINDOPACOM in support of the United States–Republic of Korea (ROK) Alliance. The USFK JEON requested improved integration of existing ballistic missile defense assets in theater. In fiscal year 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 fiscal year 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 fiscal year 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 fiscal year 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 fiscal year 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 6 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 fiscal year 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 6 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 fiscal year 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, coproduction 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 fiscal year 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 United States–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 fiscal year 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 advisories.

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 fiscal year 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

Madam Chairman and Members of the Subcommittee, in closing, our fiscal year 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.

Senator FISCHER. Thank you, General.

General Dickinson.

STATEMENT OF LIEUTENANT GENERAL JAMES H. DICKINSON, USA, COMMANDER, UNITED STATES ARMY SPACE AND MISSILE DEFENSE COMMAND / ARMY FORCES STRATEGIC COMMAND AND JOINT FUNCTIONAL COMPONENT COMMAND FOR INTEGRATED MISSILE DEFENSE

Lieutenant General DICKINSON. Chairman Fischer, Ranking Member Heinrich, distinguished Members of the Subcommittee, I'm honored to testify before you today. Thank you for supporting our servicemembers, civilians, and their families, and your continued support to the U.S. Army, U.S. Strategic Command, and the Joint Missile Defense community.

As air and missile threats continue to evolve, your support enables the nation's air and missile defense forces to accomplish their critical worldwide missions. I will briefly summarize those missions in the context of three roles in which I serve, along with some selected achievements over the past year.

First, I serve as the Commander of the United States Army Space and Missile Defense Command (SMDC), Army Forces Strategic Command (ARSTRAT), which provides trained and ready space and missile defense forces to support the warfighter and the nation. With two warfighting brigades, as well as science and technology capability development centers, we provide low-density, high-demand capabilities for today's fight and develop future space and missile defense concepts and capabilities for tomorrow.

Last week, SMDC/ARSTRAT's 100th missile defense brigade, comprised of Army National Guard soldiers from Colorado, Cali-

fornia, and Alaska, supported the FTG–11 ground-based midcourse defense test. These flight tests allow our soldiers to demonstrate their readiness and lethality to protect the Homeland in the event of an ICBM attack.

Additionally, over the past year soldiers have supported numerous regional air and missile defense tests, including the maneuver fires integrated experiment, and a successful interoperability demonstration between THAAD and Patriot.

SMDC/ARSTRAT is also developing directed energy for air and missile defense. In 2018, soldiers at the Joint Warfighting Assessment engaged in defeating targets with a 10-kilowatt laser mounted on a Stryker combat vehicle. With soldiers' input, the Army is developing tactics, techniques, procedures, and concepts of operations for soon-to-be fielded high-energy laser systems.

In my second role I serve as the Army's Air and Missile Defense Enterprise Integrator, coordinating across the Army air and missile defense community to balance priorities, inform resourcing decisions, and pursue innovative approaches that enhance our strategic flexibility. Our team recently published Army Air and Missile Defense 2028. This document is aligned with national DOD Army strategic guidance to include the missile defense review. It synchronizes the Army's AMD [air missile defense] capabilities, capacity, training, and our ally and partner initiatives to ensure our forces are flexible, agile, and integrated, capable of executing multi-domain operations and defending the Homeland, joint and coalition forces, and critical assets.

As one of the Army's top six modernization priorities, Army air and missile defense is achieving accelerated delivery of capabilities and capacity. The Army selected and has begun production of the first of four battalions of interim mobile short-range air defense, or IM–SHORAD.

Additionally, per the National Defense Authorization Act for Fiscal Year 2019, Iron Dome was selected as the interim cruise missile defense capability for indirect-fire protection capability, or IFPC, and will serve to deliver cruise missile defense protection by the end of next year.

In the past year, the Army expanded air and missile defense capacity by activating an additional air defense artillery brigade in U.S. Indo-Pacific Command (INDOPACOM), activated a SHORAD battalion in Europe, and resourced force structure for future IM-SHORAD battalions.

Finally, I serve as the Commander of the Joint Functional Component Command for Integrated Missile Defense, or JFCC IMD, which supports U.S. Strategic Command (USSTRATCOM) by integrating and synchronizing global missile defense operations. JFCC IMD also advocates for missile defense capabilities and provides global missile defense training.

In 2018, JFCC IMD, our team spearheaded the biennial Nimble Titan campaign, an exercise that brings together representatives from over 24 allies and partners, and 4 international organizations to explore solutions for collaborative missile defense. Nimble Titan builds confidence in shared missile defense and enables collaboration, interoperability, and cost-sharing with our allies and partners.

The campaign serves as a linchpin by building trust and increasing integration to maximize our collective capability and capacity.

So in summary, there is no one silver bullet or single capability to counter the rapidly changing and complex operational environment. We must continue to develop more cost-effective capabilities that position us on the right side of the cost curve. We must invest in solutions to counter threats through all phases of flight, in any weather, and in a denied, degraded, or contested environment, and finally, all that we do depends on our greatest strength, which is our people. Our remarkable servicemembers, civilians, contractors, and their families provide global support to the Army, joint warfighter, and the Homeland every day as they deploy, develop, and operate our nation's air and missile defense systems.

So thank you for your continued support for these dedicated professionals, and I look forward to your questions. Thank you.

[The prepared statement of General Dickinson follows:]

PREPARED STATEMENT BY LIEUTENANT GENERAL JAMES H. DICKINSON

INTRODUCTION

Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee, thank you for your continued support of our servicemembers, civilians, and families and your continued support of the Army, the U.S. Strategic Command, the Department of Defense, and the missile defense community. Thank you also for the opportunity to testify before this Subcommittee. I am honored to highlight the important missile defense capabilities and ongoing enhancements that enable the defense of our Nation, forward stationed and deployed forces, allies, and partners.

As I have done for the past 2 years, today I bring both an Army and a joint perspective on effective missile defense capabilities. Within the Army and joint communities, my responsibilities encompass several mission areas.

As the commander of the U.S. Army Space and Missile Defense Command and Army Forces Strategic Command (USASMDC/ARSTRAT), I have Title 10 responsibilities to organize, train, and equip Army space and global ballistic missile defense forces. I serve as the Army's force modernization proponent for space, global ballistic missile defense, and high altitude forces and capabilities. Further, I am the Army Service Component Commander to U.S. Strategic Command (USSTRATCOM). In this role, I am responsible for planning, integrating, coordinating, and providing Army space and missile defense forces and capabilities in support of USSTRATCOM missions.

I also serve as the Army's Air and Missile Defense (AMD) Enterprise Integrator. In this role, I synchronize the balanced execution of the Army's AMD posture across the functions of force planning and sourcing requirements, combat and materiel development, AMD acquisition, and lifecycle management. I coordinate with the AMD community of interest to balance priorities, inform resourcing decisions, and pursue innovative approaches in order to enhance our strategic flexibility.

Finally, as the Commander of USSTRATCOM's Joint Functional Component Command for Integrated Missile Defense (JFCC IMD), I am responsible for coordinating global missile defense planning, conducting missile defense operations support, recommending allocation of missile defense assets, and advocating for missile defense capabilities on behalf of the combatant commanders.

My major tasks within these roles can be summarized as providing forces and capabilities for current operations; preparing forces and capabilities for the future fight; and, research and development of Army technologies that will provide future advancements in air and missile defense capabilities. To achieve this, the organizations I command align their activities to these priorities:

- Protect our Homeland
- Provide combat-ready forces and capabilities
- Plan and conduct synchronized global operations
- Prepare or adopt leap-ahead concepts and technologies
- Preserve and account for the Nation's critical resources
- Promote and foster a positive command climate

In line with my previous appearances, my intent today is to highlight the dedicated people who serve in the diverse and geographically dispersed organizations under my command, to briefly outline the strategic environment, and to emphasize USASMDC/ARSTRAT's missile defense force provider responsibilities with respect to the Army and the geographic combatant commanders (GCCs). I would also like to outline JFCC IMD's role as a warfighter advocate supporting USSTRATCOM's coordinating authority for global missile defense planning, and finally, I will summarize key Army AMD developments in the context of a comprehensive approach to addressing the evolving air and missile threat.

THE WORKFORCE—OUR FOUNDATION

USASMDC/ARSTRAT and JFCC IMD cannot carry out our wide-ranging national security missions without the dedication of our greatest asset—our people. One of my most important messages to you today is that your continued support is critical to our ability to develop and retain a highly qualified and mission-ready workforce. The Department of the Army needs predictable, stable funding to execute today's missions and to posture for the future. The October 1 impact and will ensure we continue to provide trained and ready servicemembers enacted Fiscal Year 2019 Department of Defense (DOD) budget and the fiscal year 2018 emergency budget reprogramming for Homeland and regional missile defense is making a significant and civilians to operate and pursue advancements in space and missile defense capabilities for our Nation. The supplementary resources will continue our momentum to provide additional interceptors, modernize essential infrastructure, and enhance discrimination and characterization capabilities. After more than 2 years in command, I have seen countless examples of how our strength lies in the command's agile, adaptive space and missile defense workforce, a team of more than 3,000 highly trained and skilled soldiers, sailors, airmen, marines, and civilians who stand vigilant 24/7/365, protecting the joint warfighter and defending the Homeland.

Soldiers, Civilians, and Contractors Working Together Across 11 Time Zones in 23 Locations to Protect Our Nation, Allies, and Deployed Forces

THE INCREASINGLY COMPLEX THREAT ENVIRONMENT

Current global trends indicate ballistic and cruise missiles are becoming more capable, due in part to the proliferation of advanced technologies, resulting in systems with global reach, increasing speed, and greater accuracy. Additionally, many foreign ballistic and cruise missile systems are progressively incorporating advanced countermeasures including maneuverable reentry vehicles, multiple independent reentry vehicles, and electromagnetic jamming, all intended to defeat our missile defense capabilities. Moreover, numbers of ballistic and cruise missile platforms are increasing. Many of these systems are mobile, which increases the difficulty in detecting, tracking, and targeting these weapons.

Numerous countries are developing ground-, sea-, and air-launched land-attack cruise missiles using a variety of unconventional and inexpensive launch platforms. Today, nearly 30 countries possess ballistic missile capability and some are actively pursuing hypersonic weapons. There are over 35 different variants of ballistic missiles in service across the globe today and new intermediate-range and intercontinental ballistic missiles (IRBM and ICBM) are under development. Adversaries have demonstrated rapid advances in range and overall missile performance. To meet the demands resulting from the shift to great power competition, we continue to pursue increased capability through modernization and development as well as increased capacity within the missile defense area. Russia and China have achieved parity with the United States in many cases, and overmatch in others.

Unmanned Aircraft Systems (UASs) have advanced technologically and proliferated exponentially over the past decade. As technology has progressed, both reconnaissance and attack capabilities have matured to the point where UASs represent a significant threat to Army combat operations from both state and non-state actors. The extensive range of UAS platforms in terms of size, velocity, range, altitude, flexibility, and capability make this a very challenging mission area for AMD systems. As such, we appreciate that Congress authorized the Department to take actions to mitigate the threat posed by UAS to facilities and assets related to the Department's missile defense mission.

> ***" . . . U.S. Homeland missile defense must both outpace rogue state offensive missile capabilities and hedge against possible future threat developments."***
>
> —2019 Missile Defense Review

In the future, our missile defense systems will encounter more complex electronic and cyber attacks, as well as directed energy threats that could significantly degrade U.S. missile defense operations. We expect cyber and electronic attacks will be increasingly relied upon in potential adversaries' anti-access/area-denial (A2/AD) strategies. Our ability to successfully counter these continuously advancing threats will rely heavily on our increased use of space and space-enabled capabilities. Space sensors, in greater numbers and sensor modalities, would expand our capability and capacity to track, discriminate, and successfully engage ballistic, cruise, and hypersonic threats.

The strategic missile defense environment is becoming more challenging as adversary air and missile threats continue to proliferate in number and advance in complexity. Our evolution of capabilities requires a holistic approach that effectively integrates alternative approaches and technologies to defeat air and missile threats. A comprehensive approach, including attack operations and active and passive defenses, increases lethality and enables more efficient and effective missile defense capabilities. In addition, implementing technological advances in a time of fiscal constraints requires more cost effective methods to integrate our current and future capabilities. We continue to prioritize integrated AMD resources to optimize our support of the warfighter and to partner with the Missile Defense Agency (MDA), Combatant Commands, and the Services in pursuit of fiscally responsible methods to address evolving threats.

STRATEGIC POSITIONING TO COUNTER THE THREAT

To counter the threat and meet the objectives of the 2018 National Defense and Army Strategies, USSTRATCOM and the U.S. Army continue to provide and enhance Homeland and regional missile defenses. We continue to work with our allies and partners in Europe, the Indo-Pacific region, and the Middle East to increase integration and interoperability of missile defense systems and operations.

Integrated missile defense planning, force management, and operations emphasize global coordination with regional execution so that for any threat, we match the best interceptor with the best sensors. A layered and holistic approach that integrates offense and defense will move the U.S. toward a more robust and flexible crisis response capability.

The 2017 basing of a Terminal High Altitude Area Defense (THAAD) battery in the Republic of Korea bolstered our regional defense capabilities to improve protection of U.S. and allied forces, and critical infrastructure on the peninsula. Additionally during 2017, MDA completed the emplacement of 14 additional Ground-Based Interceptors (GBIs) at Fort Greely, Alaska, to provide more capacity to defend the Nation against an ICBM attack from North Korea, or a future ICBM capable Iran.

> ***" . . . "I am confident in the ability of the Ground-based Midcourse Defense system to defend the United States from ICBMs fired from North Korea or Iran..."***
>
> —USNORTHCOM SASC
> Posture Statement, February 2019

The 2018 National Defense Strategy prioritizes a strong commitment to security and stability in the Indo-Pacific region, Europe, and the Middle East. In conjunction with our allies and partners, the Department of Defense maintains forward-committed Patriot; THAAD; and counter-rocket, artillery, and mortar (C–RAM) forces to enhance our AMD posture, sending a deterrence message to potential adversaries and assurance to our friends. Through forward positioned AMD commands and air defense brigade headquarters, we continue to work with regional partners and allies to increase information and data sharing and we are developing a more robust global AMD force posture that leverages partner nations' growing capabilities and ca-

pacity. Eventually, this will reduce the strain on our forces while enabling more timely modernization of our AMD assets.

The Army AMD enterprise, consisting of agencies and organizations that develop, maintain, sustain, train, and employ AMD capabilities, developed Army Air and Missile Defense 2028. This document, is based on the National Security Strategy, the National Defense Strategy, the Missile Defense Review, the Army Operating Concept, the changing operational and threat environments, and the rapid pace of our technological advancement. This new path forward for Army AMD, released last month, focuses on the 2018–2028 timeframe, aligns with current Department and Army doctrine, and addresses our ability to balance current operational requirements while shaping the force and modernization efforts to counter future challenges. AMD serves as a critical enabler of the Army's ability to penetrate and disintegrate enemy A2/AD systems and exploit the resulting freedom of maneuver to achieve strategic objectives. In summary, the Army Modernization Strategy enables us to deliver advanced AMD capabilities to our warfighters on a substantially decreased timeline. The Air and Missile Defense Cross-Functional Team (CFT) is key to rapidly developing requirements and ensuring these future capabilities transition quickly from concept, to prototyping, to fielding. Army AMD continues its focus on program development of Maneuver-Short Range Air Defense (M–SHORAD), Lower Tier Air and Missile Defense Sensor (LTAMDS), Indirect Fire Protection Capability (IFPC), Army Integrated Air and Missile Defense (IAMD), directed energy, and advanced energetics.

PROVIDING AND ENHANCING MISSILE DEFENSE CAPABILITIES

USASMDC/ARSTRAT's first major task is carrying out its Title 10 responsibilities, which include being a force provider of missile defense capabilities. This command is manned by multi-component soldiers, civilians, and contractors, who contribute to operations, planning, integration, control, and coordination of Army forces and capabilities in support of USSTRATCOM's missile defense mission. Other commands around the world, including all GCCs, also leverage the capabilities we provide.

Our operational function in today's fight is to provide trained and ready missile defense forces and capabilities to the GCCs and the warfighter. For example, USASMDC/ARSTRAT soldiers serving in the Homeland and in remote and austere forward-deployed locations operate the Ground-based Midcourse Defense (GMD) system and the Army Navy/Transportable Radar Surveillance and Control, Model 2, Forward-Based Mode (AN/TPY–2 FBM) radars. Highlights of the capabilities provided to current operations and readiness by our missile defense professionals include:

Support to Global Ballistic Missile Defense: Soldiers from the 100th Missile Defense Brigade, headquartered in Colorado Springs, Colorado, and the 49th Missile Defense Battalion, headquartered at Fort Greely, Alaska, are ready to defend our Nation from an ICBM attack. In support of U.S. Northern Command (USNORTHCOM), Army National Guard and Active component soldiers operate the GMD Fire Control Systems located at the Fire Direction Center in Alaska, the Missile Defense Element in Colorado, and a detachment that oversees operations at Vandenberg Air Force Base, California. These soldiers, in conjunction with USNORTHCOM, also oversee maintenance of GMD interceptors and ground system components. At the Fort Greely Missile Defense Complex, the 49th Missile Defense Battalion military police secure the interceptors and command and control facilities from physical threats. Given their strategic mission in this remote location, the harsh environment and 20-hours per day of winter darkness, we must continuously review and enhance the Fort Greely Garrison services and support to these soldiers, civilians, contractors, and their families. With the continued support of Congress, we have already realized substantial quality of life improvements for these remotely stationed personnel and their families.

> ***" . . . the United States has a robust and credible layered missile defense system."***
>
> —USSTRATCOM SASC
> Posture Statement, February 2019

Support to GMD System Test and Development: Soldiers from the 100th Missile Defense Brigade and the 49th Missile Defense Battalion participate in GMD test activities and work with MDA developers on future improvements to the GMD system. MDA's testing regime, conducted through a series of ground-based and operational

flight tests, and rigorously verified, validated, and accredited models and simulations, emphasizes operational realism during test design and execution. This realism enables soldiers of the 100th Missile Defense Brigade to sustain and improve their proficiency and validate operational employment of the system. A current example is the recent FTG–11 test. The event enabled brigade and battalion soldiers to demonstrate their tactics, techniques, and procedures in support of an operational flight test. This test validates their readiness by performing their operational tasks while building warfighter confidence that the system will perform as designed.

> ***"Our missile defense forces here, are vital to our national defense and the world should know that they're ready."***
> —VPOTUS Elmendorf Air Force Base, Alaska, 2018

Support to Regional Capabilities: The 100th Missile Defense Brigade also provides GCCs with trained and certified AN/TPY–2 FBM missile defense batteries. These batteries are currently located at five strategic locations around the globe where they contribute to the early warning, cueing, tracking, and discrimination of threats to our allies and partners. These forward-based radars also represent a tangible contribution to both Homeland and regional defense. Soldiers manning these radars, deployed to remote and austere locations across the globe, demonstrate daily our Nation's commitment to defend deployed forces, allies, and partners from ballistic missile attacks.

Space Support to Ballistic Missile Early Warning: Space-enabled capabilities are essential for missile defense operations, providing and enabling communications; positioning, navigation, and timing; intelligence, surveillance, and reconnaissance; and early warning. We routinely coordinate and collaborate with USSTRATCOM's National Space Defense Center to ensure that space assets are poised to support missile defense.

In support of the joint force commander, USASMDC/ARSTRAT continues to provide ballistic missile early warning within the United States European Command (USEUCOM), United States Central Command (USCENTCOM), and United States Indo-Pacific Command (USINDOPACOM) theaters of operations. The 1st Space Brigade's Joint Tactical Ground Station (JTAGS) detachments, which support the Joint Force Space Component Command, are operated by USASMDC/ARSTRAT space cadre and qualified soldiers who monitor launch activity and other infrared events. They provide essential information to members of the AMD and operational communities. Our JTAGS detachments are forward deployed around the globe, providing continuous, dedicated, assured missile warning to USSTRATCOM and GCCs in support of deployed and forward-based forces. In Europe, the relocation of the JTAGS detachment from Stuttgart, Germany, to Sigonella Naval Air Station, Italy, is scheduled for completion later this year. This will increase operational missile warning capability.

> ***"The exploitation of space provides a missile defense posture that is more effective, resilient and adaptable to known and unanticipated threats."***
> —2019 Missile Defense Review

USASMDC/ARSTRAT's second major task is to develop future missile defense forces and mature current capabilities. A major component of this function is providing relevant and updated training for our global missile defense systems. During the past fiscal year, USASMDC/ARSTRAT trained approximately 200 soldiers to execute the missile defense mission of the Homeland.

USASMDC/ARSTRAT, as a recognized Army Center for Analysis, conducts studies to determine how to best meet the Army's assigned missile defense responsibilities. Our analyses validates established procedures and supports emerging processes. The Army uses these result to document its missile defense needs and pursue joint and Army validation of its requirements. With insights from these studies, we develop and operationalize the doctrine, organization, training, materiel, leadership and education, personnel, facilities, and policy requirements to address evolving threats and potential vulnerabilities to the GMD and AN/TPY–2 FBM missile de-

fense systems. This disciplined approach ensures limited resources are applied to achieve maximum operational utility.

USASMDC/ARSTRAT's third major task is to provide critical technologies to address future needs that will enhance warfighter effectiveness. Our technology development function is primarily focused on the space and high altitude domains. Additionally, although MDA is the principal materiel developer for missile defense capabilities, USASMDC/ARSTRAT continues to support the Office of the Secretary of Defense (OSD) efforts to move conventional prompt strike technology demonstration activities to acquisition Programs of Record within the U.S. Army, U.S. Navy, and U.S. Air Force. USASMDC/ARSTRAT has been heavily involved in establishing the U.S. Army Hypersonic Project Office (AHPO) and is supporting the U.S. Air Force and U.S. Navy hypersonic programs with flight test and component procurement support. The AHPO is currently providing senior Army leadership with program plans, schedules, and funding requests to support a rapid near term capability. In addition, the AHPO is supporting MDA's concept development for defense against hypersonic threats. These technical capabilities are at the forefront of developing holistic, cost-effective approaches to address the broadening missile defense challenge.

Following are brief summaries of a few of our research and development efforts, as well as an overview of the capabilities of an essential Army testing range.

High Energy Laser Technology Development and Demonstration: The Army's high energy laser (HEL) science and technology effort aims to develop ruggedized laser system components and subsystems, integrate them onto an Army vehicle, conduct demonstrations to characterize performance, and transition the technology to a Program Executive Office. A solid-state laser weapon system has the potential to be a low-cost and effective complement to kinetic capabilities in countering rockets, artillery, and mortars (RAM); UAS; and other threats. The effort builds upon earlier pathfinder demonstrations of a 10-kilowatt (kW) laser system by continuing to develop, integrate, and mature the technology at higher laser power outputs. The 50-kW class Robust Electric Laser Initiative fiber laser has been integrated into the High Energy Laser Mobile Test Truck (HELMTT) for a 50-kW laser demonstration against RAM and UAS threats. The HELMTT deployed to the High Energy Laser System Test Facility (HELSTF) at White Sands Missile Range, New Mexico, last fall for initial system checkout. During that limited demonstration, the HELMTT system showed that a high energy laser system, mounted on an Army tactical vehicle, could engage and destroy RAM targets. It will return to the HELSTF later this spring to conduct data collection to ensure we are on the right track with our HEL development efforts. This demonstration will be a key knowledge point for the next major phase of high energy laser technology development, the High Energy Laser Tactical Vehicle Demonstrator (HEL TVD). The HEL TVD supports the Army's Indirect Fire Protection Capability Increment 2—Intercept (IFPC Inc 2–I) program. It is on schedule to conduct a C–RAM 100-kW demonstration in late 2022 to validate system performance against IFPC Inc 2–I requirements.

> ***" . . . we are no more than a few years of having . . . directed energy weapons of military utility . . . "***
>
> —Dr. Michael Griffin, Center for Strategic and International Studies Interview, December 2018

During the past year, USASMDC/ARSTRAT also started work on the Multi-Mission High Energy Laser (MMHEL) as an Army Technology Maturation Initiative (TMI). The TMI will integrate a 50-kW laser system on a Stryker combat vehicle and culminate in an operational demonstration that informs M–SHORAD requirements. Supporting this effort is the Mobile Experimental High Energy Laser (MEHEL), a 10-kW laser on a Stryker. Over the past several years, MEHEL has participated in four Maneuver Fires Integration Experiments at Fort Sill, Oklahoma, and a Joint Warfighting Assessment in Germany. During the 2018 Joint Warfighting Assessment, soldiers from the 2nd Cavalry Regiment successfully operated the MEHEL during limited live-fire exercises. MEHEL is helping warfighters develop tactics, techniques, and procedures, as well as concepts of operations for future high energy laser weapons.

Low-Cost Target Development: The Army has completed the initial effort to develop a suite of threat representative, short-range ballistic missile targets for lower-tier missile defense testing at a substantially reduced cost. Over the past few years, we completed three detailed target designs and successfully demonstrated all three of the configurations, which leverage excess solid rocket motors. The initial launch

of Zombie targets was the Pathfinder Zombie Demonstration flight in December 2016, followed by

Sabre Zombie targets in June and November 2017 for Patriot intercept tests. These missions were critical operational tests of the Patriot PAC–3 Missile Segment Enhancement (MSE) interceptor. Development of a two-stage Zombie ballistic missile target known as Black Dagger was completed last year, culminating with a successful risk reduction launch in June 2018. The Black Dagger target is meant to represent a broader range of short-range ballistic missile threats by achieving longer range, higher altitude, and increased velocity. The Zombie suite of targets has multiple missions planned in support of MDA, Patriot, and Army IAMD over the next several years. The goal remains to provide more cost effective ballistic missile targets. Accomplishing this goal, will result in an overall reduced cost to the DOD's test execution mission.

Missile Defense Testing Range: USASMDC/ARSTRAT operates the Ronald Reagan Ballistic Missile Defense Test Site (RTS) at the U.S. Army Garrison—Kwajalein Atoll in the Republic of the Marshall Islands. RTS provides critical testing support to both offensive and defensive missile testing requirements for programs such as GMD and U.S. Air Force strategic ballistic missile systems. RTS retains preeminent ballistic missile testing capabilities used in validating the Nation's ability to sustain a strong, credible ballistic missile deterrent as a key element of national security and the security of U.S. allies and partners.

RTS continues to support the developmental and operational testing of both Homeland and regional missile defense systems. Two Standard Missile-3 tests were successfully supported with MDA in 2018 (FTM–29 in January 2018 and FTO–03 E1 in December 2018). Planning and preparation for support to the Army Patriot system, the MDA Ground-Based Interceptor, and THAAD systems continued throughout 2018 for future test events.

RTS also supports offensive ballistic missile testing for the Air Force Global Strike Command. During 2018, RTS supported four Minuteman III test (Glory Trips) launches to successfully validate and verify the effectiveness, readiness, and accuracy of the weapon system. Hypersonic system testing has become a significant element of test planning at RTS during 2018. Because of the geographic remoteness and available complex sensor suite, RTS has seen a significant upswing in hypersonic systems test planning. There are currently five active hypersonic test programs in various stages of planning at RTS.

In concert with its testing mission, RTS conducts continuous deep space surveillance and space object identification operations to increase national capabilities and reduce expenditures for both mission sets. The U.S. Air Force continues testing of its most advanced surveillance system—Space Fence. In a few years, this improved surveillance capability will enable proactive space situational awareness while complementing existing systems at the RTS.

ARMY CONTRIBUTIONS TO THE NATION'S MISSILE DEFENSE CAPABILITIES

Army Air and Missile Defense 2028 meets the directives of the National Defense Strategy and the Army vision and enables Multi-Domain Operations (MDO). To achieve the AMD force of 2028, we must continue to modernize and develop AMD capabilities, build sufficient AMD capacity for MDO, and ensure AMD forces are trained and ready. MDO requires that our capabilities and associated command and control systems have robust interoperability, to include with joint and allied forces, and be highly resilient. Accomplishing these essential tasks will allow us to provide deterrence via forward stationing and enable a more robust, comprehensive defense by coordinating and integrating with our partners and allies. AMD is one of six Army modernization priorities in which recent Army investments have significantly increased. The Army AMD CFT is the Army's modernization lead for these capabilities and works closely with the other Services, the Joint Staff, and MDA toward joint IAMD capabilities. The Program Executive Office for Missiles and Space is the Army's materiel developer for these capabilities and works closely with the AMD CFT. A summary of the Army's AMD strategic direction and major programs follows:

AMD is a Critical Enabler of the Army's Ability to Conduct Multi-Domain Operations

Air and Missile Defense Readiness: Readiness is the Army's top priority. The operational demand to meet the requirements of joint warfighters continues to stress the Army AMD force, impacting current and future readiness, as well as modernization

initiatives. With a significant portion of the AMD force decisively committed, the Army continues to take action to mitigate this stress on the force and restore strategic flexibility. Within the last five years, the Army implemented a Sustainable Readiness Model, established an AMD test detachment, and fielded the Dismounted Patriot Information Coordination Central (DPICC). Last year, the Army completed fielding of five DPICCs to USINDOPACOM, USEUCOM, and USCENTCOM providing these combatant commanders greater flexibility and a smaller deployable footprint to meet mission requirements.

Mission Command: Closely linked to AMD readiness is the ability to provide low density/high demand AMD mission command elements. The mission command elements are pivotal to laying the foundation and creating an environment that supports the integration of Army AMD forces into joint command and control (C2) architectures. Over the past year, the Army has activated an additional Active component Air Defense Artillery brigade headquarters in USINDOPACOM and is rotating a National Guard Air Defense Artillery brigade headquarters to USEUCOM, and is elevating the command of the 10th Army Air and Missile Defense Command in USEUCOM to a general officer.

Terminal High Altitude Area Defense (THAAD) System: THAAD, a key component of the Ballistic Missile Defense System (BMDS) architecture, is designed for area defense of deployed and allied forces, population centers, and critical infrastructure against short-, medium-, and intermediate-range ballistic missiles. THAAD is a mobile and globally transportable, low density/high demand asset. THAAD has a unique endo- and exo-atmospheric intercept capability using proven hit-to-kill technology. There are currently seven operational THAAD batteries. THAAD batteries are deployed to Guam and the Republic of Korea in response to the North Korean nuclear and missile threat. The United States Forces Korea (USFK) Joint Emergent Operational Needs Statement (JEONS) requirement brings a remote launch capability in fiscal year 2019 and a THAAD Missile Segment Enhancement Integration capability in fiscal year 2021. As directed in the 2019 Missile Defense Review, the Army, in conjunction with OSD and MDA, is currently reviewing and validating the THAAD requirements in order to support current operation plans.

Patriot/Patriot Advanced Capability-3 (PAC–3) Missile Segment Enhancement (MSE): The Army Patriot force remains the cornerstone of AMD protection for our deployed forces, friends, and allies. The Patriot force is 40 percent forward stationed/forward deployed as GCCs' increasing AMD requirements drive the operational tempo and stress on the Patriot force. The PAC–3 and PAC–3 MSE interceptors employ hit-to-kill capability against ballistic missiles. PAC–3 MSE fills the engagement gap between the THAAD and the PAC–3 missiles while also defeating advanced threats earlier, at greater range, with increased lethality. The PAC–3 MSE is in full-rate production and is the latest generation hit-to-kill PAC–3 interceptor in the Patriot force to meet global capability requirements. Over the next year, ongoing efforts will increase annual PAC–3 MSE production capability by approximately 30 percent to address increased U.S. requirements and demand from our international partners.

Patriot must continually modernize through software and hardware upgrades to avoid obsolescence and to take advantage of the extended battlespace performance afforded by the PAC–3 MSE interceptor. This modernization effort provides combat identification enhancements, addresses upper tier debris mitigation, improves performance of the PAC–3 MSE interceptor, and enables Army and joint interoperability improvements. The Post Deployment Build (PDB)-8 Conditional Materiel Release hardware and software was approved in November 2018. An agile build, PDB–8.0.6, was created in support of the USFK JEONS to expand Patriot and THAAD interoperability. The JEONS requirement brings the launch-on-remote capability, which expands Patriot's battlespace by enabling it to utilize the AN/TPY–2 radar battlespace by the Patriot system. This capability will be pure fleeted across Patriot in PDB–8.1 in fiscal year 2022. For adversary overmatch, the Army is continuously improving Patriot capability against the near-term evolving threat while we move toward the Army IAMD Battle Control System (IBCS) architecture including a new Lower Tier Air and Missile Defense Sensor (LTAMDS) and the IFPC Inc 2–1.

Lower Tier Air and Missile Defense Sensor (LTAMDS): LTAMDS will provide sensing capabilities in the lower tier portion of the ballistic missile defense battlespace and allow the full kinematic capabilities of the PAC–3 MSE missile. Additionally, LTAMDS will serve as a sensor node on the IBCS network, address capability gaps, modernize technology, reduce operations and sustainment cost, mitigate obsolescence, increase battlespace, and enhance reliability and maintainability.

To ensure a fair-and-open competition, an LTAMDS Sense-Off demonstration will be conducted in 2019. The upcoming Sense-Off competition provides industry the opportunity to demonstrate potential LTAMDS solutions. The Army will leverage

Sense-Off results, along with concurrent modeling and simulation efforts, to evaluate current industry capabilities and determine future growth potential. Following the Sense-Off and proposal evaluations, the Army will award a contract later this year to a single vendor for the delivery of six prototypes. The rapid prototyping effort goal is the delivery of four sensors to one battalion in 2022.

Indirect Fire Protection Capability Increment 2 – Intercept (IFPC Inc 2): As the end of the operational lifecycle approaches for short-range AMD capabilities such as Avenger, the Army is developing new capabilities to defeat air, cruise missile (CM), and RAM threats. The primary IFPC–Inc 2 mission is to provide a robust protection capability against these threats to supported forces within fixed and semi-fixed locations. To address a gap in defenses against potential Russian and Chinese CM threats, the Army recently reported to Congress its intent to rapidly field an interim capability utilizing the Israeli Iron Dome system no later than fiscal year 2020. Concurrently, the Army plans to execute a decision on enduring IFPC capability by the end of fiscal year 2019. Two batteries of the enduring IFPC–Inc 2 capability will be deployed no later than the conclusion of fiscal year 2023.

Counter-Unmanned Aircraft Systems (C–UAS): Technological advances and the proliferation of commercial and tactical UAS in both reconnaissance and attack capabilities have matured to the point where they represent a significant threat to Army operations from both state and non-state actors. The extensive range of platforms in terms of size, velocity, range, altitude, flexibility, and capability make this a very challenging mission area for AMD systems. C–UAS efforts are critical to defeat the rapid proliferation of small, commercially available UAS technology on the battlefield. In response to a warfighter Joint Urgent Operational Needs Statement (JUONS), the Army has deployed over 500 C–UAS systems (man-portable, expeditionary, and mobile) and continues to adapt to changes in theater UAS threats. The modification of counterfire target acquisition radars, equipped with multi-mission air surveillance target acquisition capabilities, improves the warfighter's ability to detect and defeat these low, slow, and small UAS threats. Efforts continue to close the risk gap to protect our maneuver forces with short range defense capabilities.

Army Long-Range Persistent Surveillance (ALPS): In support of a JUONS, the ALPS passive sensor is currently being fielded to USINDOPACOM, USEUCOM, and USCENTCOM. The Army demonstrated the ability to integrate ALPS into the Army IBCS in 2018. Once fully integrated into Army IBCS, the ALPS passive sensor will provide continuous, 360-degree, long-range surveillance against fixed and rotary wing aircraft, UAS, and CM threats.

Maneuver-Short Range Air Defense (M–SHORAD): M–SHORAD will provide a dedicated maneuverable and survivable AMD capability for maneuvering forces against fixed-wing, rotary-wing, and UAS threats. The Army delivered two Avenger battalion equipment sets to USEUCOM in support of the European Deterrence Initiative. The equipment was accompanied by personnel and infrastructure allowing the establishment of an Active component Avenger battalion. Additionally, the Army is rotating an Army National Guard Avenger battery to Europe to provide protection of maneuver forces. While the current Avenger and Stinger systems provide limited capabilities today, we must develop and field more advanced systems to outpace the threat. In fiscal year 2018, the Army began the development and fabrication of initial M–SHORAD systems that integrate existing Army capabilities into a Stryker combat vehicle. Rapid prototype development and integration activities continue and fielding of four M–SHORAD battalions is scheduled for fiscal years 2021 through 2023. In addition, the Army continues to mature high energy lasers and electronic warfare to increase M–SHORAD capabilities in support of the maneuver force. M–SHORAD will begin to integrate a laser with an initial capability in fiscal year 2024. By fiscal year 2028, M–SHORAD battalions will field a mix of directed energy and missile-based systems.

Army Integrated Air and Missile Defense (IAMD): Army IAMD integrates current and future AMD sensors and weapons into a common integrated fire control capability. The Army's common integrated and networked AMD C2 capability, IBCS, will allow the warfighter to fully integrate joint and multinational AMD capabilities across all echelons. IBCS allows rapid convergence of sensors, shooters, and C2 components on an integrated fire control network. Once fully fielded, IBCS will provide a game-changing capability, allowing AMD forces to be tailored and scaled appropriately to meet the given threat. The flexible number and mix of capabilities can be task organized into a formation with an inherent, integrated C2 system. The IBCS open architecture will enable rapid integration of legacy and developmental sensors and shooters, providing capabilities to defeat emerging threats in multi-domain operations. The program continues to execute on plan in accordance with the 2018 Congressional report.

The program will field common missile command nodes for Army AMD forces to defend against manned aircraft and UAS, air-to-ground missiles, tactical ballistic missiles, CM, and RAM attacks. The IBCS will operate with air surveillance and fire control capabilities across the Army, and with joint and multinational AMD capabilities across all echelons. It will enhance the lethality of the AMD force, dismantling the current system-centric control paradigm, which will dramatically increase capability and also facilitate open industry competition in support of the AMD community. Additional efforts are currently underway to explore the feasibility and potential benefits of integrating Army's IBCS and MDA's BMD System Command, Control, Battle Management, and Communications (C2BMC), to include THAAD fire control center, to fully support Army IAMD interoperability with the BMDS.

JOINT FUNCTIONAL COMPONENT COMMAND FOR INTEGRATED MISSILE DEFENSE (JFCC IMD)—INTEGRATING AND SYNCHRONIZING MISSILE DEFENSE

JFCC IMD is USSTRATCOM's missile defense integrating element, formed to execute its Unified Command Plan (UCP) assigned missile defense mission and enable the headquarters to focus on integration and advocacy. Headquartered at Schriever Air Force Base in Colorado Springs, Colorado, JFCC IMD is manned by a cohesive team of Army, Navy, Air Force, Marine Corps, civilian, and contractor personnel.

As the Secretary of Defense and various combatant commanders have previously testified, warfighters remain confident in our ability to protect the Nation against missile attacks. However, as the global missile threat continues to evolve, we must invest in holistic approaches to defeat adversary missiles before launch or during all phases of flight (boost, midcourse, and terminal phases). Additionally, we must continue to invest in capabilities that limit or mitigate the effects of an attack which penetrates our defenses. JFCC IMD's principal mission is to coordinate with, and operationally support, the joint warfighters at the GCCs, and advocate for their requirements with the materiel developers at MDA and the Services. On behalf of the GCCs and USSTRATCOM, JFCC IMD champions warfighter priorities and capability needs, including continued development of a robust sensor network, integrated discrimination capabilities, redundant and resilient C2 networks with enhanced cybersecurity defenses, and improved interceptors for both Homeland and regional missile defenses.

Through JFCC IMD, we work across DOD and alongside key allies and partners to improve integration of existing capabilities, maximizing efficiency and effectiveness in global missile defense missions. The essential force multiplier is integration—a critically important mission enabler that JFCC IMD directly supports. As a functional component command of USSTRATCOM, JFCC IMD executes support to designated UCP responsibilities along four lines of effort:

- Synchronizing global missile defense planning, global force management, and missile defense security cooperation activities.
- Conducting global missile defense operations support, to include asset management, alternate execution authority, federated intelligence support, and network monitoring and protection.
- Executing above element, joint, and combined global missile defense training and education, exercises, and experimentation.
- Advocating for and recommending acceptance of global missile defense capabilities, conducting analysis and assessments of current and future capabilities, and supporting ground & flight tests.

To accomplish these efforts, we maintain close collaborative relationships with the GCCs, MDA, the Services, OSD, the Joint Staff, and our allies and partners. We continually seek to enhance our deployed forces' capabilities while gaining operational experience and confidence in our collective ability to defend the Nation, deployed forces, partners, and allies. Some of our key efforts to enhance missile defense planning and capabilities for both the Homeland and regional architectures follow:

Expansion and Integration of the Missile Defense Architecture: In response to the evolving strategic environment, we continue to bolster Homeland and regional missile defense capabilities. In development of the global missile defense mission, we are supporting the advancement of the new capabilities such as Aegis Ashore in Poland; the Standard Missile-3 Block IIA under co-development with Japan; Long Range Discrimination Radar at Clear Air Force Station, Alaska; 20 additional GBIs in a new missile field at Fort Greely, Alaska; Homeland Defense Radar–Hawaii; Pacific Radar; Spacebased Kill Assessment; and various other new capabilities such as neutral particle beam, high energy laser, and other directed energy technologies. Given the many challenges associated with implementation of these architectures,

JFCC IMD, in support of USSTRATCOM's coordinating role for global missile defense, collaborates with the GCCs to assess and address cross-regional gaps in the areas of planning, policy, capabilities, and operations.

Multi-Regional Missile Defense Asset Management: JFCC IMD, in coordination with USSTRATCOM and the GCCs, manages the availability of missile defense assets to balance operational readiness posture, coordinates the scheduling of missile defense system maintenance activities, and supports MDA and Service test requirements. The asset management process allows us to continually assess our readiness to defend against missile attacks and to recommend adjustments to optimize the overall missile defense architecture.

Cybersecurity of the Ballistic Missile Defense System: JFCC IMD, in coordination with USSTRATCOM and MDA, conducts the Cybersecurity Service Provider mission for the BMDS to ensure cyber defenses and operations are planned and executed across the globe. JFCC IMD works with key stakeholders to enhance the cyber defense posture of our missile defense operational architecture against malicious activity. We are collaborating with our mission partners to incorporate realistic cybersecurity testing in support of the Warfighter Capability Acceptance process. JFCC IMD also works closely with the Joint Staff, combatant commanders, and MDA to educate, train, and exercise cybersecurity protocols to ensure the highest levels of readiness.

Global Planning and Assessment: As regional and global missile threats continue to increase in number and complexity, JFCC IMD works with the missile defense community to refine processes that synchronize transregional global missile defense planning and operations. Codified in periodic revisions to the Global Missile Defense Concept of Operations, these processes ensure unity of effort and mitigate potential seams and gaps across geographic areas of responsibility. Consistent with the Department's transition to planning based on adversary problem sets, JFCC IMD has continued to refine our process for adversary-centric missile defense plans assessments, and completed further objective analysis of missile defense risks across multiple GCC plans. This assessment methodology identifies systemic risk, informs recommendations for shortfall mitigation, and increases effectiveness in future missile defense planning efforts. This analysis informs our biennial Global Integrated Air and Missile Defense Assessment which shapes recommendations for global force management and future capability advocacy. Looking forward, we will focus our efforts with the warfighter community to continue establishing approaches and processes necessary to enable increased integration and a more holistic approach to missile defense.

Global Force Management: USSTRATCOM, as the designated Joint Functional Manager for missile defense, relies upon JFCC IMD to evaluate and recommend to the Joint Staff sourcing of missile defense requirements based on assessed risk. Due to the low density/high demand nature of missile defense assets, all sourcing decisions have a direct and significant impact on other combatant commanders' campaign and contingency plans. We continue to refine our approach to prioritize steady-state global missile defense requirements. This Global Prioritized Defended Asset List categorizes the GCCs' critical assets based on global risk. It informs our recommendations in the Global Force Management process, enabling senior leaders to make informed decisions on allocation of low density missile defense forces.

Allied and Partner Missile Defense Integration: Given that we will never have enough active defense capacity, integrating our allies and partners into a common and mutually supportive architecture is a critical warfighter priority. In support of those efforts, our Global Missile Defense Concept of Operations includes an International Engagement Framework which provides a common approach to identify potential partners, a model to identify a level of maturation, and an assessment mechanism. This approach has formed the analytical basis for the Department's Reports to Congress on Allied Integration for the past 2 years. Another venue aimed at promoting increased cooperation is the Nimble Titan campaign, a biennial series of multinational missile defense experiments. Nimble Titan brings together policy and military subject matter experts from allies and partner nations to explore collaborative missile defense, synchronize policy and military initiatives, and identify potential future concepts. Today, ministries of foreign affairs and defense representatives from 24 nations, the North Atlanta Treaty Organization (NATO), three additional multinational organizations, as well as DOD, OSD, Joint Staff, Combatant Commands, and MDA convene quarterly to exchange views and insights, collectively exploring policy and operational concepts. The Nimble Titan 18 campaign highlighted the importance of common threat perception, differences in triggers for offensive action, challenges of intelligence and information sharing in a multinational coalition, and experimentation with global, regional, and national defense designs with layered defense. The campaign explored regional verses national defense de-

signs to combat overmatch of threats, where nations with missile defense assets provided coverage for regional partners without assets. Additionally, increased intelligence sharing led to a multinational coalition to prevent missile proliferation and decreased risk of escalation.

> ***"By working together with allies and partners we amass the greatest possible strength for the long-term advancement of our interest . . . "***
> —2019 National Defense Strategy

The ongoing Nimble Titan 20 campaign incorporates recent guidance from worldwide senior leaders and lessons learned from past campaigns to experiment with the future use of space sensors for missile defense, the use of deterrence, and defense against and use of non-kinetic effects to include cyber, as part of IAMD. Nimble Titan continues to be a gateway for the U.S. to establish crucial relationships with allies and partners. It also informs the missile defense policies of the participating nations and international organizations. Events like Nimble Titan foster greater confidence in combined missile defenses and provide a means to advance U.S. efforts in collaboration, integration, interoperability, and burden sharing with our allies and partners.

JFCC IMD, in coordination with Combatant Commands and selected allies and partner militaries, is developing a multilateral information-sharing and modeling and simulation construct to enable collaborative planning and provide a better assessment of allied and partner nations' missile defense systems and capabilities. It also participates in regular multilateral tabletop exercises and events to help partner nations identify and close capability gaps. Additionally, we have successfully integrated allies directly into the JFCC IMD staff through the Foreign Liaison Officer (FLO) program. Our first FLO, a German Air Force officer, has been an integral player in Nimble Titan, NATO BMD training, and allied and partner modeling and simulation efforts. We are seeking to add additional FLOs to increase our understanding of allied missile defense policies, capabilities, and planning in order to optimize missile defense planning and force allocation.

Joint Missile Defense Training and Education: In coordination with USSTRATCOM, the Joint Staff, Combatant Commands, and the Services, we continue to develop comprehensive and innovative training programs to close gaps between Service, joint, and regional missile defense training and education. JFCC IMD's Joint Ballistic Missile Defense Training and Education Center, was designated last year by OSD as a Center of Excellence. It now offers 16 mission-oriented resident and mobile training team courses, and online courses to include orientation, asset management, C2BMC situational awareness, and general officer/flag officer seminar training. Over the past year, JFCC IMD instructors executed 240 courses, training over 3,500 students worldwide. Additionally, in keeping with Joint Vision 2020, JFCC IMD provided training courses to our allies and partners through military-to-military and Foreign Military Sales training venues. In 2018, this included training to the Japan Self Defense Force Joint Staff, the Republic of Korea Armed Forces, and the Peninsula Shield attendees at the Fires Center of Excellence Top Gun course.

Warfighter Capability Acceptance and Integrated Master Test Plan: As missile defense architectures mature, warfighters require a credible, comprehensive assessment of new capabilities to inform operational acceptance into the global BMDS. The warfighter relies on a robust and operationally relevant test campaign to confidently field and integrate new capabilities into their existing IAMD architectures.

In April 2018, Warfighter Capability Acceptance was completed for the entire fleet of operational GBIs, thus enhancing Homeland defense capabilities for USNORTHCOM and USINDOPACOM. Warfighter Capability Acceptance is scheduled to be completed in 2019 for improvements made to Robust IRBM Defense for USEUCOM and USCENTCOM.

Last year's test campaign included several significant tests. In April 2018, the Department demonstrated interoperability between the THAAD and Patriot weapons systems. Additionally in September 2018, international cooperation was demonstrated when Japanese Maritime Self Defense Force and MDA completed an Aegis BMD intercept flight test, in cooperation with the U.S. Navy, off the coast of Hawaii. Finally, in December 2018, the Department conducted an Aegis Weapon System Engage-On-Remote intercept of an IRBM-class target with an SM–3 Block IIA interceptor demonstrating the effectiveness of the European Phased Adaptive Approach Phase III architecture.

This year, JFCC IMD supported the FTG–11 test which demonstrated several firsts, including the first salvo (two GBIs) engagement; operational flight test of the GMD system; first use of the space segment of the Space-based Kill Assessment in a GMD flight test; and first Aegis SM–3 Block IIA simulated engagement of an ICBM class target. The Navy and MDA will demonstrate fleet defense using a salvo of two SM–6 missiles. Additionally this year, new capabilities that will be demonstrated in flight test are THAAD remote launcher capability and Patriot launch on remote engagement using THAAD.

Missile Defense Review (MDR): The recently released MDR reinforces our commitment to defending the United States, our deployed forces and allies from adversary missile launches. The review lays out a strategy to prioritize a comprehensive approach to countering the increasingly capable and diverse missile threat. It acknowledges the limitations of relying solely on defending against missiles inflight and seeks to improve our integration of offensive and defensive actions. Combining offensive capabilities with a credible missile defense capability sends a strong message of deterrence to our adversaries. We are pursuing new concepts and capabilities to ensure effectiveness against current and future threats. But, as we address future threats, we must account for the AMD assets required to defend the Homeland while simultaneously improving our regional capabilities. The MDR assigned a number of follow-on reviews to ensure the missile defense enterprise appropriately addresses requirements development, trans-regional integration, and pre-launch attack operations. The JFCC IMD team is fully engaged in these efforts and I am confident they will effectively inform meaningful reforms.

> ***"The MDR looks at, and beyond, the contemporary threat environment to consider emerging missile challenges and their implications for U.S. missile defense roles and requirements."***
>
> —2019 Missile Defense Review

In summary, JFCC IMD continues to expand our Nation's global missile defense architecture and explores future capabilities to maintain operational advantage against current and future threats. Competitive edge is maintained through integrated planning and operational support, deliberate investments in our capability developments by MDA and the Services, investments in our warfighters through education and training, expansion of collaboration with our allies and partners, and the speed of innovation and fielding to get capability in the hands of our warfighters.

CONCLUSION

Chairman Fischer and Ranking Member Heinrich, as a member of the joint missile defense community, the Army continues to pursue enhancements to the Nation's IAMD systems, from the tactical to the strategic levels of warfare. As outlined here, USASMDC/ARSTRAT and JFCC IMD perform a broad set of critical national security missions. These missions include providing professional warfighters and capabilities to support current operations, ensuring they are prepared for tomorrow's fight, and developing new technologies required to maintain a technological advantage against our adversaries. Our trained and ready soldiers, operating GMD elements in Colorado, Alaska, New York, California, and from remote, globally deployed locations, remain on point to defend the Homeland against an ICBM attack. As a force provider to the GCCs, our soldiers provide essential regional sensor capabilities, ballistic missile early warning, and satellite communications. Our regional forces continue to leverage allied collaboration and planning efforts in developing integrated and interoperable defenses against the various threat sets. USSTRATCOM, through the JFCC IMD, continues to integrate BMDS capabilities to counter global missile threats and to protect our Nation, deployed forces, allies, and partners.

While operational, doctrinal, and materiel developments are essential, our most important assets are the thousands of soldiers, sailors, airmen, marines, civilians, and contractors who deploy and operate our IAMD systems. As recognized by Department leadership, the strength behind our outstanding workforce is their families. Their contributions and sacrifices are foundational to the dedication and performance of our workforce—the role and support of our families empowers mission accomplishment.

I appreciate having the opportunity to address missile defense matters and look forward to addressing your questions.

Senator FISCHER. Thank you, General.

Secretary Rood, the deployment of space-based sensors is generally looked upon as a necessary next step for missile defense, especially as threats from maneuvering hypersonic weapons increase. Last year, funding to pursue such a network was not included in the budget. It was placed on MDA's unfunded priorities list. But Congress provided funding to begin moving forward.

Now, in this year's budget request, the project is again on the unfunded priorities list. Can you help me understand what the Department's approach is here? We have heard a lot of testimony about how important this capability is, but it doesn't seem to ever be included in the budget documents. What's going on?

Secretary ROOD. Senator, as you point out, the growth in hypersonic threats that we face is one of our concerns. So in the approach that the Department has taken for this year as compared to last year, one of the things that we've had is that Under Secretary Mike Griffin, former National Aeronautics and Space Administration (NASA) director, who also spent a great deal of his career working in missile defense, has put forward a concept that the Department is embracing for a proliferated low Earth orbit (LEO) constellation of satellites. That proliferated, or P–LEO constellation, has funding requested from the Department that the committee will review, of course, to begin the work both to architect that proliferated LEO concept, which leverages work that the Defense Advanced Research Projects Agency (DARPA) has done, initially with studies of the architecture, the sensor, a space transport layer to communicate that data, and then a ground-based system as well for command and control. That work would be done by the Space Development Agency (SDA).

Senator FISCHER. Is it $20 million that's in the budget for the SDA to study that low orbit architecture?

Secretary ROOD. The SDA budget request is for just under $150 million for that purpose. That will include $20 million, as you point out, for the P–LEO sensor technology, but it will also include funding requested for the transport layer at $15 million, the ground warning integration for $30 million, as well as the launch and space situational awareness portion of that at $10 million, and for the staff and studies just under $45 million. That's in addition to a space-based discrimination study for the Space Development Agency, which has applications both for ballistic missile defense and other activities.

Senator FISCHER. General Greaves, can you discuss the project on the Missile Defense Agency's unfunded priorities list? Would you say it's premature to move forward at this point, or is this for work that needs to be done regardless of the outcome of this study?

Lieutenant General GREAVES. Madam Chairman, thank you for the question. It is absolutely essential that we continue to move forward, and this work would be needed to be done now or done later. It involves essentially initiating work for long lead procurement of such things as the sensors themselves, the focal plane arrays that will be needed to do the missile defense mission from low

Earth orbit, things such as cryogenic coolers, and things such as solar arrays, which take a long time to be developed.

So what Secretary Rood has mentioned is a proliferated architecture where Dr. Griffin's organization and the Space Development Agency will be presenting and preparing the infrastructure required to host whatever mission set is plugged into that low Earth orbit architecture, such as missile defense. It could be positioning navigation and timing. It could be some other mission.

But our enemy is time. This Nation is extremely capable of doing just about anything it puts its mind to. The threat is moving faster and faster, and the reason I include it as my top priority in the unfunded list is that I believe that as time is the enemy, let's not waste it, and if additional funding is provided, that's where it would go.

Senator FISCHER. Thank you.

General O'Shaughnessy, can you talk about why a space-based sensor network is necessary in terms of threat?

General O'SHAUGHNESSY. Yes, ma'am. Thank you for the opportunity.

First off, obviously with our adversaries, continuing to make more complex weapons systems that we have to be able to respond to. An example is hypersonics, where our current sensing capability just doesn't have the ability to watch a hypersonic from birth, from the time it launches, all the way to the time that it would impact. The space-based sensing layer gives us the ability to see it from the time that it launches, and because of the unique fashion in which the trajectory is, where it starts out very high but then it will come down low, it will not be seen by our current sensors. The space-based sensing capability now gives us the ability to track it from birth all the way to ultimately when we defeat it.

So to me, that is of the highest urgency that we gain that capability as soon as possible, because our adversaries are actively developing these weapons as we speak.

Senator FISCHER. Agree. Thank you.

Senator Heinrich?

Senator HEINRICH. I'm going to stay on the same subject because I think I'm in a very similar position to the Chair on this issue. It just seems like this is the thing that we should be doing now. I'm deeply concerned that SDA doesn't even exist yet, and we can't continue to push this off down the timeline.

So I guess I want to ask you, Under Secretary Rood, isn't this an urgent need that we ought to be focused on now?

Secretary ROOD. Senator, I would agree that this is a high-priority need. The hypersonic testing that we see being conducted by countries like Russia and China is a noteworthy concern. The Space Development Agency, which reports to Under Secretary Mike Griffin, has just begun its work with a director and a small staff being named, and they have started the construction of the agency. As you know, it's part of a focus for a Space Force and a renewed focus that the Department would have on that broad mission area.

So I quite agree that it's an important priority. The early parts of this program are leveraging work that DARPA has done in order to ramp that up over time, and that's listed in the Department's plans coming out through the coming years.

Senator HEINRICH. I have great respect for Dr. Griffin. I just think this needs to land someplace that is ready to move now, as opposed to in the future.

One of the things that I'm concerned about that's related to this is that MDA's budget includes $34 million to revive work done in the 1990s on neutral particle beam technology for a potential space-based directed energy interceptor, and I think all of you know that I'm about as big a booster of directed energy technology as you're going to find in Washington, but it seems to me that it's important to have the sensors in place to discriminate these paths before we start talking about a new interceptor; and, from a budget point of view, that we might want to move up the space-based layer and consider doing something like this that is brand new down the road.

General Greaves, what was the reason back in the 1990s that that program was stopped? What's the reason for reviving it today? Are we doing this in the right order?

Lieutenant General GREAVES. Senator Heinrich, just a short summary. It was stopped because the Cold War ended, essentially. A lot of work was done back then to prove out the basic technology. Most of the components except for two of the major actions within that system are at high technology readiness levels, within being proven in the lab.

The reason why we looked at it is akin to the comment that was made earlier about what are we doing new that's different that can reduce the cost of missile defense and move us down the cost curve. So we looked at something that was radically different that had a significant amount of work done that we can prove in a lab and then move to space if the Nation decides that's what we need to deploy. But do it in the lab, prove the technology, then move to space.

As far as the order in which things are done, I firmly believe that with the work that's been going on with the space sensor layer with the Missile Defense Agency, with the United States Air Force, and with DARPA since 2015, there's a lot of work that's been done with industry already to lay the groundwork for the deployment of these sensors. The major change this year has been the movement from the medium Earth orbit deployment of an architecture to a low Earth orbit deployment of an architecture.

So we will continue to use the funding that we received last year. If we receive additional funding this year, it will go into the very same sensor technology and development activities. I think that we'll be ready in time to match up with the infrastructure that the Space Development Agency is producing; i.e., the communications transport layer, as well as the satellite process.

Senator HEINRICH. I'm going to run short on time here. Given the votes coming up, I'm just going to yield back and we'll see where we go from here.

Senator FISCHER. Senator Hawley?

Senator HAWLEY. Thank you, Madam Chair.

I thank the gentlemen for being here. Thank you, as always, for your exemplary service.

I want to start, actually, by going back to something that you said, Secretary Rood, about the positioning of the—is it the TPY–

2?—in Turkey. We just heard, before the full committee, from the new United States European Command (EUCOM) commander that we are strongly considering and indeed may pull back F–35s from Turkey if they move forward with their procurement.

Are we worried about the TPY–2 being placed in Turkey given its current pursuit?

Secretary ROOD. Not at present, although depending on where our relationship with Turkey should go, of course, it would be one of the things that we would watch. We do still enjoy generally good relations with Turkey. There are some areas, particularly in interest in the S–400 Russian air defense system, that concern us, and that's what you were referring to, that there may be some results. But as far as Turkey hosting the deployment of that radar, we've been pleased. It's been a positive experience for us.

That's not the only facility, of course, that the United States military maintains in Turkey. We have other both Air Force and Army facilities there.

Senator HAWLEY. Right. A number of you have mentioned, both in your written testimony and here, the development by both China and Russia of hypersonic weapons of intercontinental range. So say something more—we'll start with you, Secretary Rood—if you could, about what we are doing to defend the continental United States and Hawaii, the Homeland, from these hypersonics, and are we in a position where we're likely going to need to rely on nuclear deterrence in order to successfully defend ourselves? What are the options that are on the table?

Secretary ROOD. We do plan to rely on both nuclear and conventional deterrence to deal with the hypersonic threat, in addition to other things that we use those capabilities for. However, our basic approach—and others on the panel can add if I leave something off—would be first we want to have the capability to detect and track those launches of hypersonics. So that's where this proliferated low Earth orbit concept with lower-cost sensors we hope can begin as early as 3 years from now to place into orbit would provide the means, along with a space transport communications layer and the ability to control those things on the ground—first to track it, to have enhanced command and control, and then some of the money that has been requested this year is to continue to work on architecture to affect the hypersonic vehicle during its flight.

Senator HAWLEY. Can you just say a word on nuclear deterrence, about the importance of low yield tactical nuclear weapons to an effective contemporary deterrent, and given the context now of the return of peer or near-peer competition?

Secretary ROOD. Yes. What we see in both Russia and China is a substantial improvement and increases in their nuclear forces; in Russia's case, a very large growth of so-called tactical nuclear weapons. One of the things we see in Russia's doctrine, which we see them exercise as well, is escalate to deescalate, and we get concerned that some of the Russian writings and their practices lead us to conclude they think they have an advantage, that if they escalate and perhaps use tactical nuclear weapons earlier, that the United States does not have a comparable capability that is survivable and responsive. Therefore we have requested money for both

a low-yield modification to an existing warhead for a submarine-launched ballistic missile and a submarine-launched cruise missile. A submarine-launched cruise missile is further behind and we're just doing the AOA, or analysis of alternatives, at this stage, Senator.

Senator HAWLEY. Thank you very much.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator Hawley.

Senator King?

Senator KING. I'm going to ask a series of dumb questions, which people have told me I'm well equipped to do.

[Laughter.]

Senator KING. The first one is give me a speed comparison between a ballistic missile and a hypersonic missile.

Lieutenant General GREAVES. Let's see. Hypersonic missiles go Mach 5 or above, and Intercontinental-range Ballistic Missiles (ICBMs) are at, depending on altitude, Mach 10, 12, 13, something like 22,000 miles an hour.

Senator KING. So a ballistic missile is much faster, but a hypersonic missile doesn't go up and down, it goes straight; is that correct?

Lieutenant General GREAVES. The hypersonic missile follows a profile that's boosting and then reduces altitude into a longer glide phase, and then a shorter terminal phase.

Senator KING. What's the range of a hypersonic missile? Could a hypersonic missile go from North Korea to the continental United States?

Lieutenant General GREAVES. Yes, depending on the booster that's attached to it. It could range ICBM or intermediate range nuclear missile or——

Senator KING. Does a hypersonic missile create a more difficult or a different targeting scenario for our missile defense?

Lieutenant General GREAVES. It's a different, and with the current sensor network that we have, a more difficult problem, and that's why the space sensor layer is so significant, so that we can capture it from the time it launches to the time we intercept it, birth to death.

Senator KING. Is North Korea doing any work on hypersonics, or is that just China and Russia?

Lieutenant General GREAVES. I would need to discuss that in a classified forum. But the concern is potential, if not likely, proliferation.

Senator KING. Can hypersonic missiles have nuclear warheads?

Lieutenant General GREAVES. Yes.

Senator KING. So this presents a really new challenge, and you say that the necessary step is additional sensors?

Lieutenant General GREAVES. That is the first step, sir, to ensure we have custody——

Senator KING. Did I understand from the Chair's question that those sensors, that that new sensor layer is on the unfunded priorities, not on the front burner?

Lieutenant General GREAVES. It is on both. It is initiated in the Space Development Agency's budget to develop the architecture to support that sensor layer. But as my if not top concern, near top

concern, it's my number-one priority in the Missile Defense Agency's unfunded list that was requested by the Congress.

Senator KING. It seems to me that's a very, very high priority given the speed with which hypersonics are being developed by our adversaries.

Lieutenant General GREAVES. Sir, I would agree, and I made a comment earlier that in my mind the enemy is time, not the ability to develop effective defenses against hypersonic threats.

Senator KING. General Greaves, could you describe the recent test? Is that something that you can describe here in an open setting?

Lieutenant General GREAVES. Yes, sir. The reference is to the acronym FTG–11, flight test ground-based midcourse defense 11, which, together with the U.S. Northern Command and General Dickinson's team, we executed back on last Monday. It was the most complex, comprehensive, and operationally challenging test ever executed by the Missile Defense Agency.

Senator KING. It was a success, was it not?

Lieutenant General GREAVES. It was. We are doing about 9 months' worth of data review because we collected lots of data, but the initial look says it was a complete success.

Senator KING. Define complete success. Did the bullet hit the bullet?

Lieutenant General GREAVES. Yes, sir. The object of the test was to launch an ICBM, an intercontinental ballistic missile representative target, and we did that from the Marshall Islands out at Kwajalein, to ensure to achieve the speeds you asked about earlier, and the profile of a realistic threat. But this test was different because we launched within a very short period of time two ground-based interceptors, operationally released by the combatant commander using their operational processes, which is very important, and the lead interceptor intercepted the ICBM representative threat.

But what's most important is that it created a debris field, and this test has been 10 years or more in the making, and the importance of that is the trailing interceptor was able to discern the debris from the next most lethal object that I can talk about in a classified forum, and also intercept that object.

What that means is enemy operations that seek to confuse our missile defense system by launching junk or debris would not be successful. That's why it was a success.

Senator KING. Congratulations. That's an amazing achievement. So please convey the heartfelt congratulations from this committee.

One other quick question. Do we know if the North Koreans are developing a submarine-launched missile capacity?

Secretary ROOD. Yes, Senator, they are.

Senator KING. So that changes this calculation again. If they're launching their missiles from North Korea, that's one thing. If they're launching them from the Bering Strait or somewhere in the North Pacific, that's a different problem.

Secretary ROOD. It changes the defense equation in terms of where the origin could be and what are other anti-submarine capabilities in a potential conflict, how they would be utilized, and it

also changes the geometry depending on how the North Koreans could choose to deploy that.

Senator KING. And the time.

Secretary ROOD. Yes, depending on where they launch from. Yes, sir.

Senator KING. Thank you, Madam Chair.

Senator FISCHER. We have had a vote called. We don't know for sure what the schedule is going to be for votes in the next few hours, but we'll try and do a tag team here until we're sure what's happening.

Senator Sullivan?

Senator SULLIVAN. Thank you, Madam Chair.

I really want to reiterate what my colleague from Maine said in a bunch of his questions. But first of all, gentlemen, congratulations. The way I've been describing this—General Greaves, correct me if I'm wrong. I think Senator King's questions were actually quite good; basic, but good.

So is this a bullet? How fast is this bullet going? I'm talking about the successful test.

Lieutenant General GREAVES. Twenty-two thousand miles an hour.

Senator SULLIVAN. So it's one bullet hitting another bullet; correct?

Lieutenant General GREAVES. Yes, sir.

Senator SULLIVAN. At 22,000 miles an hour in space?

Lieutenant General GREAVES. Yes, sir.

Senator SULLIVAN. Okay, and then the first successful hit created a fragment——

Lieutenant General GREAVES. Debris field.

Senator SULLIVAN.—and the second missile then tracked the biggest fragment, adjusted at 22,000 miles an hour, and hit the fragment?

Lieutenant General GREAVES. Yes, sir.

Senator SULLIVAN. That's unbelievable.

Lieutenant General GREAVES. I would say it hit the next most lethal object, because the architecture——

Senator SULLIVAN. Is that the next biggest object?

Lieutenant General GREAVES. The next object that most closely resembles a threat vehicle.

Senator SULLIVAN. First of all, congratulations.

Second, you might remember in the last couple of National Defense Authorization Acts (NDAAs) I had rather comprehensive missile defense bills that got incorporated, very bipartisan, by the way, but the Congress encourages you to test at least once a year. We want you to continue that, and, in part, here's the reason.

Had that test failed, the New York Times, certainly The Los Angeles Times—for whatever reason, they are real big skeptics of missile defense—it would have been front page news, how horrible and weak the system is. I don't even know if I read any news articles on this remarkable test. So if any media, if you're listening—I don't know if we have any media here, but why don't you write an article on this? Because had it failed, it would have been front page news. We all know that, and yet you do something that is unbelievable and you get no press.

So, thank you. We're noticing, and it's remarkable.

My colleague from Maine is always asking the questions that I want to ask, so here it is. What message does this send to our adversaries, Kim Jong-un, Putin, the Chinese, anyone else who wants to mess with us? Can they do this?

[No response.]

Senator SULLIVAN. Well, you don't have to answer that.

[Laughter.]

Senator SULLIVAN. But what message does it send?

General O'Shaughnessy?

General O'SHAUGHNESSY. Part of our deterrence is based on a credible capability to deny an enemy the ability to achieve its objective. So this test clearly shows that they would not be able to achieve their objective, which leads to our ability to deter so we could prevent a conflict from ever happening because they know they can't reach their objectives. As the operator of the ballistic missile defense system, this gives me great confidence because we actually use our operators, the actual folks who are doing it, to include your team from Greeley, as we launched this through the operational construct. It really gives us that high sense of confidence that we can use it to deter our adversaries.

Senator SULLIVAN. Secretary Rood, what do you think in terms of the message this sends, whether you're Kim Jong-un or Putin or whomever?

Secretary ROOD. I think it sends a very strong message about the credibility of our capability and reinforces deterrence. Missile defenses are part of contemporary deterrence, both offenses and defenses. If you're Kim Jong-un or another adversary, you have to think about first the probability that your attack would be successful; and then secondly, even if we successfully defended against an attack, an attempt to incinerate an American city, the story wouldn't end there. We still maintain our offensive capabilities.

Senator SULLIVAN. I think it's a great point. My point—and again, you guys are the experts, and you've done a great job, remarkable. But I think it's the message of if you do want to go out in a flame of glory, Kim Jong-un or the Ayatollahs in Iran, (a) it won't work if we have this capability; (b) we will flatten your country after you try, so it's double deterrence. I think that that's important.

Let me ask one quick question here. I think you're kind of seeing what you might call in the military a foot stomper on the issue of space-based sensors. The last two NDAAs, again in a very bipartisan way, led by bills that my team and I and a lot of you wrote, but to deploy a space-based sensor, there's a strong interest in doing that here. I think you're seeing it. We would be a little bit, I think, disappointed if somehow, with the development of the new Space Development Agency, if that kind of got lost in the shuffle there.

General Greaves, I'm going to ask you a question. Of course, I'm going to ask for your professional military advice on this one. But where do you think the best place for space-based sensors to be put and deployed the most rapidly would be, in the Missile Defense Agency or in the new Space Development Agency?

Lieutenant General GREAVES. Sir, I will say that——

Senator SULLIVAN. I know it kind of puts you a little bit on the spot.

Lieutenant General GREAVES. It really doesn't because the Space Development Agency, as it was stood up, was given special authorities that are very similar or almost exactly what the Missile Defense Agency has, except for the milestone decision authority. I think that's still within the——

Senator SULLIVAN. So MDA or the new Space Development Agency, most rapid deployment for space-based sensors?

Lieutenant General GREAVES. If it's executed per the plan that was laid out, the Space Development Agency is best suited to provide the capability, and the example is the——

Senator SULLIVAN. Is that a big if?

Lieutenant General GREAVES. If it's executed. My concern is the big if, because if it's done the way we did the Space Tracking and Surveillance System (STSS), the space tracking surveillance satellite program, where the Space and Missile System Center contracted and delivered that capability to the Missile Defense Agency, where the Missile Defense Agency held the requirements and we continue to lead operation of that capability, that can work.

If it's all co-located in one organization that has responsibility for developing space capability, that's probably the most efficient place to be. But it's got to have, it must have, the responsibility, authority, and accountability that I have in my position today. If that is not executed, if the Space Development Agency does not have milestone decision authority, which is critical for acquisition programs, then that is not the most efficient place for it to be.

Senator SULLIVAN. You're seeing a lot of us want to get that deployed quickly.

Lieutenant General GREAVES. Yes, sir.

Senator HEINRICH. [presiding] Senator Jones?

Senator JONES. Thank you, Mr. Chairman.

Thank you all for being here today and for your service.

This is really just for anybody that might want to chime in here. I'm wondering if we've already made plans or plan to make any changes to our missile defense structure as a result of the President's announcement that we're going to be withdrawing from the Intermediate-Range Nuclear Forces (INF) Treaty. What changes are there, if there are going to be any, or if you've already made them or whatever? Are we covering those with the budget that's there?

Mr. Secretary?

Secretary ROOD. Senator, in the budget for missile defense, there isn't a change necessary as a result of the President's decision to withdraw from the INF Treaty. Of course, that will take effect in August of this year. The change that you will see going forward is the treaty, of course, prohibited the United States from the pursuit of intermediate range missiles, and we will begin to explore, and there's funding requested from the Congress to explore concepts and to look at what the options are that would be available to the United States for offensive missile capability.

But from the defensive perspective, to withdraw from the treaty would not affect the budget request for defenses.

Senator JONES. All right. Anybody else? Is that covered?

All right. So, General Dickinson, coming from Alabama and the Huntsville area, the Space Force is an intriguing part. We've been part of a Space Force in some way or another for a long, long time. I'm wondering how the proposed Space Force will impact your command, and how do you believe creating a Space Force is going to enhance our national security?

Lieutenant General DICKINSON. Well, thank you for that question. So, in terms of Army space, we've got some great capabilities within the Army space portfolio, if you will, that as we go along in support of the legislative proposal that is now here on the Hill that I think will fit nicely with that proposal.

Our work right now in terms of supporting the ground maneuver forces that reside within the Army, in terms of the future of that, I think we will still see our ability to do that. But as the Space Force, the opportunity to be able to organize, man, and equip as an enterprise for space, as a space warfighting domain is all included within that proposal, and I think I support that.

Senator JONES. Great. Thank you.

General Greaves, let me also congratulate everyone on the success of the salvo intercept test. My only simple question of this is what are the next steps on that, and are they adequately funded in this budget?

Lieutenant General GREAVES. The next step, sir, the number-one priority in the agency is to continue ensuring that we maintain and sustain the deployed fleet so that General O'Shaughnessy retains his high confidence in the system. That's the number-one priority.

The next step is to continue on with the reliable kill vehicle program. I mentioned earlier that it's part of a disciplined acquisition strategy. We had very strict entrance criteria into what's called a critical design review. The design did not meet it, so I assessed that and made the decision that we would not enter into it.

What we're working now is to get back to the critical design review. But the top priority is to deliver that more reliable kill vehicle along the plan that we have submitted in the budget.

Senator JONES. So the budget is okay on that? You're satisfied that it's adequately funded in this budget?

Lieutenant General GREAVES. Yes, sir.

Senator JONES. Great. All right.

That's all I have, Mr. Chairman.

Thank you so much for being here, gentlemen.

Senator HEINRICH. In that case, I'll fill up a little time here and follow up on what Senator Jones was just chatting about.

General Greaves, the redesigned kill vehicle has a projected delay of 2 years, and I understand there's a process in place to review the challenges in the RKV program and to ensure that we develop and provide the warfighter with a more reliable kill vehicle. In your statement you described the test events that will involve the RKV, and I just want to confirm that given the delay time there, the 2-year delay, that these tests will still occur before you procure RKVs so that you fulfill the 'fly before you buy' requirement.

Lieutenant General GREAVES. Senator, the answer is, in general, yes. As part of the disciplined acquisition approach, we have not deleted or modified any of those test requirements. The only caveat

I'll state is that we may approach the Secretary of Defense (SECDEF) as granted in the language for a waiver of some sort if we believe that we can and are able to and are credible enough to pursue that waiver. But the scheduled delay was planned. It encompasses the activity we need to complete a disciplined acquisition approach, which I firmly believe we should continue on.

Senator FISCHER. [presiding] Thank you, Senator Heinrich.

Secretary Rood, in last year's hearing we discussed some of the unanswered policy questions related to boost phase missile defense. It was my understanding at the time that these issues were being considered by the Missile Defense Review, but the MDR did not go into any great detail other than to state that boost phase capabilities could enhance our missile defense efforts.

Can you discuss what the Department is pursuing with respect to boost phase capabilities and whether there are unanswered policy questions that really need to be resolved before any capabilities can be deployed?

Secretary ROOD. Yes. First, boost phase defenses are very attractive to us because the missile is at its slowest point, and potentially the debris could even fall back on the launching state's territory. That's also the area where we don't have substantial capability of any note in our arsenal as part of a layered defense, which is another reason it's attractive to us, to get at the missile as early as it is launched.

With respect to the policy barriers, there aren't any policy barriers at this stage. As the Missile Defense Review notes, we are giving all the framework and guidance that the developers need in order to go pursue those capabilities.

One of the noteworthy areas that we speak to in the Missile Defense Review is the incorporation of our tactical air fifth-generation platforms as first sensors, and later potentially carriers, for interceptors to attack offensive missiles in their boost phase. We're also looking at other potential capabilities in directed energy for that purpose. But it's mostly a capability limitation. At this stage the policy gives encouragement to pursue the boost phase defenses.

Senator FISCHER. Thank you.

General Greaves, when we spoke yesterday it was an unclassified setting, and you explained the low orbit sensors. We've had a lot of talk about that. I know my colleagues went to vote, but I think it would be good for the record if you could give us an explanation of really what that all entails, what we went through yesterday. I think it would be helpful to have that in the record, what we're talking about here.

Lieutenant General GREAVES. Thank you, Senator Fischer. Let me begin with the activity that I was involved with 3 years ago, 3-½ years ago now, when I was the commander at the Space and Missile Systems Center. Vice Admiral Sering was in my position, and General Hyten was transitioning between Air Force Space Command and USSTRATCOM. We saw the need for a shared responsibility, shared capability between what the U.S. Air Force was providing with the Space-based Infrared System in geo-synchronous orbit 22,000 miles out in space, and the ability to execute such missions at lower orbit levels, such as the hypersonic defense mission.

So we, working with industry, explored architectures, which resulted in a government reference architecture, essentially, based at medium Earth orbit, about 10,000 miles out, but with fewer spacecraft to do the hypersonic defense mission and look for new, low signal level propulsion capability as the threat is developing.

So that's where we started, and we were making significant progress in that area. What has changed within the last year—and the last year has been a year of transition within the Department—is that Dr. Griffin is now approaching space capability from a Department-wide perspective. So what has changed is that with industry's progress in actually developing the capabilities to proliferate multiple small satellites in low Earth orbit, very significant potential to deploy a low Earth orbit architecture that can do multiple missions, one of which is missile defense.

So the vision from Dr. Griffin is to deploy that architecture, multi-hundred satellites, very small, together with a communications transport layer to move the information around among satellites and to the ground and to the warfighters where it needs to be, and to have mission areas plug in as required. We do not need 200 satellites to do the missile defense mission. We need a smaller number. Positioning, navigation, and timing may need a smaller number. But together we would ride on these spacecraft buses, as we call them, take advantage of a communications transport layer architecture, and execute the mission at lower cost.

The difference also between what our original government reference architecture was and what Dr. Griffin is proposing has to do with resiliency, the ability while under attack to gracefully degrade your capability and not have it shut off immediately. The way I try to explain it is if you've got six big targets up at medium Earth orbit, that's a lot easier to go against and have a bigger effect upon than a few hundred down at a lower orbit that we have shown through analysis and study that can gracefully degrade and still maintain capability.

Senator FISCHER. Thank you, sir.

Senator King?

Senator KING. Thank you, Madam Chair.

Let me just follow up, and I apologize. You understand, for some odd reason, the Chairman and I aren't in charge of the schedule around here.

Senator FISCHER. We should be.

Senator KING. We should be, yes. It would work much more efficiently. But let me follow up.

I was asking questions about could the capability of the North Koreans in a submarine—if a missile is launched from somewhere in the mid-Pacific between Hawaii and California, would you still have time, if it were a ballistic missile, to target and hit it as successfully as you did the one coming from Kwajalein?

Lieutenant General GREAVES. Senator, yes. That would be an intermediate-range to short-range attack, for which our current systems—the THAAD system is an example, and if they're in the right position to defend a certain area, or the SM–3s that are carried on Navy ships as part of the Aegis weapon system, they would be positioned, and we've demonstrated the ability to counter those threats.

The latest demonstration was last year with THAAD against an Intermediate-Range Ballistic Missile (IRBM).

Senator KING. So that deals with the shorter range.

Lieutenant General GREAVES. Yes.

Senator KING. With the submarine launch, if that's the choice.

Secretary Rood, talk to me about directed energy. One of the problems with missile defense is that the missiles that we're shooting are quite expensive. Where are we with directed energy? How far away are we? What might the role be—for example, could it be ship-borne into the boost phase? Give me a tutorial on where we are in directed energy.

Secretary ROOD. Senator, I can begin, and then General Greaves and General Dickinson may have something to add to that as well.

But the short answer would be we are requesting funding to continue directed energy work that the Missile Defense Agency would lead. The main reason that that work for ballistic missile defense has been centered at higher altitudes, both for high-altitude unmanned aerial vehicles (UAVs) or potentially space-based applications, is it's difficult to propagate lasers in the atmosphere. There's a lot of water, clouds, other things, and so by going up above the cloud layer or at a higher altitude or in space, that is a simpler——

Senator KING. Then you have the problem of weight and a sufficient electric charge.

Secretary ROOD. Yes, sir. This is the engineer's challenge, yes. If you optimize in one area, other parts of the trade space, you do encounter that. But it is easier to propagate the beam across that area, and the energy that is output and beam quality on the target is the key, really energy on the target. General Greaves could teach a Ph.D. dissertation course, so perhaps I should defer to him on it.

Lieutenant General GREAVES. Senator, the main constraints or challenges have to do with power on the target, as well as beam control to ensure you can stabilize it, as well as pointing the laser in the right direction. So those are the major challenges we're working on right now.

The scaling effort is one that has the most priority. The original lasers that flew on the airborne laser, for example, they were chemical based, so they were huge and took up lots of room. Right now we're working with three industry partners, the National Labs, looking at electric lasers; fiber-combined lasers is one of the technologies. The other technology is—forgive me for the acronym here, but diode-pumped alkali lasers. We've seen significant progress with both of those, and we're shooting to essentially move up from about 30 or 40 kilowatts. For us in the missile defense area, 1 megawatt is high power. We need that to go against a——

Senator KING. If you had 1 megawatt at the source, what's the delivered power to the target?

Lieutenant General GREAVES. We need 1 megawatt at the target.

Senator KING. So what I'm looking for is what's the differential? How much—in the electric business I used to be in, we talked about line losses. What's the differential between where it leaves and where it hits?

Lieutenant General GREAVES. Sir, it depends on the altitude from which the weapon is fired. We're looking at above 55,000 to 60,000 feet to get out of the atmosphere to allow maximum power

on target, energy on target. I missed the second part of your question.

Senator KING. Well, in order to put a megawatt on the target, how much power do you have to have leaving the source? A megawatt-and-a-half, or 2, or 1 and——

Lieutenant General GREAVES. I may have misspoken. We need a megawatt capability at distance with line loss to affect the target. I'm sorry about that.

Senator KING. Okay.

Secretary ROOD. I know less about this than General Greaves. I think the answer, Senator, is it's highly dependent on several variables, the beam quality from its emission at 1 megawatt, and your ability to control that and change its optic over time. In other words, it's not like electricity transmission. It's a constant depending on what your sensor is telling you about how this very dynamic environment with water and air is moving, and you sense that, you change, like with a contact lens changing its prescription over time, what you are putting out. So it's a highly complex set of variables to say it depends on many of the qualities of the system, how much line loss, essentially, you have.

Is that accurate, General?

Lieutenant General GREAVES. Yes. What I'll say, sir, is while we were working on this successful mission within the last 3 weeks, we've been doing some testing out of White Sands against representative objects out there, but at much, much shorter distances, and very successful in penetrating threat representative articles——

Senator KING. Can I be assured that this is a major area of research and development and effort? It seems to me this is an enormously potentially important development.

Lieutenant General GREAVES. Sir, within the Missile Defense Agency it absolutely is, and that's why we continue to have three activities going on in that area and request funding for it.

Senator KING. Thank you.

Lieutenant General DICKINSON. Senator, if I could add on to that, that's a major priority within the U.S. Army. We've had some success, a lot of success recently with integrating a 10-kilowatt laser into a Stryker combat vehicle where it is totally self-contained within that vehicle that will be able to maneuver with ground maneuver forces. While 10 kilowatts (KW) may not sound like a lot, what we've done over the past few years is grow it from a 2 kilowatts to a 5 kilowatts, and our road map is to put a 50 kilowatts onto a Stryker combat vehicle within the next 4 or 5 years and be able to provide that to the ground maneuver commander.

What we envision using that for is we've already demonstrated successfully against an unmanned aircraft system, and we've actually had soldiers actually operate the system when it was a 2KW/5KW/10KW as recently as this year, and we envision that in the future. So that's allowed us to have warfighters using the technology at a very early stage so that we can start developing our techniques and procedures that we will use in combat.

We're on a path to get a 100 kilowatts high-energy laser as part of our IFPC increment 2, our indirect fire protection capability in the Army, which will be responsible for fixed and semi-fixed de-

fense, and we envision that. It's going to be designed for not only unmanned aerial system (UAS) but also counter-rocket artillery and mortar, and we've already demonstrated some success with a 50 kilowatts against artilleries out in White Sands missile range.

Senator KING. I foresee a hand-held UAS anti-weapon staffed entirely by duck hunters from Arkansas.

[Laughter.]

Senator KING. Thank you.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator.

Senator Sullivan?

Senator SULLIVAN. Thank you, Madam Chair.

You know, one of the things that all of you have been mentioning is that time is the enemy here because of the advancements of—whether it's North Korea or some of our other adversaries or potential adversaries. As an Alaska senator, I certainly take pride in the fact that we are the cornerstone of our nation's missile defense with the Fort Greeley field and the long-range discrimination radar and the radar sites out in the Aleutian Island chain, and we're making progress on all of these, as you know, gentlemen.

One area, though, where it looks like we're not making progress—General Greaves, can you talk about the potential 2-year delay of the redesigned kill vehicle, and is that a best-case or worst-case scenario? Can you talk in public about what the problem is?

Lieutenant General GREAVES. Senator, I'll start with the last question. We cannot discuss the details of the problem. What I'll say in general is that if this same issue had occurred when we were developing the original extra-atmospheric kill vehicle, the current fleet, a decision could have been made to move ahead and deliver the capability, whatever we had, the best capability that we can deliver.

The major difference here is that from the outset this acquisition strategy was destined or intended to deliver a more reliable vehicle that followed a disciplined acquisition process to include robust design, robust testing, and a system which was more maintainable——

Senator SULLIVAN. But does that make the acquisition process slower, almost by definition?

Lieutenant General GREAVES. No, it does not, sir, because of the unique acquisition authorities that both the Congress and the Department have provided to the Missile Defense Agency. The issue with acquisition is the inability for rapid decision-making within DOD 5000. That's the simplest way I can put it. But with the authorities in this position that I occupy to be the milestone decision authority, which has major approval authority before we make major decisions, before we get to production, as the program manager, as the head of the agency, the decision authority lies right here.

It's what I personally use to decide that if we had done something other than that, we would not be credible to the acquisition strategy that we signed up to.

Senator SULLIVAN. So let me—can you answer the first part of my question? Is that a best-case or worst-case scenario? Two years is a lot of time.

Lieutenant General GREAVES. It is.

Senator SULLIVAN. Especially given that time is the enemy.

Lieutenant General GREAVES. We are testing components as we speak, and that time may be adjusted over the next few months.

Senator SULLIVAN. Which way do you think it's going to be adjusted?

Lieutenant General GREAVES. More likely shortened, but it could go the other way. When we developed the plan for up to 2 years, we took a best guess, almost worst case——

Senator SULLIVAN. Is there something we can do as a Congress to help you with shortening that time line?

Lieutenant General GREAVES. Negative, sir. Continue to support what we're doing, ensure we——

Senator SULLIVAN. Is it a contractor issue? Is it a company issue?

Lieutenant General GREAVES. It's a technical issue, sir.

Senator SULLIVAN. Okay. Let me ask Secretary Rood, you and I were all at the big rollout of the Missile Defense Review at the Pentagon. I think it was important, an important symbol that not just you and the Secretary of Defense and the Vice President but the President of the United States was there. I think that also sent a message to our adversaries and our friends that this is a serious issue for the country.

In your view, what are the top three most critical elements of the 2019 Missile Defense Review? A number of us—and you know that you and I had a lot of discussions about this—were pressing you guys to get this nice piece of work out as soon as possible so it could impact the NDAA. Well, here we are. We're already starting to draft up the NDAA. What are the key elements that you think you need our help on? Again, one of the positive things that's going on with regard to missile defense right now in the last few years is that it's generally a bipartisan endeavor in the Congress, particularly in this committee.

So, top three things, and what do you need from us, and is there anything missing? Now that you've written it and put your heart and soul into it, and the President rolled it out, are there things that you think, oh, shoot, we should have gotten that in there, and let's try and get it in the NDAA?

Secretary ROOD. Well, on the first question, in terms of the key elements of the Missile Defense Review, I think for the purposes of the NDAA one of the things that you see contained in the Missile Defense Review is the support for the legacy systems. That is to say, as those things that are existing programs. Sustainment costs more, upgrades need to be made to them, and then additional units that we've procured. So the Missile Defense Review essentially says let's continue to support what are installed bases or those things that are currently planned and keep them robust and vital.

Senator SULLIVAN. So like the things in Alaska the President highlighted in his remarks.

Secretary ROOD. Yes, sir. So that would be one part of it. But at the same time, then, the Missile Defense Review speaks to devel-

oping new technologies and looking for new breakthroughs and things that will take us to the next level, if you will, of effectiveness of missile defense, things like space-based sensors, starting to look at spacefbased interceptors, directed energy, whether that's lasers, neutral particle beam, or other activities like that. Trying to do this in a more innovative way, leveraging DARPA's work for this proliferated low Earth orbit series of sensors and the means to communicate with them.

So, one, the Congress continuing to support the planned sustainment and upgrades and additional production of the current legacy systems, if you will; support for these new technology efforts; and there's a certain art between always, when you're moving to the next generation of technology, how robustly do you fund that, because, as you know, those efforts start smaller but then grow in funding.

Then the third area, which may sound very fundamental but has had a huge impact on us, the Congress last year did terrific work in the defense area to both finish an authorization bill and an appropriations bill before the end of the fiscal year, and I've seen the impact that that has had on our ability, the purchasing power. Essentially, that gives us more, the stability and the ability to focus on things other than continually managing change orders and change activities to keep going. So the terrific work that you did last year, if it were possible again—and they were strong bills, the authorization and appropriations bills that showed bipartisan support for what we are doing. If you can re-create that, it's hard to understate how important and how much that has benefitted the Department overall.

Senator SULLIVAN. Thank you.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator Sullivan.

Gentlemen, earlier we had a discussion on the recent missile defense test, and I would like to ask you, General O'Shaughnessy, if you have anything to add about USNORTHCOM's involvement in that test.

General O'SHAUGHNESSY. Thank you, ma'am. As we discussed about the sense of confidence that that test gives us as the operators cannot be overstated. For us to actually participate in the test from the aspect of the same way that we would do it in an actual launch, so not in a test environment, not using a different system but using the very systems that we would use, with the very people that we would use to man those systems, in a manner that is representative of a real-world event, really gives us the confidence in the system, confidence in our ability to give our senior leadership a sense of confidence that we can execute this mission. We had a discussion with Senator Sullivan about our ability to have that credible deterrence and be able to say with authority that we do have the confidence to be able to defend this Nation. I'm thankful to General Greaves for giving us that opportunity.

If you actually look at the myriad of different things that were tied to this test to take full advantage of the cost of putting this together is not insignificant, but to take full advantage of that, from the operational side, from the test side, from some of the fu-

ture capabilities that we tied into the test as well, I think it was masterful the way that General Greaves put that together.

Senator FISCHER. Thank you. Congratulations again.

Also, sir, I understand that what you can say is limited in this unclassified environment, but can you briefly describe your level of concern about your ability to defend the Homeland from cruise missile threats that we're facing?

General O'SHAUGHNESSY. Thank you for highlighting that. We talked a lot about ballistic missiles today, and hypersonics, but the one in the middle, the cruise missile threat, is equally as potent, and we certainly have adversaries that have invested significantly in that cruise missile threat; for example, certainly Russia and China. As we look to defend the Homeland, that is one of our significant concerns. As you mentioned, for much of this we'd have to go to a classified environment. We've had the opportunity to have some of that discussion.

But I do have concerns that we have to continue to invest in our ability to defend against the cruise missile threat as well, to be able to stay ahead of our adversaries. So as we do go forward, I was happy to see, for example, the Ballistic Missile Defense Review became the Missile Defense Review. That's a very subtle but very important change within that, that the focus is not just on ballistic missiles but also on the cruise missiles.

So as we look to go forward, I look forward to the committee's continued support to invest in and allow us to be able to pursue advanced capabilities to defend against what our enemy is doing to hold us at risk with advanced cruise missiles that have low radar cross sections (RCS's), very difficult to track and very difficult to defeat, and so we have to stay ahead of that threat.

Senator FISCHER. Thank you, sir.

Senator Heinrich?

Senator HEINRICH. I apologize for going back to ploughed ground here, but I do want to return to the space sensor layer issue because I'm just having a hard time with the timeline. Correct me if I'm wrong, but it's my understanding that the Space Development Agency doesn't have budget authority yet, doesn't have funding yet, and will need a reprogramming request approved by Congress before they can really get off the ground.

So at this point it exists in name only, which is why I'm having a hard time understanding why we just don't move forward with this space development layer under MDA and re-sort out the relationships a year down the road once we know how SDA is working and how it's organized and that it's ready to hit the ground running.

Maybe Secretary Rood?

Secretary ROOD. Well, the Space Development Agency, as you say, is just being stood up in terms of the director being named and the initial staff and the charter, and its authorities have been granted. We are at the beginning phase of the creation of that entity. The intent is, as General Greaves said, that it be modeled for rapid acquisition and centralized authority after the Missile Defense Agency's authorities but with a focus on space. So the initial requests to the Congress, as you point out, sir, relates to reprogramming; and then, of course, the funding for the next fiscal

year, for fiscal year 2020, to fund those projects, and it's just part of a broader activity that would affect more than the missile defense mission.

The intent is, because of our contested warfighting environment in space, that we have a more rapid acquisition, sir.

Senator HEINRICH. I think I get the underlying architecture and the need for an entity that can move rapidly and nimbly. I'm more worried about losing this, what could be a real bottleneck for us on hypersonics to the right of the timeline.

Secretary ROOD. Well, certainly this is one of the considerations that the Department leadership—as the Secretary was evaluating what work to provide to the Missile Defense Agency and what the Space Development Agency was given, there was some consideration, but the belief being that with Under Secretary Griffin's oversight, and he oversees the Missile Defense Agency as well, sir, that the Space Development Agency, with a focus on a narrow set of items initially that would grow, could provide the fastest possible route to get those things into orbit.

I agree with you that it is a priority that this continue and be done with purpose.

Senator HEINRICH. General Greaves, in the fiscal year 2018 annual report, Director of Operational Test and Evaluation, DOT&E, again recommended the MDA should develop independently accredited modeling and simulation to evaluate Ground-Based Missile Defense (GMD) effectiveness. Can you explain what needs to be done, if more needs to be done in that area, and whether or not additional resources are needed to meet DOT&E's recommendation?

Lieutenant General GREAVES. Thank you, Senator. We worked with General Behler's organization in DOT&E to develop a plan that we are executing now to eventually, not in the too-far term, deliver accredited models. So that work is going very well. I think if you ask DOT&E, they will tell you the same thing.

While additional resources, if provided, would help to speed that up, I believe that——

Senator HEINRICH. You feel good about the fundamentals.

Lieutenant General GREAVES. Absolutely. The commitment is there. We made it a centerpiece of the organization while I've been there, and it was seriously started before he departed. The Missile Defense Agency has always had models and simulations that we used, but the realization that we really can't grade our own homework, if you get right down to it, that that's not credible, that we needed an agency that's appointed and certified and recognized as being able to grade our homework, to go do that.

So the effort has been getting the two cultures, the people to work together to realize that it's for the better good.

Senator HEINRICH. Thank you.

Senator FISCHER. Thank you, Senator.

Thank you, gentlemen, for your attendance today.

With that, the hearing is adjourned.

[Whereupon, at 3:57 p.m., the committee adjourned.]

[Questions for the record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR ELIZABETH WARREN

MISSILE DEFENSE POLICY

1. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, Lieutenant General Dickinson, the fiscal year 2020 Budget Request for the Department of Defense includes nearly $50 million to pursue the development of non-kinetic and kinetic options for space-based missile defense interception. In 2016, former Missile Defense Agency (MDA) Director Adm. James Syring told the House Armed Services Committee the following: "I have serious concerns about the technical feasibility of interceptors in space, and I have serious concerns about the long-term affordability of a program like that." Do you agree with Adm. Syring? Please provide an unclassified explanation why or why not.

Secretary ROOD. It makes sense to leverage existing fielded capabilities to their fullest extent, and we are doing so. At the same time, we must invest in new capabilities to keep pace with, and stay ahead of, the advanced threat in defense of the United States, our allies and partners. For fiscal year 2020, the DOD budget requests funding to continue improving existing sensor programs as well as to proceed with a number of other efforts that begin to move us in a new direction to support a holistic, cost-effective approach to space-based sensors. For missile defense, these include: a proliferated Low-Earth Orbit (pLEO) sensor technology effort; developmental work for a space sensor technology demonstration for hypersonic tracking; and an architectural assessment for a missile defense space-based discrimination layer.

General O'SHAUGHNESSY. Due to the complexity and evolution of missile threats, I believe we need missile defense technology that is lethal, reliable, and resilient to defend the Homeland now, and to keep pace with the threats into the future. As part of our integrated, layered approach to missile defense, I support the Department of Defense's efforts to evaluate the potential effectiveness and cost of space-based interceptor technology to help inform the best way forward for required missile defense capabilities.

Lieutenant General GREAVES. As of today, I do not agree or disagree with VADM Syring (Ret). Previous concerns about space-based missile defense were based on the best information available at the time. Many factors affect affordability and technical feasibility. The 2019 Missile Defense Review tasked MDA to study development and fielding of a space-based missile intercept layer capable of boost-phase defense. This report is scheduled to be completed by July 2019, and will identify the technologies, schedule, cost, and other requirements for a space-based defensive layer for boost-phase defense. The affordability of space-based missile defenses must be a driver from the start of the design process. Affordability begins by picking the right mission space for space-based missile defense and then completely understanding the capabilities and limitations of an architecture designed to that mission space—to include the susceptibility of space-defense concepts to responsive adversary tactics. The proposed funding will be used to better understand the drivers of feasibility and costs in today's environment so that the leadership can make informed decisions.

Lieutenant General DICKINSON. Given the potential technical advancements since the referenced statement, I support the Department's efforts to examine the benefits, feasibility and affordability of a range of technologies for the Warfighter to defeat the advanced threat. This includes a healthy re-examination with industry of past efforts as technologies mature and in the case of space, the evolution of commercial space offers economies of scale previously unavailable.

2. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, if Russia or China were to move to put missile defense interceptors in space, how would you advise the Secretary of Defense to respond? Please provide an unclassified explanation.

Secretary ROOD. Russia and China have substantial missile defense programs. In Russia's case, that nation maintains a significant missile defense system that is deployed near Moscow. Though I cannot say what specific position the United States would take regarding a particular future hypothetical system, I can say that the actions the United States is taking to improve space-based missile defense sensor systems and to explore space-based interceptor concepts are fully consistent with our obligations under relevant international law, including the United Nations Charter and the Outer Space Treaty.

General O'SHAUGHNESSY. As the USNORTHCOM Commander, I am focused primarily on defending the Homeland against adversaries' offensive weapon systems

targeting the United States. I would defer to the Missile Defense Agency Director to address this with the Department.

Lieutenant General GREAVES. MDA defers to Under Secretary of Defense for Policy (USD(P)). As the Program Executive for the Ballistic Missile Defense System (BMDS), the Director, MDA is responsible for developing missile defense systems that meet technical requirements and deliver capability to the warfighter.

Lieutenant General DICKINSON. As this is a policy issue and outside my purview, I respectfully defer to Under Secretary of Defense (Policy).

3. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, what historical evidence is available to demonstrate that space-based missile defense has been affordable and effective for the United States? Please provide an unclassified explanation.

Secretary ROOD. Conceptual benefits of engaging missile threats from space, particularly for boost phase defense, have long been recognized, as well as the critical technical and operational issues that would have to be resolved on the way to a militarily useful and affordable capability. Space-based missile defense concepts have been studied sporadically going back to Project Defender in the late 1950s and early 1960s. The Brilliant Pebbles program—which ran from Concept Definition with Industry in 1990 to its termination in 1993—was the last attempt to develop a capability. Given the significant advantages of space-based missile defenses, the 2019 Missile Defense Review requested the Missile Defense Agency study development and fielding of a space-based missile intercept layer capable of boost-phase defense. This report is scheduled to be completed between July and the end of 2019, and will identify the technologies, schedule, cost, and other requirements for a space-based defensive layer for boost-phase defense.

General O'SHAUGHNESSY. I currently rely on space-based capabilities to provide information regarding missile detection, warning, and preliminary impact, which are critical for execution of our Homeland defense mission. As part of an ongoing layered approach for missile defense in the future, I look forward to the results of Department of Defense's evaluation of the concepts and technology for space-based defenses and defer to Under Secretary Rood and Lieutenant General Greaves for any further details regarding potential effectiveness and affordability for space-based missile defense.

Lieutenant General GREAVES. Conceptual benefits of engaging missile threats from space, particularly for boost phase defense, have long been recognized, as well as the critical technical and operational issues that would have to be resolved on the way to a militarily useful and affordable capability. The objective is to provide defense in depth and to deprive the adversary of unchallenged access to midcourse with complex countermeasures. Space-based missile defenses are a logical supplement to the existing midcourse tier of the Ballistic Missile Defense System. Given the significant advantages of space-based missile defenses, the 2019 Missile Defense Review tasked MDA to study development and fielding of a space-based missile intercept layer capable of boost-phase defense. This report is scheduled to be completed by July 2019, and will identify the technologies, schedule, cost, and other requirements for a space-based defensive layer for boost-phase defense.

Lieutenant General DICKINSON. As MDA is the lead for the MDR directed study on this effort, I respectfully defer to MDA. However, we have leveraged the Nation's significant space sensor investment in the conduct of the missile defense mission. I am confident that this historical information will be used in any cost and operational effectiveness study.

4. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, the Missile Defense Review (MDR) proposed a six-month feasibility study "of the concepts and technology for space-based defenses." What is the expected completion date for that study? A date range would also be acceptable.

Secretary ROOD. We plan to complete this study between July and the end of 2019.

General O'SHAUGHNESSY. I look forward to the Department of Defense's evaluation of the concepts and technology for space-based defenses, and I will continue to communicate our operational requirements that support our Homeland defense mission. I defer to Under Secretary Rood regarding the timeline for expected completion of the study.

Lieutenant General GREAVES. The Missile Defense Agency will complete this study and publish its findings by July, 17, 2019.

Lieutenant General DICKINSON. As MDA is the lead for this study, I respectfully defer to MDA.

5. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, depending on the results of the MDR's six-month feasibility study, is it possible that the Missile Defense Agency may request supplemental funding in fiscal year 2020 to continue development of space-based interceptors?

Secretary ROOD. Upon the completion of the study, the Missile Defense Agency and the Department will determine the next steps for space-based interceptors. If additional funding is required, we would not anticipate that request until the President's Budget request for fiscal year 2021.

General O'SHAUGHNESSY. As the NORAD and USNORTHCOM Commander, I rely on the Services and the Missile Defense Agency to program and acquire the necessary capabilities for our warfighter missions. I defer to Under Secretary Rood and Lieutenant General Greaves regarding any potential future funding requests, pending the results of the feasibility study.

Lieutenant General GREAVES. Upon the completion of the study, MDA and the Department will determine the next steps for space-based interceptors. If additional funding is required, we would not anticipate that request until President's Budget 2021.

Lieutenant General DICKINSON. As this is an MDA funding issue, I respectfully defer to MDA.

6. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, how would a United States ballistic missile defense capability against Russia or China affect our ability to maintain a stable strategic nuclear balance with those countries?

Secretary ROOD. The United States ground-based midcourse defense system deployed in Alaska and California is not designed to negate, nor is it capable of negating, the strategic nuclear arsenal of Russia or China. Rather, the United States relies primarily on its strategic nuclear forces to deter a Russian or Chinese strategic nuclear attack. Even with planned growth in United States missile defense capabilities over the Future Years Defense Program, the U.S. will continue to rely primarily on strategic nuclear forces to maintain strategic stability.

General O'SHAUGHNESSY. Our defensive Ground-based Midcourse Defense system was designed and deployed against North Korea and potential Iranian ballistic missile threats. It was not designed or intended to defend against Russian or Chinese ballistic missile threats. I defer to Under Secretary Rood on any potential changes relating to current U.S. BMD policy.

Lieutenant General GREAVES. MDA defers to Under Secretary of Defense for Policy (USD(P)). As the Program Executive for the Ballistic Missile Defense System (BMDS), the Director, MDA is responsible for developing missile defense systems that meet technical requirements and deliver capability to the warfighter.

Lieutenant General DICKINSON. As this is a policy issue, I respectfully defer to Under Secretary of Defense (Policy). However, we believe United States missile defenses do not undermine Russia or China's large and sophisticated strategic nuclear deterrent.

7. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, the MDA has said repeatedly that there is no military requirement for an "East Coast" Ground-Based, Mid-Course Defense (GMD) site. MDA has also previously stated that the estimated $3-$4 billion cost to construct a third GMD interceptor site in the eastern United States would be better spent on improving ballistic missile defense system (BMDS) sensor and discrimination capabilities. Do you agree with previous MDA assessments?

Secretary ROOD. The United States is currently defended from intercontinental missile threats by 44 ground-based missile defense interceptors—with 40 interceptors located at Fort Greely, Alaska and 4 interceptors at Vandenberg Air Force Base, California. The Department is currently in the process of deploying an additional 20 ground-based interceptors at Fort Greely, Alaska by 2025, providing Homeland defense against the foreseeable projected threats. As part of continued efforts to evaluate optimized U.S. defensive capabilities, Congress required, and DOD explored, the development of additional missile defense Interceptor Sites in the continental United States (CIS). The Department continues to explore additional capabilities to address the advancing threat and provide operational flexibility which will be considered when making a final CIS decision. However, at this time there is no operational requirement for a third CIS.

General O'SHAUGHNESSY. There is some increased operational capability with an East Coast site, particularly in that it would provide increased capacity as well as dispersal of interceptors. But while that is important, my top operational priorities

for resources remain focused on developing our persistent, discriminating sensor architecture, as well as improving interceptor reliability and lethality, which may prove more dynamic and responsive to future threats. We continue to be vigilant for future threats to the Homeland and are postured to readdress the assessment of the "East Coast" GMD site if needed.

Lieutenant General GREAVES. The MDA assessment remains unchanged. The current Ground-Based Interceptor (GBI) sites at Fort Greely, Alaska and Vandenberg Air Force Base, California provide the capability necessary to protect the United States Homeland against the current and projected Intercontinental Ballistic Missile (ICBM) threat from North Korea, as well as a future Iranian ICBM threat, should it emerge. Twenty additional interceptors are planned for the GBI site in Alaska. An additional GBI site located within the United States would add battlespace and interceptor capacity, but would come with materiel development and sustainment costs. The Department has determined that investment in discrimination and sensor capabilities will yield more cost-effective near-term improvements to United States Homeland missile defense for threats from Iran and, hence, implementation of a continental United States interceptor site is not currently programmed.

Lieutenant General DICKINSON. Yes, I strongly believe that the limited ballistic missile defense resources should continue to be prioritized to improving the sensor architecture and increasing interceptor reliability.

8. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, the Missile Defense Review proposes to bring the SM–3 IIA interceptor into the national missile defense architecture, beginning with a test of the interceptor against an intercontinental ballistic missile (ICBM) class target in 2020. Combined with the GMD system, the United States by 2030 could have several hundred interceptors available for national missile defense. How do you predict Russia and China would respond to such a capability?

Secretary ROOD. Pursuant to the Missile Defense Review (MDR) and pursuant to the National Defense Authorization Act for fiscal year 2018, the Department plans to conduct a test of the SM–3 IIA interceptor against an intercontinental-ballistic missile (ICBM) target in 2020. Regarding Russia's and China's reactions, it is important to recognize both nations are pursuing national and regional missile defense programs of their own. For example, Russia has a missile defense system ringing Moscow with 68 nuclear-tipped interceptors. Also, in the event that the SM–3 IIA test is successful and we decide to field an underlay to the Ground-based Midcourse Defense (GMD) system, we would be doing so to address the long-range missile capabilities of North Korea, and potentially Iran. An SM–3 IIA underlay for Homeland defense would be insufficient to counter the large quantity and sophistication of Russian and Chinese ICBMs and other long range nuclear missiles, and therefore would not negate their strategic forces.

General O'SHAUGHNESSY. I defer to the intelligence community regarding a predicted response from Russia and China if the SM–3 IIA interceptor is integrated with the GMD system architecture in the future.

Lieutenant General GREAVES. MDA defers to Under Secretary of Defense for Policy (USD(P)). As the Program Executive for the Ballistic Missile Defense System (BMDS), the Director, MDA is responsible for developing missile defense systems that meet technical requirements and deliver capability to the warfighter.

Lieutenant General DICKINSON. As this is a policy issue, I respectfully defer to Under Secretary of Defense (Policy).

9. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, the MDR asserts that U.S. missile defense capabilities "may also help dissuade missile proliferation among potential adversaries by reducing the political and military value of their missiles." How do you reconcile this assertion with North Korea's recent aggressive development of ballistic missiles of different ranges?

Secretary ROOD. The United States relies on a broad range of strategies to deter and dissuade potential adversaries. Against missile attacks, we take a comprehensive approach consisting of deterrence, active defenses, passive defenses, and offensive capabilities. Missile defense is one element of our broader deterrence strategy to persuade a potential adversary that the benefits of developing, deploying and using missiles will not be achieved. Should dissuasion and deterrence fail, it's essential that we have the ability to protect the nation, our forces, and allies and partners from missile attack.

General O'SHAUGHNESSY. I defer to Under Secretary Rood and the intelligence community regarding the effects of United States missile defense policy and capabilities on North Korea's aggressive development of ballistic missiles.

Lieutenant General GREAVES. MDA defers to Under Secretary of Defense for Policy (USD(P)). As the Program Executive for the Ballistic Missile Defense System (BMDS), the Director, MDA is responsible for developing missile defense systems that meet technical requirements and deliver capability to the warfighter.

Lieutenant General DICKINSON. As this is a policy issue, I respectfully defer to Under Secretary of Defense (Policy).

10. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, as Congress and the Administration negotiate on defense funding for fiscal year 2020, do you think that it makes sense to fully leverage the sensors the United States currently has fielded for missile defense detection, discrimination and tracking before funding new programs?

Secretary ROOD. It makes sense to leverage existing fielded capabilities to their fullest extent, and we are doing so. At the same time, we must invest in new capabilities to keep pace with, and stay ahead of, the advanced threat in defense of the United States, our allies and partners. For fiscal year 2020, the DOD budget requests funding to continue improving existing sensor programs as well as to proceed with a number of other efforts that begin to move us in a new direction to support a holistic, cost-effective approach to space-based sensors. For missile defense, these include: a proliferated Low-Earth Orbit (pLEO) sensor technology effort; developmental work for a space sensor technology demonstration for hypersonic tracking; and an architectural assessment for a missile defense space-based discrimination layer.

General O'SHAUGHNESSY. U.S. Northern Command fully leverages currently fielded missile defense sensors in support of our ballistic missile defense mission. However, these sensors do not provide the complete persistent discrimination capability required. Additional sensors, such as the Long Range Discrimination Radar, Homeland Defense Radar—Hawaii, and the Pacific Radar will improve persistent tracking and discrimination coverage of threat missiles for entirety of flight, which will enhance our ability to defend the Homeland.

Lieutenant General GREAVES. I agree that it always makes sense to apply currently fielded systems to the fullest extent to meet ongoing and emerging missions. To do this, we must combine keen awareness of the changing threat, a thorough understanding of the capabilities and limitations of the current systems, and detailed planning for any potential upgrades or refinements to keep pace with our adversaries. The Ballistic Missile Defense (BMD) program has done this with improved discrimination made to the Sea Based X–Band Radar (SBX), the Army Navy Transportable Radar Surveillance and Control Model 2 (AN/TPY–2) radars, and the Army Navy Shipboard Radar Surveillance and Control Series 1 as well as threat catalog enhancements to the Upgraded Early Warning Radars. Where existing sensors didn't provide enough coverage or project capabilities to stay ahead of the advanced threat in defense of the Homeland, the Department made the case for the Long Range Discriminating Radar, the Hawaiian Homeland Defense Radar and the Pacific radar. The threat assessment was clear and we responded. With programs like the BMDS Overhead Persistent Infrared (OPIR) Architecture (BOA) and Command and Control, Battle Management and Communications and related fusion systems, the Missile Defense Agency and its partner agencies employed an enterprise approach to data sharing. Because of this, the BMDS has made dramatic improvements in ground processing to extract everything possible from existing sensors such as the Space Based Infrared System, AN/TPY–2s and outside data sources to enable us to track advanced threats in real time—and we are tracking these threats today. But we can only use this capability where sensors are actually observing the threat, and there are huge portions of the globe where the BMDS has limited-to-no sensor coverage. We need to fill those gaps. With emerging hypersonic and maneuvering threats as well as advanced ballistic threats, we are reaching the limits of our existing sensors to adequately defend the United States when these new capabilities become operational, as these maneuvering threats could evade detection and tracking by many of our current generation sensors. This is why I have advocated for a detection and tracking space layer to give us persistent coverage and adequate sensitivity to view and defend against this next generation of threats. A detection and tracking space layer will be integrated into our existing architecture that, by design, processes all available OPIR sensor data.

Lieutenant General DICKINSON. As MDA is the lead for the NDAA directed BMD Sensor AOA Study, I respectfully defer to MDA.

11. Senator WARREN. Secretary Rood, General O'Shaughnessy, Lieutenant General Greaves, and Lieutenant General Dickinson, are you using all available sensors, including those not originally designed for missile defense?

Secretary ROOD. I concur with Lieutenant General Greave's statement that: "The Ballistic Missile Defense System (BMDS) leverages all appropriate sensors to support Homeland and regional missile defense. Not all sensors possess the characteristics and attributes to be useful for missile defense applications. The Department continues to explore the utility for sensors currently outside of the BMDS to support missile defense, and weighs the integration and testing cost with the assessed benefits to the BMDS. DOD has undertaken steps over the last decade to incorporate data sharing across multiple domains to improve the capabilities of the BMDS to detect and track ballistic threats, including significant investment in extending the service life of Cobra Dane, the integration and exploitation of Overhead Persistent InfraRed (OPIR) sensor data, the initial mobile sensor integration and developmental demonstrations of airborne sensor tracking, as well as, use of the F–35 sensor suite."

General O'SHAUGHNESSY. Per the Missile Defense Review, we are actively working with the Missile Defense Agency to examine how additional discriminating radar sites in the Pacific and other potential sensors could add to our capability. I defer any specific questions to Lieutenant General Greaves.

Lieutenant General GREAVES. The BMDS leverages all appropriate sensors to support Homeland and regional missile defense. Not all sensors possess the characteristics and attributes to be useful for missile defense applications. The Department continues to explore the utility for sensors currently outside of the BMDS to support missile defense, and weighs the integration and testing cost with the assessed benefits to the BMDS. DOD has undertaken steps over the last decade to incorporate data sharing across multiple domains to improve the capabilities of the BMDS to detect and track ballistic threats, including significant investment in extending the service life of Cobra Dane, the integration and exploitation of OPIR sensor data, the initial mobile sensor integration and developmental demonstrations of airborne sensor tracking, as well as, use of the F–35 sensor suite.

Lieutenant General DICKINSON. As MDA is the lead for the NDAA directed BMD Sensor AOA study, I respectfully defer to MDA.

QUESTIONS SUBMITTED BY SENATOR JOE MANCHIN

TRANSFER OF MISSILE DEFENSE AGENCY PROJECTS TO SPACE DEVELOPMENT AGENCY

12. Senator MANCHIN. Secretary Rood and Lieutenant General Greaves, the MDA was created and granted powers to prioritize correctly and rapidly acquire much needed systems and capabilities in the missile defense mission area. A significant amount of work in missile defense revolves around space-based detection, tracking and kill assessment capabilities. Already, the transfer of responsibility for the Space Sensor Layer research and development to the Space Development Agency (SDA) has apparently led to an unfunded priority designation for this much needed capability in fiscal year 2020. What are the plans and timelines, if any, to transition other space based capabilities such as the Space Based Kill Assessment (SKA) and the Space Tracking and Surveillance System to the SDA so as to not cause disruptions or slowed development for these critical programs?

Secretary ROOD. The Space Development Agency, as established, was given special authorities that are very similar to what the Missile Defense Agency (MDA) has. This allows SDA to anticipate and respond to some of the Department's most significant challenges in space on short timelines. The SDA is uniquely postured to rapidly develop and deploy advanced capabilities such as the Space Sensor Layer. It will rapidly develop and deploy next-generation space capabilities including rethinking how we do rapid experimentation, prototyping, and innovating for space. For many on-going programs, such as MDA's Space Based Kill Assessment (SKA) and Space Tracking and Surveillance Systems (STSS), the Department has concluded that it is preferable for them to remain with their parent Services or Agencies, rather than transferring them to the SDA. Regardless of which organization has the lead for these critical programs, the SDA, MDA, and the Services will continue to work closely together to ensue capability integration.

Lieutenant General GREAVES. The Space Development Agency was recently established March 2019 and per the fiscal year 2020 President's Budget focusing on developing the department's proliferated LEO architecture, primarily the transport layer. MDA expects transition discussions at some point in the future.

NORTHER DEFENSE RADARS

13. Senator MANCHIN. General O'Shaughnessy, you have now testified twice over the critical task of defending northern and arctic approaches to North America and

the United States. Your testimony has also cited the aging Cold War era array of radars that make up the Northern Warning System (NWS). I am concerned that there is nothing in this year's budget specifically addressing the modernization or recapitalization of this critical capability with estimates currently in the billions required for these tasks. Have recent tests conducted with the NWS reassured your confidence in the ability of this network of radars to defend against ballistic and cruise missile threats or should we be prioritizing investment in this system to ensure safety of the Homeland?

General O'SHAUGHNESSY. Defense of our Homeland is my absolute top priority. The results of the North Warning System (NWS) assessment indicated that the NWS does not currently provide the indications and warning, detection, tracking, and identification required to defend against current and emergent aerospace threats. To get after this requirement, the Northern Approaches Surveillance Analysis of Alternatives (NAS AOA), led by the Air Force, is an ongoing, comprehensive analysis of the capabilities and architecture required to ensure our ability to detect, identify, and track advanced airborne threats in the northern approaches to the Homeland. Thanks to Congressional support, that critical effort was supported with two-year Research, Development, Testing, and Evaluation (RDT&E) dollars in fiscal year 2019, and fully funds the NAS AOA contract through fiscal year 2020. The fiscal year 2020 President's Budget also includes Science and Technology funding to research the potential for employing over-the-horizon radars in the Arctic. In the meantime, we are working closely with the Air Force to augment and extend the capability of the NWS while continuing our high-priority efforts to identify and field a replacement capability as soon as possible.

THAAD AND PATRIOT SYSTEMS

14. Senator MANCHIN. General O'Shaughnessy and Lieutenant General Greaves, I see the budget contains procurement for Terminal High Altitude Area Defense (THAAD) interceptors and system upgrades as well as THAAD and Patriot integration capabilities and tests. But I do not see any additional THAAD battery procurements. Currently the United States operates only seven THAAD batteries. Both of you have testified that a THAAD—Patriot combination can be very effective in defeating terminal Hypersonic Glide Vehicles, cruise missiles and other difficult to track and target threats. What is the plan for procurement of these systems to ensure we have comprehensive coverage of critical U.S. assets from emerging threats?

General O'SHAUGHNESSY. The Terminal High Altitude Area Defense (THAAD) program has a demonstrated capability against Intermediate Range Ballistic Missiles and we have a request into the Missile Defense Agency to explore THAAD's utility for our Homeland defense mission. I defer to the Missile Defense Agency and the Services regarding any potential future plans for additional THAAD batteries and Patriot systems.

Lieutenant General GREAVES. The Army, Joint Staff, OSD and MDA are conducting a study on THAAD Batteries and Interceptor quantities in response to the Missile Defense Review (MDR). The integrated capabilities of THAAD and Patriot are informing this study which is due out this summer. Specifically the study will provide a current assessment of the required number of THAAD Batteries to support needed worldwide THAAD deployments, including potential deployment timelines, and basing and deployment options. The study results will be considered during the development of the President's Budget for 2021. THAAD and Patriot could provide contributions to defend against Hypersonic Glide Vehicles. However, MDA, Joint Staff, Army and OSD are assessing BMDS architecture of Interceptors, Sensors, and Command and Control to counter emerging threats including Hypersonic Glide Vehicles and influence acquisition decisions for the future of the BMDS.

HYPERSONIC DEFENSE SYSTEMS

15. Senator MANCHIN. General Greaves, I noticed in the MDA budget a decrease over the Future Years Development Plan (FYDP) in research and development funding for Hypersonic Defense (PE 0604181C). This is concerning as the hypersonic weapon threat is one of the greatest threats we're facing right now. Is this decline in funding due to meeting objectives and requiring less money or is it due to reprioritization to other missile defense objectives?

Lieutenant General GREAVES. Defending against the hypersonic threat remains a high priority for MDA. The FYDP funding profile declines as these objectives are met, not because of reprioritization of funds to other efforts. The President's Budget 2020 Hypersonic Defense program of record represents a near-term body of work, prior to completion of the Department's Defense against Hypersonic Threats Anal-

ysis of Alternatives (AOA). This work includes modification of existing or use of in-development ground-based sensors (AN/TPY–2 radar, Long Range Discrimination Radar, the Homeland Defense Radar—Hawaii, and Pacific Radar) and the C2BMC system to track and report the threat. MDA will consider the AOA recommendations to counter the threat in long term, such as potential Hypersonic Defense future architectures including weapon solutions, in the fiscal year 2021 MDA budget deliberations. Upon completion of the AOA, MDA will address recommendations to counter the threat in subsequent budget deliberations. Based on the preliminary findings in the AOA, acceleration of a Hypersonic Defense capability was included in MDA's fiscal year 2020 Report to Congress on Unfunded Priorities. The report included $719 million in fiscal year 2020 to begin the following:

- Development of Glide Phase Engagement Capability (Over-the-Horizon) with 2 concepts for competitive environment
- Leverage and upgrade additional C2BMC and ground sensor capabilities
- Participate in partner flight tests to provide additional data sources for integrated capability demonstrations
- Develop land based terminal defense capability
- Invest in additional component and integrated technologies across the kill chain for future architecture spirals.

DEPARTMENT OF DEFENSE AUTHORIZATION FOR APPROPRIATIONS FOR FISCAL YEAR 2020 AND THE FUTURE YEARS DEFENSE PROGRAM

WEDNESDAY, MAY 1, 2019

UNITED STATES SENATE,
SUBCOMMITTEE ON STRATEGIC FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

U.S. NUCLEAR WEAPONS POLICY

The Subcommittee met, pursuant to notice, at 2:29 p.m. in room SR–222, Russell Senate Office Building, Senator Deb Fischer (Chairman of the Subcommittee) presiding.

Committee Members present: Senators Fischer, Cotton, Rounds, Cramer, Hawley, King, Heinrich, Manchin, and Jones.

OPENING STATEMENT OF SENATOR DEB FISCHER

Senator FISCHER. The hearing will come to order.

The Subcommittee meets today to receive testimony on U.S. nuclear weapons policy, programs, and strategy in review of the administration's budget request for fiscal year 2020.

Testifying before the Subcommittee today are: Ellen Lord, the Under Secretary of Defense for Acquisition and Sustainment; David Trachtenberg, the Deputy Under Secretary of Defense for Policy; General Timothy Ray, the Commander of Air Force Global Strike Command; and Admiral Johnny Wolfe, the Director of the Navy's Strategic Systems Programs.

Thank you for appearing before us today. I also want to express my particular appreciation for this Department's emphasis on the importance of nuclear deterrence.

Secretary Lord, your prepared testimony unequivocally describes nuclear deterrence as, "the Department of Defense's highest priority," echoing similar comments from a number of other senior leaders, such as General Dunford. As you all know, a lack of senior leader attention has been a challenge for the nuclear enterprise in the past, and I am pleased to see this Department is properly prioritizing this issue.

Similarly, I think there is bipartisan recognition in Congress that if foreign nuclear threats continue to grow and our platforms reach the end of their serviceable lives, modernization is necessary to ensure our deterrent remains credible. We look forward to hearing from each of you about your efforts in this regard, and your assess-

ment of how any delay or disruption would impact our ability to met deterrence requirements.

Your full statements will be made part of the record. But, first, I would like to recognize the Ranking Member for any comments he would like to make.

Senator Heinrich.

STATEMENT OF SENATOR MARTIN HEINRICH

Senator HEINRICH. Thank you. Let me thank Chairwoman Fischer for holding today's hearing.

I also want to thank our witnesses for taking the time to testify today. We very much appreciate your service to our country and to the job that each of you perform.

Every national security action we take is underpinned by our deterrent. So, it's important we continue its modernization. Some have claimed it's too expensive. But, even in its peak years, the Congressional Budget Office has said that its cost, relative to the Department of Defense (DOD) budget, will only be 6 percent. I have often said that 6 cents on the dollar to protect us from World War III or an existential threat is money well invested.

There is a lot to cover in today's hearing, besides modernization. I'm concerned about pulling out of the Intermediate-Range Nuclear Forces (INF) Treaty with nothing to show for it. It seems to me that we have given Putin everything he wanted since he broached this topic with the Administration officials 15 years ago. In turn, we have left our North Atlantic Treaty Organization (NATO) allies in a bind.

I am concerned about the upcoming expiration of the New Strategic Arms Reduction Treaty (START). If we let this treaty expire, it'll be the first time since 1972 that we have not had some form of arms control treaty in place for strategic stability. The Senate ratified New START, with the condition of modernizing the triad, which President Obama certified in February of 2011, and which continues to this day. Arms control and modernization should go hand in hand. I take this relationship very seriously.

I am encouraged that the President has recently announced that he wants to include China in an arms control discussion, and to add nonstrategic nuclear weapons as a future arms control agreement. But, he should renew New START first, and that should be our priority.

Let me close on this issue of pit production. I continue to question the validity of producing 80 pits per year by 2030 under the split production option proposed by the National Nuclear Security Administration (NNSA). The Institute for Defense Analyses (IDA) found that none of the options analyzed by the NNSA can be expected to provide 80 pits per year by 2030, and none of the options was demonstrably better than the others. I'd like to note, however, that, when the NNSA analyzed a split production at the Savannah River site, it was for 80 pits a year by 2030, at an added cost of some $14 billion to the taxpayer. I am very leery, to say the least, of the split option, given that an independent report said it will not even achieve by 2030, and it will cost even more than the additional $14 billion to be requested by Congress.

Madam Secretary, you certified to this Committee on May 10th, 2018, that the recommended alternative is, "likely to meet pit production timelines and requirements responsive to military requirements," and it is also, "cost-effective and has reasonable near-term and lifecycle costs that are minimized to the extent practicable compared to other alternatives." I would like to ask that, in light of this report, that you report back to the Committee on reevaluation of your certification.

[The information referred to follows:]

Secretary LORD. The 2018 Nuclear Posture Review stated "An effective, responsive, and resilient nuclear weapons infrastructure is essential to the U.S. capacity to adapt flexibility to shifting requirement." This is the Department of Defense's (DOD) highest priority mission and reestablishing a resilient plutonium pit production capability to support this mission is a top priority for the DOD and National Nuclear Security Administration (NNSA). After several decades with almost no pit production, we are now faced with aging warheads that are nearing their end-of-life. In order to meet the challenges of the current and evolving security environment, DOD requires a steady-state ability to produce plutonium pits to: enhance warhead safety and security; meet future DOD and NNSA requirements; replace older existing plutonium pits deliberately and methodically; and enable the ability to respond to changes in deterrence requirements arising from the reemergence of great power competition.

In an assessment of multiple options, we found NNSA's two-site plutonium pit production approach most suitable because it meets NWC-endorsed and statutory requirements; provides resiliency through its use of multiple production facilities; and offers future potential to increase pit production above the minimal 80 ppy. This approach comes with some schedule and cost risks that can be managed given appropriate authority and requested funding. I am committed to working collaboratively with NNSA and Congress to ensure the pit production strategy is executed successfully.

Senator HEINRICH. Again, thank you today for coming, and I look forward to hearing all of your testimony.

Senator FISCHER. Thank you, Senator Heinrich.

As I visited with the panel before we started the hearing, we do have four votes beginning at 3 o'clock, and so I have asked them to submit their statements for the record. I also suggested to them, during the questioning, if they feel there is a part of their prepared statements that they would like to include it at that point during the questioning, they were free to do so at that time.

OPENING STATEMENT OF HON. ELLEN M. LORD, UNDER SECRETARY OF DEFENSE FOR ACQUISITION AND SUSTAINMENT

Secretary LORD. Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee, thank you for the opportunity to testify today.

I am pleased to join Deputy Under Secretary of Defense for Policy David Trachtenberg, General Timothy Ray, and Vice Admiral Johnny Wolfe to discuss what three successive Secretaries of Defense have called the Department of Defense's highest priority mission: ensuring that the United States has a safe, secure, reliable, and credible nuclear deterrent—now and in the future.

I am here representing the entire Acquisition and Sustainment team of over 100,000 dedicated military, civilian, and contractor professionals who execute our mission every day.

As Under Secretary, I am responsible for leading the Department's efforts to both sustain and modernize the nation's nuclear

weapon delivery systems and related nuclear command, control, and communications (NC3) systems.

I would like to frame my remarks and our discussion around two key points:

1. Although still militarily effective today, the U.S. nuclear deterrent remains dependent on rapidly aging nuclear delivery and NC3 systems that were built during the Cold War; and
2. After 25 years of primarily drawing down and life extending these systems, repeated decisions to defer recapitalization of our nuclear forces have caught up to us.

While sustainment efforts have allowed us to defer nuclear modernization investments for many years, delay is no longer an option. Nearly all of the systems that comprise the current nuclear deterrent are well beyond their original service lives, and can no longer be cost effectively life extended.

Now, we must concurrently acquire and field modem systems in each leg of the strategic nuclear triad. The choice is stark: either we invest in modernizing our nuclear forces, or we unilaterally eliminate them due to obsolescence.

The fiscal year 2020 budget request for DOD's nuclear forces is consistent with this urgency. In total, the budget request includes $24.9 billion for nuclear forces, or 3.5 percent of DOD's budget. This includes $8.4 billion for recapitalization and $16.5 billion for operations and sustainment.

Because nuclear deterrence is DOD's number one priority mission, nuclear modernization programs are our highest investment priorities. As these programs mature in the coming decade, the funding they require will increase. The total projected cost of sustaining and modernizing our nuclear forces will peak at approximately 6.4 percent of the DOD budget in the late-2020s.

The cost of this effort is significant but manageable. From a historical perspective, it is far less expensive in relative terms than previous nuclear recapitalization programs carried out during the Cold War.

Any large collection of complex and integrated programs faces risks, and our nuclear recapitalization and sustainment efforts are no different. The dedicated professionals in DOD and our partners at the Department of Energy are actively managing these programs to reduce risk, accelerate schedules, and seek efficiencies wherever possible.

We recognize that this is a 20-year nuclear modernization journey we are embarked upon—but perhaps the biggest driver of risk is that we started that journey 15 years too late.

I want to thank this Subcommittee for its longstanding, bipartisan support to our nuclear deterrent mission and the men and women in uniform who are its backbone. I look forward to your questions.

[The prepared statement of Secretary Lord follows:]

PREPARED STATEMENT BY SECRETARY ELLEN M. LORD

Chairwoman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee, thank you for the opportunity to testify today on U.S. Nuclear Weapons Policy, Programs, and Strategy and the fiscal year 2020 Budget Request. I am pleased to join Deputy Under Secretary of Defense for Policy David

Trachtenberg, General Timothy Ray, and Vice Admiral Johnny Wolfe to discuss the Department of Defense's (DOD) highest priority: ensuring that the United States has a safe, secure, reliable, and credible nuclear deterrent now and in the future.

ROLE OF ACQUISITION AND SUSTAINMENT IN DOD'S NUCLEAR ENTERPRISE

I am here today representing the entire DOD Acquisition and Sustainment (A&S) team of thousands of dedicated military, civilian, and contractor professionals who execute the A&S mission every day. As Under Secretary, I am responsible for leadingthe Department's efforts to both sustain and modernize the nation's nuclear weapon delivery systems and related nuclear command, control, and communications (NC3) systems.

To enable these efforts, I chair the Nuclear Weapons Council (NWC) and the Defense Acquisition Board, co-chair the Council on Oversight of the National Leadership Command, Control, and Communications System (CONLC3S), and have been designated DOD's NC3 Enterprise Capability Portfolio Manager. I also serve as the Defense Acquisition Executive and the Milestone Decision Authority (MDA) for all of the major nuclear modernization acquisition programs. In addition, A&S has three Assistant Secretaries focused on Acquisition, Sustainment, and Nuclear, Chemical, and Biological Defense Programs. These and other roles and responsibilities of the Under Secretary for A&S put our organization at the center of a complex and integrated set of programs that must be executed successfully to ensure the long-term credibility of our nuclear deterrent.

2018 NUCLEAR POSTURE REVIEW AND TODAY'S NUCLEAR THREAT ENVIRONMENT

For more than 70 years, U.S. nuclear forces have deterred our adversaries, assured our allies, and helped prevent competition among the Great Powers from escalating into large-scale conflict. For much of that history, this mission has been underpinned by the strategic nuclear triad consisting of ground-based intercontinental ballistic missiles (ICBMs), ballistic missile submarines (SSBNs) armed with submarine-launched ballistic missiles (SLBMs), and nuclear-capable bombers. For decades, Republican and Democratic administrations alike have recognized the critical importance of the nuclear triad for keeping the peace.

The 2018 Nuclear Posture Review (NPR) reaffirmed the need to maintain the triad and other longstanding, bipartisan views on U.S. nuclear posture and took a clear-eyed look at the nuclear threat environment we face today and are likely to face in the future. The 2018 NPR recognized that, while the U.S. has spent the decades since the end of the Cold War both reducing the size of the United States nuclear stockpile and the role of nuclear weapons in our defense strategy, Russia and China have gone—and continue to go—in the other direction. Our potential adversaries are actively increasing the role of nuclear weapons in their strategies and increasing the size and sophistication of their nuclear forces.

For instance, Russian President Vladimir Putin publicly announced last year that Russia is actively developing and testing entirely new nuclear capabilities such as a nuclear-powered, nuclear-armed cruise missile and a nuclear-powered, nuclear-armed transoceanic underwater vehicle. Russia also is modernizing and expanding its arsenal of approximately 2,000 non-strategic nuclear weapons, including nuclear torpedoes, nuclear air and missile defense interceptors, nuclear depth charges, nuclear landmines, and nuclear artillery shells—more than a dozen types. Russia's public statements and nuclear threats, its deployment of systems in direct violation of the Intermediate-Range Nuclear Forces Treaty, its well-documented and well-rehearsed military doctrine to use nuclear weapons to "de-escalate" a conventional conflict, and its military resourcing decisions make clear that Russian leaders have not followed the United States' post-Cold War lead with respect to nuclear weapons.

China also continues to expand and diversify its nuclear forces. China is modernizing its full array of nuclear missile forces, is deploying sea-based weapons, and has announced their intent to form a nuclear triad by developing a nuclear-capable, next-generation bomber. North Korea's nuclear capabilities also threaten our Homeland and our allies and add to an already complex strategic picture.

As outlined in the NPR and National Defense Strategy, we must now face the reality of growing nuclear threats coupled with the reemergence of Great Power competition as a driving force in world affairs. After 25 years of primarily drawing down and sustaining the nuclear forces we built during the Cold War, repeated decisions to defer recapitalization of our nuclear forces have caught up to us. Now, we must concurrently acquire and field modern systems in each leg of the strategic nuclear triad—and in our non-strategic nuclear forces—while also sustaining our aging legacy systems until modernized systems are available. We must also reinvigorate our science, technology, and innovation base to ensure that the investments we are

making in our forces lead to the greater flexibility, adaptability, and resiliency called for by the NPR.

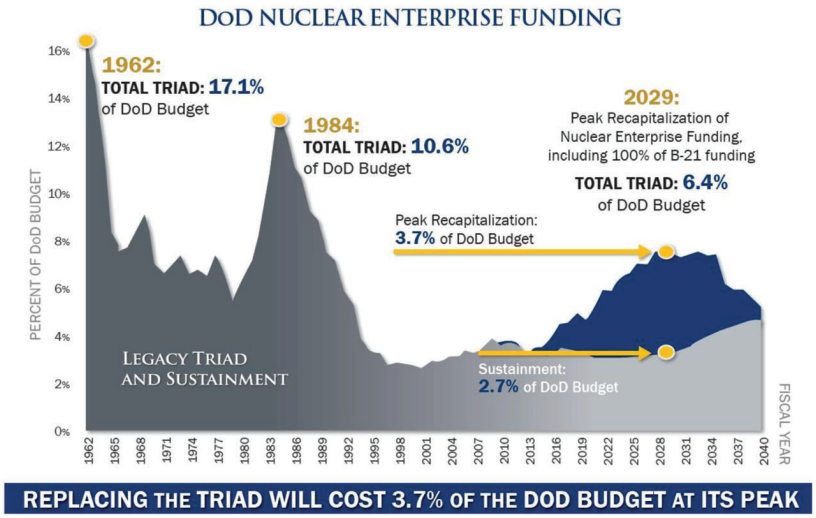
Although still militarily effective today, the U.S. nuclear deterrent remains dependent on nuclear delivery and NC3 systems that were mostly fielded in the 1980s or earlier. Through the Services, DOD is sustaining these legacy nuclear forces until they can be replaced by modern systems. While these sustainment efforts have allowed us to defer investments for many years, we have reached a point where delay is no longer an option. Nearly all of the systems that comprise the current force are well beyond their originally designed service lives and will reach the end of their sustainability in the 2025 to 2035 timeframe. The United States must make a choice: either we continue to invest in modernizing and replacing these systems or we accept the loss of our ability to deter the most severe threats to our nation and our allies and partners.

SUMMARY OF FISCAL YEAR 2020 BUDGET REQUEST FOR NUCLEAR FORCES

The fiscal year 2020 budget request for DOD nuclear forces is consistent with this urgency and is designed to address the risks we face across our nuclear enterprise. It funds the sustainment of our legacy forces and provides the necessary funding to continue modernizing them. In total, the fiscal year 2020 budget request includes $24.9 billion for nuclear forces, or 3.5 percent of DOD's budget. This includes $8.4 billion for recapitalization and modernization and $16.5 billion for operations and sustainment.

Because nuclear deterrence is DOD's number one priority mission, nuclear modernization programs are our highest investment priorities. As these programs mature in the coming decade, the funding they require will increase—the cost to recapitalize strategic delivery systems and NC3 is expected to peak at approximately 3.7 percent of the annual DOD budget in 2029 before decreasing again. When added to the relatively flat sustainment expenses, the total projected cost of sustaining and modernizing our nuclear forces will peak at approximately 6.4 percent of the DOD budget in the late-2020s. DOD is mindful of the sustained financial commitment ahead of us and gratefully recognizes the ongoing support Congress and the American people provide for this most important mission.

The cost of this effort is significant but manageable. As seen in the figure below, from a historical perspective, it is less expensive in relative terms than previous nuclear recapitalization programs. Comparatively, previous rounds of nuclear modernization during the Cold War cost the nation 10.6 percent of DOD's annual budget in the 1980s, and 17.1 percent in the 1960s. Measured against the catastrophic consequences of a major conflict or nuclear war, the cost of nuclear modernization is one we can afford to bear. As former Secretary of Defense Mattis said, "America can afford survival."



Ballistic Missile Submarine Force

The sea-based leg of our nuclear triad consists of 14 *Ohio*-class SSBNs armed with Trident II (D5) SLBMs. Originally designed for a 30-year service life, our *Ohio*-class submarines have already undergone a service life extension to prolong their lifespan to 42 years. The Navy will continue to operate and sustain the fleet out to 2040, but further service life extensions of the *Ohio*-class are not possible. In addition to hull fatigue and nuclear reactor life limitations, in the coming decades advances in our adversaries' anti-submarine warfare capabilities require us to develop and field a modern submarine fleet.

To maintain the effectiveness of the submarine force, the Navy is developing the *Columbia*-class SSBN—a next-generation strategic deterrent platform expected to serve until 2084. *Columbia* will take advantage of new technologies, such as a life-of-ship reactor core. Without the need to ever refuel, these ships will need less time in overhaul and therefore enable the Navy to meet the same deterrence requirements while reducing the fleet size from 14 to 12. This alone will lead to many billions of dollars in acquisition and operating cost savings. Additional improvements will ensure that *Columbia* remains survivable in future threat environments, while design flexibility will allow for future upgrades. The *Columbia* program is currently in the engineering and manufacturing development (EMD) phase, and advanced procurement began in fiscal year 2018. Production of the lead ship of the class is expected to begin in the first quarter of fiscal year 2021. The fiscal year 2020 budget request for *Columbia* totals $2.2 billion.

The Navy is extending the life of the Trident II (D5) Strategic Weapons System (SWS) to match the *Ohio*-class submarine service life and to serve as the initial SLBM for the *Columbia*-class SSBN. This is being accomplished through an update to all SWS subsystems: launcher, navigation, fire control, guidance, missile, and reentry. Two major components of this effort are the D5 Life Extension (D5LE) missile and Shipboard System Integration (SSI) Program. The Navy deployed 24 life-extended (D5LE) missiles in fiscal year 2018 and remains on track to complete deployment by fiscal year 2024. The SSI program refreshes shipboard electronics hardware and upgrades software to enable extended service life, efficient and affordable maintenance and continues to provide the highest level of nuclear weapons safety. The Navy completed 16 installations in fiscal year 2018—7 more are scheduled to be completed this year.

ICBM Force

For the ground-based leg of the triad, the Air Force is concurrently sustaining 400 deployed Minuteman III (MM III) ICBMs and developing their replacements, the Ground Based Strategic Deterrent (GBSD) weapon system. The MM III has been in service since 1970 and has been life extended several times. When it is finally retired, after 2030, it will be the longest serving ICBM in history. For sixty years, MM III will have played a central role in our nuclear triad by providing a highly responsive capability that complicates adversary attack planning and decision making. However, U.S. Strategic Command has noted that as it reaches its end of life, MM III will face a more challenging threat environment that will make it increasingly difficult for the missile system to effectively hold targets at risk. MM III will also contend with attrition issues due to required testing and the aging and obsolescence of key missile components.

GBSD addresses the problems of MM III aging, attrition, and declining capability. The GBSD program is a comprehensive effort to replace the missile system, weapon system command and control, and ground systems—as well as convert, modernize, or replace aging MM III infrastructure. Beginning with its initial deployment in 2028, GBSD will provide improved capability versus the legacy MM III, and ensure the ICBM force remains safe, secure, effective, and reliable out to 2075.

The GBSD program is currently in the Technology Maturation and Risk Reduction (TMRR) phase, with two prime contractors competing over the next year to address risk and develop the most cost-effective solution to meeting military requirements. The fiscal year fiscal year 2020 budget request includes $678 million of RDT&E and MILCON funding for the continued development of the GBSD weapon system. By the end of fiscal year 2020, the program plans to complete its TMRR Preliminary Design Review, conduct a Milestone B review, and award the contract for the EMD phase of the program.

Bomber Force

The airborne leg of the triad is currently comprised of B–52H bombers capable of delivering nuclear-armed air-launched cruise missiles (ALCMs) and B–2A bomb-

ers capable of delivering nuclear gravity bombs. To sustain this most visible and flexible leg of the triad and maintain its effectiveness in a threat environment characterized by continuously improving adversary air defenses, the Air Force is carrying out multiple modernization programs to extend the service lives and improve the capabilities of these aircraft. For instance, the B–52 fleet is scheduled to receive new engines as part of the B–52 Commercial Engine Replacement program—this will be the first engine replacement for the B–52 since its introduction in 1962. B–52Hs will also receive an upgraded radar through the Radar Modernization Program and an improved communications and mission management system known as Combat Network Communications Technology (CONECT). CONECT will provide an integrated communication and mission management system with a machine-to-machine interface for weapons targeting and will enable greater weapons carriage flexibility.

Similarly, the B–2A fleet will receive upgrades to multiple systems, including the Defensive Management System (to ensure its ability to operate in highly contested environments) and its Stores Management Operational Flight Program software (to enable the aircraft to use advanced digital weapon interfaces and allow carriage of the B61–12 nuclear gravity bomb).

To supplement—and eventually replace—the legacy bomber force, DOD is developing a modern, long-range, penetrating bomber. The B–21 Raider will give the Air Force a highly-survivable conventional and nuclear-capable bomber that ensures the ability to penetrate advanced air defense systems in an anti-access/area denial environment well into the future. The Air Force plans to acquire a minimum of 100 B–21s, with the first expected to enter service in the mid-2020s. B–21 is currently in the EMD phase and is transitioning to the development of the first test aircraft. The fiscal year 2020 budget request includes $3 billion for the program.

DOD is also sustaining the nuclear-armed AGM–86B ALCM, first introduced in the early 1980s, until it can be replaced by the Long Range Standoff (LRSO) weapon in the early 2030s. Developed to allow the B–52H to execute its deterrent missions while remaining safely outside the range of adversary air defenses, the ALCM has already undergone multiple service life extensions to keep it operational well beyond its original 10-year design life. As it ages, ALCM will face continuously improving adversary air defenses, as well as challenges to weapon system sustainment caused by out-of-production parts and limited supplies.

LRSO will be a modern, nuclear-armed, air-launched cruise missile capable of penetrating advanced integrated air defenses. Once deployed, LRSO will be carried by both the B–52H and upcoming B–21 bombers. LRSO will be the first simultaneous development of a missile and nuclear warhead in more than 30 years. The LRSO program is currently underway, with two contractors currently performing work under TMRR contracts. The fiscal year 2020 budget request includes $713 million in RDT&E funding to continue development of the missile and fund initial aircraft integration efforts.

Dual-Capable Aircraft

In addition to the three legs of the strategic nuclear triad, the U.S. maintains a force of dual-capable tactical aircraft (DCA), capable of delivering nuclear-gravity bombs. This "non-strategic" nuclear capability enhances deterrence and assurance by providing an ability to forward-deploy U.S. nuclear forces around the globe and demonstrate to allies and adversaries alike that U.S. nuclear forces are prepared to defend U.S. interests and those of our allies and partners. Today, DCA missions are fulfilled by U.S. F–15E aircraft, as well as aircraft provided by several NATO allies, capable of carrying B61–3/4 nuclear gravity bombs.

To replace the F–15E in the DCA role, the U.S. is developing DCA capability for the F–35A—which several of our NATO allies will also fly for the Alliance's nuclear deterrence mission. Fifth-generation F–35 DCA will ensure U.S. and NATO allies retain the ability to penetrate advanced air defenses long into the future. The fiscal year 2020 budget request includes $71.3 million for the F–35A DCA program, with the program planning to complete software development, separation flight testing, and mission system flight testing during the fiscal year.

Similarly, the B61–3/4s carried by our DCA are being modernized to the B61–12, which is scheduled to replace several B61 variants currently in service. The B61–12 Life Extension Program is a joint effort between DOD and the Department of Energy's (DOE) National Nuclear Security Administration (NNSA). In this program, DOD is responsible for development of a guidance-capable tailkit assembly (TKA), aircraft integration, and all-up round integration, while NNSA is responsible for the bomb assembly. Production of the B61–12 TKA is underway and Milestone C was achieved in the first quarter of fiscal year 2019. The fiscal year 2020 budget request includes $108.3 million for the program.

Sea-Launched Cruise Missile

The NPR directed DOD to pursue a modern, nuclear-armed, sea-launched cruise missile (SLCM) to supplement the triad and DCA. The SLCM will provide a regional, non-strategic nuclear capability and will help address both Russia's arms control violations and the major imbalance between Russian and United States non-strategic nuclear capabilities. This program will leverage existing technologies wherever possible to ensure cost effectiveness and will require close coordination with NNSA. The fiscal year 2020 budget request includes $5 million to support an analysis of alternatives for the SLCM.

NC3

Underpinning our entire nuclear deterrent is a complex and resilient NC3 system that must always connect the President to our nuclear forces—even under the most stressful circumstances. The NC3 portfolio comprises a complex architecture of more than 200 systems that allow detection of threats, support decision making, and enable force direction.

Our NC3 system is reliable and effective in supporting today's nuclear deterrence requirements, but it is largely based on 20th Century technologies developed during the Cold War. Modernization is essential to meet modern threats, especially in cyberspace. As DOD's NC3 Capability Portfolio Manager, I work closely with General Hyten, in his capacity as the NC3 Enterprise Lead, to sustain the systems we have while working to develop and field new capabilities across the domains of space, air, and land.

Space-based communications systems play—and will continue to play—a vital role in our NC3 architecture. As with other operating environments, space is increasingly contested and potentially a warfighting domain. Satellite systems operating in the extremely high frequency range, with their ability to communicate through severe nuclear radiation environments, are essential to ensuring resilient communications. The existing Military Strategic and Tactical Relay (Milstar) satellite constellation is long past its planned life. To replace and enhance Milstar capability, there are currently four Advanced Extremely High Frequency (AEHF) satellites in orbit with two additional satellites set to launch by 2020. The fiscal year 2020 budget request includes $149 million in total funding for AEHF. DOD is developing a number of airborne and land-based satellite terminals to take advantage of this new AEHF constellation. For instance, the Family of Beyond Line of Sight Terminals (FAB–T) program is developing force element and command post terminals to provide the resilient communications necessary to link senior national leaders together with each other and with our nuclear forces. The fiscal year 2020 budget request includes $198 million in RDT&E for FAB–T.

In the air domain, the NC3 system currently relies on E–4B and E–6B aircraft to act as alternate command posts and communications relays to help direct our nuclear forces. These aircraft date to the 1970s and 1980s and also require recapitalization. An analysis of alternatives is underway to replace these systems in the early-2030s with newer, more capable, and more sustainable platforms. Additionally, DOD is developing a common Very Low Frequency (VLF) receiver that, when fielded, will replace aging communications systems on our B–52H and B–2A bomber fleets that are challenged by a vanishing vendor base.

Finally, in the land domain, the Air Force's Global Aircrew Strategic Network Terminal (Global ASNT) is being developed to modernize our survivable communications links between the President and certain elements of the nuclear enterprise such as Wing Command Posts, bomber and tanker Mobile Support Teams, and more. Global ASNT will replace the Single-Channel, Anti-Jam, Man-Portable (SCAMP) system, which is based on 1980's technology. The fiscal year 2020 budget request includes $123 million for Global ASNT Increment 2.

NUCLEAR WEAPONS COUNCIL AND ALIGNMENT WITH NNSA

As statutory chair of the Nuclear Weapons Council (NWC), the Under Secretary for A&S has responsibility for not only sustaining and modernizing DOD's nuclear forces but also ensuring those activities are synchronized with their associated nuclear warhead development programs managed by NNSA. The NWC is a joint DOD and DOE/NNSA governance body established to facilitate alignment and coordination—and establish priorities—as the two Departments fulfill their shared responsibility for providing the nation's nuclear deterrent. The NWC continually seeks to guide and balance the many programs needed to maintain our existing nuclear weapons stockpile while also modernizing it. We also review, coordinate, and help set requirements that drive capability and capacity decisions at NNSA, which is

particularly important as NNSA recapitalizes its nuclear weapons production infrastructure—much of which dates to the 1950s and 1960s or earlier.

Regarding capability and capacity, the 2018 NPR re-confirmed, and the NWC supports, NNSA's efforts to establish a responsive enterprise capable of designing and producing the nuclear weapons DOD needs to deter conflict and assure allies. This includes rebuilding NNSA's strategic materials production and processing capabilities for plutonium, uranium, lithium, and tritium—as well as key capabilities for the design and manufacture of strategic radiation hardened microelectronics. While all these materials and capabilities are important to sustaining confidence in the U.S. nuclear stockpile, pit production is a lynchpin. Funding to support implementing the pit production capability needed to meet DOD's requirements lowers risks associated with the aging of plutonium in existing pits and provides the ability to respond to potential challenges, caused by renewed strategic competition, in a timely fashion.

A responsive enterprise also includes ensuring NNSA has a world-class workforce capable of responding to the dynamic and uncertain nuclear future we face. With the reemergence of Great Power competition and increasing nuclear threats, it is important to ensure NNSA's workforce and infrastructure are prepared to provide a credible, flexible, and modern deterrent that can adapt to change and emerging requirements in a timely manner. As the Secretary of Defense's preface to the NPR stated:

> "Recapitalizing the nuclear weapons complex of laboratories and plants is also long past due; it is vital we ensure the capability to design, produce, assess, and maintain these weapons for as long as they are required. Due to consistent underfunding, significant and sustained investments will be required over the coming decade to ensure that National Nuclear Security Administration will be able to deliver the nuclear weapons at the needed rate to support the nuclear deterrent into the 2030s and beyond."

The NWC regularly convenes to synchronize efforts between DOD and NNSA on the vision, strategy, and execution of nuclear programs. Similar to the challenges faced by aging nuclear delivery systems in DOD, the nuclear weapons produced and sustained by NNSA continue to age—with many well-beyond their originally expected service lives. DOD and the NWC support NNSA's nuclear weapon life extension programs (LEP), Stockpile Stewardship Program, and Stockpile Responsiveness Program. Collectively, these programs enable sustainment of the current nuclear weapons stockpile, improved understanding of aging effects in the stockpile, and prepare NNSA's enterprise for the future. For example, NNSA's Stockpile Responsiveness Program is an important means to develop and retain the next generation of world-class scientists and engineers that NNSA needs. It also allows NNSA to explore and mature technologies for potential insertion into future LEPs, exercise critical design and production skills, and develop options for responding to emerging threats.

NPR IMPLEMENTATION AND NUCLEAR ENTERPRISE REVIEW FOLLOW-UP

NPR Implementation

The 2018 NPR confirmed the findings of previous NPRs that the diverse capabilities of the nuclear triad provide the flexibility and resilience needed for deterrence in the most cost-effective manner. To turn the NPR's policy direction into action, A&S has been leading and supporting a variety of implementation activities.

For instance, the NWC took quick action to respond to the NPR's tasking to develop and field a low-yield, submarine-launched ballistic missile, completing necessary reviews and authorizations to enable NNSA to build a first production unit of the W76–2 warhead just 12 months after the NPR was released. The NWC has also reviewed requirements related to the nuclear-armed SLCM directed by the NPR, and NWC stakeholders are engaging to support the analysis of alternatives related to that weapon.

More long-term, the NWC has published a fiscal year 2019–2044 Strategic Plan, which will help guide efforts to align programs related to nuclear delivery platforms, warheads, and infrastructure. More broadly, A&S continues to assess and mitigate risks across the defense industrial base that may impact our nuclear sustainment and modernization efforts—including with respect to large solid rocket motors, radiation hardened microelectronics, and aeroshells.

Nuclear Enterprise Review Follow-up

The 2014 Nuclear Enterprise Review (NER) identified a series of problems across the DOD nuclear enterprise and made hundreds of recommendations to correct

them. As then-Secretary of Defense Hagel stated upon conclusion of the NER in a November 14, 2014, Message to the Force on Our Nuclear Enterprise:

> "Our nuclear deterrent plays a critical role in assuring U.S. national security, and it is DOD's highest priority mission. No other capability we have is more important . . . For too long, we have overlooked career paths, compensation, infrastructure, and small unit leadership that are mission-critical in the nuclear force. That is changing. It will continue to change."

DOD continues to carry this torch and continues to take action to ensure our nuclear enterprise stays healthy. For instance, the Nuclear Deterrent Enterprise Review Group (NDERG), created in 2014 to ensure effective follow-up on the NER's recommendations, recently met and reviewed progress across the enterprise.

As we institutionalize the NDERG for the long-term, A&S is leading the NDERG in a transition from a mission that largely looks back to address and close recommendations from the 2014 NER to instead also look forward to identify and address problems early. While the NDERG has closed many of the recommendations from the 2014 NER, some of the remaining recommendations are enduring, which will require DOD to track their associated metrics indefinitely. The NDERG and its stakeholders are also in the process of developing leading indicators and data analysis tools to ensure risks, issues, and opportunities across the nuclear enterprise are understood and effectively communicated to senior leaders.

CONCLUSION

History has made clear that the U.S. nuclear deterrent is the foundation of U.S. national security and fundamental to international stability. The fiscal year 2020 budget request for DOD's modernization and sustainment programs reflect that importance. Any large collection of complex and integrated programs faces risks, and our nuclear recapitalization and sustainment efforts are no different. The dedicated professionals in A&S, the Services, and NNSA are actively managing these programs to reduce risk, accelerate schedules, and seek efficiencies wherever possible. We recognize that this is a 20-year nuclear modernization journey we are embarked upon—but perhaps the biggest driver of risk is that we started that journey 15 years too late. Delay is no longer an option. I encourage Congress to provide the full amount of the budget request for nuclear programs in both DOD and NNSA.

OPENING STATEMENT OF HON. DAVID J. TRACHTENBERG, DEPUTY UNDER SECRETARY OF DEFENSE FOR POLICY

Secretary TRACHTENBERG. Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Committee, thank you for the opportunity to testify on the President's Fiscal Year 2020 Budget Request for Nuclear Forces.

For decades, the United States has led the world in efforts to reduce the role and number of nuclear weapons. Unfortunately, as described in the 2018 *National Defense Strategy* and *Nuclear Posture Review,* Russia and China have chosen a different path and have increased the role of nuclear weapons in their strategies and actively increased the size and sophistication of their nuclear forces.

For this reason, a robust and modern U.S. nuclear deterrent is necessary to prevent competition from escalating to large-scale conflict.

THE NUCLEAR THREAT

Russia

Russia continues to prioritize modernizing its nuclear forces, including every leg of its strategic triad. According to the Russian Defense Minister, 90 percent of the country's strategic nuclear forces will be upgraded by 2020.

In March 2018, only a month after the United States and Russia reached New START limits on strategic systems, Vladimir Putin

announced that Russia is developing even more new nuclear weapons capabilities. Moreover, Russia is modernizing and expanding an active stockpile of approximately 2,000 nonstrategic nuclear weapons that can be deployed on ships, bombers, tactical aircraft, and with ground forces.

China

China continues its expansive military modernization, including deploying advanced sea-based weapons, developing a new generation of road-mobile missiles, improving its silo-based weapons, testing hypersonic glide vehicles, and developing a nuclear-capable, next-generation bomber.

North Korea

North Korea's nuclear capabilities pose a potential threat to our allies and Homeland.

Although we remain hopeful that negotiations may produce a pathway to peace and denuclearization, we must also remain vigilant and maintain a strong deterrence posture.

POLICY

In light of these threats, the Department's 2018 Nuclear Posture Review prioritizes maintaining a safe, secure, survivable and effective nuclear deterrent as the ultimate foundation of our nation's security. To remain credible, our aging nuclear forces must be modernized—delay is not an option.

The 2018 NPR reaffirmed the conclusions of previous Republican and Democratic administrations that the diverse, complementary capabilities of the nuclear triad ensure no adversary believes it can employ nuclear weapons for any reason, under any circumstances.

Unfortunately, each leg of the triad is now operating far beyond its originally-planned service life. If not recapitalized, these forces will age into obsolescence.

The Department's request to recapitalize or modernize the nuclear enterprise is about 1.2 percent of the total DOD budget request. In addition, the budget request to sustain and operate nuclear forces is about 2.3 percent, for a total of about 3.5 percent of the DOD budget.

DECLARATORY POLICY

Our nuclear declaratory policy remains consistent with long-standing precepts that "the United States would employ nuclear weapons only in extreme circumstances . . . "

The United States has a long-standing policy of constructive ambiguity regarding nuclear employment that has deterred potential adversaries since the advent of the nuclear age. Establishing a policy of "no-first-use" of nuclear weapons would undermine U.S. extended deterrence and damage the health of our alliances because it would call into question the assurance that the United States would come to the defense of allies in extreme circumstances. "No-first-use" could embolden adversaries to test what they might perceive as a weakened U.S. resolve to defend our allies and vital interests with every means at our disposal. It could undermine U.S. nonproliferation objectives if allies and partners felt the need to de-

velop or possess their own nuclear weapons to deter potential adversaries.

ARMS CONTROL

With respect to arms control, as a consequence of Russia's clear violation of the Intermediate-Range Nuclear Forces (INF) Treaty, and consistent with the Sense of Congress expressed in the Fiscal Year 2019 National Defense Authorization Act, the United States suspended its obligations under the Treaty. We. also gave notice of our intent to withdraw from it. Let me be clear: It is Russia that has abandoned the Treaty as a result of its violation, and our Allies fully support these United States actions in response.

Consequently, the United States is moving forward with developing conventionally-armed, ground-launched, intermediate-range missile capabilities. What sort of system we ultimately develop will be driven by our assessment of military requirements and in consultation with Congress and with our allies and partners.

More generally, the United States is committed to arms control efforts that advance U.S., allied, and partner security, are verifiable and enforceable, and include partners that comply responsibly with their obligations. Accordingly, we must take account of the prevailing international security environment, which is more complex and challenging than nearly a decade ago when the New START Treaty was signed.

New technologies, the development by Russia of new strategic weapons systems (several of which would be unconstrained by New START), Russia's significant advantage in non-strategic nuclear weapons, and the expansion by China of its own nuclear capabilities present new challenges for arms control.

CONCLUSION

Chairman Fischer, let me conclude by stating that nuclear deterrence is the bedrock of U.S. national security. Our nuclear deterrent underwrites all U.S. military operations and diplomacy across the globe—it is the backstop and foundation of our national defense. A strong nuclear deterrent also contributes to U.S. nonproliferation goals by eliminating the incentive for allies to have their own nuclear weapons.

I thank the Committee for its previous support and urge continued support for the important nuclear programs and funding contained in the President's fiscal year 2020 budget request.

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

[The prepared statement of Under Secretary Trachtenberg follows:]

PREPARED STATEMENT BY UNDER SECRETARY DAVID J. TRACHTENBERG

Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Committee, thank you for the opportunity to testify on the President's Fiscal Year 2020 Budget Request for nuclear forces and our nuclear posture.

Today, the United States faces an extraordinarily complex and dangerous global security environment, in which the central challenge to our prosperity and security is the reemergence of long-term strategic competition with China and Russia, which seek to overturn the long-standing rules-based international order and change territorial borders.

This is acknowledged in the 2018 National Defense Strategy, which also notes that rogue regimes such as North Korea and Iran are destabilizing regions through their pursuit of nuclear weapons or sponsorship of terrorism.

While we are hopeful for a peaceful denuclearization of the Korean Peninsula, North Korea continues to pose a threat to the United States Homeland, as well as our allies, and Iran seeks to establish itself as the dominant regional power in the Middle East, restrict our access, support proxies, and sow violence throughout the region.

For decades, the United States led the world in efforts to reduce the role and number of nuclear weapons. Successive treaties enabled reductions in accountable strategic U.S. nuclear warheads, first to 6,000, and ultimately to 1,550. Thousands of shorter-range nuclear weapons not covered by any treaty were almost entirely eliminated from the U.S. nuclear arsenal. Overall, the U.S. nuclear weapons stockpile has drawn down by more than 85 percent from its Cold War high.

Unfortunately, Russia and China have chosen a different path and have increased the role of nuclear weapons in their strategies and actively increased the size and sophistication of their nuclear forces.

For this reason, a robust and modern U.S. nuclear deterrent helps ensure the United States competes from a position of strength and can deter nuclear attack and prevent large-scale conventional warfare between nuclear-armed states for the foreseeable future.

THE NUCLEAR THREAT

The 2018 *Nuclear Posture Review* (NPR) reflects DOD's strategic priority to maintain a safe, secure, survivable and effective nuclear deterrent. The NPR examined the challenges posed by Russia, China, North Korea and Iran in order to recommend a nuclear force posture adequate to deter aggression by these and other countries.

Russia

Russia continues to prioritize high levels of defense spending to upgrade its nuclear forces and pursue advanced weapons specifically designed to counter U.S. military capabilities. Russia's nuclear modernization program covers every leg of its strategic triad and includes advanced modern road-mobile and silo-based intercontinental ballistic missiles (ICBMs), new submarine-launched ballistic missiles (SLBMs), and long-range strategic bombers. According to Russia's TASS News Agency, Russian Minister of Defense Sergei Shoigu announced on February 21, 2017 that 90 percent of the country's strategic nuclear forces will be armed with modern weaponry by 2020.

In March 2018, only a month after the United States and Russia reached the limits on strategic systems established under the New START Treaty, President Vladimir Putin announced that Russia is developing even more new nuclear weapons capabilities, which include: 1) an intercontinental-range, nuclear armed hypersonic glide vehicle; 2) a maneuverable, nuclear-armed air-launched ballistic missile; 3) a long-range, nuclear-powered cruise missile; 4) a nuclear-powered, nuclear-armed underwater unmanned vehicle; and 5) a new heavy intercontinental range ballistic missile, called the SARMAT. President Putin, during this same speech, also announced that Russia developed new laser weapons systems "that have been supplied to the troops since last year."

This past February (2019), President Putin declared that Russia had successfully tested nuclear-propulsion engines that would allow the nuclear-tipped cruise missiles and underwater drones to travel for unlimited distances and evade traditional defenses. Some of these weapons would not be subject to the New START Treaty's central limits and verification regime as they exist today.

On top of all of this, Russia is modernizing and expanding an active stockpile of approximately 2,000 nonstrategic nuclear weapons—often referred to as tactical nuclear weapons—that can be deployed on ships, bombers, and tactical aircraft, and with ground forces. None of these are limited by any arms control treaty. In contrast, the United States forward deploys to Europe small number of just one type of nonstrategic nuclear weapon—the B61 nuclear gravity bomb—which is delivered by a dual-capable tactical aircraft. Both the B61 and its delivery aircraft are being modernized, but not increased in number.

Russia's military doctrine emphasizes the coercive nature and military value of nuclear weapons. During its military operation against Crimea, Russia raised the alert level of its nuclear forces and issued veiled nuclear threats to ensure the West did not intervene. Russia has repeatedly brandished its nuclear sword towards our NATO Allies in recent years. In July 2017, Russian President Putin signed a new naval doctrine that stated, "under conditions of escalation of a military conflict,

demonstration of readiness and determination to use force, including the use of non-strategic nuclear weapons, is an effective deterrent factor." More recently, in his annual state-of-the-nation address on February 20, 2019, Putin said that, if Washington deployed intermediate-range missiles in Europe, Moscow would target the countries hosting the United States weapons.

China

China continues its expansive military modernization and is focused on establishing regional dominance and expanding its ability to coerce U.S. allies and partners. Consistent with a military strategy that stresses "optimization of its nuclear force structure," China is modernizing and rapidly expanding its already considerable nuclear forces, with little to no transparency regarding the scope and scale of its nuclear modernization program. China is the only P–5 country that has not announced publicly the size of its nuclear arsenal, and has rebuffed multiple U.S. attempts to engage in a meaningful bilateral dialogue on nuclear posture and risk reduction issues.

China is developing a new generation of mobile missiles, with warheads consisting of multiple independently targetable reentry vehicles (MIRVs) and penetration aids. In particular, China has developed a new road-mobile strategic ICBM and its most advanced ballistic missile submarine armed with new submarine-launched ballistic missiles (SLBM).

China has also announced development of a new nuclear-capable strategic bomber, indicating China's intent to develop a nuclear triad and has deployed a nuclear-capable precision guided DF–26 intermediate-range ballistic missile capable of attacking land and naval targets. China also tested a hypersonic glide vehicle in 2014.

China's nuclear forces include a mix of strategic-range systems capable of striking the Homeland as well as theater-range forces capable of threatening allies, United States bases, and forces in the region. As China's capabilities both diversify and improve, there is risk China may perceive that these weapons provide it with coercive options in a crisis or conflict. China's modernization is troubling, and the lack of transparency combined with growing Chinese assertiveness in the region is one of the most serious risks to regional stability in the Indo-Pacific.

North Korea

North Korea's nuclear capabilities pose a potential threat to our allies and the United States Homeland and add to an already complex strategic picture. North Korea has conducted six increasingly sophisticated nuclear tests and three ICBM flight tests that demonstrate its ability to strike the United States Homeland. Although we remain hopeful that negotiations may produce a pathway to peace and denuclearization, we must also remain vigilant and maintain a strong deterrence posture.

POLICY

The 2018 Nuclear Posture Review reflects the Department of Defense's strategic priority to maintain a safe, secure, survivable and effective nuclear deterrent. Nuclear forces are the ultimate foundation of our nation's security. Our deterrent forces must be modernized to remain credible—delay is not an option.

The highest U.S. nuclear policy and strategy priority are to deter potential adversaries from nuclear attack of any scale against the United States or its allies and partners. However, deterring nuclear attack is not the sole purpose of nuclear weapons. Given the diverse threats and profound uncertainties of the current and future threat environment, U.S. nuclear forces play the following critical roles in U.S. national security strategy:

- Deterrence of nuclear and non-nuclear attack;
- Assurance of allies and partners;
- Achievement of U.S. objectives if deterrence fails; and
- Capacity to hedge against an uncertain future.

Effective U.S. deterrence of nuclear attack and non-nuclear strategic attack requires ensuring that potential adversaries do not miscalculate regarding the consequences of nuclear first use, either regionally or against the United States itself. They must understand that the costs far outweigh any perceived benefits from non-nuclear aggression or limited nuclear escalation.

Declaratory Policy

U.S. nuclear declaratory policy is consistent with longstanding precepts that "the United States would employ nuclear weapons only in extreme circumstance to defend the vital interests of the United States, allies and partners." The 2018 Nuclear Posture Review (NPR) clarifies that the "extreme circumstances" that may lead the

United States to consider nuclear use, include, but are not limited to: significant non-nuclear strategic attacks on U.S., allied, or partner civilian population or infrastructure; and significant non-nuclear strategic attacks on U.S. or allied nuclear forces, their command and control, or warning and attack assessment capabilities. This clarification is intended to reduce the possibility of adversary miscalculation.

The 2018 NPR further states: "The United States will not use or threaten to use nuclear weapons against non-nuclear weapons states that are party to the NPT and in compliance with their nuclear non-proliferation obligations."

No-First Use

The United States has a long-standing policy of constructive ambiguity regarding U.S. nuclear employment that has deterred potential adversaries from nuclear coercion or aggression since the advent of the nuclear age. A policy of "no-first-use" would undermine U.S. extended deterrence and damage the health of our alliances because it would call into question the assurance that the United States would come to the defense of allies in extreme circumstances. "No-first-use" would likely embolden adversaries to test what they might perceive as weakened U.S. resolve to defend our allies and vital interests with every means at our disposal. Finally, a no-first use policy could undermine U.S. nonproliferation objectives if allies and partners felt the need to develop or possess their own nuclear weapons to deter potential adversaries.

POSTURE

The policies set forth in the 2018 NPR reaffirmed the conclusions of previous Republican and Democratic administrations that the diverse capabilities of the nuclear triad provide the flexibility and resilience needed for deterrence in the most cost-effective manner. Each triad leg is essential, complementary, and critical to ensuring no adversary believes it can successfully employ nuclear weapons for any reason, under any circumstances.

Unfortunately, each leg of the triad is now operating far beyond its originally-planned service life. Over the past 25 years, the United States made only modest investments in basic nuclear sustainment, life-extension, and operations. Most of the nation's nuclear delivery systems, built in the 1980s and prior, will reach their end-of-service life in the 2025–2035 timeframe and cannot be sustained further. If not recapitalized, these forces will age into obsolescence. Our choice is not between replacing our Cold War systems or keeping them, but between replacing them or losing them altogether. Similarly, the DOE/NNSA infrastructure has long been underfunded and overdue for the upgrades necessary to create a modern, efficient nuclear complex to meet the nation's national security missions. DOD relies on the continued investment in recapitalization of DOE/NNSA's laboratories, production and test facilities.

Consequently, we must not delay the recapitalization of the triad and our nuclear command, control, and communications (NC3) system initiated by the previous Administration. The fiscal year 2020 Budget Request funds all critical Department of Defense (DOD) modernization requirements, helping to ensure that modern replacements will be available before the Nation's legacy systems reach the end of their extended service lives. The fiscal year 2020 Budget Request for nuclear forces is $24.9 billion or roughly 3.5 percent of the DOD budget. This includes $8.4 billion for recapitalization programs (including the B–21, ground-based strategic deterrent (GBSD) ICBM, the long-range standoff (LRSO) cruise missile, and the *Columbia*-class nuclear ballistic missile submarine (SSBN)) and $16.5 billion to sustain and operate our nuclear forces.

DOD's fiscal year 2020 request to recapitalize the nuclear enterprise is about 1.2 percent of the total DOD budget request. Over the long term, nuclear force modernization will cost approximately $320 billion over 23 years. Recent estimates, such as those from the 2018 Nuclear Posture Review, project that the total cost to sustain and modernize U.S. nuclear forces will account for about 6.4 percent of the Defense budget at its highest level of funding in 2029, returning to about 3 percent for sustainment upon completion of modernization. The January 2019 Congressional Budget Office report supports DOD's estimates concluding that the estimated cost of nuclear forces "is projected to rise from about 5 percent in 2019 to about 7 percent in 2028."

Finally, in support of modernizing these strategic systems, the bipartisan National Defense Strategy Commission concluded in its 2018 Providing for the Common Defense report that "Given the criticality of effective U.S. nuclear deterrence to the assurance of allies, and, most importantly, the safety of the American people, there is no doubt that these programs are both necessary and affordable."

Supplemental Capabilities

The 2018 Nuclear Posture Review concluded that the United States must supplement its existing stockpile with two modest capabilities to ensure Russia, China, and others do not perceive a gap in our regional deterrence posture. This is intended to discourage adversaries from limited nuclear attacks—strengthening deterrence and helping prevent conflict in the first place. By modifying a small number of existing SLBM warheads to provide a low-yield option and restoring a modern nuclear sea-launched cruise missile to the force, the U.S. will have credible response options to nuclear attacks of any magnitude. The low-yield SLBM warhead and nuclear-armed sea-launched cruise missile (SLCM) are measured responses to close troubling gaps in regional deterrence that have emerged in recent years. In addition, redeploying a SLCM addresses the enormous disparity in nonstrategic nuclear forces, without attempting to match Russia system for system. Both systems complement existing capabilities in the triad by providing assured, tailored options in the face of increasingly advanced air and missile defenses. In addition, the unique attributes of a nuclear SLCM may incentivize Russia to accept constraints on its nonstrategic nuclear capabilities.

Moreover, the supplemental capabilities do not require nuclear testing or developing new nuclear weapons. They do not violate any arms control treaties or other international obligations, and they do not lower the threshold for nuclear use. They are intended to raise Russia's threshold (or likelihood) for employing nuclear weapons by convincing Russia that it would gain no advantage in using low-yield nuclear weapons.

NATO, JAPAN AND REPUBLIC OF KOREA ENGAGEMENTS

The United States continues to extend nuclear deterrence commitments to assure allies in Europe and the Asia-Pacific region. Based on our long-shared common values and interests, this commitment helps address allied concerns with regional threats, such as Russia's nuclear and non-nuclear capabilities and aggressive rhetoric; China's assertiveness; and North Korea's nuclear and non-nuclear threats.

The United States exhibits its commitment to extended deterrence in two ways: first, it maintains the capabilities necessary to deter and, if necessary, to respond decisively across the spectrum of potential nuclear and non-nuclear scenarios that could affect our allies and partners; and second it sustains regular allied dialogues to facilitate understanding of each other's threat perceptions and to determine how best to demonstrate our collective capabilities and resolve.

Within NATO, we continue to participate in the Nuclear Planning Group and the High-Level Group, which our Assistant Secretary for Strategy, Plans and Capabilities chairs. As NATO Allies reiterated in Brussels last July, as long as nuclear weapons exist, NATO will remain a nuclear alliance. The Alliance's deterrence posture continues to depend upon both U.S. strategic nuclear forces and forward deployed nuclear gravity bombs with U.S. and allied dual-capable aircraft.

In the Indo-Pacific region, the United States maintains formal extended deterrence dialogues with Japan—the United States-Japan Extended Deterrence Dialogue (EDD)—and with the Republic of Korea (ROK) (e.g. United States ROK Deterrence Strategy Committee (DSC)). Through regular bilateral meetings, allied site-visits to locations of U.S. strategic capabilities, and table-top exercises, both the EDD and DSC have helped us to develop a common Alliance understanding of deterrence principles, and to test application of those principles to scenarios we may face in the Indo-Pacific region. These dialogues contribute to alliance cohesion and effectiveness and help affirm to our allies that they should not doubt our extended deterrence commitments or our ability and willingness to fulfill them.

INTERMEDIATE-RANGE NUCLEAR FORCES (INF) TREATY DEVELOPMENTS

On February 2, 2019, after years of Russian cheating on its Intermediate-Range Nuclear Forces (INF) Treaty obligations, and after exhausting every reasonable diplomatic, economic, and military effort to persuade Russia to comply with its treaty obligations, the United States suspended its obligations under the INF Treaty and gave notice of the U.S. intent to withdraw from the Treaty. As NATO Secretary General Jens Stoltenberg asserted, "Russia is in material breach of the INF Treaty and must use the next six months to return to full and verifiable compliance or bear sole responsibility for its demise." Allies fully support the U.S. decision to suspend its obligations under INF and the U.S. intent to withdraw from the Treaty.

To be clear, what prompted the U.S. suspension was not a technical violation or an interpretive difference, but Russia's development, testing, and fielding of a ground-launched cruise missile system specifically banned by the INF Treaty. For those concerned that our suspension will cause Russia to develop these systems fur-

ther, I can only say Russia's legal obligations under the INF Treaty proved no barrier to its pursuit and fielding of a banned system in the first place. To assert that Russia is reacting to our suspension is to ignore the reality of Russia's conduct under the INF Treaty.

As the President stated in February 2019, the United States is moving forward with developing ground-launched missile capabilities. This is a direct consequence of Russia's violation of the INF Treaty. Now that our Treaty obligations are suspended, we are beginning work that if pursued to completion would be inconsistent with the Treaty. The United States is developing systems that are conventional in nature, and this work is designed to be reversible should Russia return to compliance by verifiably destroying its INF Treaty-violating missiles, launchers, and associated equipment. This development will include flight tests, although we do not anticipate progressing to this stage before the United States' withdrawal from the Treaty takes effect on August 2. What sort of system we ultimately develop will be driven by our assessment of military requirements and in consultation with Congress and with our allies and partners.

THE NEW START TREATY

As stated in the 2018 Nuclear Posture Review, the United States is committed to arms control efforts that advance U.S., allied, and partner security; are verifiable and enforceable; and include partners that comply responsibly with their obligations. As both the 2018 NPR and the 2018 NATO Brussels Summit Communique noted, we must take account of the prevailing international security environment. In the arms control context, this means Russia and, increasingly, China.

While we assess Russia to be in compliance with the central limits of New START, the history of Russia's arms control behavior is sobering. I will not recount here Russia's many violations of its treaty obligations and other political commitments. It is instructive, however, that, only a month after the United States and Russia reached the central limits on strategic nuclear systems prescribed by the New START Treaty, President Putin—with great fanfare—announced Russia was developing new long-range nuclear delivery systems, some of which would not be limited by the New START Treaty. This is troubling given that Russia is also modernizing its growing and increasingly capable arsenal of shorter-range, nonstrategic nuclear weapons, which are also not covered by New START. Members of this Committee will remember that Russia's nonstrategic arsenal was of great concern when the New START Treaty was ratified, and it remains a concern today.

That said, the Department supports pursuing a prudent arms control agenda, which could include extending the New START Treaty, provided the outcomes improve the security of the United States and our allies and partners, and effectively help manage strategic competition among states.

CONCLUSION

Mr. Chairman, let me conclude by stating that nuclear deterrence is the bedrock of U.S. national security. The U.S. nuclear deterrent must dissuade any adversary from mistakenly believing it can benefit from using nuclear weapons—even in a limited way—against the United States or its allies and partners.

Our nuclear deterrent underwrites all U.S. military operations and diplomacy across the globe—it is the backstop and foundation of our national defense. A strong nuclear deterrent also contributes to U.S. nonproliferation goals by eliminating the incentive for allies to have their own nuclear weapons.

In an increasingly complex and threatening security environment, we must make the investments needed to address the on-going atrophying of our nuclear capabilities and ensure we have the capabilities, now and in the future, to deter and defend against attacks on our Homeland, U.S. forces deployed abroad, and allies and partners.

I urge the Committee to support the important nuclear programs and funding contained in the President's fiscal year 2020 Budget Request.

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

OPENING STATEMENT GENERAL TIMOTHY M. RAY, USAF, COMMANDER, AIR FORCE GLOBAL STRIKE COMMAND AND COMMANDER, AIR FORCE STRATEGIC-AIR, UNITED STATES STRATEGIC COMMAND″

General RAY. Good morning Chairwoman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee;

thank you for inviting me to appear before you today to represent the men and women of Air Force Global Strike Command.

After three years in Europe as the Commander of Third Air Force and the Deputy Commander of United States European Command, I had a front row seat in the great power competition unfolding around us in Europe, the Mediterranean, North Africa, and the Middle East.

It became abundantly clear we must bring about a significant transition in our capabilities and our thinking as we turn our attention from seventeen years of conflict in the Middle East and counterterrorism operations to potential conflict with global competitors, with significantly more capable technology and growing strategic capabilities. Air Force Global Strike Command has a central role in delivering what the nation needs most: a safe, secure, reliable, effective, and *affordable* long range. Precision strike force—both nuclear and conventional.

Safety, security, reliability and the American Public's trust in the nuclear force is non-negotiable and must remain the bedrock of how we operate. What must change is the manner in which we train, prepare, sustain, and modernize. The Air Force nuclear arsenal can no longer be a collection of expensive programs; it must be grounded in relevant operational concepts of operations, affordable acquisition programs, improved and affordable sustainment, and robust training underwritten by effective nuclear command and control.

Transitions are difficult, but we have a unique opportunity to partner with Congress, the combatant commanders, and the Office of the Secretary of Defense to press forward with affordable, cost effective, and innovative solutions to ensure our intercontinental ballistic missile and bomber forces are ready for the challenges of the 21st Century.

Part of presenting the long-range precision strike force our nations needs is fostering the right culture and climate for the best of America's sons and daughters. As we modernize, we are putting equal attention on developing the right leaders and cultivating dignity, respect, diversity, and inclusion.

We are working to retain talent and harness the innovative mindset all airmen share.

Lastly, I want to thank you for on-time 2019 funding; I cannot articulate enough how critical on-time funding is to restoring readiness; predictable, reliable, and flexible budgets, with the right authorities to drive competition are elemental to our future success.

Chairwoman Fischer and distinguished Subcommittee Members, I want to thank you for your dedication to our great nation and the opportunity to appear before the committee, I am looking forward to your questions.

[The prepared statement of General Timothy M. Ray follows:]

PREPARED STATEMENT BY GENERAL TIMOTHY M. RAY

INTRODUCTION

For the last three years in Europe as the Commander, Third Air Force and the Deputy Commander, United States European Command, I had a front row seat in the great power competition unfolding in Europe, the Mediterranean, North Africa, and the Middle East. It is abundantly clear we must bring about a significant tran-

sition in our capabilities and our thinking as we turn our attention from seventeen years of conflict in the Middle East and counterterrorism operations to potential conflict with global competitors with more capable technology and growing strategic capabilities. Air Force Global Strike Command (AFGSC) has a central role in delivering what the nation needs most: a safe, secure, reliable, effective, and affordable long-range precision strike force—nuclear and conventional. This is a dialogue of blending what must and must not change. Safety, security, reliability and the American Public's trust in the nuclear force is nonnegotiable and must remain the bedrock of how we operate. What must change is the manner in which we train, prepare, sustain, and modernize. The Air Force nuclear arsenal can no longer be a collection of expensive programs; it must be grounded in relevant operational concepts of operations, affordable acquisition programs, improved and affordable sustainment, and robust training underwritten by effective nuclear command and control.

Transitions are the most difficult undertakings, but we have a unique opportunity to partner with Congress, the combatant commanders, and the Office of the Secretary of Defense to press forward with affordable, cost effective, and innovative solutions to ensure our Intercontinental Ballistic Missile (ICBM) and bomber forces are ready for the challenges of the 21st Century.

Thank you for the on-time 2019 funding; predictable, reliable, and flexible budgets, coupled with the right authorities to drive competition are elemental to our future success.

CONTEXT

I am personally committed to the Secretary of the Air Force and Chief of Staff of the Air Force and their three lines of effort: the Air Force We Need, building a more lethal force, and fielding tomorrow's Air Force faster and smarter. AFGSC is the warfighting command responsible for simultaneously executing two legs of the nuclear triad, overseeing the nation's Nuclear Command, Control, and Communications (NC3) capabilities and accomplishing long-range precision strike missions across the globe. Previous commanders testified from the perspective of a traditional Organize, Train, and Equip (OT&E) major command. Today, the AFGSC Commander is the Air Component Commander to United States Strategic Command (USSTRATCOM) which is a very different role. This provides a different perspective into how AFGSC forces are employed to fight. From this seat, it is possible to make decisions based on war-time operational impact rather than simply providing the forces. As modernization and sustainment programs progress, there will be ongoing analysis that leads us to risk-informed and balanced decisions throughout all phases of the acquisition process. An iterative, informed, and agile process is a key enabler for ensuring our deterrent and warfighting capabilities—legacy as well as follow-on—are firmly focused on meeting the anticipated challenges of the decades ahead. The pace of developing emerging technologies has changed drastically. Chasing the most exquisite technical solutions is too expensive and takes too much time. The pursuit should be the right strategies, "good enough" technology on-time, stable requirements, and owning the tech-baseline to support future development.

There have already been success stories as a result of these practices. For example, the Air Force selected the UH–1N replacement helicopter for $1.7 billion less than the service cost estimate. The decision to compete this contract was absolutely the right call and the competition it drove between the bidders resulted in lower prices for the Air Force. In terms of operations and sustainment, the Air Force will own the data rights and maintenance, which makes this option much more affordable in the long-term. We are particularly pleased with the unprecedented results digital based modeling and engineering has yielded in one of our most critical programs, Ground Based Strategic Deterrent (GBSD). This process is reducing risk at a faster rate and the certainty gained in the risk reduction will have a positive impact on the bottom line further down the road.

Affordability is imperative to maintain relevancy and the command is committed to seeking innovative ways to bring the cost of modernization down. There is potential for billions of dollars in savings in modernization and sustainment programs, but the Air Force must be deliberate when developing the requirements and making subsequent investment decisions. Building this trust with the nation's leaders is critical to fostering productive teamwork. Make no mistake, the nation's nuclear weapon systems and legacy bombers are old and are no longer aging gracefully. The burden of cost to sustain and maintain our legacy systems will continue to increase, and there is no long-term affordable solution that does not include replacing those systems and components affected by age-out and technological obsolescence. The

command's promise is to deliver those replacements as efficiently and affordably as possible.

AIR FORCE GLOBAL STRIKE COMMAND PRIORITIES

Componency to USSTRATCOM

In 2018, my predecessor updated this committee on the reorganization effort aligning AFGSC as the single, full-time air component to USSTRATCOM and streamlined the lines of authority for our bomber and ICBM forces. The commander of AFGSC is now the commander of Air Forces Strategic—Air (AFSTRAT–Air) and the Joint Forces Air Component Commander (JFACC) as designated by the Commander of USSTRATCOM (CDRUSSTRATCOM).

Under the previous construct, responsibilities for the air, space, and naval strategic missions were spread across several lines of authority. Now, the Joint-Global Strike Operations Center (J–GSOC) handles the day-to-day responsibilities of the strategic nuclear mission for USSTRATCOM's air component. The J–GSOC consists of the Joint Air Operations Center (JAOC) and Joint Nuclear Operations Center (JNOC). The JAOC handles the conventional portion of the command's mission while the JNOC focuses on the nuclear portion. The National Airborne Operations Center (NAOC) is also aligned under the J–GSOC. When combined with AFGSC's existing responsibility for the E–4B aircraft, AFSTRAT, through USSTRATCOM, is better postured to present the NAOC mission to support the President and Secretary of Defense. The Standoff Munitions Application Center (SMAC) provides expertise in planning and targeting of Air Force standoff weapons. The Cruise Missile Support Activity Atlantic (CMSALANT) and Pacific (CMSAPAC), aligned under the Navy's Fleet Forces day-to-day, support the J–GSOC during complex, joint targeting operations required by any combatant commander.

As CDRUSSTRATCOM's designated JFACC in addition to the Commander, AFSTRAT–Air, this dual-hatted position provides the ability to monitor, control, and direct all the air assets assigned or attached to USSTRATCOM anywhere in the world. These include the Air Force bomber, tanker, intelligence, surveillance, and reconnaissance, and ICBM forces as well as the USSTRATCOM Airborne Command Post (ABNCP) and Take Charge and Move Out (TACAMO) missions. The JFACC also supplies a common operating picture to CDRUSSTRATCOM that provides status and locations of all air assets. The success of this restructuring has been proven during global exercises for two years now, and this is a much better operations-focused construct than the previous organization.

This is relevant because the authorities granted to these positions enable an assessment of how best to accomplish the warfighting and OT&E missions through risk-informed and balanced decision making. As the warfighter, executing as the Air Component Commander, it has revealed things that have been invalid for a long time and provided the opportunity to put operating concepts in place that enhance lethality and improve relevancy. How we prioritize sustainment and modernization, Forward Locate Aircraft Generate (FLAG) operations, and requirements validation on command and control parameters are all examples of how this position is able to optimize and prioritize. There is an opportunity to make deliberate, risk-informed decisions to bring costs down based on operational impact.

Security

Security is one of the most fundamental competencies the nation demands of the military. The right questions about security need to be asked and innovative teams should determine how best to secure our installations and assets. This is more than Security Forces Defenders at the gate; this is preparing for threats from unmanned aerial systems, cyber, and other potential threats across multiple domains. The United States no longer enjoys the sanctuary it used to and the warfighting domains continue to expand, challenging the nation's collective understanding and application of warfare, ideas of national defense, and theories of victory. In 2017, the Secretary of the Air Force directed AFGSC to lead a Security Forces Review Team to provide Headquarters Air Force actionable items to improve the health and lethality of our Defender corps. While these action items are refined and addressed, progress is being made to shape the future of Security Forces as an elite, integrated team prepared to face the threats they encounter in and around our installations and missile fields.

The Ground Combat Training Squadron on Camp Guernsey (Frontier Defender) was realigned under the 90th Missile Wing at F.E. Warren AFB, Wyoming, on 1 June 2018. The regional training center operates on a Wyoming Air National Guard camp, where joint cooperation enables the training of our elite Defenders charged with protecting our nation's nuclear arsenal. The 60-member staff provides the only

training in the Air Force for Defenders assigned to nuclear security operations. Additionally, Frontier Defender continues to refine and execute the first-ever Security Forces weapons school, the 62-day Security Forces Weapons and Tactics Course. The objective of the course is to train Defenders skilled in resource analysis and the application of force protection concepts, through the lens of USAF Weapons School graduates, to ultimately provide proactive protection of our nuclear assets.

AFGSC is also collaborating with the United States Air Force Academy's Research Department. The intent is to pioneer integration of existing communications equipment employed by AFGSC's Defenders in the missile fields with commercial drone capabilities. The ability to see and sense potential threats using small, unmanned aerial vehicles and provide that information quickly and securely to ground forces will substantially increase our capability to defend the nation's nuclear assets and installations. Over the past year, AFGSC has made significant strides in an emerging security initiative to counter-unmanned aircraft systems (C–UAS) detected near important resources. Fielded capabilities include handheld and portable systems. Fixed-site and mobile vehicle-borne systems are currently being installed. These new capabilities will provide a necessary added layer of security to ensure continued weapons systems safety and operability. Additionally, the command has initiated blue-unmanned aircraft systems (B–UAS), a friendly forces pilot program, across all installations, and once training and testing are complete, B–UAS capabilities will enhance battlespace awareness to assist in meeting these emerging threats. These efforts with our partners will continue to ensure the robust integration of both existing and developing technologies to provide cost effective and robust battle space awareness to AFGSC defense forces. This is the beginning of an evolving journey. C–UAS is a rapidly developing technology and as a service, there will be an evolution to utilize the capability and defend against the threat. These are a few examples of how AFGSC is taking Security Forces training and operations in a more relevant, realistic direction.

Weapons Generation Facilities

Today's Weapon Storage Areas (WSA) are not simply storage facilities; they support rapid generation of nuclear aircraft and routine maintenance operations for the ground-based and air legs of the nuclear triad. Two ICBM wings are planned to receive modernized facilities for these missions, renamed Weapons Generation Facilities (WGFs). Additionally, bomber WGFs will be needed to accommodate mission growth and improve current capacity, and with the right number, will provide national leadership more strategic decision space. Affordability is the entering argument for the Air Force's way forward concerning WGFs. This year, AFGSC organized a cross-functional team to re-examine the design plans to identify more affordable options. The team identified options that allow for recapitalization of existing facilities where possible. For locations that do not have existing facilities capable of undergoing recapitalization, the design characteristics have been scaled back for more affordable construction. A more detailed update will be available after a final decision is made on the plan for bomber WGFs.

Infrastructure

One of the chronic challenges is the impact that degraded and unpredictable infrastructure funding is having on mission, Airmen, and families. Bases are power projection platforms and must be viewed as part of a "3–D weapon system." They are essential elements, and this is particularly true for the three ICBM bases and the five bomber bases, as they stand as deterrent 24/7/365, ready to conduct global strike missions directly from these locations. For years, the Air Force has been forced to make deliberate decisions to take risk in infrastructure funding, in order to apply scarce dollars toward higher readiness and modernization priorities. The cumulative effect has been a steady erosion of facilities and core infrastructure, and significant growth in costs to address exponentially-growing repair and replacement backlogs. There is a growing risk in facilities and infrastructure reliability, higher overall costs due to accelerated deterioration, and increasing potential for unexpected catastrophic, mission-impacting failure. Innovative Airmen have, and will continue to, focus limited resources on "mission critical, worst first" facilities and infrastructure while accepting risk in the recapitalization of facilities with less-direct mission impact such as community and base support. There is without question a correlation between facility condition and quality of life, as well as quality of work. Without consistent, reliable, and flexible funding, degrading infrastructure will continue to increase risk of mission interruption or degradation and affect quality of life of Airmen and families. Providing a predictable, stable budget with enough resources to address degrading infrastructure will not only enhance lethality, but will

go far in providing Airmen the working and living environments they deserve and increasing overall readiness.

NUCLEAR COMMAND, CONTROL, AND COMMUNICATIONS (NC3)

As the NC3 lead for the Air Force, AFGSC supports CDRUSSTRATCOM priorities of sustaining current NC3 systems and replacing the legacy systems with next generation NC3 technology to ensure secure, reliable nuclear command and control capabilities to the President and warfighters.

Sustaining current NC3 systems includes developing maintenance performance indicators to track the reliability of communications systems and predicting future maintenance actions and spare parts needs. Unfortunately, there are components that suffer from diminishing manufacturing sources and material shortages across the NC3 enterprise. For example, the decades-old Miniature Receive Terminal (MRT) on the B–52, a system that receives Emergency Action Messages (EAMs) over very low frequency, fell into that category. As a result of this analysis and planning, a vendor was identified that could manufacture the band-pass filters required to repair the MRT receivers. Today, there are enough band-pass filters in stock to sustain the aging system until replacement.

Continuing its sixth decade as the backbone of the nation's bomber fleet, the B–52 is funded in the fiscal year 2020 President's Budget for installation of a Very Low Frequency (VLF) receiver which leverages the technology currently being installed on the B–2 fleet. This VLF terminal will provide a NC3 receive-only capability. To further modernize VLF capability across multiple platforms, we are moving forward with development of a Common VLF Receiver (CVR) capable of utilizing emerging waveforms for improved EAM reception. We envision employing this receiver on airborne and ground weapons systems. Additionally, the Air Force continues to develop the Family of Advanced Line-of-Sight Terminals (FAB–T) Force Element Terminal (FET) which will be integrated onto the B–52 providing access to the Advanced Extremely High Frequency (AEHF) satellite network. AEHF will also be integrated into the ICBM's Launch Control Centers (LCC), further enhancing the redundancy that exists for NC3 in the ICBM force. We are also assessing options to leverage other programs' investments in this communication technology to enable more rapid fielding across bombers and supporting reconnaissance and tanker aircraft.

Other command and control modernization programs include the Global Aircrew Strategic Network Terminal (GASNT) Increment 1 program, which will bring nuclear tasked command posts, mobile support teams, and munitions squadrons the capability to operate on the AEHF satellite network at extended data rates. The GASNT Increment 1 program is currently undergoing operational testing and is expected to reach a Milestone C production decision in the summer of 2019. The GASNT Increment 2 program will provide advanced aircrew alerting, Ultra High Frequency (UHF) Line of Sight (LOS) and advanced High Frequency (HF) capabilities. Additionally, the Service continues efforts to upgrade the Strategic Automated Command Control System (SACCS) to improve reliability of this primary EAM distribution system.

Fully funded in the fiscal year 2020 President's Budget, communications upgrades to the E–4B NAOC will ensure a reliable, airborne NC3 platform for senior leaders. The Low Frequency Transmit System (LFTS) replaces the existing dual trailing wire antenna while reducing aircraft weight by almost a ton. The Survivable Super High Frequency (SHF) system provides reliable and sustainable voice/data capability in scintillated and jammed operational environments. Tactical UHF radios will be upgraded to Mobile User Objective System (MUOS) capability to meet CJCS requirements. Finally, the FAB–T Command Post Terminal (CPT) is being installed on the E–4B fleet and will enable Presidential National Voice Conferencing (PNVC) to replace legacy MILSTAR capability and provide connectivity to the AEHF satellite network.

As the E–4B is modernized, the nation must look ahead to replacing the aging aircraft within the National Military Command System. The joint-Service NAOC, Executive Airlift (EA), ABNCP, and TACAMO (NEAT) Analysis of Alternatives (AOA) is underway and is scheduled to report to OSD in September 2019. The AOA will evaluate whether mission realignments can improve the operational value of the airborne layer and examine potential synergies in acquiring a common platform.

The next generation of NC3 that will be in place thirty years from now is currently in development. Simply replacing the old with the new is not the right strategy; as sustainment and modernization efforts progress, retaining the modularity and data rights to incorporate new technology and ensure compatibility with new weapon systems is a necessity. AFGSC stands ready to support USSTRATCOM and

the initiatives to deliver NC3 capability on operational and threat-relevant timelines.

SUSTAINMENT

Twentieth Air Force

Twentieth Air Force (20 AF), one of two Numbered Air Forces in AFGSC, is responsible for the Minuteman III (MMIII) ICBM, UH–1N helicopter forces, the Kirtland Underground Munitions Maintenance and Storage Complex at Kirtland Air Force Base, New Mexico, the Flight Test Squadron at Vandenberg Air Force Base, California, and the ground combat training squadron at Camp Guernsey, Wyoming. The 450 dispersed and hardened Launch Facilities (LFs), are controlled, maintained, defended, and supported by AFGSC Airmen every single day, providing the bulk of our day-to-day nuclear alert force, and doing so with precision and professionalism. The ICBM forces presented to USSTRATCOM are deployed in place, and preserve strategic stability by providing the nation a credible and responsive nuclear option in a contested environment and presenting adversaries a nearly insurmountable obstacle of numbers should they consider a disarming attack on the United States. AFGSC's ICBM forces are New START compliant.

Minuteman III

AFGSC is committed to the sustainment of MMIII ICBM and its NC3 systems and support equipment. It is critical the weapon system remains viable until it is replaced by the GBSD. To sustain the existing fleet of large missile maintenance vehicles, the $136.2 million Transporter Erector Program (TERP) and the $321.8 million Payload Transporter Replacement (PTR) remain a priority. PTR production is expected to begin production in fiscal year 2019.

The ICBM LCCs will be equipped with modernized communications systems to improve reliability and replace aging and technologically obsolete systems. The LCC block upgrade, expected to begin full deployment in 2020, is a $94M modification effort that replaces multiple LCC components to include modern data storage, a weapon system console printer and oxygen regeneration unit. A significant security upgrade to the remote visual assessment capability at our LF will increase situational awareness and security. This $69.5 million program is expected to begin deployment in fiscal year 2020.

In fiscal year 2018, AFGSC conducted three MMIII flight tests and two simulated electronic launch tests. In fiscal year 2019, we are scheduled to conduct four operational MMIII flight tests and two simulated electronic launch tests that will demonstrate the operational credibility of the ground-based component of the nuclear triad and the Air Force's commitment to sustaining that capability.

In an effort to improve the nuclear capability of our ICBM force, the ICBM Programmed Depot Maintenance program began in fiscal year 2016. The program places operational LFs and LCCs on an 8-year depot-level maintenance cycle. It greatly increases the effectiveness and lethality of our ICBMs by ensuring their sustainment is done in an engineering-based, systematic way. Successful prototyping of the program was accomplished in fiscal year 2016 and from fiscal year 2016 to fiscal year 2018, 100 LFs and 15 LCCs went through the first maintenance cycle. There are 55 LFs and 6 LCCs planned in fiscal year 2019. This program is key to ensure MMIII viability through the transition to GBSD.

UH–1N

AFGSC is the lead command for the Air Force's Vietnam-era fleet of 63 UH–1N helicopters. The majority of these aircraft support several critical missions: security of our ICBM fields, transport missions in the National Capitol Region and USINDOPACOM, and critical Continuity of Operations missions. Additionally, UH–1Ns support Air Force survival training with rescue operations. Further, they participate in the Defense Support of Civil Authorities program and are frequently called upon to conduct search and rescue activities for missing or injured civilians.

AFGSC has developed a comprehensive sustainment plan for the UH–1N while transitioning to the replacement aircraft. The UH–1N will continue to operate in AFGSC through the mid-fiscal year 2020s and within the USAF until the mid-fiscal year 2030s. AFGSC is responsible for the life-cycle of all UH–1Ns in the USAF and some modernization will be necessary for the aircraft to remain effective; currently, all future modifications will be completed in the early fiscal year 2020s. These modifications are only occurring on UH–1Ns flying the longest to ensure mission effectiveness while remaining fiscally responsible. The sustainment of the UH–1N will ensure effectiveness until platform retirement.

Eighth Air Force

Eighth Air Force (8 AF) is responsible for the B–52H Stratofortress (B–52) bomber, the B–2A Spirit (B–2) bomber, the B–1B Lancer (B–1) bomber, and the E–4B NAOC, the cornerstone of survivability of the National Military Command System, providing critical continuity and communication capability for our national leaders. Bombers provide decision makers the ability to demonstrate resolve through generation, dispersal, and deployment. AFGSC's bombers are New START compliant.

The overall size of the bomber force is driven by the significant contribution to conventional campaigns, now more of a concern in this era of great power competition. Since 1991, the Air Force has conducted continuous combat operations with 46 percent fewer aircraft than we had in 1991. During this period, the demand for bombers increased resulting in a growing toll on Airmen and readiness of the aircraft and equipment. AFGSC bombers have supported operations through continuous rotations in United States Central Command (USCENTCOM), United States Indo-Pacific Command (USINDOPACOM), United States Africa Command (USAFRICOM), United States European Command (USEUCOM), and United States Southern Command (USSOUTHCOM) areas of responsibility (AORs). Additionally, AFGSC provides bomber forces to support USSOUTHCOM's Joint-Interagency Task Force-South, USEUCOM, and USAFRICOM through the Joint Staff's Global Force Management process and Bomber Task Force ordered deployments and missions. These opportunities enhance our support to our allies and display our resolve to potential adversaries. The core of AFGSC assurance and deterrence is our unwavering commitment to USSTRATCOM and our nuclear mission. AFGSC must balance global force posturing with our nuclear mission, while not jeopardizing readiness and fleet health. Unfortunately, the effects of this extremely high operational tempo are reverberating through the bomber fleet and specific examples are outlined below.

B–1 Update

The B–1 is a highly versatile, conventional-only, multi-mission weapon system that carries the largest payload of both guided and unguided weapons, of all the bombers in the U.S. inventory. Since 1991 it has provided rapid support for combatant commanders around the globe. Multiple wartime employments, high operations tempo, and harsh environment exposure have proven the aircraft's combat effectiveness, but have significantly degraded aircraft availability.

The B–1 was built as a low-level penetrator and is engineered for flight profiles different than the more stressing close air support/strike profiles flown in support of USCENTCOM. Seventeen years of steady deployments in these more stressing flight profiles has resulted in the need for increased structural inspections and repairs. To that end, a dedicated, programmed depot-level repair line is planned to stand up at Oklahoma City Air Logistics Complex beginning in fiscal year 2020 in order to assure our high standard of aviation safety. Furthermore, using Delta Airlines as a benchmark, AFGSC's Condition Based Maintenance Plus (CBM+) initiative is now underway in the B–1 maintenance community. This predictive approach to identifying aircraft subsystem degradation will optimize scheduled down time for the B–1 in order to concurrently make deferred repairs and change near end-of-life components, avoiding unscheduled breaks and ultimately resulting in improved aircraft availability. When fully implemented, CBM+ will increase mission effectiveness, aircraft availability, optimize spare parts forecasting in the supply chain, and minimize unscheduled downtime for maintenance. In combination, the additional investment in the B–1 structure and implementation of CBM+ sustainment processes will ensure the Air Force achieves the service life goal for the B–1.

The B–1 will remain a viable platform through modernization programs and upgrades to carry it through to retirement. Avionics and weapon upgrades are critical; the Integrated Battle Station, funded to $56 million in fiscal year 2020–24, includes an upgraded Central Integrated Test System, Fully Integrated Data Link, Vertical Situation Display, and flight simulator upgrades. These are essential capabilities to provide aircrew with a more flexible, integrated cockpit. This fleet wide modification will reach full operational capability in fiscal year 2020. Upgrades to Radio Cryptographic Equipment, Identification Friend or Foe, Link-16, and Bomb Rack Modifications along with the Fully Integrated Advanced Targeting Pod capability will ensure the B–1 remains completely assimilated with Joint Combat Forces.

The stand-off weapons currently employed by the B–1 include the Joint Air-to-Surface Standoff Missile (JASSM), the Joint Air-to-Surface Standoff Missile-Extended Range (JASSM–ER), and now, the B–1 is the only Air Force delivery platform for the Long-Range Anti-Ship Missile (LRASM). This precision strike capability has guaranteed a critical role for the B–1 in assuring our allies and deterring potential adversaries now and into the future.

B–2 Update

For nearly 25 years, B–2s have provided the nation with the only stealth bomber capable of penetrating air defenses anywhere in the world. The B–2 holds targets at risk with

a variety of nuclear and conventional weapons and has provided deterrence against our enemies and stability for our allies. The B–2's conventional accomplishments are numerous and incontrovertible; the bomber provided precision attacks during the Kosovo and Iraq Wars, strikes on the Taliban and Al Qaeda in Afghanistan, and on forces in Libya.

B–2 modernization efforts are addressing a nuclear command and control need by bringing a survivable very low frequency communication capability to the aircraft. Additionally, with the proliferation of anti-access/area denial threats, we must ensure the B–2's ability to penetrate enemy defenses with the Defensive Management System Modernization (DMS–M) program. The command stands behind DMS–M as a must-pay bill for continued lethality and the program is fully funded in fiscal year 2020. Additionally, the B–2 is being upgraded to carry the JASSM–ER and the B61–12 nuclear gravity weapon. These upgrades are currently programmed for $145 million in Research, Development, Test, and Evaluation and $46 million in procurement. These are critical to ensuring the bomber leg of the nuclear triad remains a viable and relevant warfighting capability.

Small fleet dynamics continue to challenge our sustainment efforts primarily due to vanishing vendors and the diminishing supply chain. There is an ongoing effort to maintain the proper balance of fleet modernization and sustainment while maintaining combat readiness. Lessons learned from the difficulty of sustaining and modernizing the B–2's small fleet, and an ever-decreasing technological advantage, are critical drivers for B–21 requirements.

B–52 Update

The B–52 may be the most universally recognized symbol of American airpower. It is able to deliver the widest variety of nuclear and conventional weapons, and boasts the best aircraft availability and mission capable rates of all three bomber platforms.

The B–52 will remain a key element of our bomber force until the 2050s, and therefore, it is paramount that we continue to invest resources into this aircraft. The modernization and sustainment of the B–52 should not be based on how long it has been in service, but rather, based on how long it will be in service. AFGSC is looking at B–52 modernization holistically, to optimize, prioritize, and deliver affordable, on-time modernization to sustain this aircraft. Modernization programs will be prioritized and integrated in an effort to make deliberate decisions on timing for concurrent programs. Integration of the existing programs with smart and efficient development and test schedules is critical to deliver affordable, lethal combat capability. Current modernization programs include the B–52 Radar Modernization Program, funded $1.03 billion in fiscal year 2020–24, and entered execution in the pre-Milestone B phase. Furthermore, B–52 training simulators require integration of various programs such as Combat Network Communications Technology (CONECT), internal weapons bay upgrade, data link capabilities, air refueling, and information technology refresh. Supporting the revitalization of these critical training tools will create high fidelity training environments in-line with Air Force priorities, such as Pilot Training Next, and directly increase the readiness of B–52 crews in support of nuclear and conventional missions.

Additionally, the 1960-era TF–33 engines currently on the B–52 are frequently operating with parts salvaged from aircraft no longer in the inventory. What the aircraft maintainers accomplish on a daily basis to keep these jets flying is nothing short of miraculous. The supply of these parts, no longer made by industry, will be exhausted and leave the engines unsustainable by 2030. The Air Force is now funding efforts, $1.4 billion in fiscal year 2020–24, to integrate and deploy replacement B–52 engines, saving fuel and extending the aircraft's range while improving reliability and sustainment.

Other initiatives include the Internal Weapons Bay Upgrade, which increases B–52 smart weapons capacity by 67 percent and adds JASSM and JASSM–ER capability. Also, there are currently 52 B–52s converted to the new CONECT configuration. This modification moves the B–52 into the digital age for the first time, providing an on-board local area network, allowing the aircrew to share a common battlespace picture. This modification is installed on every aircraft going through regular program depot maintenance cycle. The B–52 CONECT targeting upgrades and inclusion of Digital Aided Close Air Support brings a robust capability to long-range firepower available today to combatant commanders. Communications remain the cornerstone of our long-range strike capability. The ability to launch bombers

and re-task and retarget them while en route to the battlespace is a powerful force multiplier. Additionally, the addition of Link-16, a critical communications node, will enhance the operational picture integrating the aircraft with the warfighter.

Air-Launched Cruise Missile

The AGM–86B Air Launched Cruise Missile (ALCM) is an air-to-ground, winged, subsonic nuclear missile delivered by the B–52. Fielded in the 1980s, the ALCM is over 30 years old, well beyond its 10-year life expectancy, and is undergoing multiple Service Life Extension Programs (SLEP). While the ALCM remains effective today, it is rapidly becoming technologically obsolete. As our ALCMs are aging-out, our adversaries are developing new cruise missiles and fielding more capable defense systems. It is imperative that the ALCM is replaced due to its aging subsystems, the shrinking stockpile of operational missiles, and advances in enemy defense. The Air Force will invest $360 million in fiscal year 2020–24 to continue existing SLEPs and testing efforts that include critical telemetry, encryption, and flight termination components until the Long Range Stand-Off (LRSO) missile reaches operational capability in 2030.

B61

The B61 family of gravity nuclear weapons supports the airborne leg of the triad and is the primary weapon supporting our NATO allies under extended deterrence. The B61 is currently undergoing a LEP that results in a smaller stockpile, reduced special nuclear material in the inventory, modernized safety and security features, and reduced lifecycle costs by consolidating four weapon versions into one version, the B61–12. The B61–12 includes the addition of a digital weapons interface and a guided tail kit assembly. AFGSC is the lead command for the $157 million in fiscal year 2020–24 B61–12 Tail Kit Assembly program, a DOD-developed system providing reduced maintenance, reduced cost, and increased sustainability. The B61–12 Tail Kit Assembly program is in Production and Deployment Phase and is synchronized with National Nuclear Security Administration (NNSA) efforts. The Tail Kit Assembly design and production processes are on schedule and within budget to meet the planned fiscal year 2020 first production unit date, and support the lead time required for the inclusion of the Department of Energy (DoE) warhead service-life extension completion date of March 2020. This joint DOD and DoE endeavor allows for continued attainment of our strategic requirements and regional commitments.

MODERNIZATION

B–21 Raider

The B–21 Raider will fulfill two critical roles: provide a day-to-day conventional and nuclear bomber that will eventually replace the conventional B–1 and dual-capable B–2. This is highlighted because the cost of nuclear modernization often includes this program in the narrative. Technology gaps between the United States and potential adversaries are closing. The B–21 Raider will support the nuclear triad by providing an advanced and flexible deterrent capability and the ability to penetrate modern and future air defenses. Further, the B–21 will provide flexibility across a wide range of joint military operations using long-range capabilities, large and mixed payloads, and survivability. From the outset, the B–21 has been designed to have an open architecture, which enables it to more rapidly and affordably integrate new technology and respond to future threats. The program is a national security imperative that will extend American air dominance and lethality against next generation capabilities and advanced air defense environments.

The B–21 is fully funded for $3 billion in the fiscal year 2020 budget submission, and initial capability is projected for the mid-2020s. Extensive campaign and mission level analysis will determine the minimum number of B–21s required to meet combatant commander needs in the face of closing technology gaps and increasing threat capabilities.

Current bomber bases are best suited for B–21 operations, maintenance, security, and training requirements. The Air Force is conducting the strategic basing process, which includes analysis to determine construction and facility renovations necessary to support the new mission. Additionally, base operating support and off-base community support are well-established at current bomber bases. Throughout this process, the primary focus is to provide safe, secure, and lethal bomber operations in a cost-efficient manner.

Ground Based Strategic Deterrent

To ensure continued lethality and affordability of the most responsive leg of the triad, GBSD has successfully moved forward through the Technology Maturation

and Risk Reduction (TMRR) contract awarded on 21 August 2017. Following this competitive and cost-reducing TMRR phase, the source selection process will identify a single provider with material development efforts anticipated to begin in the 2020 timeframe. As continued program analysis has revealed, GBSD represents the most-effective strategy to mitigate capability shortfalls while restoring warfighting effectiveness and replacing critically-aged infrastructure. GBSD is fully funded at $10.8 billion in fiscal year 2020–24. A focus on developing a competitive edge is evident in the leveraging of Model Based System Engineering (MBSE) during TMRR where there is an estimated potential to save several billion dollars of acquisition and lifecycle costs. This is possible due to MBSE's ability to decrease design cycle timelines and ensure design modifications and their subsequent impacts are fully realized without the need for traditional prototypes or extensive paperwork reviews.

Furthermore, the modular design focus, a key acquisition tenet, is expected to reduce the need for specialized or comprehensive system overhauls throughout the 50-year operational lifecycle. The value proposition of this program is unprecedented—the Air Force will save money on maintenance, operations, and in personnel; physical access and modularity of the designs makes GBSD simpler and more affordable to sustain than any of its predecessors. The security requirements will change dramatically: there will be fewer convoys on the roads, fewer open launcher configurations, fewer defenders needed to guard the site during maintenance, and it brings new capability to the most responsive leg of the triad affordably.

Additionally, there is collaboration with NNSA and the W78 warhead replacement program, the W87–1. As of this calendar year, that program is in development. The replacement warhead will use the MK21 aeroshell and will deploy on GBSD after fiscal year 2030.

Long Range Stand-Off Missile

The LRSO will be a reliable, long-range, and survivable weapon system and is an essential element of the nuclear triad. It will be flexible and compatible with B–52 and B–21 platforms. The Air Force dedicated $2.4 billion in fiscal year 2020–24 for the LRSO to replace the aging ALCM we have relied upon for 36 years. The ALCM will not be a viable option for employment beyond 2030. The vast majority of targets covered by the bomber leg of the triad require the employment of stand-off weapons. Without LRSO on B–21s and B–52s, our ability to hold adversaries at risk is reduced, the risk to our aircraft and aircrew is increased, and the execution of the wartime mission is degraded. Stand-off weapons reduce over-flight concerns and provide the most visible and responsive extended deterrent to our allies and partners, supporting the well-established United States counter-proliferation policy. Furthermore, the bombers that will deliver the LRSO are the Nation's only recallable asset, giving U.S. leaders the maximum amount of flexibility at the most critical moments.

The LRSO missile will ensure the bomber force continues to hold high-value targets at risk in an evolving threat environment, including targets deep within an advanced integrated air defense system. Additionally, the current acquisition strategy ensures close synchronization with NNSA to fully integrate the W80–4 nuclear warhead with LRSO. This weapon will retain nuclear penetrating cruise missile capabilities through 2060. To meet operational, testing, and logistics requirements, the Air Force plans to acquire approximately 1,000 LRSO cruise missile bodies. This quantity will provide spares and supply sufficient non-nuclear missile bodies throughout ongoing flight and ground testing. The number of nuclear-armed LRSO cruise missiles (i.e., mated to a nuclear warhead) is planned to be equivalent to the current ALCM nuclear force.

UH–1N Replacement

In order to continue supporting critical national missions and fully comply with DOD and USSTRATCOM requirements, the Air Force has committed $1.6 billion in fiscal year 2020–24 toward replacing the UH–1N fleet, as the legacy platform falls short of missile field operational needs, notably speed, range, endurance, payload, and survivability. In September 2018, the Air Force selected Boeing's MH–139 as the replacement solution for the aging UH–1N fleet through a full and open competition, significantly advancing the capabilities over the legacy aircraft and saving the Air Force $1.7 billion based on the service cost estimate. The timely fielding of this platform will enable the Air Force to meet nuclear security requirements and fully support Presidential Continuity of Government missions in the national capital region. The first aircraft is already on the production line and is scheduled for delivery in November 2019. Initial Operating Capability at the first Global Strike base is anticipated in fiscal year 2022.

CONCLUSION

I look forward to updating the committee on our progress and building trust through our common goal: to protect the United States with a safe, secure, reliable, effective, and affordable long-range precision strike force. We remain focused on climate and culture to get us there, particularly in the areas of excellence, teams, and people. The Air Force requires authentic leaders who excel at two things: connecting with Airmen and connecting Airmen to the Air Force family. Leaders at every level must cultivate a culture and climate of respect, encourage personal and professional growth, and advocate for Airmen to ask for help if they need it. Our work demands excellence, not perfection, and Airmen at every level are valued team members working together to accomplish the mission. Authentic leaders encourage innovation, bold ideas, and better ways of going about our business. Revitalizing our squadrons and allowing commanders the space to lead boldly, to develop inclusive, diverse, and well-rounded teams of integrators will produce measurable results and create a better climate for the Airmen who will take our place. It will take teamwork to win tomorrow's fight and we are stronger together. We are on a good path moving forward, but there is a lot of work to be done.

AFGSC is committed to affordable modernization and sustainment of our nuclear triad and conventional forces. During this period of transition, it is imperative that we continue to seek out innovative solutions to bring the cost of modernization down. Our Air Force remains the most powerful in the world thanks to the help from Congress and the vision and courage of those who have gone before us, but we cannot be static in a world where the dynamics of power are shifting. I am encouraged by our progress and appreciate the opportunity to update this committee.

OPENING STATEMENT OF VICE ADMIRAL JOHNNY R. WOLFE, JR., USN, DIRECTOR STRATEGIC SYSTEMS PROGRAMS

Vice Admiral WOLFE. Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee, thank you for the opportunity to testify on the Department of Defense's budget request for nuclear forces. I am honored to be here today. I would like to thank this Subcommittee for its continued support of the Navy's deterrence mission, and I respectfully request my written statement be submitted for the record.

Nuclear deterrence is the number one priority mission of the Department of Defense. The nation's nuclear triad of intercontinental ballistic missiles, strategic bombers, and ballistic missile submarines is the bedrock of our ability to deter aggression, assure our allies and partners, achieve U.S. objectives should deterrence fail, and hedge against an uncertain future. Most critically, the Navy continues to focus not only on the modernization of the nuclear deterrent, but also its role as trusted steward of the safety and security of these weapons.

The Navy Strategic Systems Program—or SSP—fiscal year 2020 budget that I manage supports the continued sustainment of the deterrent as well as the modernization efforts directed in the 2018 Nuclear Posture Review. Additionally, although not part of the strategic nuclear portfolio, the SSP budget request supports the hypersonic Conventional Prompt Strike progam—an effort leveraging SSP's unique and critical non-nuclear skill set that the workforce has refined for 60 years.

The men and women of SSP and their predecessors have provided unwavering and single mission focused support to the sea-based leg of the triad for over six decades. SSP is now facing a bow wave of critical development activities. The organization must be prepared not only to sustain today's deterrent, but to modernize it so that it remains a credible and effective strategic weapon system into the future.

Today, SSP continues to extend the life of the Trident II (D5) strategic weapon system to match the *Ohio*-class submarine service life and to serve as the initial weapon system on the *Columbia*-class submarine. This is being accomplished through an update to all subsystems: launcher, navigation, fire control, guidance, missile, and reentry as well as our flight test support infrastructure. All of our life extension efforts remain on track. Additionally, we will continue to recapitalize our Strategic Weapons Facilities to continue to support and sustain SSBN operations.

These collective efforts will ensure an effective and credible sea-based strategic deterrent on both the *Ohio*-class and *Columbia*-class until the 2040s. In accordance with the 2018 Nuclear Posture Review, SSP will "begin studies in 2020 to define a cost-effective, credible, and effective submarine-launched ballistic missile that we can deploy throughout the service life of the *Columbia* SSBN."

In addition to our modernization efforts, our budget request supports the direction of the 2018 Nuclear Posture Review. Specifically, our budget request continues to fund the modification of a small number of warheads to provide a low-yield option. This near-term capability is being accomplished through our strong partnership with the Department of Energy. This effort will not increase the overall number of deployed ballistic warheads. It will, in fact, bolster our deterrence posture.

As the fourteenth Director, it is my highest honor to represent the men and women of SSP, comprising approximately 1,700 sailors, 1,000 marines, 300 coast guardsmen, 1,200 civilians, and over 2,000 contractor personnel. It is my most critical goal to ensure that they are poised to execute the mission with the same level of success, passion, and rigor, both today and tomorrow, as they have since our program's inception in 1955. Thank you for the opportunity to testify today on behalf of the men and women who make nuclear deterrence their life's work. I look forward to your questions.

Prepared Statement by Vice Admiral Johnny Wolfe

introduction

Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee, thank you for this opportunity to discuss the sea-based leg of the triad. It is an honor to testify before you this morning representing the Navy's Strategic Systems Programs (SSP).

The Nation's nuclear triad of intercontinental ballistic missiles, strategic bombers, and ballistic missile submarines (SSBNs) equipped with submarine-launched ballistic missiles (SLBM) is essential to our ability to deter major warfare with adversaries and assure our allies. Each leg provides unique attributes and, together, provides critical diversity and flexibility. The 2018 Nuclear Posture Review (NPR) reaffirmed that foreign nuclear threats are growing and Great Power competition has returned and, thus, reinforced the need to recapitalize each component of the triad. The nuclear triad is the bedrock of our ability to deter aggression, assure our allies and partners, achieve U.S. objectives should deterrence fail, and hedge against an uncertain future; it is the Department of Defense's number one priority mission.

The Navy provides the most survivable leg of the triad with our *Ohio*-class SSBNs and the Trident II (D5) strategic weapon system (SWS) they carry. SSBNs are responsible for a significant majority of the Nation's operationally deployed nuclear warheads. The Chief of Naval Operations has made clear the priority the Navy places on the sustainment and modernization of the undersea leg of the triad, directing the Navy to "be ready to deploy USS *Columbia* (SSBN 826) as quickly as possible—beating the current schedule—in order to preserve our ability to defeat the threat." Delay is not an option.

SSP's fundamental mission is to design, develop, produce, sustain, and ensure the safety and security of the Trident II (D5) SWS, comprising the SLBM, reentry systems, and shipboard systems. We strive to maintain a culture of excellence, underpinned by self-assessment, to achieve the highest standards of performance and integrity for personnel supporting the strategic deterrent mission. We focus unremittingly on our tremendous responsibility for the custody and accountability of our Nation's nuclear assets. The men and women of SSP and our industry partners remain dedicated to supporting the mission of our sailors on strategic deterrent patrol and our marines, sailors, and coast guardsmen who stand watch, safeguarding the weapons with which we are entrusted by this Nation.

Our fiscal year 2020 budget request provides the required funding to support the program of record for the Trident II (D5) SWS. To sustain this capability and usher in a new era of development efforts, I am focusing on my top priorities: nuclear weapons safety and security; the Trident II (D5) Life Extension Program; NPR-directed activities; the *Columbia*-class Program; the Industrial Base, infrastructure, and capabilities; support to the United Kingdom's continuous at-sea deterrent; and the workforce that enables this mission every day.

The men and women of SSP and their predecessors have provided unwavering and single mission-focused support to develop, sustain, and secure the sea-based leg of the triad for over six decades. SSP now faces a bow wave of critical modernization activities, and our workforce is evolving from years of sustainment efforts to large-scale development, as most recently evidenced by the 2018 NPR implementation and our expanding mission into conventional hypersonic capabilities. The organization must be prepared not only to sustain today's deterrent, but to modernize it so that it remains a credible, effective SWS that can support our ballistic missile submarines and our strategic deterrent mission through the life of the *Columbia*-class SSBN.

As the fourteenth Director, it is my highest honor to serve as the program manager, technical authority, safety and security lead, regulatory lead, and Polaris Sales Agreement Project Officer for the Navy's nuclear weapons program. Most importantly, I am honored to represent the men and women of SSP, comprising approximately 1,700 sailors, 1,000 marines, 300 coast guardsmen, 1,200 civilians, and over 2,000 contractor personnel. It is my most critical goal to ensure they are poised to execute the mission with the same level of success, passion, and rigor both today and tomorrow as they have since our program's inception in 1955.

SAFETY AND SECURITY

The first priority, and the most important, is the safety and security of the Navy's nuclear weapons. Accordingly, Navy leadership delegated and defined SSP's role as the program manager and technical authority for the Navy's nuclear weapons. At its most basic level, this priority is the physical security of one of our nation's most valuable assets. Our Marines and Navy Masters at Arms provide an effective and integrated elite security force at our two Strategic Weapons Facilities and Waterfront Restricted Areas in Kings Bay, Georgia, and Bangor, Washington. U.S. Coast Guard Maritime Force Protection Units have been commissioned at both facilities to protect our submarines. Together, the Navy, Marine Corps, and Coast Guard team form the foundation of our security program, while headquarters staff ensures that nuclear weapons-capable activities comply with safety and security standards.

The Navy maintains a culture of self-assessment in order to ensure safety and security. This is accomplished through biennial assessments, periodic technical evaluations, formal inspections, and continuous on-site monitoring and reporting at the Strategic Weapons Facilities. We strive to maintain a culture of excellence to achieve the highest standards of performance and integrity for personnel supporting the strategic deterrent mission and continue to focus on the custody and accountability of the assets entrusted to the Navy. SSP's number one priority is to maintain a safe and secure strategic deterrent for the Navy.

D5 LIFE EXTENSION PROGRAM

The Trident II (D5) SWS has been deployed on the *Ohio*-class ballistic missile submarines for nearly three decades and is planned to be deployed more than 50 years. This is well beyond its original design life of 25 years and more than double the historical service life of any previous sea-based strategic deterrent system. As a result, SSP is extending the life of the Trident II (D5) SWS to match the *Ohio*-class submarine service life and to serve as the initial SWS for the *Columbia*-class SSBN. Our life extension efforts will ensure an effective and credible SWS on both the *Ohio*-class and *Columbia*-class SSBNs until the 2040s. This is being accomplished through an update to all the Trident II (D5) SWS subsystems: launcher,

navigation, fire control, guidance, missile, and reentry. Our initial life extension of missile and guidance flight hardware components is designed to meet the same form, fit, and function of the original system, maintain the deployed system as one homogeneous population, control costs, and sustain the demonstrated performance of the system.

The Navy's D5 life extension program is executing on schedule to continue to meet deterrence requirements. In fiscal year 2018, the Navy deployed 24 life-extended D5 missiles (D5LE) to the fleet and remains on track to complete deployment by fiscal year 2024. In June 2018, we successfully conducted the first D5LE flight test of four missiles to support the Commander Evaluation Test (CET) program. The CET program obtains and monitors reliability, accuracy, and performance data of the D5LE missile population in an operational environment, and is one method used to monitor the long-term effectiveness of this nuclear deterrent weapon system.

Another major initiative to ensure the continued sustainment of our SWS is the SSP Shipboard Systems Integration (SSI) Program, which manages obsolescence and modernizes SWS shipboard systems through the use of open architecture design and commercial off-the-shelf hardware and software. The SSI Program refreshes shipboard electronics hardware and upgrades software, which will extend service life, enable more efficient and affordable future maintenance of the SWS, and ensure we continue to provide the highest level of nuclear weapons safety and security for our deployed SSBNs while meeting U.S. Strategic Command (USSTRATCOM) requirements. Our organization performed over 90 fleet and shore-based incremental installations over the last three years. Sixteen installations were completed in 2018, and two began this year with an additional five planned for completion. Three shipboard modernization increments are currently in development for future installation.

The Navy also works in partnership with the Department of Energy's National Nuclear Security Administration (NNSA) to refurbish our reentry systems. The Trident II (D5) is capable of carrying two types of warheads, the W76 and the W88, which are both undergoing refurbishment. Deliveries of life-extended W76 warheads, known as the W76–1, to the Navy are nearly 100 percent complete and are on track to finish by the end of fiscal year 2019. The W76–1 program has been a tremendous effort that informs much of our understanding of refurbishment programs, and I laud our NNSA partners for their support of the Navy's deterrent. The W88 major alteration program also remains on track to support a first production unit in fiscal year 2020 with production scheduled to be completed in fiscal year 2024. These combined efforts to refurbish the Navy's reentry systems ensure that the Navy can meet USSTRATCOM requirements for decades to come.

NUCLEAR POSTURE REVIEW ACTIVITIES

The Navy is also beginning an approach to maintain a credible and effective SWS beyond 2040. For example, we are leveraging the work being done today to extend the life of the Trident II (D5) SWS as well as investigating opportunities to innovate, such as through the application of model-based engineering. As directed in the Nuclear Posture Review, the Navy will begin "studies in 2020 to define a cost-effective, credible, and effective SLBM that we can deploy throughout the service life of the *Columbia* SSBN." These threat-informed studies will underpin decisions made to sustain the Trident II (D5) SLBM and to maintain an adaptable and flexible sea-based deterrent for the Nation. SSP has a history of more than 60 years of developing, producing, and supporting SWSs to support the undersea leg of the triad. We are optimizing our SWS by applying lessons learned from six generations of missiles and will continue to do so until the 2080s.

As we face increasingly agile, advanced, and persistent cyber threats to our nuclear enterprise, SSP must be constantly vigilant of our adversaries' means and methods of obtaining critical technology and information about the Navy's SWS. In order to protect our technical advantage from significant harm today and into the future, we are laying the groundwork with our industry partners to revolutionize our business practices. Securing program information within the industrial base and adjusting procurement approaches will ensure long-term stability of our design, development, and sustainment efforts. The ability to drive concerted progress within the nuclear enterprise is critical to the security and survivability of our current and future SWS and the platform on which it is deployed to defend the Nation.

In accordance with the 2018 Nuclear Posture Review's recommendation to pursue supplemental capabilities, SSP is fielding of a small number of low-yield SLBMs and is participating in a nuclear-armed sea-launched cruise missile (SLCM) study. The near-term low-yield SLBM and long-term SLCM efforts are intended to address deterrence gaps and assure allies. Our budget request supports executing a low-yield

SLBM option, configured to leverage the W76–1 life-extension efforts. The low-yield program, known as the W76–2, is on track to meet warfighter requirements. The W76–2 modification will not increase the number of deployed ballistic missile warheads and leverages the people, processes, and schedule from the W76–1 program to ensure a cost-effective and executable approach. The W76–2 weapon system will enhance deterrence by denying potential adversaries any mistaken confidence that limited nuclear employment can provide a useful advantage over the United States and its allies.

In the mid-term, the 2018 Nuclear Posture Review directed the Navy to investigate the feasibility of fielding the nuclear explosive package from the Air Force's W78 warhead replacement into a Navy reentry body. This ongoing effort will inform Nuclear Weapons Council decisions regarding SLBM warhead modernization needs.

SWS AND THE *COLUMBIA*-CLASS PROGRAM

The Navy's highest priority acquisition program is the *Columbia*-class Program, which replaces the existing *Ohio*-class submarines. The continued assurance of our sea-based strategic deterrent requires a credible SWS, as well as the development of the next class of ballistic missile submarines. Accordingly, the Navy is taking the necessary steps to ensure the *Columbia* SSBN is designed, built, delivered, and tested on time with the right capabilities at an affordable cost.

To lower development costs and leverage the proven reliability of the Trident II (D5) SWS, the *Columbia* SSBN will enter service with the life-extended Trident II (D5) SLBM, which is resident today on *Ohio*-class submarines. Maintaining a common SWS during the transition between existing and successor submarine platforms allows the Navy to leverage a mature material and knowledge enterprise, thus reducing programmatic costs and risks. Life-extended missiles will be shared with both the *Ohio*-class and *Columbia*-class submarines into the 2040s.

A critical component of the *Columbia*-class Program is the development of a Common Missile Compartment (CMC) with the United Kingdom. Today, the United States Navy shares the Trident II (D5) SWS with the UK aboard its *Vanguard*-class of ballistic missile submarines. Similar to the United States Navy, the UK is recapitalizing its four aging *Vanguard*-class SSBN submarines with the *Dreadnought*-class SSBN. The CMC will support the life-extended Trident II (D5) SWS to be deployed on the *Columbia* and the UK *Dreadnought*-class SSBNs. Our partnership also supports production of these two new classes of SSBNs in both United States and UK build yards. Collaborative efforts also include construction of missile tubes to support building the U.S. prototype Quad-pack module and the SWS Ashore integration test site at Cape Canaveral, Florida.

To manage and mitigate technical risk associated with the delivery of the first submarines to both the United States and UK programs, SSP is leading the development of the SWS Ashore integration test site. This is a joint effort between the Navy and the state of Florida, investing in the redevelopment of a 1950s Polaris Missile site to conduct integration testing and verification for *Columbia* and UK *Dreadnought* programs. We reached a programmatic milestone in 2017 when Test Bay One, which will be used to test the Missile Service Unit first article, achieved Initial Operational Capability. Last year, we successfully installed the first *Columbia* missile tube into Test Bay Two and, in the beginning of 2020, we are scheduled to achieve the Initial Operational Capability for verifying and validating the SWS support systems for the *Columbia* and UK *Dreadnought* programs.

To mitigate the risk in the restart of launcher system production, SSP developed a surface launch test facility at the Naval Air Warfare Center Weapons Division, China Lake, California. This facility will prove that the launcher industrial base can replicate the performance of the *Ohio*-class Trident II (D5) launcher system. Thirteen evaluation and four qualification tests were conducted in 2018, and one qualification test was conducted in January 2019. Eleven remaining tests are planned for 2019. To date, *Ohio*-class Trident II (D5) launch performance has been demonstrated.

The *Ohio*-class SSBNs begin decommissioning in the late 2020s and the *Columbia*-class must be ready to start patrols in fiscal year 2031 to maintain a minimum operational force of 10 SSBNs. The Navy has already extended the *Ohio*-class service life from 30 years to 42 years, and there is no engineering margin left for further life extension. Recapitalizing our SSBNs is a significant investment that only happens every other generation, making it critically important that we do it right. Any delay has the potential to impact not only our ability to meet operational requirements, but also the United Kingdom's strategic deterrent requirements.

INDUSTRIAL BASE, INFRASTRUCTURE, AND CAPABILITIES

Ensuring robust defense and aerospace industrial base capabilities—such as shipyard support, radiation-hardened electronics, and solid rocket motors—remains an important priority. SSP places particular emphasis on the solid rocket motor industry and its sub-tier suppliers. Although the Navy maintains a continuous production capability of solid rocket motors, the demand from both National Aeronautics and Space Administration (NASA) and the Air Force has precipitously declined. This decline results in higher costs for the Navy and puts an entire specialized industry at risk. Future Air Force modernization will provide some much needed relief beginning in the mid-2020s; however, our Nation cannot afford to lose this capability. While the efforts of our industry partners and others create short-term cost relief, the long-term support of the solid rocket motor industry, including its sub-tier supplier base, and maintenance of critical skills remains an issue that must be addressed. For example, we are concerned with ensured access to and affordability of certain critical solid rocket motor constituents, such as ammonium perchlorate. We will continue to work with our industry partners, the Department of Defense, senior NASA leadership, Air Force, and Congress to do everything we can to ensure this vital national security industry asset is preserved.

As the Navy executes the total overhaul and replacement of the SSBN and SLBM leg of the nuclear triad, which will be in service until 2084, NNSA's infrastructure must be prepared to respond in tandem to the evolving needs of the Nation. Of most importance, an effective, resilient, and responsive plutonium pit production capability and capacity can address age-related risks, support planned refurbishments, as well as prepare for future uncertainty. Additionally, tritium, lithium, and uranium, among other strategic materials, are vital to ensuring the Navy can continue to meet its strategic deterrent requirements.

SUPPORT TO THE UNITED KINGDOM

The United States and UK have maintained a longstanding shared commitment to nuclear deterrence, one that dates to the signing of the Mutual Defense Agreement in 1958 and with the Polaris Sales Agreement (PSA) in 1963. This year, the UK celebrates 50 years of its continuous-at-sea-deterrent—a momentous achievement that the U.S. has proudly supported. Today, the Navy's support encompasses not only the CMC and SSBN programs but also 100 percent of the shipboard systems, missile, and reentry portions—the Strategic Weapon System—of the UK's nuclear deterrent. As the Director of SSP, I serve as the delegated United States Project Officer of the PSA and am solely responsible for fulfilling lifecycle support to the UK's program. As SSP shapes the future SWS, we must continue to consider the UK's connection to our decisions and our responsibility to our most important ally. SSP remains steadfastly committed to the UK's continuous-at-sea deterrent and to the mutually beneficial relationship we have both maintained and celebrated for 60 years.

CONCLUSION

History reminds us that the swift, successful creation and execution of the Fleet Ballistic Missile program in the 1950s was truly a result of a cadre of hand-selected scientists, engineers, and inspirational leaders. Though process will always underpin our efforts, our dedicated predecessors—civilians, military, and industry partners alike—responded to the national need with gusto and drove this program with a vision. Today's SSP and its industry partners will continue this vision by attracting, nurturing, and retaining the next generation workforce that will enable a capable, credible strategic deterrent for our Nation for the next 60 years.

SSP ensures a safe, secure, and effective strategic deterrent and focuses on the custody and accountability of the nuclear assets entrusted to the Navy. Sustaining and modernizing the sea-based strategic deterrent capability is a vital national security requirement. Our Nation's sea-based deterrent has been a critical component of our national security since the 1950s and must continue to assure our allies and partners and deter potential adversaries well into the future. I am privileged to represent this unique organization as we work to serve the best interests of our great Nation. I thank the committee for the opportunity to speak with you about the sea-based leg of the triad and the vital role it plays in our national security.

Senator FISCHER. With that, I will begin our first round of questioning.

Secretary Lord, after the last two administrations, we've consistently heard testimony that nuclear modernization programs such

as the Ground-Based Strategic Deterrent (GBSD) have no margin for error. Can you talk about how fragile the situation is and the impact that funding cuts or additional delays would have on our ability to meet deterrence requirements?

Secretary LORD. Absolutely. Thank you, Chairman.

We are living now with Cold War technology, and we have put off modernizing the triad for multiple decades. So, now we have no margin. We need to move forward. So, any cut in funding would essentially have us unilaterally stand down, in terms of our capability to have a credible nuclear deterrent.

Senator FISCHER. When you say we have no room for any delay in meeting these modernization requirements, could you speak to us, in this setting, on the importance of our keeping up with that in regard to what our adversaries, specifically Russia and China, are doing, and why that is so important for us to know, why it's important for the people of this country to know?

Secretary LORD. Absolutely. Russia, in particular, has developed many capabilities, whether they be unmanned underwater vehicles (UUVs) or different types of warheads, over recent years. Our systems will be timing out, in terms of their capability, between 2020 and 2040. We must modernize what we have so that we can replace our systems, one for one. GBSD, for instance, there is no margin to do another Service Life Extension Program (SLEP) on Minuteman III, because not only would it be more expensive than developing GBSD, but you would not have the resiliency in the capability, because you would not have the modern equipment, you would not have the actual capabilities from a functional-range point of view, warhead capability. So, we need to, by 2028, start replacing.

Senator FISCHER. Okay, thank you.

General Ray, if you have anything to add to that. Some have argued that reducing the number of deployed Minuteman intercontinental ballistic missiles (ICBMs) to 300 or 200 missiles would be a way to extend the life of the current system and allow the delay for its replacement. Can you talk about why this isn't accurate?

General RAY. Yes, ma'am. Thank you for the question. Three dimensions to that:

The first, of course, 400 to 450 weapons deployed is a very high threshold for our enemies to derail us. It would consume up to two-thirds of an enemy arsenal to disarm us.

The second piece of that is the near-term challenge, as Secretary Lord talked about, is the timing. Last night, we had the successful launch of a Minuteman III. That testing program will consume the boosters and the propulsion system rocket engines much faster if we continue on this pace. We don't have a program to replace that.

But, when I consider the affordability formula, it features some things, such as modularity. It features a competitive environment with a good tech baseline that we own. It features a good tech base of engineers and individuals.

When I think about foregoing the GBSD, we forego a value proposition that gives us the modularity that lets Admiral Wolfe and I work together on improvements in a more affordable fashion. It also helps us in the competitive environment, since we would own the tech baseline for GBSD. But, moreover, we forego a value prop-

osition of reducing our convoys by upwards of two-thirds and the number of times that we would penetrate the sites by two-thirds. So, when we think about what the digital engineering is helping us learn, and help drive the sustainment dollars down by billions, what we give up is probably even more than just the pricetag of a new program.

Senator FISCHER. You know, you talk about affordability. General Rand, your predecessor, he testified that the GBSD would save around a billion dollars compared to performing another life extension program. General Hyten, in his annual posture statement, said that the further life extension of Minuteman III ICBM is not cost-effective, nor will it provide a weapon system capable of adapting to advancing technology.

Can you talk a little bit more about the savings that are associated with the GBSD in greater detail, and some of the other benefits that it's going to provide?

General RAY. Ma'am, I think the big help to us right now—and we've talked with your staff—is the digital engineering that is operating at an unprecedented level of this acquisition program. Secretary Roper has already declared this is the best acquisition program he has. The risk that we're reducing by the numerous design cycles—a typical design effort would take one, maybe two, manual efforts. We're on our ninth design cycle on this side of the milestone. So, the insights about how to manage requirements, the ability to create a competitive environment of areas that will give us a good return on investment for areas that we value, and then the insights on how to sustain, are tremendous to us, in terms of the ability to work with the Navy on new components and the ability to do things smartly in the design, right up front, that the two primes are telling us that it's a much more competitive environment and much more affordable approach.

Senator FISCHER. Okay. Thank you.

Senator Heinrich.

Senator HEINRICH. Under Secretary Lord, as you know, we are modernizing three weapons platforms, a new cruise missile, and multiple warhead systems, all concurrently. What contingency plans do you have if any one of these programs slips?

Secretary LORD. We are the point where, for decades, we have put off modernizing these programs. Right now, we have no choice but to move forward, and move forward in lockstep with NNSA. So, we are focused on GBSD, particularly, and looking at plutonium pit production, making sure we have 30 by 2026, that we have 80 per year by 2030. So, we do not have any margin, at this point, because, for decades, we have delayed.

Senator HEINRICH. I don't disagree, and certainly, I'm fully committed to working with you to ensure that Los Alamos can get to 30 by 2026, safely and expeditiously. However, from a broader good-government perspective, I'm going to remain determined to hold both yourself and others accountable for the decision to split plutonium production and to build, really, an entirely new plutonium pit production complex. The independent IDA study found that none of the plutonium pit options were demonstrably better than any of the others. So, I have to ask, how did the Nuclear Weapons Council select an option that is literally twice the cost of

other options and will force appropriators to find an additional 14 billion-plus dollars?

Secretary LORD. The Nuclear Weapons Council looked at the data we had. Since we do not yet have a conceptual design, we do not have firm cost data. If we get funding for the conceptual design in the 2020 budget, we will have it by the end of 2020. We will then be able to understand the cost implications. The IDA study that was done said there was no significant difference in the cost between the two alternatives. The multiple alternatives.

Senator HEINRICH. So, the need for redundancy has never been in the nuclear complex, or at least articulated, and was nowhere in the Nuclear Posture Review, was nowhere in the analysis of alternatives, or even the engineering analysis conducted by the Pentagon and the NNSA. So, when did the Nuclear Weapons Council decide that redundancy was a factor, even "the" factor, for splitting pit production?

Secretary LORD. The Nuclear Weapons Council focused on the Nuclear Posture Review, which states, "An effective, responsive, and resilient nuclear weapons infrastructure is essential to the U.S. capacity to adapt flexibly to shifting requirements." So, what we looked at was a resilient capability. It wasn't particularly redundant. What we found the best option to be was to, first, produce the 30 pits——

Senator HEINRICH. What does that mean, "resilient"? How do you define that?

Secretary LORD. It means we have the ability to have multiple options to meet our requirements. So, we will start at Los Alamos with the trained workforce we have there. We have to add about 1,000 jobs a year at Los Alamos, given everything we have in front of us. We then will look at South Carolina, where we have a facility that can be upgraded, and a large workforce in a community that's very, very interested in moving forward.

So, what we are doing is, we are standing up, first, Los Alamos, then we will move to Savannah River, and move on from there with two different options to mitigate any type of catastrophes we might have in one or the other, and also be able to tap into the workforces of each of the communities.

Senator HEINRICH. How do you square your certification that this split production option is on track to get us where we need to be, when the independent study comes to such a starkly different conclusion?

Secretary LORD. The independent study said that there was no path without risk involved, and that there was no significant differences in all the risks. So, we're waiting for the full study to be done at the end of June, and then, every day we don't move forward with the conceptual design and on to the follow-on details, we will slip. So, we think this is the best path forward right now, but we need to get down to work, and continue with it.

Senator HEINRICH. General Ray, your bomber roadmap states that we'll field 175 bombers, about 100 B–21s, and 75 B–52s, when all is said done, out in the 2030s. This has concerned some people, but it seems to me, as long as we're producing B–21s, we have the flexibility, 5 or 20 years from now, to change that number, up or

down. Do you believe this number is set in stone, or is it more flexible than that?

General RAY. It is more flexible. The bomber roadmap that we have right now is the product of a programmatically-driven solution. The analysis that we're looking at for inside of the Office of the Secretary of Defense (OSD) and inside the Air Force has revealed it will be at the forefront of anything that happens. The Air Force we need has shown a growth in bomber squadrons. The Center for Strategic and Budgetary Assessments (CSBA) study and the MITRE study show a growth in that, and so, my role here now in Global Strike Command is to set the foundation for smart and good growth.

The decision point to look closely at the B–21 production rate is in about the 2024 timeframe. So, we've got a very good program, very good program managers there, and we all agree that, once we get to that point, we have some options. But, in the meantime, there are some sustainment options we're going to look at to make the bomber roadmap that we have more affordable. I'm convinced we're underinvested in the countermaritime dimension of long-range strike. We're underinvested in hypersonics and, potentially, counterspace. So, my job is to set the foundation for the Chief and the Secretary to have some more innovative options, here, in the next 2 or 3 years, to expand beyond the minimum of 100 B–21s and 75 B–52s.

Senator HEINRICH. Thank you.

Senator FISCHER. Thank you, Senator Heinrich.

Senator Rounds.

Senator ROUNDS. Thank you, Madam Chair.

General Ray, first of all, I really appreciate that the Secretary of the Air Force's strategic decision to choose the Ellsworth Air Force Base as the first B–21 base is moving forward. Since the Air Force has requested funding in fiscal year 2020 for two weapons-generation facilities—and these would be at Warren and Malmstrom, if I'm correct—when would we expect to see funding requested for these weapons-generation facilities at all of the bomb wings, including Ellsworth Air Force Base, to support the B–21? Assuming fiscal year 2021 beginning or otherwise?

General RAY. Sir, the process we're following now, of course, with the main operating base (MOB) declaration and the National Environmental Policy Act (NEPA) process that we started that you and I talked about is one piece of it. The Secretary insisted that we rethink, and we reported back to Congress recently that we needed to reevaluate our WGF game plan. We are proud to say that there is a good plan for the ICBM WGFs, and that remains on track. The Secretary has given us a homework assignment. We've gone back and looked at that very closely, broadened our team to collaborate on some more insightful and appropriate approaches to this. She's not blessed our roadmap just yet, and so, I'd like to be able to come back to you and to the committee with a more informed long-term game plan that would—just like Senator Heinrich's question, that would accompany the right bomber roadmap and give you better insights.

[The information referred to follows:]

General RAY. In August 2019, AFGSC briefed the Acting Secretary of the Air Force and received approval on the way ahead for bomber WGFs, subject to budgetary decisions within the Air Force, Department of Defense, and the Office of Management and Budget. The Air Force remains on track to submit the Barksdale WGF as part of the fiscal year 2022 budget submission. B–21 WGF construction will be timed to coincide with projected B–21 acquisition and fielding timelines; location and funding decisions are not yet final.

Senator ROUNDS. Timeframe for that report?

General RAY. Sir, I think the decision from the Secretary should be in the next couple of months, and then our ability to refine that, I'd like to come back to you by the end of the fiscal year, if that's possible.

Senator ROUNDS. So, it would still be available to maintain on-track planned developments for fiscal year 2021 appropriations.

General RAY. Sir, if I could come back to you with that assessment, I can give you a better sense of when that would be.

Senator ROUNDS. My point being, at this point, there is not an anticipated delay in the construction processes, because all of these new facilities need to be in place before the B–21 can actually be facilitated, correct?

General RAY. Sir, not every facility has to be there, and that's part of the Site Activation Task Force (SATAF) planning that's beginning now, and part of the NEPA process. But, the sequencing of these things has been perturbated with the supplemental request for the emergency relief in our military construction (MILCON) game plan. So, we need to come back and then lay out the roadmap for the timing of how we're going to do all these steps. I think we should include all the bomber bases to give us clarity. The closest challenge that we have right now is for the Barksdale facility, based on the B–52 in the current nuclear mission, and then to add on, where we can, for the additional B–21s.

Senator ROUNDS. Okay.

For Secretary Lord and General Ray, both. Have you found that the nuclear command, control, and communications (NC3) acquisition and operational management has improved since Secretary Mattis designated U.S. Strategic Command as the enterprise lead and the Under Secretary of Defense for Acquisition and Sustainment as acquisition lead and primary policymaker for OSD?

Secretary LORD. I would like to address that. Yes, I believe it has. In fact, we just very recently completed an NC3 Enterprise Review with General Hyten, myself, General Selva, the Deputy Secretary of Defense (DepSecDef), and we are reviewing all the key programs, looking at fragility, making sure we're addressing key items. Again, we need to modernize and sustain at the same time. We're, again, dealing with Cold War technology that needs to be upgraded. What is particularly key, in my role in acquisition and sustainment (A&S), is that I have your support for the 14 billets in the 2020 National Defense Authorization Act (NDAA) that I need in order to help staff and move this forward.

Senator ROUNDS. Thank you.

General Ray?

General RAY. Sir, it's emphatically helped us as a team, greater coordination at all levels and echelons of influence and stewardship. The additional pieces, we're adding some more operationally relevant approaches to how we're doing business so that you can

manage the risk. I have great coordination with OSD, the Joint Staff, and certainly with General Hyten. I believe that's going to be very helpful. I've asked for an independent review to come in and relook at the NC3 center that is in my command. When it stood up, it was stood up without the U.S. Strategic Command (STRATCOM) role and the oversight from OSD. I believe, with some minor modifications, we can be even more effective.

Senator ROUNDS. Thank you.

I'd just—very quickly—and I'm not even sure who to address this to, so I'll offer it and then ask whoever feels comfortable with a response. Would it be fair to say that both our near-peer competitors, China and Russia, have both significant advantages today, in terms of the upgrades to their NC3 development and upgrades that basically push us to make certain that we are getting ours done just to be in a competitive and at least in a near-peer position over the next couple of years?

Secretary TRACHTENBERG. Senator Rounds, if I could, just generally, I would say, without getting into specific capabilities of Russia or China, I would note that both of those countries have very aggressive modernization programs underway, and have had them underway for quite some time. One of the basic premises contained within the National Defense Strategy is that we are at risk of losing our competitive advantages to potential adversaries; hence, the need—and I would echo the comments of my colleagues here, also—with respect to the importance of maintaining our NC3 architecture and infrastructure.

From my perspective, sir, the nuclear command, control, communications enterprise is the glue that holds our nuclear deterrent together. Hence, it is critically important to ensure the robustness and reliability of that, going forward.

Senator ROUNDS. Thank you.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator Rounds.

Senator King.

Senator KING. Thank you, Madam Chair.

Secretary Lord, in your testimony, you used the word "credibility." Do you feel that, if we slip on our schedule—for example, with *Columbia* or otherwise in all of the elements that we're trying to modernize at one time, that that diminishes credibility, which, in turn, diminishes deterrence?

Secretary LORD. Absolutely.

Senator KING. That strikes me as one of the great dangers here. As you do your planning and your charts, are there gaps? Are there places where—for example, this is hypothetical, but *Columbia* doesn't come on until a certain period? And *Ohio,* we're starting to be retired. Are there gaps in our——

Secretary LORD. Absolutely. There's a one-for-one with *Ohio* and *Columbia,* and that's why, for instance, *Columbia* is one of the major defense acquisition programs that I milestoned decision authority for, and I review that very, very closely. In fact, on Friday morning, I have a quarterly review on it, and I look very closely at what we have for capacity in our shipyards to build it.

Senator KING. Am I understanding there's been some issues about the tubes?

Secretary LORD. We have a common missile chamber, actually, with the UK [United Kingdom], and the first ones being fabricated are for the Dreadnought, the United Kingdom sub. They're up in Quonset Point, Rhode Island, right now. There were some cracks on them. It's a technically challenging weld. There were issues with the nondestructive tests that were being done. We identified it. We've gotten to the root-cause analysis and, I think, irreversible corrective action. We're working very closely with a key contractor——

Senator KING. Is that going to cause the schedule to slip?

Secretary LORD. We think it is contained. I will find out, again, on Friday. But, right now, there shouldn't be. I'll defer to Admiral Wolfe.

Vice Admiral WOLFE. Yes, ma'am—yes, sir, if I could answer that.

So, right now, based on, as Secretary Lord said, knowing what we know about the welds, getting to the root cause, we still have margin in the program. We have 11 months margin. If you look at how the Navy has responded to this, both the Navy and General Dynamics Electric Boat, we've staffed up, we've realized several things. One is, it's the fragility of the industrial base, which we've talked about already. So, making sure that we are getting that industrial base not only where it needs to be, but to get it to status quo and sustain it. That's why we've stood up, in the Navy, a separate program executive office just for *Columbia,* because this is the Navy's number-one acquisition program. So, we're taking all the steps to make sure we've got the proper oversight to keep this on track.

Secretary LORD. If I may, just one more point on that.

This is so very, very important to us that, frankly, after the last *Columbia* review, I had the week before Christmas, I had Phebe Novakovic, Chief Executive Officer (CEO) of General Dynamics (GD), come in on the Friday afternoon before Christmas to sit down and talk about how the supply chain was being managed and what we have for staffing. So, working very, very tightly with Hondo Geurts, in the Navy, on that one.

Senator KING. Well, deterrence is the heart of our defensive posture, and credibility is the heart of deterrence. So, that's obviously of great concern.

Mr. Trachtenberg, do we need to match every new Russian nuclear-armed delivery vehicle?

Secretary TRACHTENBERG. Absolutely not, Senator King, and it's certainly not our intent to match what Russia is doing, weapon for weapon. Our basic concern is that we have seen, through the development of Russian military doctrine, some of the exercises they have conducted, and our concern is that the Russians may believe that they have some kind of exploitable advantage through the development of capabilities that they have developed. Through our Nuclear Posture Review and the programs that we have asked for support for to develop, we hope that we can certainly convince the Russians not to miscalculate and believe that anything they are doing would offer them an advantage that could be exploitable or where they could miscalculate, and competition could lead to conflict. But, no, the short answer to your question is no.

Senator KING. But, clearly, again, getting back to deterrence, we need to be sure that they don't feel that they have a weapon that can penetrate our defenses or will otherwise go unresponded.

Let me ask one more question. This is sort of an odd question, but you'll have to excuse it. I'm spending a lot of my time these days in the cyber arena. One of the big issues in cyber is attribution. Where is the attack coming from? Is there a potential for attribution issues in this area, particularly where you're talking about an underwater, unmanned vehicle, knowing where it is going? We need to know who to respond to and what the response will be. Am I just making something up, here, or is this an issue?

Secretary TRACHTENBERG. No, sir. I would not say you're making anything up, here, Senator. I think you're absolutely right to focus on cyber as an element in the deterrence equation. What we have seen, certainly over the past decade or so, is the development of cyber as a domain where we need to pay particular attention to what is happening and what our adversaries are doing. Attribution is certainly one element when it comes to our overall deterrent and the credibility of that deterrent and how we might respond. Cyber is a piece of that.

So, you're absolutely correct to flag that. That is one of the additional technologies and capabilities that we need to look at, and are looking at, as a Department.

Senator KING. Well, a big part of our upgrade is command and control. I'm out of time, but that's as important as anything else we're talking about here, I think.

Secretary TRACHTENBERG. Absolutely.

Senator KING. Thank you.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator King.

Senator Cramer.

Senator CRAMER. Thank you, Madam Chair.

This was not something I was going to ask about, but just to, maybe, follow up on that line of thought. How important is space to that, then? Because we're going to have a decision to make, here, on Space Force and what happens next. Maybe whoever wants to talk about that could add to that. But, Secretary, it seemed like the appropriate time to ask.

Secretary LORD. Perhaps I'll make a comment and then pass it down through.

When you talk about nuclear command and control, space is an incredibly important portion of that to make sure we have secure and resilient communications, and our space layer is critical for that. The cybersecurity of that is another piece. That's why we're working so hard to make sure that we have hardened systems, and why so many of these systems need to be upgraded, because they're just not capable of being hardened today.

But, I'll hand over.

Secretary TRACHTENBERG. Yeah, just briefly, Senator Cramer. I would agree with that completely. Space is critically important. Almost everything that we do nowadays relies, to some degree, on space and space systems. Key aspects of our NC3 architecture—for example, missile warning or command and control—are space-based. So, we very much need to be focused on the survivability,

the resilience, and the capability of those space-based elements for the deterrence mission, as well as for others, as well.

Senator CRAMER. General Ray?

General RAY. Senator, I think one of the other dimensions is to go beyond just simply the importance when we think about where we are. One of the new roles I have under Strategic Command, is as the Joint Force Air Component Command (JFACC). So, one of the jobs I do is to coordinate the air and space dimension. With space leaving STRATCOM, I now have to be the space coordinating authority. So, I will tell you, the indications and warning dimension, to get to Senator King's point about attribution, is foundational to everything we're doing. But, what it's allowed us to do in this last exercise is to actually map kinetic and nonkinetic threats from a space, cyber, and physical domain against our nuclear command and control and indications warnings. So, we have a better roadmap now, at the very classified level, about what to contend with, and it'll help us with the recipe of how to deal with those coming.

Senator CRAMER. That's probably as important in a submarine as it is anyplace, huh?

Vice Admiral WOLFE. Yes, sir. I would tell you, cybersecurity has to be at the forefront of everything that we do, moving forward. Some people would say, "Well, you're on a submarine, you're kind of out, right? You don't need to worry about that." We all need to worry about it. So, it doesn't matter what you're doing, and everything that we're doing in the Navy, whether it be NC3, whether it be what we're doing in the Trident, cybersecurity is a part of everything that we're putting in place, moving forward.

Senator CRAMER. I'm going to resist the temptation to just go on, on the whole Space Force idea, and get, maybe, General Ray, from you, a broader elaboration on the importance of the entire triad. Because, as we're having this discussion of modernization, there are those in office who think that three legs is at least one too many, if not two too many. Maybe if you can just describe, strategically, why they're all relevant, if you believe they are, that that would be helpful.

General RAY. Yes, sir. My perspective comes from being the Deputy Commander in European Command, the head of a combatant command on a daily basis in support of General Scaparotti. I've learned to look at our triad in the context of a modernized Chinese triad, a modernized triad-plus on the part of the Russians, and clearly in the minds of our allies. Any change in that has to make a collectively more safer plan. So, our triad is foundational. It has to be where we go. As we've said, we have to modernize it. Any change in that has to be done to where we do change the rest of the dynamic, and do our allies believe that the world is a safer place? I think there's no solution right now I can imagine that would say to back off the triad. You heard Secretary Mattis, one of the brightest military minds, said, "I questioned it, and I cannot solve the deterrent reducing from the triad."

Secretary TRACHTENBERG. If I could——

Senator CRAMER. Please.

Secretary TRACHTENBERG. May I, Senator?

Senator CRAMER. Please.

Secretary TRACHTENBERG. Just briefly, to pick up on what General Ray said. I think, in terms of the triad, I tend to look at the capabilities the triad brings for deterrence as complementary rather than redundant, because I do believe each of the legs brings unique characteristics that are useful in a deterrence perspective. I think that is why every administration has reiterated the importance of maintaining all three legs of the triad. We can discuss the numbers for each, but, in terms of the critical and unique capabilities each brings, whether it is reliable command and control, resilience, survivability of the sea-based leg, adaptability and flexibility of the air-breathing leg, the bombers, the geographic dispersion of ICBMs, each brings a unique component to the overall deterrence equation, which complicates the—any attack calculations that a potential adversary might have. I think that is sort of the inherent value of the triad.

Senator CRAMER. Oh, I appreciate it. That was a great summary. I'm glad you took the time to say it, because I was even intrigued by Senator Heinrich's question about resiliency versus redundancy. I think I just heard how the two are the same—the two parts of the same umbrella, if you will, and so, I appreciate that. Thank you.

Yield back.

Senator FISCHER. Thank you, Senator Cramer.

The vote has been called, but we're going to continue with the hearing. We're moving pretty well through questions. I would urge Members to stay, or go vote and come back, because we'll have time for more questions.

Secretary Trachtenberg—oh, Senator Manchin, if you're ready, would you like to ask questions right now?

[Laughter.]

Senator FISCHER. I'll let do your first round. That's putting you on the spot. Walk in the door.

Senator MANCHIN. This will be to Secretary Lord. You and the other witnesses' testimony highlights the multiple modernization programs that we're undergoing right now. We have the ground-based strategic deterrent, the long-range standoff weapon, the B–61, and –12, and B–21. The list goes on and on. So, I'm concerned about the testimony, such as Secretary Trachtenberg's written testimony that highlights the rapid growth of China's nuclear forces in the face of all the corporate espionage we know they're conducting. So, my question would be—and I'm sorry if it's already been asked about—but, what steps are you taking to ensure that our nuclear modernization efforts remains with us and aren't stolen by the Chinese or Russians or from our subcontractors? The biggest problem we've seen to be as it goes down the food chain, procurement? It seems to be wide open for the taking.

Secretary LORD. Senator, this is really on point, because, if there's any area that has received enhanced focus over the last 18 months more than any other, it's cybersecurity. So, in my responsibility for the defense industrial base, I've looked at the problem and have seen that we have a fundamental issue, that we have National Institute of Standards and Technology (NIST) cybersecurity standards that are very hard to interpret if you're a contractor, in terms of how you actually instantiate those. So, what we're doing

right now is, by the end of this year, we will have a national cybersecurity standard, just like we have International Organization for Standardization (ISO) standards for quality.

Senator MANCHIN. Well, who's maintaining the visibility on those contracts to ensure that nuclear projects aren't being exposed the same way the Navy's undersea programs were last year?

Secretary LORD. We are, as I have responsibility for a number of the larger programs, like GBSD and so forth, so it's a milestone decision authority. So, as we go through the reviews, we look at what our supply base is doing, how they are secure, both in their software development, especially, but in terms of physical security, as well. We work very closely with intel, with DSS——

Senator MANCHIN. Do you believe the primes should be held responsible——

Secretary LORD. Absolutely.

Senator MANCHIN.—and held accountable——

Secretary LORD. Absolutely.

Therein lies the problem. Typically, primes are pretty good. Maybe the next level down. But, they lose sight, and what we did, just about 3 months ago, was, we introduced new cybersecurity clauses that are going in all the contracts, moving forward. So, it is absolutely clear——

Senator MANCHIN. How does that change the whole business model—I'm so sorry, because our time will be running—how does it change the business model, when there's a sub, three rungs down the chain, who doesn't want to, basically, give you pertinent information or have someone else have access to that information? I mean, I just couldn't believe what's going on and how vulnerable we have been over the years. There's no wonder why China has accelerated the way they did, the access they've had to the system.

Secretary LORD. I don't disagree with you. It all starts with standards that you can measure to, that have metrics, so we know what right looks like, in terms of cybersecurity. Then it turns into educating the workforce. So, we're standing up courses at our Defense Acquisition University. So, it comes to really making sure our acquisition workforce has the skillsets they need, and that we communicate that to our industrial base, and that we have actual metrics that say, "This is what"——

Senator MANCHIN. If there's not financial penalties to the prime, this'll never work.

Secretary LORD. You're absolutely correct. In fact, we go right back to source-selection criteria. If it——

Senator MANCHIN. I'm sure, any primes out there, you're not really happy with this line of questioning. But, it is the way it's evolved over the years. It's got to change.

Secretary LORD. We have never clearly said what is acceptable, what is unacceptable. So, we'll start at contract award. But, it's a critical issue, and we're having ongoing discussions. We meet quarterly with the three largest industrial associations.

Senator MANCHIN. If I may—and I'm sure anybody else—if you can keep us informed. If we can look and see what you all have been able to do——

Secretary LORD. Absolutely, I would very much like to—we can come and give you a briefing——

Secretary LORD. My office will continue to engage with you on this issue and keep you informed.

Senator MANCHIN. Love to. I've spoke to primes and everything, and I've spoke to the subs all the way down the food chain, and there is nothing that's, basically, linking them together. Sometimes the primes don't even know who the subs are far enough down the food chain.

Secretary LORD. Well, this is exactly what we've gotten at, and exactly what's going to change.

Senator MANCHIN. Well, I appreciate it—I appreciate all of y'all here. But, we just want to help you. Our job is to help you.

Secretary LORD. Thank you.

Senator MANCHIN. We want to work together.

Thank you very much.

I'm so sorry. We're all running to vote.

Senator HEINRICH [presiding]. Well, Senator Manchin, it's just you and I now, so you don't have to apologize. You can even sneak one more in, if you want, before you go.

[Laughter.]

Senator HEINRICH. He couldn't pass that up. So, you do one more, and then I've got a whole pile here.

Senator MANCHIN. The other one I would have is the relationship between the Missile Defense Agency and the Space Development Agency, to ensure that all aspect of nuclear deterrent missions are being executed under a united line of effort. If you have something along those——

Secretary LORD. Well, we are just now standing up the Space Development Agency, and what programs are within what entity are just being adjudicated now.

Senator MANCHIN. General Ray, I think that you highlighted the much-needed improvements in our satellite systems from advanced extremely high frequency satellites in orbit and production of that. How's that coming along?

General RAY. Sir, we're making good progress with the terminals and the elements. We visited the team at Raytheon recently, and all that progress is where we'd like it. We were behind, and we had to restructure the program. So, I'm pleased with it, going forward, and the key will be to keep on the primes to execute as we've laid it out.

Senator MANCHIN. Secretary Trachtenberg, your written testimony included a couple of mentions of Iran as a nation trying to tip the balance of power. Would you want to expand on that?

Secretary TRACHTENBERG. Yes, sir. You're correct, we were very much concerned, in terms of looking at Iran and seeing where Iran is going. Iran continues to be the prime supporter of terrorism. Iran continues to develop ballistic missile capabilities. So, we're watching that very carefully.

We face a variety of threats today, not just from Russia and China, as large competitors, but also there are still threats that we need to deal with from North Korea and also, potentially, Iran, as well. So, we are looking at them.

Senator MANCHIN. Are we selling missiles to Saudis?

Are we providing access to missiles to the Saudis?

Secretary TRACHTENBERG. I'm not sure what missile tech—are you talking about actual missiles?

Senator MANCHIN. Uh-huh.

Secretary TRACHTENBERG. If I could, I will get back to you on that. I'd like to take that one for the record.

Senator MANCHIN. Yeah. I would, too.

Senator HEINRICH. Thanks, Senator Manchin.

No surprise I want to return for a moment to pit production again. Under Secretary Lord, my understanding is that we're probably a few years away from a Critical Decision 2 (CD2) estimated independent cost analysis of what the real, sort of, concrete and steel costs are going to look like at the Savannah River site. Probably out in 2021–2022. So, how do you certify now that we're on track, when we don't really know even what those costs are going to look like yet?

Secretary LORD. We work very, very closely with NNSA under the framework of the Nuclear Weapons Council. What we have from them is the engineering analysis, moving forward. As they move into conceptual design, we will begin to get clear track as to the actual dollars. But, the estimates we have right now, they certify they believe in, and we back them up, and we believe this is the best path forward from the alternatives we've seen so far.

Senator HEINRICH. One of the reasons why I'm dubious is because we've done the big-box thing before. We had the Chemistry and Metallurgy Research Replacement Project (CMRR) plan, and that sort of collapsed, in and of its own weight, and everyone moved to a modular plan, which seemed to have a great deal of traction. Now we're back to the big-box plan.

I'm going to switch gears here. General Ray, I know the Nuclear Weapons Center at Kirtland coordinates nuclear certification of all systems involved with nuclear weapons. How concerned are you about the current staff levels there?

General RAY. Sir, I'm concerned about that staff level and what it's going to take to deliver, when it comes to that, into the right sustainment game plan team, the right team to go from design to execution, managing that talent base. I'm worried about that. The NC3 enterprise, in terms of the expertise. So, broadly, we're in competition for a great deal of high-tech talent. So, as we look across the entire spectrum, it's something that we, as a team, have to continue to drive a competitive environment——

Senator HEINRICH. Yeah.

General RAY.—and then to do very good planning that let's us forecast what we need. I think the digital engineering that's in front of us gives us the chance to bring in a lot of young talent, which is what we're really in the need of doing to make sure that—as Secretary Lord talked about, this is Cold War stuff. We may have a lot of older engineers in the game, and we need to bring in more and more of the young folks in the Science, Technology, Engineering and Math (STEM) program——

Senator HEINRICH. You have the incentives to be able to make that happen?

General RAY. Sir, that manpower plays in a different pool, but I certainly would be willing to follow up with some more insights later, after collaborating with the team.

Secretary LORD. May I comment on that?

Senator MANCHIN. Under Secretary?

Secretary LORD. One of the things we are very much challenged by is getting the talent we need at the right time. One of the ideas we've had, particularly on the acquisition side to get individuals with the technical credibility to run these acquisition programs, is, we are floating the idea of having sort of an Reserve Officer Training Corps (ROTC) for acquisition professionals, where, for every year of college we would pay for, we would get 2 years service back. So, we would have 8 years of very technically qualified people to help run these programs.

Senator FISCHER [presiding]. Thank you, Senator Heinrich.

We're just going to keep going.

Secretary Trachtenberg, from a policy point of view, can you discuss the importance of NATO remaining a nuclear alliance, and how close allies with independent nuclear deterrent capabilities and who are committed to NATO complement U.S. decisionmaking and deterrence posture?

Secretary TRACHTENBERG. Well, certainly, Chairman Fischer. Absolutely. It is critically important. NATO is a nuclear alliance. The NATO statements that have been made reaffirm that NATO is a nuclear alliance. We have very good relationships, of course, certainly with the UK and France, that are both nuclear partners—or nuclear states, I should say. Maintaining alliance unity, when it comes to the importance of sustaining a robust nuclear deterrent that is in the benefit, not just of the United States, but in the benefit of the alliance as a whole, is critically important. We engage in discussions at various levels with our NATO allies repeatedly. We have found a good sense of unity and an understanding among our allies, in terms of U.S. policy and the need for modernization and the need for our alliance to remain a nuclear-capable one.

Senator FISCHER. Thank you.

Mr. Secretary, in the course of the Nuclear Posture Review, did the Department gather allied feedback on the idea of adopting a no-first-use policy? What was that?

Secretary TRACHTENBERG. We discussed a variety of issues in the course of developing the Nuclear Posture Review with allies. The no-first-use issue, of course, is one that has come up repeatedly, in terms of discussions and debates over whether or not it makes sense, from an alliance perspective, to go down that path. From our perspective—and I believe it is shared by our allies, as well, that we have spoken with—a no-first-use-of-nuclear-weapons policy would be counterproductive to deterrence. It could actually undermine deterrence. It could undermine the assurance value that our nuclear deterrent brings to our allies. It could also, by lowering allied confidence that the United States, in essence, has their backs and would be prepared to defend our allied security, at any level of conflict—could push at least some of our allies to consider the acquisition of nuclear weapons, themselves.

So, I would argue, from the standpoint of a no-first-use policy, I see that, generally, as a negative, from a variety of levels, including the nonproliferation aspect of U.S. policy. I happen to believe that our current policy and our current extended deterrence, the so-called nuclear umbrella of security that we provide to others, is

perhaps one of the best and most successful nonproliferation policies that the United States has implemented.

Senator FISCHER. Thank you.

Secretary Lord, we keep hearing arguments that DOD can't afford everything it wants, it must set priorities, and that we should cut spending on nuclear forces to prioritize other things, like space or cyber. The implication here is that the Department is only requesting funds for nuclear modernization as a result of failing to prioritize. But, as I noted in my opening statement, I believe the opposite is true. Can you elaborate on the Department's priority level for nuclear deterrence?

Secretary LORD. Three Secretaries of Defense have called nuclear deterrence the DOD's number-one priority. It's very clear. Our National Defense Strategy calls it out. The Nuclear Posture Review goes into much detail about how we deliver on that, and, as we've been talking about, we really are dealing with Cold War technology right now. We have weapons that are decades over what was supposed to be their useful life, and we are out of time. We need to continue on the path we're on, or we are going to fall behind and not have the nuclear deterrence that we enjoy today.

Senator FISCHER. Secretary Trachtenberg, would you like to add anything?

Secretary TRACHTENBERG. I would, Senator. The only thing I would add is that, when you look at what our nuclear deterrent buys for us, I would argue that it is a relatively inexpensive investment, because that is the ultimate guarantor of our security. In terms of the amount of fiscal resources we invest in the modernization program, it is a relatively small fraction overall of the DOD budget, approximately 3-and-a-half percent. At the peak of the planned modernization program, that percentage may rise to about—somewhere between 6 or 7 percent of DOD spending, still much less, in percentage terms, than what we spent during the modernization cycles of the 1960s and the 1980s. So, from the standpoint of what nuclear deterrence gets us, I would have to argue that I think it's actually a bargain.

Senator FISCHER. Thank you.

Mr. Secretary, critics argue that the Department plans to develop an intermediate-range system in response to Russia's violation of the INF Treaty will serve no purpose unless a foreign nation agrees to host them. Therefore, the program shouldn't proceed without such an agreement. Of course, this view does overlook the fact that a mobile system could be deployed in response to future provocation, and potential adversaries would have to contend with this fact. Could you speak to this issue and why the Department believes intermediate-range systems are a critical part of our response to Russia's dismantling of an arms control treaty?

Secretary TRACHTENBERG. Of course, Senator. I appreciate your characterization of Russia's dismantling of an arms control treaty, because, obviously, as a consequence of Russia's clear violation of that treaty, and also, I might add, consistent with the Sense of Congress expressed in the fiscal year 2019 NDAA, the United States suspended its obligations under the treaty, and we also gave notice of our intent to withdraw from it. It is, in fact, Russia, I would argue, that has abandoned the treaty as a result of its viola-

tion, and our allies, as I mentioned previously, support the actions we have taken in response.

Yes, we are moving forward, as a result, with developing conventionally-armed ground-launched intermediate-range missile capabilities. What sort of system we ultimately develop will be driven by our assessment of military requirements and, of course, in consultation with the Congress and with our allies and partners. So, it remains to be seen where we will go, but I will say—and Senator Heinrich mentioned, at the start—made a comment—I think he expressed some concerns that we had——

Senator FISCHER. I'm sure when he returns, he'll be visiting with you about it.

Mr. TRACHTENBERG.—absolutely—that we had gotten out of the INF treaty with nothing to show for it. The point I would make there, Senator, is, we have nothing today, because, for 30-some years, we have been in strict compliance with the terms of the INF treaty that prohibited the kinds of capabilities that, if the treaty terminates in August of this year, we will then be free to develop and proceed with.

Senator FISCHER. Right, and it is a bilateral treaty. It does not take into account what other countries, such as China, may be developing. I think it ties our hands with regard to other nations when they are able to move freely about, and I agree with you on the Russians, and in regard to the INF, as well.

Secretary TRACHTENBERG. Yes.

Senator FISCHER. So, thank you.

I see we have been joined by Senator Hawley. A lot of back-and-forth here. So, if you are ready for questions, just coming in, please go ahead, Senator.

Senator HAWLEY. Okay. Thank you very much, Madam Chair.

General Ray, I appreciated the phone call that you and I had a few weeks ago about the stationing plans for the B–21. Obviously, we're very excited about that in my home State. My staff had the chance to visit Whiteman again last week. We are delighted about the future, here.

As we've discussed the need to modernize all three legs of the nuclear triad, I think this may be a good opportunity to talk about why the bomber leg is so important. I wonder, General Ray, if you could talk to us a little bit about the rationale behind maintaining, and indeed updating, burnishing this particular leg of the triad and its significance for our defense.

General RAY. Yes, sir. The comment has been made by Secretary Trachtenberg about the extended deterrence dimension of a bomber leg. The very visible and flexible element is just one piece. So, when our allies look at the extended deterrence and the counter-proliferation dimension, they probably, more than likely, look at the bomber first, the ability to escalate and send the signal with a generation of the bomber force, the flexibility of the bomber force both for penetrating and for a standoff capability. When I consider the would-be adversaries' defensive systems and the complexity of that, the clear need to go after those challenges with penetrating and standoff to assure no sanctuary of anything that could harm the United States is one of the other particular dimensions to it. But, I think when you just step back and consider all three legs,

the interrelated dimensions of this, when we think about modernizing an old fleet to a new fleet, the inherent risk on all three legs, I watch every single step of the way for the old fleet to the new fleet and knowing how will I close any of the gaps, the bomber is my most flexible and visible piece.

Secretary TRACHTENBERG. May I add a comment, Senator just briefly?

Senator HAWLEY. Yes, Mr. Secretary.

Mr. TRACHTENBERG. The bomber leg of the triad is the only leg of the triad that is essentially recallable. Because of the speed, its relative slowness compared to a ballistic missile, it gives decision-makers additional time and space to try to negotiate or reduce, in a crisis, the opportunity for miscalculation or any unintended or potential escalation. So, the bomber plays a unique role in the triad, for those reasons, as well.

Senator HAWLEY. Yeah, thank you for that. That's very significant. Thank you for pointing that out.

Let me also invite you to touch on why it's important to have different platforms that are able to fulfill this dimension. You know, it's probably hard to find two aircraft that are more different, for instance, than the B–2 or the B–52. So, speak to that, if you would, General, and, Mr. Secretary, if you want to, or anyone else.

General RAY. Yes, sir. I fielded a question earlier in this hearing about the size of the bomber roadmap. First of all, the size of the conventional bomber fleet is the sizing mechanism for how many bombers we have. The analysis we have tells us where a conventional campaign begins to falter without bombers. I can't go into that here, but all the studies are now showing a broader number of bombers are required, beyond a minimum of 100 B–21s and 76 B–52s. We just pulled one out of the boneyard to get it refurbished. So, when I think about the standoff, the stand-in, and the complementary capabilities, and the need to grow beyond these two platforms to keep our options open as much as we can in the short term, to provide the leadership the chance to make informed programmatic decisions, here, in the future, the roadmap tells us, in about the 2024 timeframe, we'll be able to make an insightful acquisition-ramp decision for the B–21. Meanwhile, we've got a lot of work to do with sustainment for the B–1, the B–52, and the B–52. All three of the current bombers.

Senator HAWLEY. Mr. Secretary, would you like to add to that?

Secretary TRACHTENBERG. I certainly concur with what General Ray has said. Agree wholeheartedly.

Senator HAWLEY. Great. Thank you very much.

My time is nearly expired, so I'll yield back. Thank you, Madam Chair.

Senator FISCHER. Since we are in votes and we've had two rounds of questions, I think, Senator Hawley, if you are satisfied with your questioning time——

Senator HAWLEY. I might just ask one thing, since you're offering Madam Chair.

Senator FISCHER. I never should open it up to you.

I know better.

[Laughter.]

Senator HAWLEY. Never give a lawyer a chance at just one other question.

You may already have testified on this, so forgive me if you have. Feel free to be extremely brief. But, I think it's so important as we think about the debate about nuclear modernization and about low-yield tactical nuclear weapons, which I'm sure you've discussed, but it never hurts to get it on the record again. There has been robust debate in this body, as you know, and in the other chamber, about a no-first-use policy, about whether we should even have low-yield tactical weapons; now that we have them, whether we should deploy them. If you could, just speak to, from a strategic perspective and a defense perspective, the importance of this class of weapons, from a defensive perspective, and why we need them, why we need to deploy them, and what role they play in our overall defense scheme.

Go ahead, Mr. Secretary.

Secretary TRACHTENBERG. If I could, briefly, Senator.

Senator HAWLEY. Yes, please.

Secretary TRACHTENBERG. I think that is a great question. The only thing I would say is that deterrence really is in the eye of the deteree, so to speak. What we want to do, and the reason why we have chosen to go forward on the path that we have chosen, with the low-yield ballistic missile, is because we have looked at what the Russians have been doing, in particular, and it is a cause of great concern, in terms of, I mentioned earlier, their doctrine, their military exercises, the possibility that they may miscalculate and believe that they could use a weapon——

Senator HAWLEY. You mean their "escalate to de-escalate" doctrine.

Secretary TRACHTENBERG. Absolutely, sir. Absolutely. So, what we are trying to do is, we are trying to foreclose any miscalculation on the part of any adversary, broadly speaking, that they may believe they have some kind of an advantage that is exploitable, that they could challenge us to take the next step that we wouldn't want them to take because they believe they've got a capability that allows them to do something where our response would be to either acquiesce or to escalate to a higher level of violence, which is something we clearly do not want to do. So, we're doing that, not to lower our threshold for nuclear use, but to raise the threshold in the minds of an adversary, or potential adversary, when it comes to nuclear use.

General RAY. Sir, my last 3 years in Europe in the competitive environment with the Russians, it's very clear in my mind they will look for the line, and they'll go right up to it, and they'll operate inside of that gray zone. Secretary Trachtenberg's right, you have to eliminate the gray zone and create a gray zone for them so they do not miscalculate and they do not intimidate us in front of our allies.

Senator HAWLEY. Thank you very much.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator.

With that, I would like to thank the panel members for their testimony today. I'll remind you that your opening statements will be

included in the record. So, if you have more to add to those, feel free to do so.

With that, I will adjourn the hearing. Thank you.

[Whereupon, at 3:36 p.m., the Committee adjourned.]

[Questions for the record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR MARTIN HEINRICH

ICBM REPLACEMENT

1. Senator HEINRICH. Secretary Lord, some have suggested we extend the life of the current Minuteman III system instead of the Ground Based Strategic Deterrence (GBSD) system to replace it. What are your views on this?

Secretary LORD. The 2018 Nuclear Posture Review highlighted the critical importance of an effective ICBM force in deterring strategic threats to the Nation. In order to maintain that capability into the future, we must continue our efforts to replace the aging Minuteman III (MM III) system with the Ground Based Strategic Deterrent (GBSD).

MM III, first deployed in the 1970s, is well beyond its original design life, will experience significant component attrition challenges, and faces emerging critical capability gaps. As described in the 2014 GBSD Analysis of Alternatives, a MM III life extension would address only some of these issues and, thus, would result in retaining a system that is less cost effective over its lifecycle and fails to address capability gaps in the deterrent.

2. Senator HEINRICH. General Ray, do you believe the existing intercontinental-range ballistic missile (ICBM) fleet can undergo another life extension program?

General RAY. (AFGSC) Extending the Minuteman system service life comes with greater cost, complexity, and does not address shortfalls. The current ICBM, Minuteman III, is faced with four different challenges: asset attrition, component/subsystem ageout, supportability challenges, and capability shortfalls. These aspects all drive a significant investment across the entire system through the mid-2030s to ensure continued ICBM viability. Analysis concluded a replacement strategy is more cost effective than life extension. A system replacement strategy provides opportunity to realize efficiencies during both the acquisition and long-term sustainment. We have miss the opportunity by at least four years to implement a sustainment/life extension program. ement a sustainment/life extension program.

3. Senator HEINRICH. Admiral Wolfe, we currently have an extremely effective and reliable missile guidance system. What are you doing to ensure the data and design can be used by the contractors who are competing for the ICBM replacement program or GBSD?

Admiral WOLFE. Since 2012, the Air Force and Navy Strategic Systems Programs have formally collaborated in technical areas, including strategic guidance systems. Over the last several years, we have conducted commonality assessments and identified components from the Navy's Mk6 Guidance Life Extension program that could be used for the Ground Based Strategic Deterrent program. The Navy has also shared with the Air Force data on current guidance sensors and potential future sensor technologies, has provided sensors for the Air Force's test and evaluation needs, and has shared experiences on ground testing capabilities. Formal collaboration including sharing relevant design and guidance system data will continue under the auspices of a 2018 Memorandum of Understanding among the Navy Strategic Systems Programs, Air Force GBSD program, and the Missile Defense Agency.

LONG RANGE STAND OFF WEAPON

4. Senator HEINRICH. Secretary Lord, we have multiple life extensions underway all at the same time. Why do you believe it is important that we also build the Long Range Stand-Off Weapon?

Secretary LORD. Maintaining a long-range, nuclear-armed, air-launched cruise missile (ALCM) capability ensures that the United States retains the ability to hold targets at risk globally, even in areas protected by advanced integrated air defense systems. ALCMs add significant flexibility to the range of capabilities available to USSTRATCOM, allowing planners to provide the President with credible response and signaling options in the event of a crisis.

The current AGM–86B ALCM will be nearly 40 years past its planned service life when scheduled to be replaced by the Long Range Standoff (LRSO) weapon, and is

already facing increased threats from advanced air defenses that it was never designed to address. Additionally, as it ages, ALCM will face continual sustainment challenges from components that are no longer in production and limited sources for replacement parts.

Additionally, as one of the less complex and least expensive aspects of the Administration's modernization plan, we believe LRSO can provide an important hedging capability for the deterrent as we transition from the legacy force to a modernized Triad.

5. Senator HEINRICH. General Ray, how does the Long Range Standoff Weapon match up against the Anti-Access/Area Denial capabilities of our adversaries?

General RAY. (AFGSC) The LRSO is being developed to be a survivable replacement for the aging Air Launched Cruise Missile (ALCM) in the future threat environment. Its design will feature advanced capabilities to allow it to penetrate current and future enemy advanced integrated air defenses, to include the A2/AD environment.

NEW START TREATY

6. Senator HEINRICH. Secretary Trachtenberg, the Pentagon has frequently touted the benefits of New Strategic Arms Reduction Treaty (START), particularly emphasizing the visibility and insight we gain into Russia's strategic nuclear forces. There have been rumors that the Trump Administration is considering either not extending the treaty or potentially even withdrawing from it altogether. If New START expires in February 2021 with nothing to replace it and there are no constraints on Russia's nuclear forces, would that increase or decrease the threat Russia poses to the United States?

Secretary TRACHTENBERG. Much has changed in the near-decade since the New START Treaty was signed in 2010, including the expansion of Russian and Chinese nuclear capabilities. A decision regarding extension of the New START Treaty has not yet been made, but will be balanced against changes in the strategic environment and broader concerns regarding Russia's non-compliance with other arms control and nonproliferation commitments. Any extension decision must weigh a variety of factors to ensure the national security of the United States and that of our allies and partners is maintained and strengthened. I defer to the Intelligence Community to provide a more detailed assessment of whether the threat from Russian nuclear forces would increase or decrease were the New START Treaty to expire without extension.

7. Senator HEINRICH. Secretary Trachtenberg, if we lose the New START data exchanges and onsite inspection rights, would the Pentagon and the intelligence community have to spend more on national technical means of verification to make up for this loss? If so, roughly how much?

Secretary TRACHTENBERG. The end of the New START Treaty's verification regime would end one source of information regarding Russia's strategic forces; however, there are other sources such as national technical means. The resulting cost impacts of an increased reliance on national technical or other means would be best addressed by the Intelligence Community.

8. Senator HEINRICH. Secretary Trachtenberg, the President has indicated he would like to broaden arms control to Russia and China. Do you believe it is wise to first extend the New START to give breathing room for these more ambitious negotiations?

Secretary TRACHTENBERG. The President has asked for options from his national security team to broaden arms control to Russia and China, and we are working to support that process. Whether or not to extend the New START Treaty is part of that discussion, but the Administration has not made any decision yet.

WEAPONS STORAGE AREAS FOR B–21

9. Senator HEINRICH. General Ray, as you know, the Air Force is evaluating constructing weapons storage areas for bases where the B–21 beds down—these are costly endeavors, not only from the special security requirements in the facility but also from the extra security forces that may be required to man them over the life of the facility. What is the status of your thinking on this?

General RAY. (AFGSC) Over the last year Air Force Global Strike Command led a cross-functional team of subject matter experts to create a Weapons Generation Facility design balancing operational utility, resilience, and affordability. We feel we have a solution optimizing all three factors and are in the process of socializing our

plan with Air Force leadership. Once the design is approved, we will move forward with funding a time-sequenced plan for constructing these facilities aligned with operational needs across the MAJCOM to include B–21 fielding. The force structure impacts of WGF design are absolutely a decision factor, and they are a significant part of the larger B–21 fielding plan.

SOLID ROCKET MOTOR BASE

10. Senator HEINRICH. Secretary Lord, the Department of Defense's September 2018 defense industrial base report highlighted the decline in U.S. suppliers of solid rocket motors. This is an important factor in the GBSD program. Are you working with the Air Force to address this issue through the GBSD program, and what is your plan?

Secretary LORD. The Department continually monitors the health and resiliency of the solid rocket motor industrial base across all defense programs that use solid rocket motors, including GBSD. My office works with all programs to ensure that they understand and consider industrial base risks when making acquisitions decisions. The GBSD program has released the Request for Proposal for Engineering and Manufacturing Development phase of the program. As such, the program has entered source selection, and any discussions related to GBSD are limited at this time.

MISSILE TUBES

11. Senator HEINRICH. Admiral Wolfe, the *Columbia*-class submarine, which is intended to replace the current Ohio fleet, encountered welding defects in the build of the missile tubes for the submarine. Building missile tubes is something we have not done for 30 years. How serious do you take this, what are the impacts, and what are you doing to correct it?

Admiral WOLFE. The Navy continues to closely oversee General Dynamic Electric Boat's (GDEB) efforts to define, scope, and mitigate any potential impact to the schedule of all missile tube efforts as ensuring the industrial base is ready to support *Columbia* is a primary risk mitigation effort. These actions follow the identification of welding issues on subcontracted missile tubes delivered for the *Columbia* and Dreadnought programs. The Navy and GDEB team have bounded the scope of the problem and correction actions are ongoing to recover from the identified issues. Initial inspections are complete and the Navy and industry partners are leveraging multiple resources across the industrial base to conduct necessary repairs and assessments. The current recovery plan is holding schedule margin for the Common Missile Compartment Super Module at 11 months ahead of the construction need date for *Columbia.*

12. Senator HEINRICH. Admiral Wolfe, are you at all worried about the industrial base's ability to produce missile tubes in quantities necessary for the *Columbia* program?

Admiral WOLFE. The vendor base remains one of the top risks for the *Columbia* program, including the missile tube portion. General Dynamic Electric Boat's (GDEB) and the Navy continue to proactively work with missile tube vendors to execute their scope of work. GDEB and the missile tube vendors also continue to execute the recovery plan from previous vendor quality issues associated with early missile tube production. The current recovery plan is holding schedule margin for the Common Missile Compartment (CMC) Super Module at 11 months ahead of the construction need date for *Columbia.*

SUBMARINE LAUNCHED CRUISE MISSILE

13. Senator HEINRICH. Admiral Wolfe, the 2018 Nuclear Posture Review recommended investigating a submarine launched cruise missile. We dropped it in 2010 due to maintenance and cost reasons. It seems to me the biggest cost will be the costs over the life of the weapon of certifying personnel and facilities to store, handle, maintain, and operate them on an attack submarine not built for it. Can you describe some of the issues you see as the biggest cost drivers in the program?

Admiral WOLFE. The nuclear-tipped sea-launched cruise missile (TLAM–N) was retired primarily as a result of what was perceived to be a more benign security situation at that time. The recommendations in the 2018 Nuclear Posture Review reflect an assessment of the current threats posed by revisionist powers Russia and China. While the United States for decades steadily reduced the role and size of its nuclear forces, Russia and China moved in the opposite direction and have increased the role of nuclear weapons in their strategies and have modernized their nuclear capabilities. The Navy is assessing the full impact of reconstituting the ca-

pability for sea-launched cruise missile with a nuclear warhead, including costs drivers such as personnel and facilities.

INSTITUTE FOR DEFENSE ANALYSES INDEPENDENT ASSESSMENT OF NNSA'S PLUTONIUM STRATEGY (MARCH 2019)

14. Senator HEINRICH. Secretary Lord, the National Nuclear Security Administration (NNSA) selected and you certified on May 14, 2018, a two-site option to produce plutonium pits where the NNSA would produce 30 pits per year at Los Alamos National Laboratory (LANL) by 2026 and repurpose the Mixed Oxide Fuel Fabrication Facility (MFFF) at the Savannah River Site to produce an additional 50 pits per year by 2030. Two sites were selected even though NNSA's engineering analysis determined the lifecycle cost of splitting production was double that of maintaining the work at LANL. What, in your view, were the specific advantages of splitting production between two sites that justify the estimated additional lifecycle cost of about $14 billion?

Secretary LORD. After several decades with almost no pit production, restoring the nation's capability to produce plutonium pits at a sustained rate is fundamental to the reliability, sustainability and credibility of the U.S. nuclear deterrent, which is the number one priority defense mission of the DOD. Therefore, a near-term focus on achieving steady-state production of 30 ppy by 2026 at LANL is essential, while simultaneously building a capability to produce at least 50 ppy at SRS to support longer-term requirements, is a necessary element of the overall strategy. This approach is consistent with the DOD requirement for steady-state production of pits that allows for the ability to enhance warhead safety and security and meet future DOD and NNSA requirements. The two-site strategy improves the resiliency, flexibility, and redundancy in our Nuclear Security Enterprise by not relying on a single production site.

15. Senator HEINRICH. Secretary Lord, the Institute for Defense Analysis recently completed an Independent Assessment of the Plutonium Strategy of the National Nuclear Security Administration. The independent assessment concluded that all of the options NNSA considered in the Office of Enterprise Assessments (EA) are extremely challenging. Each is potentially achievable given sufficient time, resources and management focus, though not on the schedules or budgets forecasted. None of the alternatives is demonstrably superior. In light of IDA's conclusions, what is your assessment of the report with respect to the ability of any of the options considered by the NNSA to produce 80 pits per year by 2030?

Secretary LORD. The IDA assessment identified that the two-site strategy could potentially achieve 80 pits per year given sufficient time, resources, and management focus. The IDA report recognized that because of the challenging timeline to meet pit production requirements, any option presents risks to producing no fewer than 80 pits per year by 2030. With DOD's support, NNSA continues to pursue the two-pronged approach to pit production, and is actively working to mitigate the risks. The two-site approach is best for DOD in our assessment.

16. Senator HEINRICH. Secretary Lord, your testimony specifically cites NNSA's efforts to establish a responsive enterprise, with production of plutonium pits as a lynchpin. However, I continue to question NNSA's emphasis on a so-called resilient infrastructure as the basis to justify splitting pit production between two sites, at twice the lifecycle cost. NNSA's studies never considered resilience as a criterion in either the Analysis of Alternatives or the Engineering Assessment, and it appeared only after the Nuclear Posture Review was released. The IDA recently completed an Independent Assessment of the Plutonium Strategy of the National Nuclear Security Administration. In light of IDA's assessment that none of the four options evaluated in the EA is demonstrably superior, and given the very much higher lifecycle cost, in your view is resilience a valid sole basis for NNSA's strategy?

Secretary LORD. Resilience is a Department of Defense (DOD) value. Despite the higher lifecycle cost, repurposing the former Mixed Oxide Fuel Fabrication Facility (MFFF) while maximizing pit production at Los Alamos to the extent practicable is the best alternative to reduce overall risk to the U.S. nuclear deterrent. This approach makes the Nuclear Security Enterprise more resilient to external threats or hazards, shutdowns, or other incidents; leverages an existing structure in the appropriate hazard category; and minimizes impacts to the mission essential work at Plutonium Facility (PF)-4 at Los Alamos.

Additionally, the Institute for Defense Analyses report concluded that accounting for the additional costs of key LANL personnel for LANL-only one-site approaches would narrow the gap between the lifecycle costs estimates. These costs were not

previously assessed. As reported in NNSA's Engineering Assessment, one-site approaches could also result in higher total project costs and later Critical Decision-4 (Approve Start of Operations or Project Completion) dates as compared to the endorsed two-site approach.

17. Senator HEINRICH. Secretary Lord, the second of the main findings of IDA's report is, "[n]o available option can be expected to provide 80 pits per year by 2030. DOD should evaluate how best to respond to this requirement shortfall." If you concur with IDA's findings, please provide the Armed Services Committee the timeline for the Department of Defense (DOD) to develop a formal response to the requirement shortfall. If you disagree with IDA's finding, please provide a full explanation of the basis for your dissent.

Secretary LORD. Reestablishing a plutonium pit production capability is a top priority for DOD and NNSA. Over the past two decades, several pit production strategies were initiated and then halted. Because of these aborted efforts, we are now out of time and must commit to—and stick with—the two-site strategy approved by the NWC last year. The risks are known, but can be managed, given appropriate authority and requested funding.

18. Senator HEINRICH. Secretary Lord, under section 3120(e) of the National Defense Authorization Act for Fiscal Year 2019, the Chairman of the Nuclear Weapons Council is required to re-certify annually on April 1 that NNSA is on track to meet the military requirement to produce 80 plutonium pits per year by 2030. In light of IDA's assessment, will you be able to make the certification for 2019?

Secretary LORD. Yes, a certification of the plutonium pit production plan was submitted to the Secretary of Defense and congressional defense committees on April 30, 2019.

STRATEGIC RAD-HARD MICROELECTRONICS

19. Senator HEINRICH. Secretary Lord, has the Nuclear Weapons Council been briefed on NNSA's plans to sustain the unique capabilities of Sandia's aging Microsystems and Engineering Sciences Applications (MESA) Complex to produce strategic rad-hard microelectronics beyond 2025?

Secretary LORD. Yes, NNSA briefed the Nuclear Weapons Council (NWC) Standing and Safety Committee in March 2018 on its strategy for the MESA Complex at Sandia National Laboratories. Since then, there is continuing dialogue and reporting from NNSA to the NWC as part of Nuclear Posture Review Implementation tasks. NNSA has committed to maintain MESA as a design agency and trusted supplier of strategic radiation-hardened electronics through 2040 and has developed a strategy, informed by the Sandia Extended Life Program report, to deliver on this commitment.

20. Senator HEINRICH. Secretary Lord, do you agree that the upgrade of MESA should be a priority for NNSA?

Secretary LORD. Yes, the MESA Complex is currently the only U.S. foundry with the capability to deliver custom strategically radiation-hardened (SRH) microelectronic components required to sustain the Nation's nuclear stockpile. Both the sea-based and land-based legs of the strategic triad depend on the survivability of the reentry systems. The survivability of reentry systems requires strategic radiation-hardened electronic devices in core circuitry in order to meet very high radiation requirements. The MESA Complex is a DOD Defense Microelectronic Activity (DMEA) accredited Category 1A Trusted Facility for trusted design, foundry, and test services for both unclassified and classified integrated circuits and other devices for the Nation's national security needs.

QUESTIONS SUBMITTED BY SENATOR ELIZABETH WARREN

FUTURE ARMS CONTROL AGREEMENTS WITH RUSSIA AND CHINA

21. Senator WARREN. Secretary Trachtenberg, senior Administration officials recently told reporters that President Trump had directed his Administration to seek a new arms control agreement with Russia and China. One official told CNN that the agreement should include "all the weapons, all the warheads, and all the missiles." The officials criticized the 2010 New START for only limiting United States and Russian deployed strategic nuclear weapons. What does the Administration have in mind with this arms control outreach project?

Secretary TRACHTENBERG. The President has asked his national security team for possible options on more comprehensive agreements with Russia and China, and we are in the midst of developing such options. However, we do not believe it is prudent to discuss our potential negotiating strategies publicly.

22. Senator WARREN. Secretary Trachtenberg, what is the Administration's strategy for achieving more comprehensive arms control deals with Russia and China?

Secretary TRACHTENBERG. The President has asked his national security team for possible options on more comprehensive agreements with Russia and China, and we are in the midst of developing such options. However, we do not believe it is prudent to discuss our potential negotiating strategies publicly.

23. Senator WARREN. Secretary Trachtenberg, how long does the Administration expect it will take to negotiate such comprehensive deals?

Secretary TRACHTENBERG. Negotiating a new agreement that encompasses a broader range of weapons than just strategic systems and includes an effective verification regime will likely take time. Since no specific proposal has been made, it is impossible to predict how long such a negotiation would take.

24. Senator WARREN. Secretary Trachtenberg, what does the Administration want China to do on arms control?

Secretary TRACHTENBERG. The President wants serious arms control that delivers real security to the American people and our allies and partners. To achieve this, he believes Russia and China must be brought to the table. The President has charged his national security team to think more broadly about arms control, both in terms of the countries and the weapons systems involved. If China is the great power its leaders claim it to be, it should increase transparency into Chinese nuclear forces and limit China's growing nuclear weapons ambitions in order to help manage strategic competition among States. Beyond this, we do not believe it is prudent to discuss our potential negotiating strategies publicly.

25. Senator WARREN. Secretary Trachtenberg, what is the Administration willing to put on the table in talks with Russia and China on more comprehensive agreements?

Secretary TRACHTENBERG. The President has asked his national security team for possible options on more comprehensive agreements with Russia and China, and we are in the midst of developing such options. However, we do not believe it is prudent to discuss our potential negotiating strategies publicly.

26. Senator WARREN. Secretary Trachtenberg, wouldn't extending New START by 5 years buy additional time to develop U.S. negotiating positions, address issues of mutual concern that impact strategic stability, and avoid new risks from an unconstrained and less transparent United States-Russian nuclear relationship?

Secretary TRACHTENBERG. We are not trying to buy time. We are attempting to address the core impediments to restoring trust with Russia and reestablishing the conditions necessary for further nuclear arms control initiatives. We must consider a multitude of factors before making any decision on whether or not to extend the New START Treaty—for example, Russia's record of compliance with arms control agreements, its overall malign behavior on other matters such as Ukraine and election interference, and the fact that its nuclear arsenal is growing in areas not currently constrained under the New START Treaty.

27. Senator WARREN. Secretary Trachtenberg, in 2012, then commander of U.S. Strategic Command General Robert Kehler stated: "I do not believe that China has hundreds or thousands more nuclear weapons than what the intelligence community has been saying, [. . .] that the Chinese arsenal is in the range of several hundred" nuclear warheads." Do you agree with this assessment? If not, why not?

Secretary TRACHTENBERG. Over the next decade, China is likely to double the size of its nuclear stockpile in the course of implementing the most rapid expansion and diversification of is nuclear arsenal in its history. It is improving its ground and submarine-based nuclear capability and is pursuing a viable nuclear "triad" with the development of a nuclear capable strategic bomber. In addition, it is working to field nuclear, theater-range precision-strike systems capable of reaching U.S. territory and United States forces and bases in the region as well as those of our allies and partners. China's nuclear deterrent cannot currently be verified as to numbers and quality of its weapons. It refuses to offer transparency into its force and refuses to participate in any serious talks that would lead to any meaningful transparency. The scope and scale of China's nuclear modernization program, combined with Chi-

na's lack of transparency, raise questions regarding its future intent. This not only increases the threat of possible nuclear coercion and conflict for the United States, and its allies and partners, but risks miscalculation and misperception.

NEW START

28. Senator WARREN. General Ray, the Department has frequently touted the benefits of New START, particularly emphasizing the visibility and insight we gain into Russia's strategic nuclear forces. There have been rumors that the Trump Administration is considering not extending the treaty or potentially even withdrawing from it altogether. If New START expires in February 2021 with nothing to replace it and there are no constraints on Russia's nuclear forces, would that increase or decrease the threat Russia poses to the United States?

General RAY. (A10) Much has changed in the near-decade since the New START Treaty was signed in 2010, including the expansion of Russian and Chinese nuclear capabilities. For example, Russia is modernizing and expanding an active existing stockpile of approximately 2,000 nonstrategic nuclear weapons that can be deployed on ships, submarines, aircraft, with ground forces, and on air and missile defense interceptors. None of these weapons are limited by any arms control treaty including the New START Treaty. A decision regarding extension of the New START Treaty has not yet been made, but will be balanced against changes in the strategic environment and broader concerns regarding Russia's non-compliance with other arms control and nonproliferation commitments. Any extension decision must weigh a variety of factors to ensure the national security of the United States and that of our allies and partners is maintained and strengthened. I defer to the Intelligence Community to provide a more detailed assessment of whether the threat from Russian nuclear forces would increase or decrease were the New START Treaty to expire without extension.

29. Senator WARREN. General Ray, if we have less visibility into Russia's nuclear capabilities, force structure, and modernization plans, which would be the case without New START, what impact would that have on U.S. military planning and spending? What countermeasures would we need to consider and what would be the cost?

General RAY. The visibility into Russia's capabilities that the New START Treaty provides is an important, but not exclusive, source of information that feeds into the Department of Defense's force requirements analysis. The Department of Defense will continue to make the necessary investments in its nuclear and conventional delivery systems to ensure a flexible and continuing deterrent capability in the face of evolving security challenges and technological developments. The President's Budget provides for the sustainment and operations of existing nuclear and conventional forces in defense of the United States.

30. Senator WARREN. General Ray, if we lose the New START data exchanges and onsite inspection rights, would the Pentagon and the intelligence community have to spend more on national technical means of verification to make up for this loss? Is there a formal or informal cost estimate to this effect?

General RAY. The end of the New START Treaty's verification regime would end one source of information regarding Russia's strategic forces; however, there are other sources such as national technical means. The resulting cost impacts of an increased reliance on national technical or other means would be best addressed by the Intelligence Community.

31. Senator WARREN. General Ray, is there any way to replace the "boots on the ground" inspections provided by New START if the treaty did not exist?

General RAY. (A10) On-site inspections are just one important tool to build trust and verify compliance with current international agreements. Regardless of the state of arms control agreements, the United States continues to maintain robust intelligence, surveillance, and reconnaissance capabilities provide insights inside another country's military capabilities. The loss of the New START treaty and its on-site inspections will force the United States to rely more on alternate means of assessing Russian capabilities.

32. Senator WARREN. Secretary Trachtenberg, is the Administration's position that Russia must agree to limits on its tactical nuclear weapons or that China must limit its nuclear forces in some way as a condition for extending New START?

Secretary TRACHTENBERG. The President wants serious arms control that delivers real security to the American people and our allies and partners. To achieve this,

he believes Russia and China must be brought to the table. Therefore, the President has charged his national security team to think more broadly about arms control, both in terms of the countries and the weapons systems involved. Whether or not to extend the New START Treaty is part of that discussion, but the Administration has not made any decision yet.

33. Senator WARREN. Secretary Trachtenberg, some Administration officials have raised concerns about new strategic-range weapons that Russia is developing. My understanding is that New START envisioned the possible development of new kinds of strategic offensive arms during the period of implementation of the treaty. Article II of the treaty states: "When a Party believes that a new kind of strategic offensive arm is emerging, that Party shall have the right to raise the question of such a strategic offensive arm for consideration in the Bilateral Consultative Commission." Has the Administration formally raised Russia's development of these new weapons for discussion in the Bilateral Consultative Commission, the treaty's implementing body?

Secretary TRACHTENBERG. Yes.

34. Senator WARREN. Secretary Trachtenberg, given the concerns you have expressed about some of the new nuclear weapons systems being developed by Russia, have you been a part of discussions with Russian counterparts about those weapons? Are you aware of whether any of your colleagues in the Department of State are having such discussions?

Secretary TRACHTENBERG. Most recently, in April 2019, a United States interagency delegation, including representatives of the Defense Department, met with Russian counterparts in a session of the New START Treaty's Bilateral Consultative Commission (BCC) to discuss ongoing New START Treaty implementation issues. The BCC usually convenes twice a year. At the April BCC, representatives from the Department of State and the Department of Defense engaged Russia on these systems, and we continue to do so.

35. Senator WARREN. Secretary Trachtenberg, General Hyten told the Senate Armed Services Committee earlier this year that he's worried about the threat these new weapons might pose a decade from now. Do you agree?

Secretary TRACHTENBERG. Yes.

36. Senator WARREN. Secretary Trachtenberg, wouldn't extending New START for another 5 years buy us additional time to discuss and address our concerns about the new weapons with Russia while retaining verifiable limits on Russia's current deployed strategic weapons?

Secretary TRACHTENBERG. We are not trying to buy time. We are attempting to address the core impediments to restoring trust with Russia and reestablishing the conditions necessary for further nuclear arms control initiatives. We must consider a multitude of factors before making any decision on whether or not to extend the New START Treaty—for example, Russia's record of compliance with arms control agreements, its overall malign behavior on other matters such as Ukraine and election interference, and the fact that its nuclear arsenal is growing in areas not currently constrained under the New START Treaty.

INTERMEDIATE-RANGE NUCLEAR FORCES TREATY

37. Senator WARREN. Secretary Trachtenberg, when I asked General Scaparrotti at a Senate Armed Services Committee hearing on March 5, 2019 whether the Trump Administration has a plan to prevent Russia from building more and new types of ground-launched intermediate-range missiles in the absence of the Intermediate-Range Nuclear Forces (INF) Treaty, he said, "I don't know that we have a plan today. I know we're working on what we think that plan might be." Why did the President withdraw from the treaty without having first developed such a plan?

Secretary TRACHTENBERG. An arms control treaty that one side abides by while the other openly and brazenly violates it does not make us safer. Since 2013, the United States engaged Russia more than 30 times to try to resolve Russia's material breach and preserve the Intermediate-range Nuclear Forces (INF) Treaty. Russia, however, continued to violate the INF Treaty, and has taken no steps to return to full and verifiable compliance. Due to our scrupulous INF Treaty compliance before our obligations were suspended, we do not have any new systems to deploy in the immediate future. Now that we have suspended our obligations under the INF Treaty, we are free to pursue work that would otherwise be prohibited by the INF Trea-

ty. Currently, we have no plans to conduct flight tests of any noncompliant systems prior the United States' withdrawal from the INF Treaty in August.

38. Senator WARREN. Secretary Trachtenberg, at the Munich Security conference in mid-February, Polish foreign minister Jacek Czaputowicz stated the following: "We are not very much in favor—we are definitely even against—deployment of [INF Treaty prohibited] missiles on our soil. But we will work out the solution with our allies in NATO because it must be united response to Russian threat in that case . . . If we do it maybe [host new missiles] it will be a decision of all the alliance." Do you agree that any decision to base U.S. ground-launched intermediate-range missiles should only be considered if it is supported by "all of the alliance"?

Secretary TRACHTENBERG. Due to our scrupulous Treaty compliance before our Intermediate-range Nuclear Forces (INF) Treaty obligations were suspended, it will be some time before we are ready to hold discussions about potential basing options. We have kept our Allies fully apprised of these developments and we continue to work together within NATO to deny Russia any military advantage from its material breach of the INF Treaty. The systems we are developing are conventional, not nuclear, and we are committed to discussing in advance with our Allies any potential basing options on Allied territory in the future.

39. Senator WARREN. Secretary Trachtenberg, has the Department begun conversations with any alliance members about hosting INF-range missiles on their territory?

Secretary TRACHTENBERG. Due to our scrupulous Treaty compliance before our Intermediate-range Nuclear Forces (INF) Treaty obligations were suspended, it will be some time before we are ready to hold discussions about potential basing options. We have kept our Allies fully apprised of these developments and we continue to work together within NATO to deny Russia any military advantage from its material breach of the INF Treaty. The systems we are developing are conventional, not nuclear, and we are committed to discussing in advance with our Allies any potential basing options on Allied territory in the future.

SUPPLEMENTAL SEA-BASED LOW-YIELD NUCLEAR CAPABILITIES

40. Senator WARREN. Secretary Trachtenberg, the 2018 Nuclear Posture Review (NPR) recommends adding a third and fourth low-yield warhead option to the U.S. nuclear arsenal in the form of a low-yield SLBM warhead and sea-launched cruise missile (SLCM). The United States already possesses low-yield warheads, including nuclear gravity bombs stationed in Europe in support of NATO, as part of the air-leg of the triad and plans to invest over $150 billion in then-year dollars in the coming decades to ensure these warheads can penetrate the most advanced air defenses. If current and planned air-launched options cannot deter or respond to Russian limited nuclear use, why are taxpayers being asked to spend scores of billions of dollars on these systems?

Secretary TRACHTENBERG. We will continue to rely on current and planned air-launched options to deter Russian limited nuclear use and to assure allies of our security commitments. In light of the continuing modernization of Russian air defenses, as well as specific developments in Russia's forces and doctrine that create a credible threat that Russia would use a small number of low-yield nuclear weapons to deter a United States military response to aggression, a low-yield submarine-launched ballistic missile (SLBM) provides the United States a near-term, flexible, limited nuclear response option that complements existing and future air-launched options. Deployed quickly in small numbers, the low-yield SLBM provides a tailored solution to this problem and, based on its attributes, corrects any misperceptions that Russia and others may have that the United States lacks credible options to deter the use of nuclear weapons in a regional conflict. Re-deployment of SLCM–Nuclear (N) is a response to broader, equally serious developments in the balance of nonstrategic nuclear forces (which favors Russia by a huge margin), the operational environment, and regional security dynamics. It provides leaders with a hedge for the current U.S. sea-based deterrent and a flexible and responsive limited use capability that further strengthens the extended deterrence and allied assurance framework in both Europe and East Asia. Proceeding with the acquisition of SLCM–N will provide negotiating leverage to capture Russia's non-strategic nuclear weapons in a future agreement.

41. Senator WARREN. General Ray, are there any targets on the planet that can't be held at risk by the B–2 or in the future the B–21?

General RAY. (A10) The specific capabilities of the B–2 and B–21 are classified. The unique combination of range, precision, payload, and ability to penetrate and operate in anti-access/area denial environments allows the B–2 to identify, locate, target, and destroy the highest value enemy targets. The B–21 is an Air Force acquisition recapitalization priority which will provide critical operational capability and flexibility across a wide range of military objectives, providing both conventional and nuclear capabilities, in fulfillment of national objectives. The B–21 will be highly survivable with the ability to penetrate modern air defenses to accomplish national security objectives despite an anti-access/area denial environment and attack targets.

42. Senator WARREN. Admiral Wolfe, the fiscal year 2020 budget request for the nuclear SLCM includes $5 million to begin an Analysis of Alternatives of the capability. To your knowledge, did the Navy support President George H.W. Bush's decision to remove the TLAM–N from deployment in the early 1990s?

Admiral WOLFE. To my knowledge, the Navy supported the 1991 decision to remove the TLAM–N from deployment. The Navy similarly supports development of a nuclear SLCM in response to the changed security environment, as noted in the 2018 Nuclear Posture Review.

43. Senator WARREN. Admiral Wolfe, did the Navy support President Obama's decision to retire the missile and warhead in 2010, and if so, why?

Admiral WOLFE. The 2010 Nuclear Posture Review noted that the security environment of the time had changed dramatically since the end of the Cold War, the threat of nuclear war had become remote, and the nuclear-equipped sea-launched cruise missile (TLAM–N) served a redundant purpose in the U.S. nuclear stockpile based on the anticipation that the security environment would continue to improve. However, as the 2018 Nuclear Posture Review highlights, the security environment has actually moved in the opposite direction with adversaries, particularly Russia and China, who have increased the prominence of nuclear weapons in their national strategies. This is demonstrated by Russia's large and increasingly capable non-strategic nuclear weapons arsenal and China's improving forces. A new sea-launched cruise missile capability is needed to provide a flexible, sea-based, non-strategic nuclear capability to improve U.S. capabilities to deter limited nuclear use and to assure our allies that we will meet our extended deterrence commitments.

44. Senator WARREN. Admiral Wolfe, if a decision is made to re-nuclearize the Navy's attack submarine fleet with a SLCM, can you tell me what doing so would entail?

Admiral WOLFE. At this time Navy is assessing the full impact of deployment of a nuclear-armed sea-launched cruise missile. We anticipate starting a comprehensive Analysis of Alternatives shortly that will provide detail and cost estimates of the impact, and we will provide that to Congress when complete.

45. Senator WARREN. Admiral Wolfe, in addition to the cost to acquire the missile and warhead, would there be additional certification, security, storage, and operational costs for re-nuclearizing the Navy's attack submarine fleet with a SLCM?

Admiral WOLFE. At this time Navy is assessing the full impact of deployment of a nuclear-armed sea-launched cruise missile. We anticipate starting a comprehensive Analysis of Alternatives shortly that will provide detail and cost estimates of the impact, and we will provide that to Congress when complete.

46. Senator WARREN. Admiral Wolfe, could arming attack submarines with nuclear SLCMs mean that each submarine could carry fewer conventional Tomahawks?

Admiral WOLFE. At this time Navy is assessing the full impact of deployment of a nuclear-armed sea-launched cruise missile. We anticipate starting a comprehensive Analysis of Alternatives shortly that will provide detail and cost estimates of the impact, and we will provide that to Congress when complete.

47. Senator WARREN. Admiral Wolfe, how might arming attack submarines with nuclear SLCMs impact conventional deterrence?

Admiral WOLFE. At this time Navy is assessing the full impact of deployment of a nuclear-armed sea-launched cruise missile. We anticipate starting a comprehensive Analysis of Alternatives shortly that will provide detail and cost estimates of the impact, and we will provide that to Congress when complete.

U.S. NUCLEAR WEAPONS SPENDING

48. Senator WARREN. Secretary Lord, in January 2019 the Congressional Budget Office (CBO) estimated the cost of the Trump administration's plans to sustain and replace the U.S. nuclear arsenal between fiscal years 2019 and 2028 at $494 billion in then-year dollars. This is an increase of $94 billion, or about 23 percent, above the CBO's 2017 estimate as of the end of the Obama administration. By 2028 nuclear weapons would consume about seven percent of total national defense spending. Do you agree with CBO's estimate?

Secretary LORD. Generally, the basis for CBO's estimate is consistent with DOD's projections, although CBO's cost growth projections were more pessimistic than our own. However, it is important to clarify that very little of CBO's projected increase was attributed to increased program cost. Most of the growth cited by CBO involved factors such as economic inflation and natural increases that come with greater program maturity.

Nuclear modernization remains the Department's highest defense and investment priority. DOD expects this effort to cost approximately 3.7 percent of the defense budget across the 23-year modernization period. These costs represent a significantly smaller percentage than past efforts, which required 10.6 percent of the defense budget in the early 1980s and 17 percent of the defense budget in the early 1960s.

A large-scale nuclear attack poses an existential threat to the United States. U.S. nuclear forces are the indispensable means of deterring this threat. The modernization program is necessary and prudent given the nature and evolution of the threat. Accordingly, we believe the current modernization plan remains affordable.

GROUND BASED STRATEGIC DETERRENT

49. Senator WARREN. General Ray, in 2016 the Department set the cost at the GBSD program's Milestone A decision at $85 billion in then-year dollars, but called for a more up to date estimate by March 2018. An estimate by the Cost Assessment and Program Evaluation (CAPE) office put the $85 billion figure at the lower end and a scale that reached as high as $150 billion. Both estimates were far higher than the Air Force's initial estimate. My understanding is that CAPE is working on a new cost estimate for GBSD that will be completed in June 2019. Has the Air Force produced an updated cost estimate for the GBSD program? If so, what is it? If not, when can we expect an updated estimate from the Air Force?

General RAY. (AQ) Total acquisition cost for GBSD is estimated at $85 billion, per the DOD Office of Cost Assessment and Program Evaluation (OSD/CAPE) updated in June 2019. The program is fully funded to the low end range of the Milestone A independent cost estimate as reflected in the Fiscal Year 2020 President's Budget request.

Then-Year $B	Jun 19 ICE	Aug 16 ICE
RDT&E	$27.1	$22.66
Procurement	$56.5	$61.5
MILCON	$1.5	$0.7
Acquisition Total	$85.1	$84.8
Ops & Sustainment	$157.5	$177.2
Life-Cycle Cost	$242.6	$262.0

50. Senator WARREN. General Ray, according to the 2018 NPR, the life of the Minuteman III "cannot be extended further." However, neither RAND in a 2014 report nor the Air Force's 2014 Analysis of Alternatives determined that another life extension is infeasible. Moreover, at a March 28, 2019 House Armed Services Committee hearing, Lieutenant General Richard Clark, USAF, Deputy Chief of Staff, Strategic Deterrence and Nuclear Integration said: "We have several of the [Minuteman III] components that are becoming obsolete. The propulsion system, the guidance system, even the ability to provide the solid rocket motor fuel, we only have one more opportunity to do that for these weapons." If there is "one more opportunity" to extend the life of the Minuteman III, why did the NPR claim that the life of the Minuteman III "cannot be extended further?"

General RAY. (AFGSC) There are several studies highlighting Minuteman III supportability challenges, component aging and asset attrition, diminishing manufacturing sources, vanishing vendors, and obsolescence. The Nuclear Posture Review highlighted the fact that "component aging and inventory attrition are rapidly driving it to the end of its sustainability," from a system perspective. The simple fact is, Minuteman III system is beyond a modernization approach. There are numerous components within Minuteman III system that cannot be supported through life extension efforts. There are insufficient quantities of items to support guidance, propulsion system rocket engine, missile inter-stage/raceway components, and flight controls, just to name a few. The NPR conclusion recognizes these facts combined with current/future adversary threats and existing platform shortfalls.

51. Senator WARREN. General Ray, in 2017 the Congressional Budget Office (CBO) projected that $17.5 billion could be saved over the next 30 years by delaying development of a new ICBM by 20 years and instead extending the life of the Minuteman III by buying new engines and new guidance systems for the missiles. Crucially, however, this approach would save $37 billion through fiscal year 2036 when the vast majority of nuclear recapitalization spending is scheduled to take place. Do CBO's estimates comport with the Air Force's estimate of the cost to sustain the Minuteman III relative to GBSD over this more confined time period?

General RAY. (AFGSC) The Air Force does not concur with the CBO estimate of costs to sustain Minuteman III relative to GBSD. As part of the 2014 Analysis of Alternatives, the Air Force reviewed a Minuteman III tech refresh option. This analysis, and subsequent program analysis, has shown that GBSD represents the most effective strategy to mitigate capability shortfalls while restoring warfighter effectiveness and replacing critically aged infrastructure. Specifically, the Air Force has determined that GBSD would provide lower total life cycle through 2075 costs than a Minuteman III tech refresh and replacement strategy. Minuteman III is 44 years old and will be more than 60 years old when finally completely replaced by GBSD in the 2030s. In order to counter the systemic age-out and attrition of the Minuteman III system, the Air Force cannot delay development of GBSD but must begin delivery of the weapon system by 2028. A program office analysis has indicated that a 4 year slip to the GBSD Full Operational Capability date would result in an estimated $22 billion in additional costs. The Department of Defense Joint Requirements Oversight Council has validated the need for a modern ICBM system. GBSD provides a more capable ICBM within the cost estimate for maintaining the existing Minuteman III capability. Additionally, GBSD is safer and more secure to operate than the current system, reducing the number of required convoys and open launcher configurations by two-thirds. The design of GBSD will provide the United States with a system that is more readily adaptable to evolving threats while significantly reducing the total cost of ownership for the ICBM.

52. Senator WARREN. General Ray, the Department continues to use Minuteman II rocket motors for military space launches, which suggests the Department has high confidence in the boosters. Which begs the question: If older Minuteman II motors are still functioning reliably, could the newer Minuteman III boosters reliably last longer than currently planned?

General RAY. (AFGSC) No; the Rocket Systems Launch Program (RSLP) enables the Department of Defense to repurpose Minuteman motors, which have been removed, from operational inventory due to age-out concerns or arms control reductions. Since the inception of the RSLP program, nearly 1200 Minuteman first, second, and third stage motors have been transferred from the ICBM fleet. Of these, 225 have been refurbished and launched, 107 were static tested to validate the RSLP refurbishment process, 381 were deemed unsuitable for launch and destroyed, and 50 motors have been assessed as unsuitable and await demil. The remaining 437 motors, considered the least suitable, await assessment for use. Reuse of these motors is only possible through the completion of an extensive refurbishment effort, by which RSLP conducts an inspection using a priority checklist to ensure the best motors are selected. This process certifies each motor for one year of use, after which the motors must undergo recertification. The high failure rate and limited certification time makes this refurbishment process unsuitable for sustaining the ICBM force.

QUESTIONS SUBMITTED BY SENATOR JOE MANCHIN

53. Senator MANCHIN. Secretary Trachtenberg, are we providing missiles to Saudi Arabia?

Secretary TRACHTENBERG. Under the Foreign Military Sales (FMS) program, the United States is currently executing FMS cases involving the following "missile" systems: Air-to-Surface includes the Hydra-70, High-Speed Anti-Radiation Missile (HARM), Hellfire and Standoff Land Attack Missile-Expanded Response (SLAM–ER); Surface-to-Air includes the HAWK; Anti-Ship includes the Harpoon; Air-to-Air includes the Advanced Medium-Range Air-to-Air Missile (AMRAAM); and Missile Defense includes the Patriot and Terminal High Altitude Area Defense (THAAD).

DEPARTMENT OF DEFENSE AUTHORIZATION FOR APPROPRIATIONS FOR FISCAL YEAR 2020 AND THE FUTURE YEARS DEFENSE PROGRAM

WEDNESDAY, MAY 8, 2019

UNITED STATES SENATE,
SUBCOMMITTEE ON STRATEGIC FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

DEPARTMENT OF ENERGY'S ATOMIC DEFENSE ACTIVITIES AND PROGRAMS

The Subcommittee met, pursuant to notice, at 2:44 p.m. in room SR–222, Russell Senate Office Building, Senator Deb Fischer (Chairman of the Subcommittee) presiding.

Subcommittee Members present: Senators Fischer, Rounds, Sullivan, Hawley, Heinrich, King, and Jones.

OPENING STATEMENT OF SENATOR DEB FISCHER

Senator FISCHER. The hearing will come to order.

Good afternoon. I would like to welcome everyone to the Strategic Forces Subcommittee's fourth open hearing of the 116th Congress and our final hearing before the committee markup for its 2020 National Defense Authorization Act.

We meet today to receive testimony on the Department of Energy's atomic defense activities and programs.

Appearing before the Subcommittee, we have the Honorable Lisa Gordon-Hagerty, Administrator of the National Nuclear Security Administration (NNSA); the Honorable Anne Marie White, Assistant Secretary of Energy for Environmental Management; and Admiral James Caldwell, Deputy Administrator for Naval Reactors at NNSA.

Thank you all for your service and for being with us today. We look forward to hearing from each you. Your full statements will be made part of the record.

We are in the middle of votes right now. The ranking Member, Senator Heinrich, is waiting to take the second vote before he returns here to the hearing room. But at this time, we will hear your opening statements. Administrator, if you would like to begin.

STATEMENT OF HON. LISA E. GORDON–HAGERTY, ADMINISTRATOR, NATIONAL NUCLEAR SECURITY ADMINISTRATION

Administrator GORDON-HAGERTY. Chairman Fischer and Members of the Subcommittee, thank you for the opportunity to present the President's fiscal year 2020 budget for the Department of Energy's
National Nuclear Security Administration. It is an honor to appear before you today proudly representing the extraordinary team at NNSA, a team that is indispensable for our U.S. national security.

I am also delighted to share this hearing with my colleagues, Admiral Frank Caldwell, my Deputy Administrator for Naval Reactors, and Assistant Secretary Anne White.

Since I last testified before this committee, NNSA has been diligently executing our three enduring missions: one, ensuring the safety, security, and reliability of our nuclear weapons stockpile; two, reducing the threat of nuclear proliferation and nuclear terrorism around the world; and three, providing nuclear propulsion for the U.S. Navy's fleet of aircraft carriers and submarines.

The President's fiscal year 2020 budget request for NNSA is an investment in these missions, our infrastructure, and our people. My priorities with this crucial funding are to revitalize the U.S. defense plutonium capabilities and other essential infrastructure, to keep our stockpile life extension programs on schedule and on budget, and to recruit our workforce of the future. My focus is on setting the conditions today for a resilient and responsive nuclear security enterprise for the next 50 years and beyond.

The 2018 Nuclear Posture Review (NPR) provided a realistic view of our world, with an evolving and uncertain political environment. The Nuclear Posture Review states that there is no margin for further delay in recapitalizing the nuclear security enterprise, an enterprise comprised of 8 laboratories, plants, and sites and a dedicated workforce of almost 44,000 employees.

NNSA's $16.5 billion budget request is a necessary investment when you consider the stakes. Russia and China are pursuing entirely new nuclear capabilities. North Korea's intentions remain unclear, and we face the most complex and demanding global security environment since the end of the Cold War. Accordingly, our fiscal year 2020 budget request represents the largest increase for our nonproliferation, counter-proliferation, and counterterrorism programs in the last 5 years.

During my nomination hearing last year, I stated that my highest priority was plutonium pit manufacturing, and that has not changed. For the next several decades, NNSA will rely on a combination of newly manufactured pits and the judicious use of existing pits to modernize the existing nuclear weapons stockpile. A modest pit manufacturing capability is necessary to ensure the safety and security of refurbished warheads while maintaining high confidence in stockpile effectiveness. Consistent with the NPR, the NNSA is committed to producing no fewer than 80 pits per year by 2030 to meet military requirements.

Last May, the Nuclear Weapons Council endorsed NNSA's path forward to recapitalize a production capability that was shuttered in the early 1990s. Our two-site approach calls for pit production at both Los Alamos National Laboratory in New Mexico and the

Savannah River site in South Carolina. Following this strategy, our fiscal year 2020 budget calls for nearly a $500 million investment in plutonium pit manufacturing capabilities at Los Alamos, which will remain the Nation's plutonium center of excellence for research and development.

Thanks to the strong support of Congress, we have stated construction on the main buildings of the uranium processing facility at Y–12 National Security Complex. I am proud to report that this vital undertaking has been on budget and on schedule for the last 6 years.

Indeed, all of NNSA's enduring missions are underpinned by the state-of-the-art scientific capabilities. As these capabilities become more important during this time of renewed great power competition, NNSA is working to stay ahead of the technology curve.

A future gap in high performance computing is being addressed through a joint effort between NNSA and the Department of Energy's Office of Science. Our contribution to that effort will be undertaken at the Lawrence Livermore National Laboratory and we will deliver an exoscale computing platform to the enterprise in 2023.

From the earliest days of the Manhattan Project, the dedicated men and women of the nuclear security enterprise have answered our Nation's call. What our team has continued to accomplish is remarkable. We completed the W76–1 life extension program under budget and ahead of schedule. We have held 33 countries plus Taiwan to become free of highly enriched uranium. We routinely deploy nuclear security experts to major public events like the Super Bowl that keep the public safe from radiological threats, and we are lending unparalleled expertise to the U.S. Navy's new *Columbia*-class program to ensure sea-based deterrence capabilities for decades to come.

Finally, I would like to emphasize that regardless of the investments we make to modernize our enterprise, the United States must continue its investment in our world-class workforce as requested by the fiscal year 2020 budget. NNSA is requesting that the current 1,690 full time equivalent (FTE) and 600 excepted service personnel caps be eliminated in order to gain flexibility in hiring authorities and to better align our personnel resources to mission priorities. With an aging workforce, NNSA has launched an integrated effort to recruit the next generation of scientists, engineers, and technicians so that we can continue to answer the Nation's call and meet tomorrow's challenges. No other government agency can accomplish these unique missions on behalf of our American people, and I could not be prouder to represent NNSA today.

Thank you for your continued strong support, the reliable, flexible, and timely budget that you provided NNSA for the current fiscal year, and for the opportunity to testify before you today. I look forward to answering your questions. Thank you.

[The prepared statement of Administrator Gordon-Hagerty follows:]

PREPARED STATEMENT BY SECRETARY LISA E. GORDON-HAGERTY

Chairman Fischer, Ranking Member Heinrich, and Members of the Subcommittee, thank you for the opportunity to present the President's Fiscal Year

2020 Budget Request for the Department of Energy's (DOE) National Nuclear Security Administration (NNSA). NNSA appreciates the Committee's strong support for our nuclear security mission and for the workforce and organizations that are responsible for executing it every day.

NNSA's enduring missions are to protect our Nation by maintaining a safe, secure, and effective nuclear weapons stockpile, reducing global nuclear threats, and providing the United States (U.S.) Navy's submarines and aircraft carriers with militarily effective nuclear propulsion. NNSA has numerous strategic partners that enable, contribute to, and benefit from our efforts, yet no other government or civilian organization can accomplish our unique mission on behalf of the American people.

The U.S. nuclear deterrent has been the cornerstone of our national security and global stability for more than 70 years, and its credibility serves as the ultimate insurance policy against a nuclear attack. While the ultimate goal of eliminating nuclear weapons has been an aspiration for generations, we must recognize the reality that foreign nuclear threats are growing. It is imperative that we modernize the U.S. nuclear deterrent and enterprise; our credibility assures our friends and allies and deters those who wish us harm.

Thanks to continued strong support from this Administration and Congress, NNSA is transforming the nuclear security enterprise to be more responsive and resilient. The following highlights: (1) NNSA's accomplishments in calendar year 2018; (2) the budget request for NNSA; (3) Weapons Activities Appropriation; (4) Defense Nuclear Nonproliferation Appropriation; (5) Naval Reactors Appropriation; and (6) NNSA Federal Salaries and Expenses Appropriation.

NNSA'S ACCOMPLISHMENTS IN CALENDAR YEAR 2018

Plutonium Pit Production: The highest NNSA infrastructure priority is re-establishing a plutonium pit production and fabrication capability to meet the Department of Defense's (DOD) military requirements. Our national requirement, supported by numerous studies and analyses, requires no fewer than 80 war-reserve pits per year by 2030. Last May, the Nuclear Weapons Council (NWC) endorsed NNSA's recommended alternative calling for plutonium pit production at Los Alamos National Laboratory (LANL) and the Savannah River Site (SRS). This two-site approach bolsters the nuclear security enterprise's responsiveness and resiliency.

NNSA's Life Extension Programs (LEPs), Modifications, and Alteration: In December 2018, NNSA completed the final weapon refurbishment for the W76–1 LEP, extending the warhead's service life from 20 years to 60 years. The W80–4 LEP, W87–1 Modification, and the W76–2 Modification continue to remain on budget and schedule. We also continue to make progress on the B61–12 LEP and the W88 Alteration 370. That said, we are currently working through recently identified challenges that will impact delivery schedules and we are assessing options with DOD to mitigate delays.

Infrastructure Investments: NNSA commenced construction of the main buildings of the Uranium Processing Facility (UPF) at the Y–12 National Security Complex (Y–12). UPF remains on budget and on schedule for delivery by the end of 2025 for no more than $6.5 billion. NNSA also broke ground on the new Albuquerque Complex, which will house 1,200 employees when complete.

Highly Enriched Uranium (HEU): Working with the International Atomic Energy Agency (IAEA), China, and Nigeria, NNSA was instrumental in the conversion of a Nigerian research reactor from HEU to low-enriched uranium (LEU) fuel. This marks NNSA's 74th research reactor or isotope production facility conversion, which was followed by repatriation of the HEU fuel to China, making Nigeria the 33rd country plus Taiwan to become HEU free.

Nuclear Material Removal: NNSA removed or confirmed disposition of more than 280 kilograms of HEU from four countries, enough material for more than 11 nuclear weapons.

Counterterrorism: NNSA's technical experts were deployed to numerous widely attended public events such as the Super Bowl and the Boston Marathon to provide radiation detection, identification, and technical advice, helping to protect the public from acts of nuclear and radiological terrorism. This level of support requires NNSA's response assets to maintain full operational readiness at all times.

Naval Nuclear Propulsion: NNSA's Office of Naval Reactors continued its record of safe and reliable nuclear propulsion and nuclear fleet support, while contributing expertise to the U.S. Navy's new *Columbia*-class program. This next generation nuclear-powered submarine will ensure required sea-based deterrence capabilities for decades to come.

Supercomputing: Lawrence Livermore National Laboratory (LLNL) unveiled the Sierra supercomputer, ranked the second-fastest in the world according to the Top 500 list.

For more than 70 years, from the early days of the Manhattan Project to the height of the Cold War, the dedicated men and women of the nuclear security enterprise have overcome every obstacle in their way, all while accomplishing a complex and enduring national security mission. With Congress' continued support, NNSA will similarly overcome the nuclear security threats that face us today and into the future.

NNSA'S FISCAL YEAR 2020 BUDGET REQUEST

The 2018 Nuclear Posture Review (2018 NPR) calls for the United States to have modern, flexible, and resilient nuclear capabilities that are safe and secure until such a time as nuclear weapons can prudently be eliminated from the world. All previous NPRs highlighted the need to maintain a modern nuclear weapons infrastructure, yet the United States has fallen behind in sustaining a modern infrastructure that is resilient and has the capacity to respond to unforeseen threats. Additionally, the 2018 NPR reiterates the United States' commitment to effective nonproliferation and arms control measures, both of which are equally important as having a credible deterrent.

For the Nation to retain a credible deterrent and prevent, counter, and respond to global nuclear security threats, NNSA will require significant and sustained investments in its nuclear security mission. In pursuit of these goals, the President's fiscal year 2020 budget request for NNSA is $16.5 billion. This is an increase of $1.3 billion, or 8.3 percent, over the fiscal year 2019 enacted level. [1]

WEAPONS ACTIVITIES APPROPRIATION

The fiscal year 2020 budget request for the *Weapons Activities* account is $12.4 billion, an increase of $1.3 billion, or 12 percent, over fiscal year 2019 request levels. The programs funded in this account support the Nation's current and future defense posture and the associated nationwide infrastructure of science, technology, engineering, cybersecurity, and production capabilities.

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 potential adversaries have increased their numbers of nuclear weapons and significantly modernized their nuclear capabilities.

Maintaining the Stockpile

In fiscal year 2019, the science-based Stockpile Stewardship Program supported certifying to the President for the 23rd consecutive year that the U.S. nuclear weapons stockpile remains safe, secure, and reliable without the need for nuclear explosive testing. This remarkable scientific achievement is made possible through the work accomplished by NNSA's world-class scientists, engineers, and technicians, and through investments in state-of-the-art diagnostic tools, high performance computing platforms, and modern facilities.

For *Directed Stockpile Work* (DSW), the fiscal year 2020 budget request is $5.4 billion, an increase of $768 million, or 16.5 percent, over the fiscal year 2019 enacted level. Included within this request is funding to support the LEPs, modifications, and a major alteration. These modernization efforts are aligned with the needs outlined in the 2018 NPR and approved by the NWC.

W76–1 LEP: The W76–1 LEP, which directly supports the sea-based leg of the nuclear triad, completed its production run in December 2018. Close-out activities in fiscal year 2020 include archiving production tooling and program records, and completing component overbuilds to support hardware provisioning for the life of the warhead system.

W76–2 Modification Program: The W76–2 is currently on schedule and on budget. The First Production Unit (FPU) was completed in February 2019. By providing the U.S. an assured ability to respond in kind to a low-yield nuclear attack, the W76–2 discourages an adversary from pursuing such an attack and therefore strengthens deterrence. Having credible response options to a nuclear attack of any magnitude ensures no adversary mistakenly believes the U.S. would be deterred from responding to a low-level nuclear attack for fear of escalation.

B61–12 LEP: The B61–12 LEP will consolidate four variants of the B61 gravity bomb and improve the safety and security of the weapon. Currently in Phase 6.4,

[1] Amounts do not reflect the transfer of funds from Naval Reactors to the Office of Nuclear Energy for maintenance and operation of the Advanced Test Reactor in fiscal year 2019.

Production Engineering, this LEP has demonstrated system performance in over 60 integrated ground and flight tests, including eight joint flight test drops. NNSA has notified your committee of a technical issue with the B61–12 that we estimate will delay the FPU. We are aggressively working to minimize the delay and are working with DOD to coordinate any possible impacts.

W88 Alteration 370: This program, which also supports the sea-based leg of the nuclear triad, is currently in Phase 6.4, Production Engineering. NNSA is aggressively managing the FPU for this program, which was scheduled for December 2019. The same technical issue impacting the B61–12 LEP will impact the W88 Alteration 370. The length of the delay to FPU is still being assessed and a number of mitigation plans are being executed at this time, in coordination with DOD, to minimize the FPU delay.

W80–4 LEP: In February 2019, the NWC approved the W80–4 LEP to transition into Phase 6.3, Development Engineering. The fiscal year 2020 request for $899 million will allow the W80–4 LEP to remain on track to achieve FPU completion in fiscal year 2025 in support of the Air Force's Long-Range Stand-Off (LRSO) cruise missile.

W87–1 Modification Program: The W87–1 program will replace the aging W78 warhead, with planned first production in 2030 to support fielding on the U.S. Air Force's Ground Based Strategic Deterrent (GBSD) missile system. In September 2018, the NWC authorized restart of Phase 6.2, Program Feasibility Study, activities on the W78 replacement warhead and renamed it the W87–1. The W87–1 Modification Program will improve the warhead's safety and security, addressing design, material obsolescence, performance, and survivability considerations.

Within DSW, the fiscal year 2020 budget request includes $636 million for Stockpile Systems, an increase of $36 million, or 6.1 percent above the fiscal year 2019 enacted level. This program sustains the stockpile in accordance with the Nuclear Weapon Stockpile Plan by producing and replacing limited-life components such as neutron generators and gas transfer systems; conducting maintenance, surveillance, and evaluations to assess weapon reliability; detecting and anticipating potential weapon issues; and compiling and analyzing information during the annual assessment process.

The DSW request also includes $1.1 billion for Stockpile Services, an increase of $76 million, or 7.2 percent, above the fiscal year 2019 enacted level, to support the modernization of capabilities to improve efficiency of manufacturing operations to meet future requirements. This request supports all DSW operations by funding programmatic and infrastructure management, and maintaining the core competencies and technologies essential for reliable and operable stewardship capabilities.

The fiscal year 2020 budget for *Strategic Materials* is necessary to maintain NNSA's ability to produce nuclear and other strategic materials associated with its weapons programs, as well as refurbish and manufacture components made from these materials. This includes uranium, plutonium, tritium, and lithium.

Strategic Materials Sustainment: The request of $257 million, an increase of $41 million, or 18.8 percent, above the fiscal year 2019 enacted level, will develop and implement strategies to maintain the technical base for strategic materials in support of NNSA's nuclear weapons, nonproliferation, and naval nuclear propulsion activities at NNSA's eight sites.

Uranium Program: The fiscal year 2020 budget request of $909 million for the Uranium Program is comprised of Uranium Sustainment ($94 million), Process Technology Development ($70 million), and the UPF project ($745 million).[2] Uranium Sustainment supports the program to maintain existing enriched uranium capabilities through enhanced equipment maintenance while preparing to phase out mission dependency on Building 9212, a Manhattan Project-era production facility at Y–12. The funding request will enable NNSA to sustain uranium manufacturing capabilities while accelerating planning and execution of the Building 9212 exit strategy to reduce risks associated with transitioning enriched uranium capabilities to the UPF. Process Technology Development supports key capability transitions out of Building 9212, including chip processing, purified metal production, and recovery of low equity material, into enduring nuclear facilities. Funding for UPF will support peak construction activities in fiscal year 2020 and fiscal year 2021. UPF will provide uranium casting, special oxide production, and salvage and accountability capabilities for the enterprise.

Plutonium Sustainment: The fiscal year 2020 budget request of $712 million, an increase of $351 million, or 97.2 percent, above the fiscal year 2019 enacted level,

[2] Process Technology Development is funded under the Advanced Manufacturing Development program, and the UPF project is funded under Infrastructure and Operations.

supports continued progress to meet pit production requirements. The requested funding would support efforts to begin the long-term plan to develop a capability to produce no fewer than 80 war-reserve pits per year by 2030, as directed in the 2018 NPR.

The time to move forward is now. Repurposing the Mixed Oxide (MOX) Fuel Fabrication Facility and producing plutonium pits at SRS and LANL is the preferred path to achieve the critical DOD requirement of 80 pits per year by 2030. Even though this approach will require NNSA to fund activities at two sites, any interruption or delay to pit production in the future due to the lack of resiliency will have huge cost increases across the entire nuclear security enterprise. NNSA is investing in the Savannah River Plutonium Processing Facility. The agency is executing conceptual design activities for the repurposed MOX Fuel Fabrication Facility and moving forward with National Environmental Policy Act activities.

NNSA is also investing at LANL to provide all the tools necessary for the enterprise to successfully support an enduring plutonium pit production mission to produce 30 pits per year by 2026. NNSA anticipates $3 billion in total funding over the next five years to enable this, and LANL is actively installing pit production equipment and has begun hiring to meet future work scope. As the Nation's plutonium center of excellence for research and development, LANL plays a critical role in early design efforts for pit production.

In addition, NNSA's budget request includes funding for the Chemistry and Metallurgy Research Replacement project at LANL, which supports our plan to cease operations in buildings dating back to the Manhattan Project, in the height of the Cold War, and transition to modern facilities.

Tritium Program: The fiscal year 2020 budget request of $269 million, a decrease of $21 million, or 7.3 percent, below the fiscal year 2019 enacted level, will provide the tritium necessary for national security requirements. Tritium must be replenished regularly because it radioactively decays at 5.5 percent per year. Tritium availability is dependent on both the production of new tritium and the recovery and recycling of tritium from returned warhead components. Mission requirements necessitate that tritium production double by the mid-2020s. NNSA's tritium strategy focuses on increasing tritium production in Tennessee Valley Authority reactors and modernizing infrastructure at SRS to support the tritium supply chain.

Lithium Program: The fiscal year 2020 budget request of $29 million, a decrease of $335,000, or 1.1 percent below the fiscal year 2019 enacted level, supports a lithium bridging strategy to maintain the production of lithium. The fiscal year 2020 budget request includes $32 million for the Lithium Processing Facility (LPF), which will replace 1940s infrastructure at Y–12 and house lithium processing capabilities by 2030. NNSA completed an Analysis of Alternatives (AOA) for the LPF and is preparing for Critical Decision 1, establishing the preferred alternative design and estimated budget.

Domestic Uranium Enrichment (DUE): The fiscal year 2020 budget request of $140 million, an increase of $90 million, or 180 percent above the fiscal year 2019 enacted level, will continue efforts to make available, when needed, the necessary supplies of enriched uranium for a variety of national security needs. The DUE program schedule is driven by the nearest-term defense need—unobligated low enriched uranium for tritium production. Other Departmental needs for enriched uranium (e.g., research reactors, naval fuel) are supported by this effort as well.

For *Research, Development, Test, and Evaluation* (RDT&E), the fiscal year 2020 budget request is $2.3 billion, an increase of $264 million, or 13.1 percent above the fiscal year 2019 enacted levels.

Increases to the *Science Program* ($587 million) provide additional funding to support subcritical experiments for pit reuse and advanced diagnostics for subcritical hydrodynamic integrated weapons experiments that produce data for stockpile certifications.

The *Engineering Program* ($234 million) sustains NNSA's capability for creating and maturing advanced toolsets and technologies to improve weapon surety and support annual stockpile assessments.

In fiscal year 2020, the *Inertial Confinement Fusion Ignition and High Yield Program* ($481 million) will continue to maintain essential experimental capabilities and expertise in high energy density stockpile science. These efforts continue to provide data to reduce uncertainty in calculations of nuclear weapons performance and improve the predictive capability of science and engineering models in high-pressure, high-energy, high-density regimes.

The fiscal year 2020 request includes $840 million for the *Advanced Simulation and Computing* (ASC) Program, which continues NNSA's close collaboration with DOE's Office of Science to implement the Exascale Computing Initiative. The ASC Program supports stockpile stewardship by developing and delivering predictive

simulation capabilities for nuclear weapons systems in addition to deploying increasingly more powerful supercomputers at Sandia, Los Alamos, and Lawrence Livermore National Laboratories.

The *Secure Transportation Asset* (STA) program provides safe, secure movement of nuclear weapons, special nuclear material, and weapon components to meet projected DOE, DOD, and other customer requirements. The Office of Secure Transportation has an elite security workforce that performs sensitive and demanding work; our agents are among the most highly trained and dedicated national security personnel operating within the United States. The fiscal year 2020 budget request is $317 million, of which $80 million continues our efforts to modernize and replace the existing fleet of transporters with the Mobile Guardian Transporter (MGT). The MGT will be used for the containment and transport of nuclear weapons, weapons components, and/or special nuclear materials.

Improving Safety, Operations, and Infrastructure

An effective, responsive, and resilient nuclear weapons infrastructure is essential to the U.S. capacity to adapt flexibly to shifting requirements. Such an infrastructure offers tangible evidence to both allies and potential adversaries of U.S. nuclear weapons capabilities and can help to deter, assure, hedge against adverse developments, and discourage adversary interest in arms competition.

More than half of NNSA's facilities are over 40 years old, and roughly 30 percent date back to the Manhattan Project. It will take sustained, significant resources to modernize NNSA's nuclear weapons infrastructure.

Thanks to the support of the Administration and Congress, NNSA is making progress in repairing, replacing, and modernizing NNSA's facilities and stabilizing deferred maintenance; yet much more remains to be done. The fiscal year 2020 budget request for *Infrastructure and Operations* is $3.2 billion, an increase of $121 million, or 3.9 percent above the fiscal year 2019 enacted level. It includes $1.1 billion for line item construction and over $580 million for minor construction and equipment recapitalization needs. Delivering these projects on budget and schedule is contingent upon stable and predictable funding profiles, and support for the President's budget request.

Many of NNSA's excess process-contaminated facilities will ultimately be transferred to DOE's Office of Environmental Management (EM) for disposition. For example, EM commenced efforts to remove Building 280 Pool Type Reactor and ancillary facilities at Lawrence Livermore National Laboratory. NNSA identified five (including Building 280) of the top ten highest risk excess facilities at Lawrence Livermore National Laboratory.

In the interim, NNSA is focusing on reducing risks where possible. NNSA has made critical investments to stabilize high-risk process-contaminated facilities until ultimate disposition, including at Y–12's Alpha 5 and Beta 4 facilities. In fiscal year 2020, NNSA is using the authority Congress provided in the fiscal year 2018 National Defense Authorization Act (NDAA) to pursue disposition of several high-risk process-contaminated excess facilities with a project cost of less than $50 million. NNSA also remains committed to reducing the risk of non-process contaminated facilities by dispositioning facilities where possible. For example, NNSA completed the Pantex Drummond Office Building (formerly known as the Administrative Support Complex) at the Pantex Plant outside of Amarillo, Texas in 2018. This building provides 1,000 employees with modern, energy efficient workspace. As a result, NNSA is now disposing of dilapidated, 1950s-era buildings and eliminating approximately $20 million in deferred maintenance. In fiscal year 2020, NNSA plans to fund the disposition of 24 additional facilities totaling 75,000 gross square feet.

Defense Nuclear Security's fiscal year 2020 budget request is $778 million, an increase of $88 million, or 12.7 percent, over the fiscal year 2019 enacted amount. To execute its enterprise security program, DNS provides funding to the sites for: protective forces; physical security systems; information security and technical security; personnel security; nuclear material control and accountability; and security program operations and planning. While NNSA faces challenges replacing and refreshing aging physical security infrastructure, we are making key investments in recapitalizing this infrastructure through the Security Infrastructure Revitalization Program (SIRP). SIRP projects address aging high-priority security systems and related security infrastructure and equipment needs at all NNSA sites. NNSA will continue to execute ongoing line-item security projects as well, including the effort to reduce the Y–12 Protected Area and use security resources more efficiently. In addition, NNSA will sustain counter unmanned aircraft systems implementation and operation at sites possessing Category 0/I quantities of special nuclear material.

Information Technology and Cybersecurity enable every element of NNSA's missions. The fiscal year 2020 budget request is $309 million, an increase of $88 mil-

lion, or 40 percent over the fiscal year 2019 request. This increase will continue cybersecurity enhancements, bolster cybersecurity capabilities, and support the continuation of IT modernization efforts. NNSA is making steady progress in enhancing and upgrading the components of the Enterprise Secure Computing environment to ensure that nuclear security enterprise missions can be completed without disruption. As NNSA mission requirements expand in scope, the IT and cyber programs require modernization, expansion, and innovation in a commensurate fashion. Cybersecurity is a defense and deterrence mechanism and a powerful tool. In the current threat environment, NNSA cannot afford to neglect its cybersecurity capabilities, which serve as frontline assets that protect the information, systems, and networks NNSA depends on to execute our mission.

DEFENSE NUCLEAR NONPROLIFERATION APPROPRIATION

The fiscal year 2020 budget request for the Defense Nuclear Nonproliferation account is $2 billion, an increase of $63 million, or 3.3 percent, above the fiscal year 2019 request. Defense Nuclear Nonproliferation account activities address the entire nuclear threat spectrum by helping to prevent the proliferation of nuclear weapons, counter the threat of nuclear terrorism, and respond to nuclear and radiological incidents around the world. The fiscal year 2020 budget request funds two program mission areas under this account: the Defense Nuclear Nonproliferation (DNN) Program and the Nuclear Counterterrorism and Incident Response (NCTIR) Program.

Nonproliferation Efforts

The Office of Defense Nuclear Nonproliferation works to: remove or eliminate vulnerable nuclear material; improve global nuclear security through multilateral and bilateral technical exchanges and training workshops; help prevent the illicit trafficking of nuclear and radioactive materials; secure domestic and international civilian buildings containing high-priority radioactive material; provide technical reviews of U.S. export license applications; conduct export control training sessions for U.S. enforcement agencies and international partners; strengthen the IAEA's ability to detect and deter nuclear proliferation; advance U.S. capabilities to monitor arms control treaties and detect foreign nuclear programs; and maintain organizational readiness to respond to and mitigate radiological or nuclear incidents worldwide.

The *Material Management and Minimization (M3)* program provides an integrated approach to addressing the risk posed by nuclear materials. The fiscal year 2020 budget request is $334 million, an increase of $40 million, or 13.5, percent above the fiscal year 2019 enacted level. The request supports the conversion or shut-down of research reactors and isotope production facilities that use HEU and the acceleration of developing new, non HEU-based molybdenum-99 production technologies in the United States. Additionally, the request for M3 supports the removal and disposal of weapons-usable nuclear material, with priority on expediting the removal of surplus plutonium from the State of South Carolina and continuing the transition to the dilute and dispose strategy for surplus plutonium disposition.

The *Global Material Security* program works with partner nations to increase the security of vulnerable nuclear and radioactive materials and improve the ability to deter, detect, and investigate illicit trafficking of these materials. The fiscal year 2020 budget request of $342 million, a decrease of $65 million, or 15.9 percent, below the fiscal year 2019 enacted level and includes efforts to secure the most at-risk radioactive material in U.S. high-threat urban areas by the end of fiscal year 2020.

The *Nonproliferation and Arms Control* program develops and implements programs to: strengthen international nuclear safeguards; control the proliferation of nuclear and dual-use material, equipment, technology and expertise; verify nuclear reductions and compliance with nonproliferation and arms control treaties and agreements; and address enduring and emerging proliferation challenges requiring the development of innovative policies and approaches. The fiscal year 2020 budget request for this program is $137 million, an increase of $6 million, or 5.8 percent, above the fiscal year 2019 enacted level. This increase serves to advance and complete development of the new Export Compliance Assistance Program to deploy export control training across DOE and NNSA facilities, implement new 10 CFR Part 810 civil penalty authority pursuant to the fiscal year 2019 NDAA, and establish and maintain a nonproliferation enrichment testing and training platform in cooperation with the IAEA and select foreign partners.

The *Defense Nuclear Nonproliferation Research and Development* program supports innovative unilateral and multilateral technical capabilities to detect, identify, and characterize foreign nuclear weapons programs, illicit diversion of special nuclear material, and nuclear detonations worldwide. The fiscal year 2020 budget request for this program is $495 million, a decrease of $80 million, or 13.9 percent,

below the fiscal year 2019 enacted level. This decrease is due to shifting the HEU Reactor Conversion program to M3, as it is no longer in the research and development phase.

Nonproliferation Construction consolidates construction costs for DNN projects. The fiscal year 2020 budget request is $299 million, an increase of $79 million, or 35.9 percent, above the fiscal year 2019 enacted level. Last year, NNSA terminated activities for the MOX Fuel Fabrication Facility project to pursue the dilute and dispose option to fulfill the U.S. commitment to dispose of 34 metric tons of plutonium. The $220 million for the MOX Fuel Fabrication Facility will be used to continue termination activities. The request also includes $79 million for the Surplus Plutonium Disposition project, which supports the dilute and dispose strategy.

Nuclear Counterterrorism and Incident Response (NCTIR)

The Office of Counterterrorism and Counterproliferation (CTCP) provides effective capabilities to respond to any nuclear or radiological incident in the United States or abroad by applying the unique technical expertise found in NNSA's nuclear security enterprise. Highly trained personnel with specialized technical equipment maintain readiness to support lead federal agencies to find and render safe potential nuclear and radiological threat devices, to effectively manage the consequences of nuclear or radiological emergencies, and to support enhanced security operations for National Security Special Events (NSSE).

NNSA's Aerial Measuring System (AMS) provides airborne remote sensing in the event of a nuclear or radiological accident or incident within the continental United States, as well as in support of regularly scheduled NSSE. The AMS fleet consists of three Beechcraft B200 fixed-wing aircraft with an average age of 33 years and two Bell 412 helicopters with an average age of 24 years. The age of the current aircraft leads to unscheduled downtime resulting in reduced mission availability. A 2017 AOA on the AMS aircraft determined that recapitalization of the aging aircraft fleet is necessary to continue to provide Federal, State, and local officials with rapid radiological information following an accident or incident. In fiscal year 2019, the fixed-wing aircraft will be replaced, and the rotary-wing aircraft will be replaced in fiscal year 2020. The fiscal year 2020 budget request for AMS recapitalization is $35.5 million.

NNSA, in conjunction with the Federal Bureau of Investigation (FBI), supports render safe teams at FBI field offices in 11 major American cities that are specially trained and equipped to identify and mitigate the function of a nuclear or radiological device (i.e, "stabilization"). CTCP will conduct stabilization training and operations and begin transitioning to the Capability Forward initiative, under which lifesaving responses to a nuclear threat device will be accelerated. Under this initiative, NNSA will provide additional training, equipment, and technical support to the current 11 stabilization cities—eventually growing to 14 U.S. cities by fiscal year 2022—to allow FBI teams to execute render safe operations more rapidly. CTCP will also improve and expand NNSA training facilities to accommodate the increased training requirements associated with regional render safe capabilities.

The Nation's nuclear incident response teams require the ability to communicate classified technical assessments in deployed, and often austere, environments using highly secure means. Information requirements encompass both nuclear device design information and intelligence assessments. The equipment used by NNSA's nuclear incident response teams is aging, resulting in increasing maintenance costs and heightened risks to the emergency response mission. This budget includes funding for recapitalization of incident response equipment consistent with lifecycle planning to maintain operational readiness. The budget also includes funding for state-of-the-art, secure, deployable communications systems that are interoperable with FBI and DOD mission partners that will help provide decision makers with real-time technical recommendations to mitigate nuclear terrorist threats.

CTCP maintains an operational nuclear forensics capability in three distinct areas: (1) pre-detonation device disassembly and examination; (2) post-detonation assessment; and (3) analysis and characterization of nuclear materials. The program maintains readiness to deploy device disposition and device assessment teams, conduct laboratory operations in support of analysis of bulk actinide forensics, and deploy subject matter expertise and operational capabilities in support of ground sample collections that support attribution of a nuclear detonation.

The *Emergency Operations* program's fiscal year 2020 budget request includes $35.5 million under NCTIR to support NNSA's Office of Emergency Operations. This funding will support NNSA's all-hazard emergency response capabilities that positively impact the Department's emergency management continuity and devolution programs, enhance the ability of the Department to respond to, and recover from, catastrophic emergencies or other man-made hazards or natural disasters.

NAVAL REACTORS APPROPRIATION

Advancing Naval Nuclear Propulsion

Nuclear propulsion for the U.S. Navy's fleet of submarines and aircraft carriers is critical to the security of the United States and its allies as well as the security of global sea lanes. The Office of Naval Reactors remains at the forefront of technological developments in naval nuclear propulsion by advancing new technologies and improvements in naval reactor performance. This preeminence provides the U.S. Navy with a commanding edge in naval warfighting capabilities.

The *Naval Reactors* fiscal year 2020 budget request is $1.65 billion, a decrease of $140 million or approximately 8 percent, below the fiscal year 2019 enacted level. This request reflects reductions to planned funding levels following additional funding enacted in fiscal year 2018 for the S8G Prototype Refueling Overhaul and Spent Fuel Handling Recapitalization Project. In addition to supporting today's operational fleet, the requested funding is the foundation for Naval Reactors to deliver tomorrow's fleet and recruit and retain a highly-skilled workforce. One of Naval Reactors' three national priority projects, continuing design and development of the reactor plant for the *Columbia*-class submarine, featuring a life-of-ship core and electric drive, will replace the current *Ohio*-class fleet and provide required deterrence capabilities for decades. The project to refuel a research and training reactor in New York will enable 20 more years of research, development, and training for fleet operators. Funding will also be used to support construction of a new spent fuel handling facility in Idaho that will facilitate long term, reliable processing and packaging of spent nuclear fuel from aircraft carriers and submarines.

Naval Reactors has requested funding in fiscal year 2020 to support these projects and fund necessary reactor technology development, equipment, construction, maintenance, and modernization of critical infrastructure and facilities. By employing a small but high-performing technical base, the teams at Bettis Atomic Power Laboratory in Pittsburgh, Pennsylvania; Knolls Atomic Power Laboratory and Kesselring Site in New York; and the spent nuclear fuel facilities in Idaho can perform the research and development, analysis, engineering, and testing needed to support today's fleet at sea and develop future nuclear-powered warships. These laboratories also perform the technical evaluations that enable Naval Reactors to thoroughly assess emergent issues and deliver timely responses to provide nuclear safety and maximize operational flexibility.

NNSA FEDERAL SALARIES AND EXPENSES APPROPRIATION

The fiscal year 2020 budget request for *Federal Salaries and Expenses* is $435 million, an increase of $25 million, or 6.0 percent, over the fiscal year 2019 enacted level. The 2018 NPR highlighted the need to properly support civilian personnel who protect the United States against nuclear threats. Effective deterrence would be impossible without the vital contributions our personnel make to the United States' nuclear capabilities and deterrence. NNSA's workforce is critical to the success of the Nation's nuclear security enterprise. NNSA must have a sufficient workforce, with the right capabilities, to ensure we can modernize the nuclear deterrent, recapitalize an aging infrastructure, and continue to meet the requirements of our nonproliferation and counterterrorism programs. To effectively accomplish our mission deliverables, NNSA's workforce must be aligned to meet the mission needs of today and those in future.

NNSA's expanding and challenging national security missions require it to recruit, train, and retain a highly skilled and dedicated federal employee and Management and Operating (M&O) contract workforce. A skilled federal workforce is required to execute appropriate program and project oversight as the nuclear security enterprise is busier than it has been since the end of the Cold War. However, funding alone is not the only thing needed. NNSA must continue to provide its highly-talented men and women with the tools necessary to support their work, including providing the necessary human resource authorities to attract, recruit, and retain its world-class workforce. To validate the size of the federal workforce needed to execute our mission, NNSA engaged in a multiyear effort to critically analyze its manpower requirements. Within the past year, the Office of Personnel Management and NNSA's Office of Cost Estimating and Program Evaluation both independently determined the need to significantly increase federal staffing levels.

The number of additional staff recommended in both studies would exceed the statutory cap on NNSA's full-time equivalent employees. In March 2019, the Government Accountability Office (GAO) endorsed both OPM and CEPE's staffing analyses' conclusions and recommended that Congress work with NNSA on the statutory staffing cap to ensure it is consistent with our federal human capital requirements to meet the evolving needs of the mission. These studies, and GAO's recommenda-

tions in particular, support NNSA's request to eliminate the current 1,690 FTE and 600 Excepted Service personnel caps to achieve greater flexibility in hiring authorities. Eliminating both of these caps and matching our Federal Salaries and Expenses budget request would allow the NNSA to align personnel resources to mission priorities. This is more pressing now because the OPM staffing study was conducted before new requirements from the 2018 NPR and multi-site plutonium pit production approach were endorsed by the Nuclear Weapons Council in May 2018.

Management and Performance

Since 2011, NNSA has delivered approximately $2 billion in projects, a significant portion of NNSA's total project portfolio, under budget. We are committed to encouraging competition and increasing the universe of qualified contractors by streamlining major acquisition processes. NNSA will continue to focus on delivering timely, best-value acquisition solutions for all programs and projects, by using a tailored approach to contract structures and incentives that are appropriate for the special missions and risks at each site. NNSA's Office of Acquisition and Project Management continues to: lead improvements in contract and project management practices; provide clear lines of authority and accountability for program and project managers; improve cost and schedule performance; and ensure that Federal Project Directors and Contracting Officers possess the appropriate skill mix and professional certifications to manage NNSA's work.

Conclusion

NNSA's diverse missions are critical to the national security of the United States: maintaining the safety, security, reliability, and effectiveness of the nuclear weapons stockpile; reducing the threat of nuclear proliferation and nuclear terrorism around the world; and providing naval nuclear propulsion to the U.S. Navy's fleet of aircraft carriers and submarines. NNSA is mindful of its obligation to improve acquisition, safety, and security practices continually, and to use in a responsible manner, the resources entrusted to it by Congress and the American people. By investing in our nuclear security enterprise and continuing our efforts to modernize our scientific, technical, and engineering capabilities and infrastructure, NNSA will continue to deliver on its nuclear security mission.

Senator FISCHER. Thank you, Madam Secretary.

Secretary White, welcome.

STATEMENT OF HON. ANNE MARIE WHITE, ASSISTANT SECRETARY OF ENERGY FOR ENVIRONMENTAL MANAGEMENT

Secretary WHITE. Chairman Fischer and Members of the Subcommittee, thank you for the opportunity to appear today. The fiscal year 2020 budget request of $6.5 billion demonstrates the Administration's commitment to tackling the environmental legacy of nuclear weapons production that helped end World War II and the Cold War.

Madam Chair, since the Office of Environmental Management's (EM's) inception, our dedicated workforce has cleaned and closed sites, dramatically reducing the EM footprint from 107 sites to just 16. Progress continues at every site.

Last month, I was in New Mexico with Ranking Member Heinrich to mark the 20th anniversary of the Waste Isolation Pilot Plant (WIPP), our key facility for final disposition of transuranic waste across the EM complex. I saw firsthand progress on a number of vital infrastructure projects at WIPP, including upgrades to electrical, fire suppression, and compressed air systems. WIPP not only has an amazing history to celebrate but a very bright future ahead.

Over the course of the last year, workers in South Carolina at the Savannah River site (SRS) consolidated more than 400,000 cubic yards of coal ash and ash contaminated soil. They got it done safely and 14 months ahead of schedule, saving $9 million and

earning them the Project Management Institute Award for project excellence.

For the first time in the history of the Savannah River site, EM is processing two salt waste streams at the site. With help from the parallel processing systems, now more than 10 million gallons of salt waste have been processed since salt decontamination operations began at SRS.

At Oak Ridge, we took another significant step towards large-scale cleanup at the Y–12 site.

During my confirmation hearings, I committed to enhance safety through risk mitigation and cleanup and to address overall taxpayer liability. That is precisely what I have focused on during my first year on the job. We are getting a clear picture of EM liabilities for the first time. We are increasing accountability to Congress and to the American people through stronger project management and oversight. That includes addressing issues long raised by the Government Accountability Office.

There are opportunities with the potential to get cleanup projects done and off the books safely, sooner, and at a reasonable cost. The Department is evaluating these opportunities, including new technologies, treatment options, and disposal capabilities in a comprehensive way. Following on recommendations from wide-ranging and nonpartisan outside groups, the Department is evaluating its interpretation of the statutory term "high level radioactive waste."

EM is also taking steps to get the best value out of every cleanup dollar that Congress provides. That includes identifying impactful regulatory reforms and improving procurements through a new end-state contracting model.

As EM is put on a sustainable path forward, the budget request provides the resources to build upon recent successes and bring a renewed sense of urgency to the program. The request provides the resources to make progress on cleanup activities across the complex, including addressing radioactive tank waste at the Savannah River site and driving the direct feed low activity waste approach to initiate Hanford tank waste treatment.

At Los Alamos, funding is included to initiate two transuranic waste processing lines, complete characterization of the high explosive plume in Canyon de Valle and implement the full interim measure for the chromium plume.

In the interest of time, I will stop there and just note that more details about the work we have planned are provided in my written testimony.

EM's historical successes have been achieved through the dedication of leaders on both sides of the aisle with a uniformity of purpose to drive the cleanup mission towards completion. I want to work with Congress to clean up these sites so that our host communities can envision a vibrant future with diverse and enduring economic opportunities.

I appreciate this opportunity and the Subcommittee's support of the EM mission.

[The prepared statement of Secretary White follows:]

PREPARED STATEMENT BY ANNE MARIE WHITE

Chairman Fischer, Ranking Member Heinrich and Members of the Subcommittee, thank you for the opportunity to appear before you today to represent the Department of Energy's (DOE) Office of Environmental Management (EM). I would like to provide you with an overview of the EM program, key accomplishments during the past year, and planned accomplishments through the President's Fiscal Year 2020 Budget request of $6.5 billion, which includes $5.5 billion in Defense Environmental Cleanup funding.

The request demonstrates the Administration's continued commitment to the vital mission of EM to address the environmental legacy of nuclear weapons production that helped end World War II and the Cold War.

This legacy is one that includes challenges like the safe disposition of radioactive wastes; the management of spent nuclear fuel and special nuclear material; the cleanup of contaminated soil and groundwater; and the decontamination and decommissioning (D&D) of thousands of excess facilities.

Madam Chair, this year marks the 30th anniversary of the EM program. Since its inception, our dedicated workforce has worked effectively to reduce the footprint of the cleanup program from 107 sites comprising a total of 3,100 square miles to just 16 sites, with an active cleanup footprint of less than 300 square miles.

While it does not always make headline news, we are sustaining progress at each of our EM sites, and we have realized a set of key accomplishments over the past year.

Last month I was out in New Mexico with Ranking Member Heinrich to mark the 20th Anniversary of the Waste Isolation Pilot Plant (WIPP), our key facility for final disposition of transuranic waste across the EM complex.

I had the opportunity to see firsthand progress on a number of vital infrastructure projects at WIPP, which include upgrades to electrical, fire suppression, and compressed air systems.

From there I headed to Los Alamos where I received an update on the early success of the chromium plume interim measure.

Over the past year, EM took another significant step towards large-scale cleanup at the Y–12 site in Oak Ridge, Tennessee, by removing over 3 tons of mercury from equipment and completing all of the site preparation required for construction of the new Mercury Treatment Facility. This vital infrastructure will help EM fulfill a commitment with the U.S. Environmental Protection Agency (EPA) and the State of Tennessee to reduce the levels of mercury leaving the Y–12 facility.

Workers in South Carolina consolidated more than 400,000 cubic yards of coal ash and ash-contaminated soil at the Savannah River Site. They completed it safely and 14 months ahead of schedule, saving $9 million.

For the first time in the history of the Savannah River Site (SRS), EM is processing two salt waste streams at the site. With help from the parallel processing streams, now more than 10 million gallons of salt waste have been processed since salt-decontamination operations began at SRS. The waste is being processed through two salt-decontamination operations: an integrated interim salt processing operation called the Actinide Removal Process and the Modular Caustic Side Solvent Extraction Unit, and a newly implemented process called Tank Closure Cesium Removal.

Workers in South Carolina consolidated more than 400,000 cubic yards of coal ash and ash-contaminated soil at the SRS. They completed it safely and 14 months ahead of schedule, saving $9 million.

At Hanford, EM continued hot cell cleanup and workers began installing equipment to excavate highly contaminated soil under the 324 Building. This facility operated from 1966 to 1996 and supported research involving radioactive materials.

From my time in industry, I understand where cleanup work gets done. It is out in the field. Our men and women on the ground are doing a great job and making progress—but we must do more.

Despite this great work and the important federal investment year after year, EM faces significant challenges. Cleanup progress is being significantly outpaced by environmental liabilities.

Even with significant budgets, EM is swimming upstream as we gear up to tackle some of our remaining toughest challenges. Simply throwing more taxpayer dollars into EM will not address these challenges.

This Administration, and the Secretary of Energy's senior leadership team are taking action to ensure the sustainability of the EM program and address issues long-raised by the Government Accountability Office.

Since the inception of the EM program, our knowledge and technology have matured significantly. We need to employ a sustainable completion-centric cleanup ap-

proach, using the latest knowledge in waste composition, risks, and attainable end states. We need to pursue cleanup in a manner that properly incentivizes performance, strengthens oversight, and delivers results.

EM is committed to working in a collaborative manner with Congress and others toward a future that will not simply enable the cleanup program to continue—but will propel the mission forward and drive it toward completion and closure. The Subcommittee will see EM focus on strengthening program management, oversight, and accountability to ensure value for the American taxpayer.

That starts with abandoning vague notions of our challenges and truly getting to the bottom of what we are dealing with using accurate up-to-date information.

Work must be prioritized based on real risks and sound science, rather than perceived risks or soundbites.

There are some real potential improvements for how EM treats and disposes of waste safely, quickly, and cost-effectively. The Department has a responsibility to carefully evaluate these options, including new technologies, treatment options, and disposal capabilities that did not exist when cleanup plans were first developed.

To that end, EM is looking 10 years out at what the barriers are and how they could be mitigated for faster completion. We are developing site options analyses to identify opportunities to complete cleanup work through more efficient, innovative, or novel approaches over the next decade. This includes considering the range of possibilities in terms of what could be achieved at sites across the complex if we are willing to reassess our assumptions, consider new approaches and disposal options, and just think outside the box.

EM will soon complete site options assessments and we look forward to engaging with Congress as well as stakeholders and regulators throughout the cleanup community on the best ways to move forward.

As announced in a Federal Register notice in October 2018, the Department is evaluating its interpretation of the statutory term high-level radioactive waste. In the notice, the Department sought public comment on an interpretation that would classify high-level radioactive waste based on its actual radiological content and associated risks rather than solely on the source of the waste. If implemented, this would bring the U.S. more in line with the rest of the world, and be consistent with many reports and recommendations from wide-ranging and non-partisan outside groups. It is important to note this is the first step in a process that must comply with existing programmatic and regulatory requirements and law. The Department's consideration of a new interpretation does not alter or abrogate the Department's responsibilities or policies under existing regulatory requirements or agreements.

EM is also taking steps to get the best value out of every cleanup dollar that Congress provides.

Consistent with the Deputy Secretary's initiative on regulatory reform, I have directed staff and the field to look at opportunities for change.

Based on my experience in the field, this will lead to an enhanced safety culture because many of the reforms are common sense approaches that can streamline our work.

EM is focused on driving down the operating and maintenance costs for its facilities, which represent a significant portion of EM's annual budget that could otherwise be used for actual cleanup work.

As project lifecycle schedules drag out, aging facilities' components and equipment are stretching resources. We can either invest money towards cleanup or we can maintain aging facilities and build new facilities, but we cannot do it all.

One of the most transformative initiatives is in the area of contracting. EM has billions of dollars in procurements coming up at some of our largest sites over the next few years, representing a significant opportunity to improve our procurement processes, contract management, and oversight performance.

In February, the Department released Final Requests for Proposals for the first two contracts that are representative of this new "end-state contract" model. Proposals from offerors are currently being evaluated for award later this summer.

End-state contracting is not a contract type but an approach to creating meaningful and visible progress through defined end-states, even at sites with completion dates far into the future. This is intended to create and motivate a culture of completion.

Madam Chair, this new approach to procurement; the discussions we are having on the regulatory front; the ongoing options analyses; and the funding proposed in the fiscal year 2020 budget request, will yield impactful results.

The fiscal year 2020 budget request for EM is $6.5 billion, which includes $5.5 billion for defense environmental cleanup activities; $247 million; for non-defense

environmental cleanup activities; and $715 million for Uranium Enrichment Decontamination and Decommissioning Fund cleanup activities.

As EM is put on a sustainable path forward, the fiscal year 2020 budget request provides the resources to build upon recent successes, bring a renewed sense of urgency to the program, and enable meaningful, measurable progress to projects and sites throughout the cleanup complex.

From day one, the Secretary of Energy has made the environmental cleanup mission a key priority for the Department of Energy.

EM's 2020 budget request provides the resources to make progress on cleanup activities across the complex, including increasing efforts to address radioactive tank waste at the Savannah River Site through start-up of the Salt Waste Processing Facility and continued construction activities for Saltstone Disposal Units.

At Hanford's Office of River Protection, the budget drives the focus on the Direct Feed Low Activity Waste approach to initiate tank waste treatment by December 2023.

Resources are also provided for Hanford's Richland Operations Office for work on River Corridor decontamination and decommissioning activities including remediation of the highly contaminated 300–296 waste site under the 324 Building.

At Oak Ridge, the request advances construction on the Outfall 200 Mercury Treatment Facility, continues deactivation and demolition of remaining facilities at the East Tennessee Technology Park, and continues preparation of Building 2026 to support processing the remaining U–233 material at the Oak Ridge National Laboratory.

The budget includes funding to initiate two transuranic waste processing lines, complete characterization of the high explosives plume in Canon de Valle, and implement the full interim measure for the chromium plume at Los Alamos in New Mexico.

At SPRU in New York, EM would be able to complete verification of cleanup, site restoration, and closeout activities.

Together, these investments for environmental management will enable EM to make significant progress in fulfilling its cleanup responsibilities.

EM's greatest successes have historically been achieved through the hard work and dedication of leaders on both sides of the aisle who are determined to get big things done. I want to express my desire to work with the Congress towards a future that propels the EM mission forward and drives cleanup toward safe completion, sooner, and in a cost-conscious manner.

BUDGET AUTHORITY AND PLANNED ACCOMPLISHMENTS FOR SELECTED SITES

Office of River Protection, Washington
(Dollars in Thousands)

Fiscal Year 2019 Enacted	Fiscal Year 2020 Request
$1,573,000	$1,392,460

Key Accomplishments Planned for Fiscal Year 2020

- Initiate cold commissioning of the Waste Treatment and Immobilization Plant to support Low Activity Waste Facility hot commissioning and production operations by December 31, 2023.
- Design and construct tank farm facility upgrades (i.e. 222–S Laboratory, 242–A Evaporator and the Effluent Treatment Facility) for staging waste in 2021 for Waste Treatment Plant operations.
- Incorporate lessons learned from Savannah River cesium processing to facilitate fabrication, testing and delivery of the Tank-Side Cesium Removal System to pretreat waste for the LAW Facility.
- Perform tank integrity activities to ensure adequate double shell tank space is available for Direct Feed Low Activity Waste (DFLAW) operations and AX retrievals.
- Complete retrieval of single shell tank AX–102 by 2021 in support of the corresponding Consent Decree milestone.
- Advance a production-scale offsite disposition path for tank waste. utilizing the regulatory pathways created by Test Bed Initiative
- Hanford Tank Closure End-State Contract scheduled for award in Q4 2019 incentivizes risk-based cleanup that reduces financial liability.

Richland Operations Office, Washington
(Dollars in Thousands)

Fiscal Year 2019 Enacted	Fiscal Year 2020 Request
$954,097	$718,098

Key Accomplishments Planned for Fiscal Year 2020

- Reduce risk and facility costs by supporting construction activities for future relocation of Cesium & Strontium capsules to dry storage by the Tri-Party Agreement (TPA) due date of August 2025.
- Shrink the extent of radiological and chemical contamination in groundwater at Hanford through treatment of 2.2 billion gallons.
- Complete 324 Building structural modifications, removal of the hot cell floor, and readiness review activities for start of soil removal for remediation of the 300–296 waste site below the building.
- Hanford Central Plateau Cleanup End-State Contract scheduled for award in Q4 2019 incentivizes risk-based cleanup that reduces financial liability.

Savannah River Site, South Carolina
(Dollars in Thousands)

Fiscal Year 2019 Enacted	Fiscal Year 2020 Request
1,551,014	$1,642,509

Key Accomplishments Planned for Fiscal Year 2020

- Complete removal of material-at-risk from Building 235–F which addresses remaining activities in accordance with Defense Nuclear Facilities Safety Board Implementation Plan to reduce residual Plutonium 238.
- Liquid Waste/Salt Waste Processing:
  - Supports Salt Waste Processing Facility (SWPF) start of radioactive operations necessary to meet State commitments and advance completion of cleanup mission
  - Enables waste removal preparation activities required to support SWPF planned operations rate greater than current rate for salt waste processing, allowing tank closure to proceed at a more rapid pace.
  - Continues construction of Saltstone Disposal Unit 7 and initiate construction of Saltstone Disposal Units 8/9 and design of Saltstone Disposal Units 10–12 to support SWPF planned rates.
- Funding to initiate the Savannah River National Laboratory's Advanced Manufacturing Collaborative facility (AMC)

Idaho National Laboratory, Idaho
(Dollars in Thousands)

Fiscal Year 2019 Enacted	Fiscal Year 2020 Request
$443,200	$347,654

Key Accomplishments Planned for Fiscal Year 2020

- Complete exhumations at Accelerated Retrieval Project area in support of meeting regulatory milestone to retrieve, process and dispose of targeted buried waste by 2023.
- Initiate hot operations of Integrated Waste Treatment Unit, pending successful demonstrations of the phase 2 simulant run number 3 and phase 3 performance run, to begin treating liquid sodium-bearing waste leading to closure of the final 3 liquid waste tanks.
- Complete processing and packaging of legacy transuranic waste so that it is ready for certification and shipment.
- Idaho Cleanup Project End-State Contract scheduled for award in Q2 2020 incentivizes risk based cleanup that reduces financial liability.

Oak Ridge Site, Tennessee
(Dollars in Thousands)

Fiscal Year 2019 Enacted	Fiscal Year 2020 Request
$646,281	$428,875

Key Accomplishments Planned for Fiscal Year 2020

- Complete demolition of 90 percent of East Tennessee Technology Park facilities and continue environmental remediation work.
- Complete processing contact-handled and remote-handled legacy transuranic debris waste inventory.
- Complete construction of transuranic sludge processing test area.
- Complete preparation of Building 2026 for processing remaining U–233 material.
- Complete second of four years of construction of the Mercury Treatment Facility.
- Complete preliminary design and early site preparation of On-Site Comprehensive Environmental Response, Compensation, and Liability Act Disposal Facility.
- Oak Ridge Reservation Cleanup Contract End-State Contract scheduled for award in Q3 2020 incentivizes risk based cleanup that reduces financial liability.

Carlsbad Field Office, New Mexico
(Dollars in Thousands)

Fiscal Year 2019 Enacted	Fiscal Year 2020 Request
$403,487	$398,334

Key Accomplishments Planned for Fiscal Year 2020

At Waste Isolation Pilot Plan (WIPP):

- Support receipt of up to 10 shipments of transuranic waste per week.
- Continue construction progress on Safety Significant Confinement Ventilation System (15–D–411) and on Utility Shaft (formerly Exhaust Shaft) (15–D–412).
- Complete two infrastructure recapitalizations (public address system and electrical substations).

Los Alamos National Laboratory, New Mexico (Dollars in Thousands)

Fiscal Year 2019 Enacted	Fiscal Year 2020 Request
$220,000	$195,462

Key Accomplishments Planned for Fiscal Year 2020

- Commence operations in two (of three planned) TRU processing lines to treat waste for shipment to WIPP.
- Reduce risk by completing ~50 shipments of TRU waste to WIPP.
- Complete characterization of RDX (high explosives) plume beneath Cañon de Valle and continue activities to determine final remedy.
- Prevent migration of Chromium plume offsite by implementing a hydraulic barrier.
- Continue investigation and cleanup activities required to meet Consent Order milestones.
- Continue groundwater and surface water sampling to remain compliant with the Consent Order and Individual Permit.

Nevada National Security Site, Nevada
(Dollars in Thousands)

Fiscal Year 2019 Enacted	Fiscal Year 2020 Request
$60,136	$60,737

Key Accomplishments Planned for Fiscal Year 2020

- Complete closure of Corrective Action Unit (CAU) 97 Yucca Flat/Climax Mine.
- Complete 3 percent for a total of 66 percent towards the closure of CAUs 101/102 Central and Western Pahute Mesa.
- Initiate and complete 18 percent towards the installation of 4 post-closure monitoring network wells for CAUs 97 Yucca Flat/Climax Mine and 99 Rainier Mesa/Shoshone Mountain.
- Conduct annual post-closure monitoring and maintenance of 197 closed-in-place contaminated soil and industrial-type sites.
- Conduct annual post-closure sampling, monitoring and maintenance at 16 well locations associated with 76 closed-in-place contaminated groundwater sites.
- Operate DOE-owned waste disposal facility with the capability to receive between 1.2 to 1.5 million cubic feet of low-level and mixed low-level waste in support of cleanup activities across the DOE complex.
- Maintain Nevada's Agreements in Principal and grants and provide funds for the Low-Level waste fee agreement.
- Nevada Environmental Program Multiple Award Small Business End State Contract scheduled for award in Q2 2020 incentivizes risk based cleanup that reduces financial liability.

Senator HEINRICH [presiding]. Admiral?

STATEMENT OF ADMIRAL JAMES F. CALDWELL, JR., USN, DEPUTY ADMINISTRATOR FOR NAVAL REACTORS, NATIONAL NUCLEAR SECURITY ADMINISTRATION

Admiral CALDWELL. Chairman Fischer, Ranking Member Heinrich, and distinguished Members of this Subcommittee, thank you for the opportunity to testify here today.

I also thank the subcommittee for consistently supporting Naval Reactors, enabling my team to provide the Navy with propulsion plants that give our nuclear-powered warships the incredible advantage of unmatched reliability, speed, and endurance to carry our national security missions around the world.

Our National Security Strategy and National Defense Strategy recognize the increasingly complex global security environment marked by the reemergence of great power competition, and these also recognize the erosion of our competitive advantage. The Chief of Naval Operations has made it clear that the Navy must become more agile, must compete in ways that are sustainable, and must be prepared to control the high end of maritime conflict.

Our nuclear Navy is essential in achieving these objectives. Today, nearly 45 percent of our Navy's major combatants are nuclear-powered, including 11 aircraft carriers and 69 submarines. In 2018, Naval Reactors supported the operations of the nuclear fleet, including 22 submarine deployments, 36 strategic deterrent patrols, and 5 aircraft carrier deployments.

Naval Reactors' budget request for fiscal year 2020 is $1.65 billion, a reduction of $140 million from last year's request, or 7.8 percent from the fiscal year 2019 request. Our budget fully supports three national priority projects.

The first project supports the Navy's number one acquisition priority by developing the new propulsion plant for the *Columbia*-

class ballistic missile submarine which will feature a life-of-ship reactor core. That core is made possible by the reactor technologies developed over many decades. Because of your support, the Navy began procuring long lead propulsion plant equipment for the lead ship this fiscal year as planned, and we will begin manufacturing the *Columbia*-class reactor core later this year.

The second project is refueling and overhauling a research and training reactor in New York. There is a dual benefit to this effort; first, facilitating the reactor development for the *Columbia*-class and, second, providing 20 years of training for nuclear operators.

The third project consists of the naval spent fuel handling facility in Idaho which will enable long-term, reliable processing and packaging of spent naval nuclear fuel from Navy nuclear propulsion plants.

This year's budget also invests in three key areas: first, developing advanced reactor technology for future classes of nuclear-powered warships; recapitalizing vital laboratory facilities and infrastructure; and also remediating efforts to reduce environmental liabilities of legacy facilities.

I want to assure the Subcommittee that our planning efforts are done with rigor. Investments we make today in research and development not only advance Navy warfighting capabilities but also result in cost savings and improve capability for the fleet far into the future.

I understand the difficult budget environment in which Congress must craft legislation, and I respectfully urge your support of our fiscal year 2020 budget request. Thank you for this committee's longstanding support. I look forward to answering your questions.

[The prepared statement of Admiral Caldwell follows:]

PREPARED STATEMENT BY ADMIRAL JAMES F. CALDWELL

Chairman Fischer, Ranking Member Heinrich, and distinguished Members of the Subcommittee, thank you for the opportunity to appear before you today and present the President's Fiscal Year 2020 Budget Request for Naval Reactors. Your strong support for the work we do ensures our nuclear Navy has the power and propulsion to carry out missions around the world.

This past year marks the 70th anniversary of the founding of the Naval Nuclear Propulsion Program under the leadership of Admiral Hyman Rickover. In 1955, just seven years after the creation of our program, the first nuclear-powered warship, USS *Nautilus* (SSN 571) reported "Underway on nuclear power". Since *Nautilus,* follow-on classes of ever more capable nuclear-powered submarines and aircraft carriers have ensured our warfighting edge over potential adversaries. Reactor core lives have increased from just under two years to over 40 years. Our ballistic missile submarines have provided the most survivable leg of our nuclear triad for nearly six decades and are essential to our ability to deter major warfare and assure our allies. Our fast attack submarines operate virtually undetected, safeguard vital commercial sea-lanes, and stand ready to protect American interests. Our aircraft carriers—4.5 acres of sovereign territory—provide our Nation unparalleled mobility and the sustained ability to project combat power, deter conflict, and protect our interests.

Today's security environment is dynamic and challenging, best characterized as a return to great power competition. In the maritime domain, nuclear propulsion enables the Navy to conduct missions vital to national security by providing unmatched mobility, flexibility, responsiveness, and endurance. These key attributes ensure our nuclear fleet can meet the demands of forward presence and crisis response world-wide. Today, nearly 45 percent of the Navy's major combatants are nuclear-powered (11 aircraft carriers, 14 ballistic missile submarines, 50 attack submarines, and four guided missile submarines).

Last year, with Naval Reactors support, the Navy deployed 22 submarines and conducted 36 strategic deterrent patrols. At any given time, there were at least 47 submarines deployed or ready to deploy within days. Our carriers, USS *Carl Vinson* (CVN 70), USS *Theodore Roosevelt* (CVN 71), USS *John C. Stennis* (CVN 74), USS *Harry S. Truman* (CVN 75), and USS *Ronald Reagan* (CVN 76) deployed during 2018. This past December, USS *Harry S. Truman* (CVN 75) successfully concluded a historic, two-part deployment as part of the implementation of the Dynamic Force Employment plan, demonstrating our Navy's ability to be more agile and operationally unpredictable to potential adversaries.

In submarine shipbuilding, the Navy recently saw the keel laid for the attack submarines Pre-Commissioning Units (PCU) *Montana* (SSN 794) and *Hyman G. Rickover* (SSN 795), and the commissioning of USS *Colorado* (SSN 788), USS *Indiana* (SSN 789), and USS *South Dakota* (SSN 790). This totals 17 *Virginia*-class submarines.

In aircraft carrier shipbuilding, USS *Gerald R. Ford* completed her initial at sea operations and began her Post-Shakedown Availability in July. Construction of the *John F. Kennedy* (CVN 79) is nearing completion, and she is scheduled to be christened later this year. The third carrier of the *Ford*-class, *Enterprise* (CVN 80), began construction activities this past year and will proceed as part of a two-carrier buy of CVN 80 and CVN 81, which is anticipated to generate substantial savings for the Navy. As these aircraft carriers join the fleet, they will bring unmatched capabilities to our Navy. The propulsion plant for the *Ford*-class represents the first newly designed aircraft carrier propulsion plant in 40 years. These ships not only match the high speed of our *Nimitz*-class aircraft carriers but provide 25 percent more energy and three times the electrical generating capacity. Additionally, the propulsion plant design reduces maintenance by 30 percent and manpower by 50 percent. These advances in propulsion plant design are a direct result of the dedicated and sustained effort by Naval Reactors and its field activities, our Department of Energy (DOE) laboratories, nuclear industrial base suppliers, the Navy design team, and the nuclear shipbuilders.

This committee's support has enabled the safe operation of the nuclear fleet, substantial progress on our key projects, and our continued oversight and regulation of all areas across the Naval Nuclear Propulsion Program. Naval Reactors' budget request for fiscal year 2020 is $1.65 billion, a reduction of $140.2 million, or 7.8 percent, from our fiscal year 2019 request. The budget request fully supports the requirements for our three major projects—*Columbia*-class propulsion plant development, the refueling overhaul of a research and training reactor in New York, and the construction of the Naval Spent Fuel Handling Facility in Idaho. The budget request also ensures Naval Reactors can support the operational nuclear fleet, continue research and development efforts for the next generation of nuclear powered warships, and make progress on both the recapitalization of our laboratory facilities and the environmental remediation of our legacy responsibilities.

MAJOR PROJECTS

Columbia-class Propulsion Plant

The *Columbia*-class ballistic missile submarine is the Navy's number one acquisition priority. Naval Reactors is on track to support the start of ship construction in fiscal year 2021 and is committed to delivering the life-of-ship reactor core and the electric drive propulsion system necessary for the *Columbia*-class program. Fiscal year 2020 funding of $75.5 million will continue supporting procurement of the lead ship propulsion plant components. The Navy began procuring long-lead material for the propulsion plant this year, and also will begin manufacturing the life-of-ship reactor core.

S8G Prototype Refueling Overhaul

The fiscal year 2020 budget request includes $155 million to support the refueling overhaul of one of the New York land-based prototypes, which will enable an additional 20 years of Naval Reactors' commitment to research, development, and training. As part of this refueling project, we will insert recently manufactured *Columbia*-class type fuel modules in the prototype reactor as part of testing and demonstrating the manufacturability necessary for production and delivery of the *Columbia*-class reactor core. The prototype refueling overhaul is scheduled to complete in fiscal year 2021, with a return to training operations shortly thereafter.

Spent Fuel Handling Recapitalization Project

The fiscal year 2020 budget request includes $238 million to continue construction of the Naval Spent Fuel Handling Facility, which broke ground in 2017. Full support from Congress has enabled us to keep this project on track. The cost and sched-

ule baselines were approved in September of 2018. Design and site preparation for this facility continues, and it is on track to receive spent nuclear fuel from aircraft carriers in fiscal year 2024 and be fully operational by fiscal year 2025.

TECHNICAL BASE FUNDING

In addition to our three priority projects, Naval Reactors maintains a high-performing technical base to: 1) execute nuclear reactor technology research and development that supports today's fleet and ensures our Navy maintains its technological advantage over adversaries and, 2) provide the necessary equipment, construction, maintenance, and modernization of critical infrastructure and facilities. The funding required for this base also supports the lean federal workforce that provides the oversight necessary to carry out this important technical work safely and efficiently. These activities are vital to our ability to provide 24–7 support to the nuclear-powered Navy.

Research and Development

By employing an effective technical base, the teams of talented and dedicated people at Program sites—the Bettis Atomic Power Laboratory in Pittsburgh, the Knolls Atomic Power Laboratory and Kesselring Site in greater Albany, the Naval Reactors Facility in Idaho, and our Washington, DC headquarters—can perform the research and development, analysis, engineering, and testing needed to support today's fleet at sea and develop more capable nuclear-powered warships for tomorrow's fleet. Advanced nuclear technologies such as those employed in the *Columbia* reactor require extensive development and prototyping, spanning a decade or more to mature the technology to a point where it is ready to incorporate in a ship design. Technology development will receive increased emphasis in the coming years as we complete our major projects and increase our focus on the development of tomorrow's fleet.

Our labs perform the technical evaluations that enable Naval Reactors to thoroughly assess approximately 4,000 emergent issues annually and deliver timely responses that ensure nuclear safety and maximize operational flexibility. Our research and development efforts must continue so that we can provide the Navy more capable propulsion plants in the future. The performance of our reactors is key to maintaining advantages over our potential adversaries. The technological advances that go in our propulsion plants today are a direct result of research and development investments that began decades ago. Continued investment now is vital to the generations of scientists and engineers who will design the propulsion plants of the future.

Facilities and Infrastructure

Our laboratory facilities and infrastructure are critical in carrying out Naval Reactors' mission. The budget request supports recapitalizing our Naval Nuclear Laboratory facilities and infrastructure systems, many of which have supported the Program since its inception 70 years ago. Without this recapitalization we will be unable to effectively support nuclear fleet operations and advanced research and development efforts at the level required by this complex technology. Our budget request this year also reflects the increase in our efforts in decontaminating and decommissioning (D&D) older facilities that have been in existence since the start of the Program in the early 1950s. We have approximately $8 billion in environmental liabilities requiring D&D efforts—about one-third of these facilities are no longer in use. We are increasing our emphasis on retirement of theses liabilities in an environmentally responsible and cost-effective manner to support best use of our funding.

I want to assure the committee that the planning efforts we execute in budgeting for current and future projects are done with extreme rigor. We conduct comprehensive reviews of our budget to ensure we are making the right investments and tradeoffs. Our budget profile is consistent with projections in earlier Future Years Nuclear Security Plan submissions. Investments we make today in research and development efforts not only advance capabilities, but will also result in cost savings far into the future. We provide unmatched value to our Nation's defense and have a history of cost-effectively meeting our obligations. I understand the difficult budget environment in which Congress must craft legislation, and I respectfully urge your support for aligning allocations with the Fiscal Year 2020 Budget Request.

Senator HEINRICH. Thank you, Admiral.

I am going to go ahead and jump into my opening statement. We apologize for the back and forth, but that is what happens when we have a series of votes around here. So Members will be coming

and going, and hopefully by the time I am done with my opening statement, the chair will be back as well.

I want to thank Chairwoman Fischer for holding today's hearing.

I certainly want to thank all of our witnesses for taking the time to testify. We very much appreciate your service to our country and the job that you perform.

There are a number of issues I want to raise today at this hearing. First and foremost is the issue of plutonium and the recent report by the Institute for Defense Analysis, or IDA, which essentially invalidated all NNSA conclusions from last year's engineering assessment.

In that report, IDA stated that it was not feasible to construct and operate any facility by 2030 to produce 80 pits per year at the cost range you found in the engineering assessment. This is quite serious because we legislated last year based on that previous assessment.

More importantly, the issue is not with construction costs although we know from the IDA that these numbers are drastically underestimated. What I will be looking for is the lifecycle cost. The real cost drivers are staffing and facilities and getting them fully operational and capable of producing our war reserve pits. I will be looking closely at this issue, and according to the Office of Enterprise Assessments (EA), we know the lifecycle costs will exceed the cost of other options considered by at least $14 billion, which I would point out is double the estimate for the alternative.

On the critical issue of rebuilding our warheads, I am pleased with the cooperation with the Department of Defense (DOD). But I am concerned that we may be recreating a similar problem to what we had in the early 2000s of balancing workload, design, and engineering between the two weapons laboratories. Livermore, over the next 10 to 15 years, will be tasked with two major systems, the W80–4 cruise missile warhead and the W87–1 warhead, while Los Alamos will be exiting the B61–12 program. This is a serious issue, given we had just staffed up for the B61 program.

Finally, Ms. White, welcome to our Subcommittee. It was great to see you in New Mexico recently. It goes without saying that you are responsible for the Waste Isolation Pilot Plant, and as you know, we have waste backed up at every major Department of Energy (DOE) site because of the fire and drum explosion several years ago at the WIPP site, as well as the lack of adequate ventilation at WIPP to conduct operations. I want you to elaborate on what is being done to bring back that capacity in a safe and effective manner. I know you touched on that in your opening statement.

More importantly, when it does become operational, I am concerned, as my State has been for the past 30 years, that we continue to adhere to the grand bargain between the State of New Mexico and the Federal Government on what kind of waste can be disposed in this unique, one-of-a-kind facility. Until recent events, WIPP's success, in contrast with Yucca Mountain, for example, was our ability to reach a consensus between the State and Federal Government, and that consensus was enacted into law in 1992 with the Bureau of Land Management (BLM) Land Withdrawal Act under Energy Committee jurisdiction. The last thing we want is an

upset Governor who retains Resource Conservation and Recovery Act, or RCRA, authority over this facility, an upset delegation, and an upset Senate committee over trying to dispose of waste that is not explicitly defined in the Land Withdrawal Act. So I will be asking you some questions concerning waste reclassification and attempts to dispose of waste not explicitly defined in the WIPP Land Withdrawal Act.

Again, thank you for coming today, and I very much look forward to hearing all of your testimony and to questions.

Senator FISCHER [presiding]. Thank you, Senator Heinrich.

We will begin our first round of questions.

Secretary Gordon-Hagerty, as you discuss in your opening statement, this year's budget request of $16.48 billion for NNSA—this is $1.3 billion over last year's enacted level, which some suggest is a dramatic increase.

However, last year's budget projected a $16 billion top line for NNSA in fiscal year 2020, a 3 percent difference from the level of funding requested in this budget. Instead of being a massive or an unexpected surge in spending, NNSA's budget is following the anticipated path. The modernization programs that have been planned for a very long time are finally getting started and they are off the ground, and the cost will increase as activities progress and programs become more mature.

That being said, can you talk about the importance of funding this budget at the requested level and what impact cuts would have on your ability to build a responsive nuclear infrastructure, as well as your ability to meet the deterrence requirements set out by U.S. Strategic Command (STRATCOM)?

Administrator GORDON-HAGERTY. Chairman Fischer, thanks for the question.

There are a number of opportunities that are critical to our request in the fiscal year 2020 budget. You have alluded to several of them. But we have three major priorities in NNSA at the present time. One is to continue our infrastructure modernization. For those that are unfamiliar, more than 50 percent of our facilities are 40 years old or older, 30 percent of which were built in the Manhattan Project days. To maintain an infrastructure like that and ask our 44,000 men and women in our workforce to maintain the U.S. nuclear deterrent and provide assistance and support to nonproliferation, counter-proliferation, counterterrorism programs to me is just unacceptable. So we are on a trajectory to modernize our long past modernization of our infrastructure, and many of the requirements that we have and resources for which we are requesting will continue us on that path.

As I mentioned in my opening statement, for example, the uranium processing facility that will recover all of the work that has been—or most of the work that has been done in what is known as 92–12 at Y–12, a facility that was built during the Manhattan Project, long past its prime—we will be completing that program as long as we are receiving the funding request that we have asked for, which is $745 million this year, to continue the construction on the main processing facility. We will complete that facility by the end of 2025. But as long as we are on this trajectory and the path

forward for those major construction activities, that is just one of so many others.

Another one is the Los Alamos National Laboratory and our PF–4, a facility that is 40 years old. But we maintain that as our singular location to do pit work, actinide chemistry, and basically the basic research and surveillance on our U.S. nuclear weapons stockpile.

I could explain many more facilities, but that is just one of our highest priorities.

The second, of course, is our workforce. In the next 5 years, more than 40 percent of our workforce will be retirement-eligible. We need to change the mindset of what we are doing with the challenges we have to obtaining clearances for new employees, for a number of other issues that we have at our eight labs, plants, and sites, our seven field offices and our headquarters. It is urgent that we find a way to be able to hire the existing workforce changes that we need, the increases that we need in our workforce, as well as the workforce of the future. So we have a number of different priorities that we are undergoing right now, but that is just to maintain the existing nuclear weapons stockpile.

Senator FISCHER. I think that one of the main points here is we are no longer just studying modernization. We are no longer trying to define modernization. Now we are working on it. We are moving forward. Would you agree with that?

Administrator GORDON-HAGERTY. Yes, that is correct.

Senator FISCHER. We are on schedule.

Administrator GORDON-HAGERTY. Yes, we are.

Senator FISCHER. Thank you.

Also, this year's budget requested a significant increase for subcritical experiments. Can you talk about the importance of these activities, specifically how they will enable our continued certification of the stockpile without returning to testing and support the W80–4 and the W87–1 life extension programs?

Administrator GORDON-HAGERTY. Yes. For the last 25 years, since we stopped underground explosive testing in 1992, a voluntary moratorium on underground explosive testing, the Department of Energy and NNSA undertook a science-based stockpile stewardship program, and in light of not being able to conduct underground explosive testing, we need to certify the stockpile on an annual basis. I am happy to say for the last 25 years, our three laboratory directors and the STRATCOM Commander have sent letters to the President from the Secretary of Defense and the Secretary of Energy certifying the stockpile is safe, secure, and reliable.

But in order to do so, we need state-of-the-art scientific capabilities, of which one is Enhanced Capability for Subcritical Experiments (ECSE), which is a planned activity that we are going to plan on conducting at Nevada national security sites. Those are subcritical experiments that we currently undertake, but that will be a new suite of capabilities that we are looking forward to employing in the future.

In addition to that, we have high performance computing, as I mentioned, exoscale at Lawrence Livermore National Laboratory, which we will be able to operate that platform beginning in 2023.

There are a number of different, very highly important scientific and engineering capabilities that we have spread out throughout our entire complex that inform us on the health of the stockpile.

Senator FISCHER. Without these experiments, would it be possible to certify the Life Extension Programs (LEPs)?

Administrator GORDON-HAGERTY. It would be highly doubtful that we would be able to do so with the confidence that we have currently.

Senator FISCHER. Thank you.

Senator Heinrich?

Senator HEINRICH. Secretary Gordon-Hagerty, the NNSA's engineering analysis back in May of 2018 provided a lifecycle cost estimate for each of our nation's plutonium options. Are you familiar with those numbers, and do you have that slide with you today?

Administrator GORDON-HAGERTY. Yes, I do. Thank you.

Senator HEINRICH. I have got it here.

I want to direct your attention to alternative 1, the Savannah big box alternative, and then also to alternative 2C which I will call the Los Alamos PF4 plus modules alternative.

For this committee and for Congress, can you state what the estimated lifecycle cost is for alternative 1, the Savannah?

Administrator GORDON-HAGERTY. The number that we had when we completed the Environmental Assessment was $27.8 billion.

Senator HEINRICH. So can you state what the estimates were for the other options?

Administrator GORDON-HAGERTY. Certainly. Alternative 2 alpha, $18.8 billion; alternative 2 bravo, $14.3 billion; and alternative 2 Charlie, $14.8 billion.

Senator HEINRICH. Exactly.

The independent Institute for Defense Analysis has said that no one option the NNSA considered is valid for actually being able to produce 80 pits by 2030. So if no one option is fundamentally better than the others, why build an entire new weapons complex with an additional price tag of $14 billion in lifecycle costs?

Administrator GORDON-HAGERTY. Senator Heinrich, we recognize that pit production activities at two locations is going to result in higher lifecycle costs. Recognizing the numbers that I gave you, our lifecycle costs are over a 50-plus year period, not an annual basis, if you will, so total lifecycle costs.

Additionally, this is fundamentally to ensure the resiliency of our nuclear weapons stockpile. At present, as a reminder, we have not had a plutonium pit production capability since the early 1990s when we shuttered the Rocky Flats plant in Colorado. The last time we produced war reserve pits was in 2011 at Los Alamos. Therefore, we have a challenge ahead of us if we want to just maintain the current nuclear weapons stockpile and that of the 87–1, which is the 78 replacement, which is what is driving our numbers to have the not fewer than 80 pits per year, as directed by the requirements laid out by STRATCOM and as approved by the Nuclear Weapons Council.

Senator HEINRICH. Well, I certainly agree with the goal of 80 pits per year, but I am trying to understand why nowhere else in the entire complex do we have this requirement. We have one uranium facility. We have one tritium facility. We have one plutonium facil-

ity. The IDA study said that basically none of the options were any better than the other. I just think it is very hard to justify an additional $14 billion in taxpayer money.

I want to jump to another budgetary issue, and that is you should have in front of you the estimated out-year costs for plutonium from your budget data. I am curious in particular, if you look at the line on Los Alamos National Laboratory (LANL) pit production from fiscal year 2020 and then across to fiscal year 2024—and this is during the ramp to get to the point where we are ramping up to achieve the 30 pits per year by 2026. So we have fiscal year 2020 at $21.2 million. Fiscal year 2021 is $231.3. Fiscal year 2022 is at $244, then $284 in 2023. Then it drops to $75 million in fiscal year 2024. I am trying to make sense of that 75 number given that it is in the midst of that ramp.

Administrator GORDON-HAGERTY. Well, first of all, I am happy to say that our requirements are to place more than $3 billion over the next several years into Los Alamos for its pit production capability. It is going to be a challenge at best to get to our 10 pits per year by 2024, our 20 by 2025, and the 30 and then 30 in perpetuity in 2026. Those numbers come from our Future Years Nuclear Security Program (FYNCP).

I am happy to say also that since we submitted the fiscal year 2020 budget, we have put more fidelity into these numbers, and we would be able to brief you on these. But let me assure you that those numbers are only going to increase, and we are working very closely with Los Alamos that is providing us with additional fidelity into what their requirements will be. So rest assured, we are looking to do everything we can to ensure operability at PF4 and throughout the NNSA enterprise.

Senator HEINRICH. Fantastic.

My time is up, so I am going to wait for the second round. I have got some questions, Secretary White, for you regarding WIPP, but we will get to it in the second round. Thanks.

Senator FISCHER. Thank you, Senator.

Senator Rounds?

Senator ROUNDS. Thank you, Madam Chair.

I want to take my time and work my way through a primer with you, if we could. I think one of the challenges we have in gaining support for moving forward with the necessary improvements in the entire program is to have a lot more people understand exactly what we are talking about. So far, we are talking about pits. We are talking about specifics that within the industry itself are well known but not outside of the industry. Let us talk about this for just a little bit so that people understand the need for the additional production and what it entails.

Can we start talking with just exactly what a pit is, and as much as we can in an unclassified session, what is involved in making it, and what it is used for? So this is going to be a primer.

This is really important that we gather support because when we start talking about making changes within the nuclear production capabilities of our country, it is necessary that folks back home start to understand that there is a real need and that just because we have capabilities that have been here for years, it does not mean that we do not need additional capabilities for the operation

of our nuclear capabilities. I would defer to any of you who want to work your way through this with us.

Administrator GORDON-HAGERTY. Thank you. If I may start.

First of all, plutonium is used in the primary of a nuclear weapon or a bomb, and it is the material, if you will, the ingredient that provides the necessary explosive power, plus additional materials, whether they are highly enriched uranium and the secondary and other materials that we need, critical materials that make up a nuclear warhead or a bomb.

Senator ROUNDS. How about for the Navy itself with regard to the nuclear fuel needs for the carriers and our submarines?

Administrator GORDON-HAGERTY. So that is uranium, and it is highly enriched uranium that we use. It is also part of the material that we process through our defense enterprise.

Senator ROUNDS. Is it done at the same locations as these pits are produced?

Administrator GORDON-HAGERTY. It is actually done at Y–12 and at other locations throughout the United States where they actually make the fuel rods.

Senator ROUNDS. So when we talk about the pits themselves, we are not talking even about the amount of production needed for the fuel. We are talking about our need for our weapon systems.

Administrator GORDON-HAGERTY. For our entire enterprise. You are exactly right, and this is just to maintain our existing nuclear weapons stockpile. We are the only nuclear nation that is not currently designing or fielding new nuclear weapons. Every other nuclear weapon state is. What we are doing is extending the life of our existing nuclear weapons stockpile. If I might, the oldest nuclear weapon system that we have in our stockpile right now is the B–61 that was fielded in the early 1960s.

Senator ROUNDS. I understand that right now that we are upgrading or we intend to upgrade through what? About the year 2020. We are beginning sometime in the year 2020 through what? 2023 for the B61–12 to be available. Is that about right?

Administrator GORDON-HAGERTY. Correct. That should be beyond 2025. We have an issue right now with the life extension program on the B61, and we are addressing that right now.

Senator ROUNDS. So when you do that, can you simply use the nuclear material that was in the earlier weapons to be redone, or do you need to use one of these new pits?

Administrator GORDON-HAGERTY. In the case of the W78, which is what we are replacing now with something called the W87–1, which is currently existing in the stockpile, we will need to modernize our pit for that. That is precisely what we are trying to deal with right now——

Senator ROUNDS. Now, if I understand it, the W78 is not for the B61.

Administrator GORDON-HAGERTY. No. The B61—we are going to continue to use that and many elements of it. But what we are doing is increasing the safety and security of the actual nuclear weapon itself, and we are introducing new robust systems and additional surety features that we can talk about in a classified space, if you would like.

Senator ROUNDS. Okay. When we talk about a pit itself, how big is a pit? How much material is it? Are they standard?

Administrator GORDON-HAGERTY. In unclassified terms, it is several kilograms or more.

Senator ROUNDS. Do we use multiple pits per weapon system?

Administrator GORDON-HAGERTY. No. There is a single pit in the primary for a nuclear weapon system, and there is a secondary. It depends what the configuration is and what the nuclear weapon——

Senator ROUNDS. If you were to talk to the public on this and you were to say this is the reason why we need to produce more pits, a lot of folks are going to say, well, we have already got plenty in stock. We have got lots of weapons out there. What is the need for the increase in production of pits? I think that is a really important thing to discuss.

Administrator GORDON-HAGERTY. It is based on military requirements and what the military requirements and target sets are. So we take our direction from STRATCOM, the Strategic Command, about what their requirements are, what our nuclear weapons stockpile requirements are based on direction from the President.

Senator ROUNDS. So what you are actually saying, though, is that it is not even just to replace those that are there. It is because when we modernize, we are actually looking at different types of weapon systems that we need in order to be a deterrent force into the future. We are not just talking 2 years from now. We are talking 25, 30, 40 years from now.

Administrator GORDON-HAGERTY. Exactly. We are talking more likely 50 and beyond. That is exactly what we are doing. In fact, you raise a good point, Senator. One of the issues about plutonium right now is plutonium aging, and it is a challenge that we have and that is, in fact, why we are doing some of the studies that we are undertaking and some of the modernizations that we are undertaking. In fact, that is why we are doing the 78 replacement for the 87–1, which is exactly why we need the new plutonium pit production capability, something again that we have not had since the early 1990s.

Senator ROUNDS. Thank you.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator Rounds.

Senator Jones?

Senator JONES. Thank you, Madam Chairman.

Thank you all for being here today.

I want to go back, Secretary Gordon-Hagerty, to something you mentioned earlier today, and that is about staffing levels. Let us get to some nuts and bolts.

Forty percent of your staff is going to be retirement-eligible in 4 or 5 years. But as I understand it, a couple of studies have already said it is understaffed now. Your responsibilities are increasing and if the Administration and Congress want you to do your job, we got to provide you the tools.

So can we talk a little bit about staffing? What are the challenges that you are facing in recruiting? What can we do to help? Are there specific things that are stopping you from bringing new people on for this really important role that you have got here?

Administrator GORDON-HAGERTY. We have a number of staffing challenges currently and ahead of us. One of the things that we have requested is if Congress would consider lifting the cap on our FTEs, for our full-time equivalents, for our federal workforce, which is at 1,690 at the present time. We are bumping up close to that right now, and that is just to staff our headquarters and our field offices. Most of those personnel are at our field offices.

However, we have taken a look at what we need to do about these staffing challenges, and what we are doing is sort of what I consider disruptive technology. What we have done is we have come together with all of our labs, plants, and sites, our field offices, and our headquarters, and instead of doing basically 16 different stovepipe staffing plans, if you will, we are coming together and we are getting together with all the labs, plants, and sites hiring authorities and our field offices and our headquarters. We have had a hiring day, which we undertook in January of this year, where we had 1,700 applicants. Just to give you some idea—for those of you in the federal workforce, you will understand—we actually offered 53 jobs at that time. So that is unheard of that the federal workforce could actually offer those kinds of jobs.

That said, we are working very closely with organizations and with some of our labs, plants, and sites such as Los Alamos. Los Alamos has just undertaken an agreement with Northern New Mexico College to start a technician program for radiological technicians so that they can bring in a new pipeline of radiological technicians to do work in plutonium operations and working with radioactive materials.

We are finding different ways of trying to resource, if you will, or source the next generation, the best and brightest, and those are scientists. Those are engineers. Those are technicians. Those are people that put hands on weapons. Those people that put hands in glove boxes, as well as the primary and secondary designers. We are trying to find different ways of finding that pipeline, if you will.

We have a number of very interesting programs now where we support universities and colleges around the United States where we can actually grow our workforce through those endeavors. But we really need to break that paradigm.

I am also happy to say that we have also established things called national security or nuclear security enterprise days. We have conducted on-site employment opportunities at Georgia Tech, at University of California at Merced, and Texas A&M so far this year. We will be going to the State of Ohio and we will be going to the State of North Dakota in the next several months or so, probably in the fall time to see what we can do to encourage a pipeline of new students throughout our United States that might want to come to work at our great eight labs, plants, and sites, field offices, and our headquarters.

So we are really trying to break that paradigm because it is crucial now. Los Alamos is looking to hire 1,000 people this year. Sandia is looking to hire 1,000 people this year. Livermore is looking to hire 500 people. We are talking about really thousands of people in our workforce not only in the next 5 years but now in order to handle the increasing workload that is on us right now.

Senator JONES. All right. Well, great. I wish I had asked a question that you were passionate about.

[Laughter.]

Senator JONES. Well, let me just ask this. I want you very succinctly if you can—we are hearing talk from different sectors about that it may be too expensive to modernize all three prongs of the nuclear triad. I do not agree with that. But I would like for you to just right here on the record, maybe in less time than you talked about the staffing, tell us how they work together and why it is important that we modernize all of the nuclear triad.

Administrator GORDON-HAGERTY. Well, I would certainly defer to the Department of Defense since they are the ones that employ the nuclear triad. But it is imperative to have a credible deterrent in the United States, that we have every capability possible in order to show that we have a robust deterrent and play into the global threats that we see now and on the horizon. It certainly would make sense to maintain the triad as it is.

Senator JONES. All three work together as a part of that deterrent.

Administrator GORDON-HAGERTY. All three work together. That is exactly right.

Senator JONES. Thank you.

Thank you, Madam Chairman.

Senator FISCHER. Thank you, Senator.

Senator Hawley?

Senator HAWLEY, Thank you, Madam Chair.

Thank you to all of the witnesses for being here.

Administrator, if I could just start with you. It is nice to see you again the other day, and thank you for being here. Thank you for your service.

Can I come back to Senator Heinrich's question? What is the answer to his question about the alternative facilities here for pit production? If in fact there is no advantage one over the other, then why build the new facility at Savannah River?

Administrator GORDON-HAGERTY. Senator, always nice to see you too again. Thank you.

First of all, we believe that it is necessary to have resiliency throughout the enterprise. Now, admittedly, I would like to see a resilient enterprise that has redundant capabilities throughout our entire complex, but that would just break the budget and that is just untenable.

However, we have decided that our highest priority is for pit manufacturing and production. It is our impression that putting all of our capabilities at a single site while we are maintaining plutonium pit production capabilities, which is what we are trying to do at Los Alamos and get them to 30 pits per year by 2026, we do not believe that it is appropriate to put all of our requirements in a single location and that redundancy is critical to maintaining our nuclear enterprise now and in the future.

Again, as I had mentioned in the outset of my discussion, plutonium facility 4 at Los Alamos is over 40 years old. These numbers that Senator Heinrich had referred to do not include the lifecycle costs for either modernizing that facility or replacing that facility.

So we have got challenges ahead of us no matter where we look in the enterprise. We had an opportunity to repurpose a facility at South Carolina, and we think that is the best way to go for a resilient and a functioning enterprise for the next 50 to 75 years.

Senator HAWLEY, The redundancy piece is really important to you. Is that right? Can you just explain why it is so critical?

Administrator GORDON-HAGERTY. Because putting our capabilities in a single location, if there is a major activity or a major incident at a single location, our entire nuclear weapons enterprise is down for any kind of pit production capability or monitoring, even our surveillance. So if we lose our single location, then we do not have an enterprise that is resilient and we may be unable to or it will put in jeopardy the capability to surveil our current nuclear weapons.

Senator HAWLEY, So what I hear you saying is when you think about the different options here, the various alternatives, they are not all the same in the sense that—it is not merely about the amount of production you can get cumulatively out of these facilities. It is also about resiliency and redundancy, and these are important factors that weigh heavily in the decision-making process. Is that fair? Am I understanding you correctly?

Administrator GORDON-HAGERTY. They are critical.

Senator HAWLEY, Now, back to reaching the 2026 pit production goal, you said a little bit earlier that it is going to be a stretch—I think that was the word you used—to reach that goal. Can you say a little bit more there and what sort of mitigation strategies we are going to employ if we do not, in fact, hit that goal?

Administrator GORDON-HAGERTY. Certainly. We are working incredibly closely with our colleagues at Los Alamos National Laboratory and, for that matter, all of our colleagues around the enterprise pulling together a team to find out where we can minimize risks, maximize opportunities and working in parallel on several strategic plans. Los Alamos is required to put together a plutonium pit plan for us. They are undertaking that right now. We have seen the draft, and we are working on that plan with them to get us to that 30 pits per year. So we are working, doing everything we possibly can to give Los Alamos the tools necessary to be successful to get us to those requirements of the 30 pits per year by 2026.

Senator HAWLEY, Very good.

In the time I have remaining, let me just shift gears briefly and, Admiral, ask you. I noticed that the Congressional Budget Office (CBO) is estimating that over the next 10 years, about 6 percent of defense spending is going to go toward modernizing the triad and managing the various life extension programs, which is quite a bit of money and focused on a pretty narrow sector of our national defense. I just want to ask you about the effective management of some of these programs.

I understand the Naval Reactors is moving out of the development phase and into production for the *Columbia*-class. Has your experience with developing this reactor informed your approach to program management and avoiding delays that are inherent to fielding new technologies like this one?

Admiral CALDWELL. Yes, sir. Thanks for the question.

I would say that my experience to date with the *Columbia* program has absolutely informed the way ahead. What I have realized is that we are trying to build a larger Navy and recapitalize an important national asset on a shipbuilding industry that did not build submarines through the 1990s and really into the start of the 2000s. That shipbuilding industry and the supporting vendor base has some fragility in it, and it requires that we manage it very carefully if we are going to be successful. We have learned that it takes a tremendous amount of oversight, in fact, in some cases intrusive oversight.

It takes a close partnership with our partners in the vendor base to understand what their capacity is, to make sure that we are in dialogue with them, and to be very sensitive to increases in production or changes in the way that we tackle production. For example, many times a vendor will make a change in production to accommodate maybe affordability or maybe to make it easier to manufacture. If you are not careful, you can induce errors.

This close relationship, partnership is critical, and oversight is essential if we are going to get this right. That comes from the Navy and it also comes from our prime contractors that have to be really involved with their subcontractors if we are going to get this right.

Senator FISCHER. Thank you.

Senator King?

Senator KING. Thank you, Madam Chair.

This really is not addressed to you three, although you are part of this enterprise. I think those of us that are engaged in this issue have to do a better job of communicating to the public the importance of the modernization. I met with a group of Maine people yesterday who basically asked why we are spending all this money. Is it another nuclear arms race? By the way, 6 percent of the budget is $42 billion a year. This is not insignificant. You could do a lot of Head Start slots for $42 billion a year. I mean, there are a lot of other important priorities.

So this is just a comment that I think the Defense Department and the strategic people have to really communicate with the public about this because this is a major commitment. You know, I had this discussion yesterday, as I said, with a group of people that were very skeptical, and I said we have got to have a—you used the right word—credible deterrent. That is the whole rationale for the modernization. But I think the case has to be made. What is the incremental value that we are getting for that $42 billion over and above what we have now? I hope you will take that back. As I say, that is not really a question, but I think it is very important as we go into this next year and this budget cycle.

Admiral Caldwell, you are now developing and have developed a nuclear propulsion capability that has a longer life. Have you ever done a calculation of what that saves us over the long haul, in other words, not having to refuel, having a longer life on a submarine, for example? It strikes me that is a sort of hidden savings that I think is important to quantify.

Admiral CALDWELL. Yes, sir. We have done some of those calculations. Well, first off, we always try to build on technology to improve what we are delivering to the fleet. Over the life of the

program, we have been able to deliver reactor cores that are life-of-the-ship cores. In fact, every submarine we are building today has a life-of-the-ship core, and the carriers have a 25-year core and they get refueled once in life. The ability to have a core in the *Columbia* submarine that lasts over 40 years will allow us to do the mission with 12 submarines versus the 14 today.

Senator KING. That is a huge savings right there.

Admiral CALDWELL. That is a huge saving, and we think that is about $40 billion over the total ownership of the program.

Now, there are cost savings in other ways too, sir. For example, if you look at the *Ford* aircraft carrier, we designed that reactor plant with 25 percent more energy in the core, three times the electrical generation capacity. We were able to take out roughly 30 percent of the required maintenance in the propulsion plant, and we were able thereby to reduce the manning in the propulsion plant by about 50 percent. So if you take that figure and you add that up over 11 carriers or a 12-carrier force is what the Navy wants and you do that for the lifetime, that is real money. If you take all those kind of cost saving measures that are in the *Ford,* it is about $80 million per year per carrier. So that is real money.

We are focused on not only delivering quality but seeing can we manufacture these things cheaper, easier, and can we do it so that it is affordable from a total ownership cost.

Senator KING. Thank you. That is important. I think there are other areas as well. We could talk about the *Truman,* but that is another topic.

Secretary White, this is an issue I keep raising in Energy and Natural Resources and here: waste. You all have developed waste disposal techniques and technologies. Can you please help us on the civilian side? Because this is the unanswered question with regard to nuclear power. We had a bill in Energy and Natural Resources to promote nuclear power. It is fossil free. It has a lot of positives. But we still have not answered the waste question that has been pending now for about 70 years. Your thoughts.

Secretary WHITE. So Yucca Mountain is not within my purview. But I would have to vehemently agree with you that in order to sort of support the viability of commercial nuclear power, the waste question needs to get solved. We also have to be able to decommission these facilities effectively both in terms of safety and costs.

Senator KING. What we have now are effectively 100 or so high-level nuclear waste sites scattered all over the country. We have one in Maine.

What I hope you can do is share some of your expertise and poke the Department because this is a question that is really impeding our national policy I think.

Secretary WHITE. I agree with you totally. I will definitely take that back to the Department.

Senator KING. Thank you. Yes, pass it back to my friend, Governor Perry. He will know who it is coming from when I say Governor Perry.

Secretary WHITE. Absolutely.

Senator KING. Thank you.

Thank you, Madam Chair.

Senator FISCHER. Thank you, Senator King.

Admiral Caldwell, for some time now, your three major priorities have been the *Columbia*-class reactor, the S8G land-based reactor, and spent fuel handling project in Idaho. Can you talk about what you see as the next key challenges or objectives for the Naval Reactors?

Admiral CALDWELL. Yes, ma'am, I can.

As you know, the last several years, we have been focused on these three high priority, national priority tasks. As the budget for those winds down, I would put the future funding requirements into sort of three broad categories.

First is to support the operating fleet. That is number one in Naval Reactors in our day-to-day business. That is important because when you operate a nuclear fleet, you have to make sure that you provide the technical support and the backing for all the sailors that operate these great ships and make sure our Navy can go out there and do the things that we need to do.

We have a number of aging platforms. We have extended the life of the Trident submarine out past 40 years. That was never intended that way. If you go back and look at the aircraft carriers, we never intended to operate them necessarily for 50 years, but we are. The same is going to be true for our 688 or our Los Angeles class submarines. In fact, we are going to refuel five to seven of those, and it will take some of those out past 40 years of operations. So being able to support that current fleet is vitally important. That is number one.

Number two is building the technologies for the future fleet. The Navy is examining the future capabilities that we need, and they are talking about more energy in the core, life-of-the-ship cores, stealth, acoustics, and improved capability. So I need to invest in technologies that are going to be the game changers in terms of affordability, capacity, capability for the U.S. Navy. So that is number two.

Number three are my facilities. I have a number of facilities, just as the Administrator said, that are aging, that go back 60 years or longer. I need to recapitalize those facilities and I also need to decontaminate and decommission a large number of those facilities. So you will see in my budget submission and in the future FYNCPs a budget request to support taking a bigger chunk out of that Deactivation and Decommissioning (D&D), as well as recapitalizing very important facilities at our labs that allow us to do this important work that supports the fleet.

So those are the three big areas, ma'am.

Senator FISCHER. Thank you, Admiral.

Secretary Gordon-Hagerty, as we have discussed, some are criticizing this budget as being insufficiently committed to nonproliferation programs. This argument is being made despite the fact that the fiscal year 2020 request and the associated out-year funding projections would increase top line spending on nonproliferation above the levels projected in last year's budget even though it eliminates spending for the mixed oxide (MOX) program. Can you explain that to us in greater detail?

Administrator GORDON-HAGERTY. Yes, I can. In fact, thank you.

This is the largest increase that has been requested in the last 5 years for our nonproliferation, our counter-proliferation, and counterterrorism programs. As you rightly state——

Senator FISCHER. Sometimes we focus on the other side of your programs, and I think this is really important.

Administrator GORDON-HAGERTY. It is incredibly important. Thank you.

We are doing a number of things with this budget in what we are looking to do in the out-years, one of which is something that is very important, which is the cesium blood irradiators. Oftentimes we are replacing cesium blood irradiators that are large sources with non-radioactive sources. They are x-ray machines, and we are doing this around the United States, and hopefully we will be able to do this around the world as well. By the end of 2027, we will have completed the removal of the cesium irradiators from the United States, which could be an opportunity for terrorists to take the materials and make them radiological dispersal devices or otherwise known as dirty bombs. At the end of 2027, we anticipate completing that program throughout the United States. So you do see a natural decrease in those budgets.

There are a number of different programs that we have that come to fruition. So oftentimes some might state that we are drawing down on our nonproliferation programs. There could be nothing further than the truth. We believe very strongly in nonproliferation goals, counterterrorism, and counter-proliferation as well. We are working very closely with the interagency to put new programs in place around the United States to support the Federal Bureau of Investigation (FBI) initiatives for counterterrorism, and we are working very closely and we have just gotten approval from the White House to do so. So you see that also in our engagement strategy and approach and request for the 2020 budget.

Senator FISCHER. Thank you.

Senator Heinrich?

Senator HEINRICH. Assistant Secretary White, first off, I just want to thank you for joining me in Carlsbad last month to celebrate 20 years of operation at that one-of-a-kind facility.

One of the concerns—and we talked about this a little bit there in Carlsbad, but one of the concerns I continue to hear about are the ongoing problems with air quality underground. Are there some things that we can do now to improve air quality until the new ventilation system is up and fully operational in a couple years? For example, have we considered switching all of those diesel-powered underground equipment over to electric-powered equipment like they have in some of the other mining facilities?

Secretary WHITE. So, yes, we have been looking at switching over to electric. But in the meantime, though, there are immediate things we have been doing such as kind of simple operational things like ensuring vehicles are turned off if they are not being used.

Other things. We have worked very closely with the miners themselves to say, hey, what do you think about how we can get more air flow. We have changed some things like operating right in the middle of the drifts rather than over at the side, some really kind of simple operational things like that, applying some local

ventilation to get some air movement in spaces where there is some dead air. So we are making improvements constantly. We are also really trying to see if there are ways we can accelerate the schedule on the new ventilation system. So we are very concerned about it, and like I say, we are working very closely with the miners themselves on this.

Senator HEINRICH. I appreciate that. I want to encourage you on both fronts. Obviously, the miners themselves have the direct day-to-day experience, and it is not an easy job and we want them to be working in the safest environment possible.

I want to ask you in addition, does the Waste Isolation Pilot Plant accept non-defense transuranic waste?

Secretary WHITE. It does not.

Senator HEINRICH. Would it require a change in the enabling statute to accept non-defense waste?

Secretary WHITE. That is a legal question. I would imagine the answer is yes.

Senator HEINRICH. That is my read.

I do understand that the Nuclear Regulatory Commission (NRC) is developing a rule for greater than class C waste, but under the 1986 Low Level Waste Policy Act, the Department is charged with disposing of it. If this new NRC rule does become final, what would the Department need to do to implement this legislation?

Secretary WHITE. So what we have done to date is there was a requirement that we submit to Congress our report on our environmental impact statement, the options within that. That was submitted to Congress in 2017. The rule that asked us to do this report also said then we would await congressional action. So we are awaiting that action.

The other pieces and parts that need to happen are NRC would need to decide first in the case of Waste Control Specialists (WCS), if that were a selected facility. They would need to decide if Texas can be the regulator or if NRC would be the regulator and the licenser. Then also there would need to be a regulatory basis and new regulations and requirements would need to be developed. So we are a ways down the road before we will have a disposal option for greater than class C.

Senator HEINRICH. So my understanding is that DOE under the Atomic Energy Act has the authority to reclassify nuclear waste as long as it removes the highly radioactive component and it can be safely disposed of at a low level waste level and that last October, you made such a proposal public. Do you know how that proposal, if it were to move forward, would potentially impact WIPP?

Secretary WHITE. So right now, where we are in the process is we put out a Federal Register notice. We gathered a large number of comments, I think 5,500. We are doing our due diligence and looking very carefully through those comments, seeing what they have to say to make a very deliberate decision on this issue.

In terms of implementation, we have not done the necessary studies to determine what specific waste streams would go to which specific disposal routes. But should the Department make that decision, we would like for the whole process, both the States where the waste resides now and the receiving States to be a very transparent process, and simply following our existing rules around the

National Environmental Policy Act, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is not going to be enough. So we want to go the extra mile because this is very important to our nation.

Senator HEINRICH. I would certainly agree with you there.

Thank you, Madam Chair.

Senator FISCHER. Thank you.

Senator King?

Senator KING. First, you used the term "dead air." I think of dead air is what happens when a reporter asks me a question I do not want to answer. It is dead air.

[Laughter.]

Secretary WHITE. For me, it is when a Senator asks me one.

[Laughter.]

Senator KING. Good for you.

This is more a comment than a question, but it goes to the costs that we were talking about.

One of the anomalies of the federal budgetary process—one of the many—is that we have no capital budget. Everything is operations even though we are buying 40-year assets. No other entity on earth I think would not separate that expenditure from paying a park ranger, and yet that is what we do. It distorts the way the budget works particularly when we are making major capital investments, as we will be over the next whatever the term is for this particular modernization. But it goes for building buildings and everything else. I mean, I just make that comment that it really is I think one of the unacceptable ways that we budget. Hopefully, that is something that we can try to address because to pay for a 40-year asset in cash essentially over the construction period is not a good budget. It is not budgeting or accounting. It is not an accurate representation of the actual cost over the life of the project. So I just offer that. I could not resist under this circumstance.

Thank you.

Senator FISCHER. Senator Heinrich, anything else?

Senator HEINRICH. I will save my questions for the questions for the record.

Senator FISCHER. I would like to thank the panel for being here today. We appreciate all of your information that you provide us. I would ask that you be available for questions, written questions, and get those back to us as soon as possible.

With that, the hearing is adjourned.

[Whereupon, at 3:50 p.m., the Subcommittee adjourned.]

[Questions for the record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR MARTIN HEINRICH

WORK BALANCE BETWEEN LOS ALAMOS AND LIVERMORE LABS

1. Senator HEINRICH. Administrator Gordon-Hagerty, Livermore will be leading the work on the W80–4 cruise missile warhead and the W87–1 Inter-continental Ballistic Missile (ICBM) warhead. Meanwhile, Los Alamos is finishing work on the B61–12. In the future, how will you balance work for Los Alamos for design and engineering given Livermore has the bulk of the work for the next 10–15 years?

Administrator GORDON-HAGERTY. The national laboratories have managed varying life extension program (LEP) workloads in the past and maintained their modernization skills. This is now reinforced by initiatives like the Stockpile Responsiveness Program and the important peer review work done across the nuclear security

enterprise. There is still a significant amount of LEP work to be conducted at Los Alamos National Laboratory, as well as future LEP requirements and other initiatives such as the recapitalization of a pit production capability. Additionally, design and engineering capabilities continue to be utilized at both labs as these activities are required for the day-to-day maintenance and minor alterations and modifications needed to keep the stockpile in a ready-for-deployment status.

NNSA STRATEGIC VISION 2018

2. Senator HEINRICH. Administrator Gordon-Hagerty, this week the National Nuclear Security Administration (NNSA) released the Strategic Vision 2018, which is in response to the findings of the Augustine—Mies Congressional Commission on the Governance of the Nuclear Enterprise. Chapter one of the report presents a clear and implementable vision for the organization—one that changes its culture. How do you intend to implement and track this Strategic Vision document to promote the change in culture of a mission driven organization?

Administrator GORDON-HAGERTY. In association with the release of the Strategic Vision, NNSA also released the Governance and Management Framework and the Strategic Integrated Roadmap. The Governance and Management Framework shows how the agency will deliver its mission in a resilient, agile, and responsive manner. The Strategic Integrated Roadmap illustrates the path to achieving goals now through the next 25 years. Collectively, the three documents set the stage for realizing the cultural changes necessary to ensure that NNSA continues to demonstrate excellence and is responsive to the nation's nuclear security and strategic defense needs now and into the future.

Issuing these documents alone does not transform NNSA. Doing so requires leadership, training, dedication, and ongoing communication. NNSA will work together as one team by drawing upon common values across the nuclear security enterprise, building enduring and trusted relationships, promoting transparency, fostering a passion for and awareness of mission, and demonstrating a commitment to success at all levels. NNSA is poised to continue making essential contributions to U.S. and global security now and into the future.

SURPLUS PLUTONIUM DILUTE AND DISPOSE—LOS ALAMOS NATIONAL LABORATORY

3. Senator HEINRICH. Administrator Gordon-Hagerty, my understanding is that to perform the dilute and dispose operations for surplus plutonium in later years you intend to ship plutonium from Pantex to Los Alamos National Laboratory (LANL) to turn it into oxide power. Then, you will ship it to the Savannah River Site to be packed; and then, ship it again back to Carlsbad, New Mexico to be disposed of at the Waste Isolation Pilot Plant. Is this truly the optimal strategy and have you considered alternatives that could reduce the number of required shipments?

Administrator GORDON-HAGERTY. NNSA has previously and will continue to evaluate opportunities to improve the efficiency of the dilute and dispose process, including optimizing transportation requirements.

4. Senator HEINRICH. Administrator Gordon-Hagerty, looking at your planned plutonium funding for fiscal years 2020 through 2024, I note there are increased operations for Los Alamos' plutonium facility to dilute and dispose of the 34 metric tons of surplus plutonium that was to go to the Mixed Oxide (MOX) facility, while at the same time we are increasing operations for pit production in PF–4. Can all of these tasks be done effectively in the plutonium facility? How is this work being coordinated?

Administrator GORDON-HAGERTY. Los Alamos National Laboratory (LANL) is aware of the need to maintain dilute and dispose (D&D) activities and has incorporated D&D plans into the overall site strategy for plutonium that is currently under development. LANL is developing an integrated schedule for all Plutonium Facility (PF)-4 activities to balance resources among all the programs that PF–4 supports.

5. Senator HEINRICH. Administrator Gordon-Hagerty, is it true you are going to have to add another entrance into the plutonium facility to accommodate both dilute and dispose and pit production?

Administrator GORDON-HAGERTY. NNSA is working with Los Alamos National Laboratory to evaluate the investments needed to support increased operations at Plutonium Facility (PF)-4 to meet pit production requirements and other missions. With an increased operational tempo, there will be a need to accommodate additional staff in PF–4. Updated staffing analyses will inform the basis for personnel-

related infrastructure such as offices, parking, training, and entry control capabilities.

NNSA'S PLUTONIUM STRATEGY AND THE INSTITUTE FOR DEFENSE ANALYSIS'S ASSESSMENT FOR THE DEPARTMENT OF DEFENSE

6. Senator HEINRICH. Administrator Gordon-Hagerty, with respect to your recommended alternative for plutonium pit production announced in May 2018, I continue to have serious concern over the substantially higher estimated lifecycle cost of establishing a second site to produce 50 pits year by 2030 compared to enhancing the current capabilities at Los Alamos. What is the status and timeline to complete the conceptual design to repurpose the Mixed Oxide Fuel Fabrication Facility for pit production and to approve the selected alternative and updated cost range, including lifecycle cost, to support CD–1?

Administrator GORDON-HAGERTY. To achieve DOD's requirement of not less than 80 pits per year by 2030, NNSA's recommended alternative repurposes the Mixed Oxide Fuel Fabrication Facility at the Savannah River Site in South Carolina to produce plutonium pits while also producing pits at Los Alamos National Laboratory (LANL) in New Mexico. Though we expect the lifecycle cost of a two-site approach to be higher than that of a one-site approach, the recent Institute for Defense Analyses (IDA) study noted that this gap in costs would be reduced when accounting for the cost to maintain the aging Plutonium Facility (PF)-4 and the cost of additional LANL personnel. Additionally, the proposed two-site approach supports the need for resiliency, flexibility, and redundancy across the nuclear security enterprise for the critical plutonium pit production mission by not relying on a single production site.

NNSA is currently executing conceptual design activities for the proposed Savannah River Plutonium Processing Facility (SRPPF) to produce 50 pits per year, with a goal of achieving Critical Decision-1 (CD–1) by September 30, 2020. An independent cost estimate for refurbishment of the proposed SRPPF will be performed prior to CD–1.

7. Senator HEINRICH. Administrator Gordon-Hagerty, when completed, will you provide the Armed Services Committees notification of the approval of the selected alternative and the updated cost range?

Administrator GORDON-HAGERTY. Yes, when Critical Decision-1 is approved, NNSA will notify the Committees of the approval of the selected alternative and the updated cost range.

8. Senator HEINRICH. Administrator Gordon-Hagerty, it is clear that the key milestone in NNSA's plutonium strategy is achieving 30 pits per year at Los Alamos. However, the Institute for Defense Analysis's recent independent assessment for the Department of Defense (DOD) presents a rather sobering and pessimistic view of the overall plutonium strategy. The key findings include: none of the four options NNSA considered to reach 80 pits was demonstrably better; each is achievable but not on the schedule or budget currently forecast; and none of the options can provide the 80 pits per year DOD requires by 2030. What is your assessment of the report with respect to the ability of any of the four options considered by the NNSA to produce 80 pits per year by 2030?

Administrator GORDON-HAGERTY. NNSA realizes that production of not less than 80 pits per year (ppy) by 2030 is an ambitious goal, but we remain committed to meeting the requirement laid out in the 2018 Nuclear Posture Review. The Institute for Defense Analysis (IDA) study based its conclusion that NNSA cannot reach the 80 ppy milestone in 2030 with any of the proposed options on the history of recent large construction projects within DOE. On that comparative basis, IDA could find no example of a project on the same scale as pit manufacturing being completed in the time frame we need. It is also worth noting that IDA could not find an example of repurposing an existing facility as a comparison; their assessment was based only on large construction projects that involved new construction. These past projects do not reflect the fact that DOE has incorporated lessons learned from life extension programs and capital construction projects as well as improved program management processes to facilitate execution of projects on schedule and within budget.

PLUTONIUM STORED AT THE NEVADA NATIONAL SECURITY SITE

9. Senator HEINRICH. Administrator Gordon-Hagerty, my understanding is Secretary Perry has assured the Nevada delegation the NNSA will begin removing the half-ton of Savannah River plutonium from Nevada by 2021. In addition, Secretary Perry has indicated the second half-ton of plutonium will not be shipped from South

Carolina to Nevada. Can you tell us in open session where this plutonium is headed?

Administrator GORDON-HAGERTY. No, pursuant to the Atomic Energy Act (AEA), the Department of Energy is charged with safeguarding national security information related to the shipment of special nuclear material. As the material removed from the Savannah River Site will be used for national security missions, details of the campaign are classified, in accordance with the AEA.

MOLYBDENUM 99 FROM LOW ENRICHED URANIUM

10. Senator HEINRICH. Administrator Gordon-Hagerty, the American Medical Isotopes Production Act of 2012 directed NNSA to implement a technology-neutral program, in cooperation with non-Federal entities, to produce molybdenum-99 without using highly enriched uranium (HEU). The NNSA should take a lot of credit for working with industry to develop a domestic supply of the medical isotope, Mo-99, using only low-enriched uranium. In February, NNSA completed its evaluation of applications submitted in response to a funding opportunity for the production of Mo-99 without the use of HEU. What is the status of the negotiations with the four U.S. companies selected for new cooperative agreement awards to produce Mo-99?

Administrator GORDON-HAGERTY. Currently, NNSA is reviewing the proposed budgets for the four potential vendors to include a review of pricing and cost reasonableness; total budget cost; and an assessment of costs proposed, to ensure costs are allowable under Federal Acquisition Regulation. Concurrently, NNSA is preparing contract documents in anticipation of four awards.

11. Senator HEINRICH. Administrator Gordon-Hagerty, how soon do you anticipate domestic production of Mo-99 will begin?

Administrator GORDON-HAGERTY. NorthStar began domestic production of Mo-99 in November 2018.

12. Senator HEINRICH. Administrator Gordon-Hagerty, are we on track to eliminate the use of highly enriched uranium for radioisotope production in the United States and overseas?

Administrator GORDON-HAGERTY. Yes, we are on track to eliminate the use of highly enriched uranium (HEU) for radioisotope production. The first domestic producer in the United States in 30 years, NorthStar, began production in November 2018 with non-HEU technology. Three of four major global suppliers now produce with low-enriched uranium (LEU). The fourth, Belgium's Institute of Radioelements, plans to convert to 100 percent LEU by June 2022.

DOMESTIC URANIUM ENRICHMENT

13. Senator HEINRICH. Administrator Gordon-Hagerty, since the closure of the Paducah Gaseous Diffusion Plant in 2013, the United States has lacked the capability to enrich uranium using a domestic technology. The Department of Energy (DOE)/NNSA requires unobligated enriched uranium to meet stockpile requirements, fuel reactors that produce tritium, and power the nuclear Navy. In rough terms, about how many years will the existing inventory of enriched uranium, including HEU, provide NNSA to extend the need date for unobligated low enriched uranium for tritium production and other purposes?

Administrator GORDON-HAGERTY. NNSA's nearest-term need for unobligated low-enriched uranium (LEU) is to fuel tritium production reactors. NNSA is currently executing a campaign to down-blend highly enriched uranium materials from the existing uranium inventory, which will provide enough unobligated LEU for tritium production through 2041.

14. Senator HEINRICH. Administrator Gordon-Hagerty, based on the present projection, in approximately what year does NNSA currently expect it will need to reestablish a domestic uranium enrichment capability?

Administrator GORDON-HAGERTY. NNSA's ongoing down-blending campaign will provide low-enriched uranium (LEU) for tritium production through 2041. NNSA is currently conducting an Analysis of Alternatives to examine all options for meeting the enriched uranium mission need. Any option pursued will need to be in place in time to provide LEU by 2041.

15. Senator HEINRICH. Aministrator Gordon-Hagerty, DOE/NNSA requires enriched uranium, but not necessarily unobligated enriched uranium, to fuel research and medical isotope reactors as part of its nonproliferation mission. Am I correct that Urenco USA's plant, the nation's only operating commercial uranium enrich-

ment facility, is a possible near-term option to meet DOE's need for enriched uranium fuel, including HALEU, for these nonproliferation activities?

Administrator GORDON-HAGERTY. NNSA's nonproliferation requirements for high-assay low enriched uranium (HALEU) have been incorporated into its ongoing Domestic Uranium Enrichment Analysis of Alternatives, which includes Urenco USA as a potential option.

ALBUQUERQUE COMPLEX PROJECT

16. Senator HEINRICH. Administrator Gordon-Hagerty, last July NNSA broke ground on a new state-of-the-art office facility for its federal workforce in Albuquerque. I was pleased to join you at the event. The $175 million Albuquerque Complex Project will provide modern, safe and reliable workspace for the 1,200 employees who support the nation's vital national security mission. The building will also meet a Leadership in Energy and Environmental Design gold standard. What is the status of the project and the expected date NNSA staff will begin to occupy the new office building?

Administrator GORDON-HAGERTY. Construction of the NNSA Albuquerque Complex Project is well underway and remains on schedule and on budget. The project continues to make progress toward meeting LEED objectives and is on track to achieve Gold level certification. NNSA staff are scheduled to begin occupying the building in 2021.

LANL CLEANUP

17. Senator HEINRICH. Secretary White, I have worked with Senator Udall to increase funding this year for cleanup work at LANL to $220 million, consistent with the achievable scope of work. With respect to the future scope of work for environmental cleanup at Los Alamos, N3B has developed a 5-year cost baseline at the level of $220 million per year, $25 million above your fiscal year 2020 request. Clearly, there is sufficient environmental remediation work throughout LANL to accelerate cleanup work above the $195 million baseline request. Do you have any doubt that the Office of Environmental Management (EM) can effectively execute a scope of work at $220 million for fiscal years 2020 through 2024?

Secretary WHITE. The 2016 Consent Order establishes an effective structure for accomplishing and prioritizing work through risk-based cleanup campaigns with achievable milestones and targets. The Consent Order has an annual planning process to update Appendix A (Solid Waste Management Unit/Area of Concern List), Appendix B (Milestones and Targets), and Appendix C (Campaigns), as appropriate. The fiscal year 2020 Budget will support the continued retrieval and disposition of legacy transuranic waste at Technical Area-54 and the deactivation and decommissioning of excess facilities at Technical Area-21. Moreover, the fiscal year 2020 budget will support the final remedy and site completion at remaining Solid Waste Management Units that are co-located in the footprint of the structures and will also facilitate progress on the ongoing Chromium Interim Measures and Characterization campaign and Royal Demolition Explosives Characterization campaign.

AIR QUALITY IN WIPP

18. Senator HEINRICH. Secretary White, thank you for joining me last month at the Waste Isolation Pilot Plant to celebrate 20 years of operation at that important facility. One concern I've been hearing about is the ongoing problems with the air quality in the underground. Are there addition steps we can take now to improve the air quality until the new ventilation system is operational in late 2022? In the interim, to improve fire safety and reduce emissions in the underground, does your fiscal year 2020 budget request include funding to replace diesel with electric- or hybrid-powered equipment, such as bolters, haulers, graders, Load/Haul/Dumps, forklifts, etc.?

Secretary WHITE. The Carlsbad Field Office is aggressively taking a number of approaches at the Waste Isolation Pilot Plant (WIPP) to address air quality in the underground. In collaboration with our workforce, we have identified and implemented a number of changes to our processes and procedures in the underground including shutting off vehicles if stopped for more than a few minutes, keeping running vehicles in the middle of drifts where air flows are higher, and routing exhaust to unoccupied spaces (this is done with bolters that sit stationary while installing bolts). Also, we are installing supplemental localized ventilation in low flow areas, such as dead legs to keep the airflow moving.

Plans are underway to upgrade the entire underground fleet with low and no emission vehicles. WIPP has already ordered its first electric powered vehicle and is working to have it in service this summer.

COLUMBIA LIFE OF CORE FUEL

19. Senator HEINRICH. Admiral Caldwell, what is the status of the life of core fuel you are producing for the *Columbia*-class submarine and do you expect any issues when moving it into production for the fleet?

Admiral CALDWELL. Naval Reactors is supporting construction of the first *Columbia*-class submarine by developing a reactor plant with a life-of-ship core that will be in service for more than 40 years.

In support of this effort, the types of core materials that will be used in the *Columbia*-class reactor core were also used in the Technology Demonstration Core being delivered this summer to refuel the Naval Reactors' land-based prototype at our facility in New York. We have completed manufacturing of the alternate core material to refuel this prototype. This effort proved the ability to manufacture alternate core material on a production scale and identified means to improve manufacturability and performance of the *Columbia*-class core.

Earlier this year, Naval Reactors placed the reactor plant long-lead procurement contract with Navy funding (Shipbuilding and Conversion, Navy), including the reactor core, to support the shipyard's build plan. The contract was placed on time, following design efforts that began in 2010, and we expect to remain on schedule and on budget in support of *Columbia*-class construction beginning in fiscal year 2021 with delivery in fiscal year 2028.

LOW ENRICHED URANIUM FUEL

20. Senator HEINRICH. Admiral Caldwell, some have advocated using Low Enriched Uranium fuel similar to the French for their submarines. What are the issues, here in open session, from a technical and cost perspective?

Admiral CALDWELL. The Naval Nuclear Propulsion Program has a history of using highly enriched uranium in naval cores. This technology has enabled the program to develop reactor cores that are capable of lasting the entire life of a submarine. The effect of this capability can be seen in the ability to replace 14 *Ohio*-class submarines with 12 *Columbia*-class submarines by forgoing a mid-life reactor refueling. This results in substantial savings over the life of the class in terms of acquisition, maintenance, and operational costs.

Today, nearly 45 percent of the Navy's major combatants are nuclear powered, including 11 aircraft carriers and 69 submarines. The U.S Navy mission has a global reach with a high operating tempo and energy requirements. The French operate far fewer nuclear-powered ships. Their nuclear fleet is less than one-seventh the size of the U.S. nuclear-powered fleet. The French nuclear-powered ships are typically refueled every seven to ten years. Transitioning the U.S. Fleet to low-enriched uranium (LEU) fuel would result similarly in approximately two to three refuelings over the life of a ship, deviating from our current life-of-ship submarine core designs. Based on fleet size, the costs would be significantly greater for the U.S. Navy to maintain an LEU fleet.

Furthermore, an LEU fuel system would not provide any military benefit to the performance of U.S. naval reactors. LEU fuel would fundamentally decrease the available energy in a naval reactor at a time that energy demands are expected to increase and would negatively affect reactor endurance, reactor size, ship costs, ship availability, force structure, and maintenance infrastructure.

IDAHO SPENT FUEL PROJECT

21. Senator HEINRICH. Admiral Caldwell, what is the cost and completion status of the spent fuel pond facility at the Idaho National Laboratory? Are there any issues you are worried about?

Admiral CALDWELL. The Spent Fuel Handling Recapitalization Project will design and construct a new facility, the Naval Spent Fuel Handling Facility, to incorporate the capabilities for naval spent nuclear fuel handling that currently exist in the Expended Core Facility (ECF) and its supporting facilities. Additionally, a major portion of this new facility is required to support additional capability, which does not exist in the ECF, to handle full-length aircraft carrier naval spent nuclear fuel received in M–290 shipping containers.

I approved the Performance Baseline and Start of Construction (Critical Decision-2/3) in September 2018. The project has an estimated total project cost of approximately $1.687 billion with completion in fiscal year 2025, of which, $40 million was included to account for potential increases in market-based conditions, such as unanticipated increases in labor costs and domestic steel prices. Naval Reactors continues to closely monitor and evaluate the volatility in labor costs and material

prices as well as other issues typical for a construction project of this size in Idaho (e.g., winter related impacts).

The project is completing site preparation, has begun the mass geotechnical excavation, and will begin permanent construction activities this fiscal year.

SPENT FUEL EXAMINATION FACILITY AT THE IDAHO NATIONAL LABORATORY

22. Senator HEINRICH. Admiral Caldwell, my understanding is the spent fuel facility you are building at the Idaho National Laboratory will not have a capability to examine the fuel. What are you doing about this and how much might it cost?

Admiral CALDWELL. The capability to examine naval spent nuclear fuel from refueled or defueled warships is vital to Naval Reactors' mission of delivering reliable and effective nuclear propulsion plants. It enables resolution of emergent fleet issues, confirmation of continued safe and reliable operation in the fleet, design and manufacture of longer-life and higher-powered cores, and demonstration of performance of new fuel technologies. This capability is currently provided by the Expended Core Facility (ECF) located at the Naval Reactors Facility in Idaho. ECF is more than 60 years old and requires recapitalization.

Naval Reactors is taking a phased approach to recapitalizing the capabilities of the ECF that supports all Naval Reactors Program requirements, keeping recapitalization projects to a manageable scope and size, and considering affordability. The first step will be recapitalizing spent fuel handling operations to the new Naval Spent Fuel Handling Facility (NSFHF), which will be completed by the Spent Fuel Handling Recapitalization Project in fiscal year 2025. Although some types of spent fuel examinations will be able to be accomplished in the NSFHF water pools, other types of spent fuel examinations must be performed in a dry environment (i.e., hot cells).

The Naval Examination Acquisition Project will recapitalize the spent fuel examination capabilities currently provided by the ECF hot cells. The project was initiated with Critical Decision-0, Mission Need Statement, in January 2018, and is planned to begin preliminary design in fiscal year 2023. The project is targeted to complete as early as the mid-2030s with a cost between $500 million and $1.3 billion.

ELECTRIC DRIVE

23. Senator HEINRICH. Admiral Caldwell, my understanding is you are building an electric drive propulsion system for the *Columbia*-class submarine and the contractor has had issues building it. What is the status of this project?

Admiral CALDWELL. In 2017, the vendor manufacturing the prototype Main Propulsion Motor for the electric drive system identified a manufacturing issue related to the procurement of improperly insulated material for the prototype motor stator. The vendor did not properly relay requirements to sub-tier vendors. This required remanufacturing a major portion of the prototype motor. The remanufactured prototype motor has since been delivered to the motor assembly facility where the vendor is completing final assembly and component testing. The vendor is under a firm fixed price contract and therefore is absorbing the costs associated with these actions.

In order to de-risk the lead ship motor assembly manufacturing process, the vendor built a full-scale mock-up motor at its motor assembly facility to prove out the final assembly process and special tooling. Additionally, we installed an alternate motor at the test facility and have started system level integration testing to ensure the prototype system (controllers and drives) perform and communicate as expected. By implementing these mitigation actions, we have been able to preserve the required nine-month margin for the required in-yard date for construction of the ship. As such, delivery of the production motor to the shipyard for construction of the lead ship will remain on schedule to support construction beginning in fiscal year 2021.

QUESTIONS SUBMITTED BY SENATOR ELIZABETH WARREN

"LOW-YIELD" NUCLEAR WEAPONS

24. Senator WARREN. Administrator Gordon-Hagerty, my understanding is that the First Production Unit of the W76–2 was completed in February 2019, and that the NNSA is currently on a path toward completing the W76–2 Initial Operational Capability warhead quantity and delivering the units to the Navy by the end of Fiscal Year 2019. According to your written testimony for the May 8, 2019, Strategic Forces Subcommittee hearing, the W76–2 "provid[es] the U.S. an assured ability to respond in kind to a low-yield nuclear attack [and] discourages an adversary from

pursuing such an attack and therefore strengthens deterrence." If funding for further work on the W76–2 were canceled in fiscal year 2020, would the United States have no other viable capabilities to deter a low-yield nuclear attack?

Administrator GORDON-HAGERTY. Canceling NNSA funding for the W76–2 in fiscal year 2020 would not prevent NNSA from completing 100 percent of the production required for the W76–2 warheads, as all production is scheduled to complete in fiscal year 2019. Fiscal year 2020 funding for the W76–2 is exclusively allocated to the administrative tasks associated with completing the program. The Department of Energy defers to the lead agency, the Department of Defense, on further details related to military capabilities and calculus.

SAUDI CIVILIAN NUCLEAR COOPERATION AGREEMENT

25. Senator WARREN. Administrator Gordon-Hagerty, do you or any other NNSA official have current or prior involvement in Trump Administration efforts to negotiate a civilian nuclear cooperation agreement under Section 123 of the Atomic Energy Act of 1954? If yes, please explain the nature of that involvement.

Administrator GORDON-HAGERTY. Yes, pursuant to Section 123 of the Atomic Energy Act of 1954, as amended, the Department of Energy provides technical support to the Department of State in the negotiation of all peaceful nuclear cooperation agreements. The Office of Defense Nuclear Nonproliferation within NNSA provides this function for the Secretary of Energy. NNSA has provided such technical support to the negotiations since 2012, when the previous Administration commenced with such negotiations.

QUESTIONS SUBMITTED BY SENATOR JOE MANCHIN

ENVIRONMENTAL LIABILITY CONTRACT MANAGEMENT

26. Senator MANCHIN. Secretary White, federal accounting standards require agencies responsible for cleaning up any contaminated site to estimate their financial responsibility for doing so. As of fiscal year 2018, the Office of Environmental Management's liability was recorded as $377 billion. This number is worrisome as the liability growth has outpaced cleaning spending from fiscal year 2011 to fiscal year 2018, in large part due to contract and project management problems. During fiscal year 2018 alone, the Department managed 14,455 contracts and subcontracts valued at more than $25 billion and $375 million respectively. The DOE Inspector General has identified numerous issues to include lagging schedules, fraud, waste, and abuse specifically linked to weaknesses in project management and oversight. What actions are you and the Department taking to address the issues cited by the Inspector General to improve management practices and oversight to ultimately improve efficiency and reduce costs?

Secretary WHITE. EM has several initiatives in place to improve oversight and respond to the Inspector General's concerns. For example, EM is transitioning to an end state contracting (ESC) model on all major contracts. These contracts will focus on objective "end states" that reflect EM's goals of accelerated closure, lower financial liability, and lower risk. They are cost-plus-incentive fee indefinite delivery/indefinite quantity contracts with task orders that have shorter durations, more discrete scopes of work, and more accurate cost and schedule targets. EM is also aligning Performance Evaluation Measurement Plans for existing cost-plus-award-fee contracts with EM goals and ESC principles, and using a fee advisory determination board led by EM headquarters to share best practices and verify consistency in determination of award fees across the EM complex.

EM is committed to effectively resolving the issues and challenges identified by the Inspector General and to uphold the Department's commitment to cleanup.

ENVIRONMENTAL LIABILITY AND TECHNOLOGY DEVELOPMENT

27. Senator MANCHIN. Secretary White, according to the Government Accountability Office, Department of Energy staff and management are aware of the increasing federal liability associated with defense nuclear waste cleanup. DOE staff noted that the change in liability over the past 8 years is a multifaceted problem due to the complex cleanup work and also the range of technologies that are available for remediation. The National Academy of Sciences produced a report this year that recommends that DOE change how it manages science and technology development in order to speed up remediation efforts and reduce cost. In the early 2000s, the environmental technology budget for the Department was around $200 million, but now is only around $25 million. Do you believe the current budget for tech-

nology development is sufficient to meet the challenges that have been raised by the National Academy of Sciences and Department employees?

Secretary WHITE. The Office of Environmental Management (EM) has been very successful with its cleanup program to date, reducing the number of sites to be addressed from 107 to 16. The Technology Development program works with the sites, National Laboratories, and site contractors to address the remaining challenges. As the cleanup program has matured, the focus of technology development has shifted to solve site-specific technology issues. Although the EM Headquarter technology development budget has been reduced to $25 million, the sites are also investing in technology development. For example, Oak Ridge funds $3 million for mercury research related to a site-specific contamination issue, and the Office of River Protection has requested $10 million in the fiscal year 2020 Budget to fund a test bed initiative for demonstrating grouting and disposal of low-level waste. EM has developed a number of tools for clean-up since the organization was established in 1989. We are also looking at technologies and innovative approaches from other industries, such as the mining and oil industries, where we can adapt an existing technology or approach to address DOE's challenges.

Y–12 FACILITY UPGRADES AND IMPACT

28. Senator MANCHIN. Administrator Gordon-Hagerty, on April 6 of this year you gave testimony to the House Energy and Water Development Subcommittee that pieces of the roof were falling in at the old Lithium Processing facility locate at Y–12 to highlight the need for repairs and modernization. This followed a chemical spill on April 4 reported at the facility. Although both incidents are considered minor and did not affect the overall safety of the operations there, they raise concerns of the condition and long-term sustainability of operations under current conditions. As a part of your budget there are funds going to continuing projects to build new Uranium and Lithium processing facilities. Given the recent issues and your understanding of the state of facilities and operations at Y–12, are the current timelines for construction and upgrade of weapons going to meet the timeline goals of the Uranium Processing facility completion in 2025 and warhead upgrades by 2030?

Administrator GORDON-HAGERTY. NNSA is committed to constructing the Uranium Processing Facility (UPF) for no more than $6.5 billion by the end of 2025. UPF has been on budget and on schedule for six consecutive years. The UPF nuclear facilities were baselined in March 2018 and construction is underway. UPF supports NNSA's enduring uranium mission and its commitment to modernize its infrastructure.

NNSA management practices ensure that we follow integrated schedules to align our strategic materials work with our warhead modernization activities. The W87–1 Modification Program, which has a scheduled First Production Unit date of fiscal year 2030, remains on budget and on schedule. As part of NNSA's overall strategy, NNSA continues to maintain existing facilities until such a time when operations can move into the new facilities.

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