

TITLE II—RESEARCH, DEVELOPMENT, TEST, AND EVALUATION

Subtitle A—Authorization of Appropriations

Authorization of appropriations (sec. 201)

The committee recommends a provision that would authorize the appropriations for research, development, test, and evaluation activities at the levels identified in section 4201 of division D of this Act.

Subtitle B—Program Requirements, Restrictions, and Limitations

Development and acquisition strategy to procure secure, low probability of detection data link network capa- bility (sec. 211)

The committee recommends a provision that would require the Chief of Staff of the Air Force (CSAF) and Chief of Naval Operations (CNO) to develop a joint development and acquisition strategy to procure a resilient, low latency, and low probability of detection data link network capability that would enable effective operation in the contested environments highlighted in the National Defense Strategy. The strategy's solution should ensure that the network is affordable with minimal impact to existing host platforms and minimal overall integration costs. The CSAF and CNO would submit the strategy to the congressional defense committees no later than March 1, 2020.

Additionally, the provision would limit the obligation or expenditure of fiscal year 2020 funds for operation and maintenance for the Office of the Secretary of the Air Force and the Office of the Secretary of the Navy to 50 percent of those funds until 15 days after submission of the plan required in the provision.

Establishment of secure next-generation wireless network (5G) infrastructure for the Nevada Test and Training Range and base infrastructure (sec. 212)

The committee recommends a provision, funded elsewhere in this Act, that would require the Secretary of Defense to establish a secure fifth generation (5G) wireless network at the Nevada Test and Training Range as part of the Department of Defense (DOD) test infrastructure in order to provide an advanced cellular range for the Department. The committee recognizes the revolutionary effect that 5G technology will have on the DOD. However, the committee is concerned that the DOD lacks the ability to test and develop tactics to leverage 5G technology as well as to negate enemy use of this advanced capability.

In addition, the provision would require the installation of a secure 5G base infrastructure network at a second location in order to improve the DOD's understanding of the impacts of 5G technology on continental United States base operations.

Limitation and report on Indirect Fire Protection Capability Increment 2 enduring capability (sec. 213)

The committee recommends a provision that would prohibit the obligation or expenditure of any funds for fiscal year 2020 for the Army's Indirect Fire Protection Capability Increment 2 (IFPC Inc 2) enduring capability program until the Secretary of the Army submits a report to the congressional defense committees containing: (1) An assessment of whether the enduring IFPC Inc 2 requirements are still relevant for the threat anticipated for the period when the program would be fielded; (2) A list of candidate systems considered for IFPC Inc 2, including those developed outside of the Army; (3) An assessment of the systems against representative threats; (4) An assessment of other relevant characteristics, including cost of development, cost per round, technological maturity, and logistics and sustainment; and (5) A plan for how the Army would integrate the chosen system into the Integrated Air and Missile Defense Battle Command System.

The provision would also require the Secretary of the Army to identify a program of record in the President's budget request for fiscal year 2021 that addresses the Army's responsibility per Department of Defense Directive 5100.01 to "conduct air and missile defense to support joint campaigns," specifically as it pertains to defense against supersonic cruise missiles.

The committee notes that the Army's plan to procure two Iron Dome batteries in accordance with section 112 of the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Public Law 115-232) meets the intent of the Congress as an interim solution for defense against cruise missiles. The committee is concerned, however, that the Army has artificially constrained the options considered for the enduring program, including holding some candidate systems to different standards than other systems and excluding some options altogether. Further, the committee is concerned that the requirements for IFPC Inc 2 are not representative of the current threat posed to U.S. and allied air bases and other fixed sites in theater and will be even further disconnected from the future threat. The committee commends the efforts of Army Futures Command in this area thus far and encourages the command to aggressively pursue a technological solution that will provide the defense necessary to enable joint theater campaign plans.

Electromagnetic spectrum sharing research and development program (sec. 214)

The committee recommends a provision that would require the Secretary of Defense, in consultation with the Administrator of the National Telecommunications and Information Administration and the Federal Communications Commission, to establish an electromagnetic spectrum sharing research and development program for fifth-generation wireless network technologies, Federal systems,

and non-Federal incumbent systems that would focus on expanding sharing of electromagnetic spectrum. The committee believes that this program is important in assessing the benefits and risks to the Department of Defense (DOD) of spectrum sharing and its impacts on the warfighter.

The provision would require, within 180 days, the establishment of test beds to demonstrate the potential of cohabitation between these systems. The provision would also require the Secretary of Defense, in coordination with the appropriate Federal agencies, to propose a strategy to integrate Federal and non-Federal electromagnetic spectrum enterprises not later than May 1, 2020. The Secretary of Defense, in consultation with the Administrator and the Commission, would also provide to the relevant congressional committees periodic briefings on the status of the test beds, including the incorporation of sharing technologies into international standards, and reports identifying recommendations to facilitate sharing frameworks in the bands of electromagnetic spectrum that are the subject of the test beds.

Sense of the Senate on the Advanced Battle Management System (sec. 215)

The committee recommends a provision that would express the sense of the Senate on the Air Force's approach to the Advanced Battle Management System (ABMS). The committee is supportive of the Air Force's vision for the ABMS as a system of systems that can integrate and fuse data from disaggregated sensors. However, the committee remains concerned about the speed of fielding based on the current projected end of life for the Joint Surveillance and Target Attack Radar System aircraft.

Modification of proof of concept commercialization program (sec. 216)

The committee recommends a provision that would make the pilot program authorized in section 1603 of the National Defense Authorization Act for Fiscal Year 2014 (Public Law 113-66; 10 U.S.C. 2359 note) permanent. The provision would also add a section that includes commercialization of dual-use technology with a focus on priority defense technology areas that attract public and private sector funding as well as private sector investment capital, including from venture capital firms in the United States.

Modification of Defense quantum information science and technology research and development program (sec. 217)

The committee recommends a provision that would amend section 234 of the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Public Law 115-232) by specifying a list of organizations to be consulted in developing the research and investment plan required in the provision and by requiring the Department of Defense to develop, in coordination with appropriate Federal entities, a taxonomy for quantum science activities and requirements for relevant technology and standards.

Technology and National Security Fellowship (sec. 218)

The committee recommends a provision that would authorize a technology and national security fellowship for individuals that possess an undergraduate or graduate degree that focuses on science, technology, engineering, or mathematics course work.

Direct Air Capture and Blue Carbon Removal Technology Program (sec. 219)

The committee recommends a provision that would require the Secretary of Defense, in coordination with the Secretary of Homeland Security, the Secretary of Energy, and the heads of other Federal agencies as deemed appropriate by the Secretary of Defense, to carry out a program on the research, development, testing, evaluation, study, and demonstration of technologies related to blue carbon capture and direct air capture.

Subtitle C—Reports and Other Matters

National security emerging biotechnologies research and development program (sec. 231)

The committee recommends a provision that would direct the Department of Defense (DOD) to develop a coordinated research program in emerging biotechnologies. The committee notes that advances are occurring in biotechnology at an intersection of traditional biology, synthetic biology, engineering, and biotechnology. Advances in these areas could lead to improvement in many capabilities relevant to defense missions, including enhancing servicemembers' performance, increasing lethality and survivability, and improving battlefield healthcare. This progress could also yield commercial advances in areas such as gene editing, cloning, and faster development of new drugs and vaccines.

Such potential advances in emerging biotechnologies include: new bacteria or implantable devices that could enhance warfighter cognitive and physical performance; improved information and information use to create more realistic computer simulations of warfighter physiology; development of biosensors to monitor warfighter performance or environmental conditions; engineered biomaterials for defense applications; and improved novel wound-healing or casualty care and diagnosis technologies and systems.

The committee believes that the Department needs a coordinated research effort to ensure that programs in this area are consistently aligned to current DOD strategies and informed by global and commercial developments in the field. Further, since these technologies may also develop into future threats to the military and the Nation, the provision would require the Department to develop policies on the control of research information and products as needed to protect national security. The provision would further require the Secretary of Defense, in carrying out this program, to develop strong partnerships with industry, universities, and inter-agency partners so that the DOD can leverage the best investments made across the country and world and to ensure that the biotechnology research mission area is served by the best possible technical talent and world-class research facilities.

Cyber science and technology activities roadmap and reports (sec. 232)

The committee recommends a provision that would direct the Under Secretary of Defense for Research and Engineering to develop a roadmap for the science and technology activities of the Department of Defense in support of the Department's cyber needs and missions. The provision would also require the Under Secretary to submit an annual report on these activities. The committee believes that long-term science and technology cyber research is critical to developing capabilities that will enable the warfighter to maintain dominance in cyberspace in the long run.

Requiring certain microelectronics products and services meet trusted supply chain and operational security standards (sec. 233)

The committee recommends a provision that would require the Secretary of Defense to establish, by January 1, 2021, supply chain and operational security standards and requirements for microelectronics and to purchase microelectronics and related services to the maximum practicable extent from providers that meet these standards. In addition, the provision would require that the Secretary ensure that manufacturers of secure microelectronics are able to use the same production lines, facilities, and personnel for microelectronics products and related services intended for both Department of Defense (DOD) and commercial end-uses. The provision would require the Secretary to take such actions as are necessary and appropriate to foster a competitive secure industrial base. The committee directs the Secretary of Defense to brief the congressional defense committees on the supply chain and operational security standards not later than February 1, 2021.

The committee believes that changes are needed to the traditional approach to ensuring a supply of trusted microelectronics. The current approach is not economical for existing or prospective suppliers of trusted microelectronics, because the DOD buys most of its microelectronics from purely commercial companies and prevents its trusted suppliers from selling commercially products that are built on trusted microelectronics production lines. The committee encourages the Secretary of Defense to work with Five Eyes partners, North Atlantic Treaty Organization (NATO) allies, and other allies to promote a shared secure microelectronics industrial base for secure 5G and other applications.

The committee believes that the standards and procurement preferences that the DOD develops for secure microelectronics products and services should be developed such that they are applicable for adoption by the Federal government, our allies, the carriers implementing 5G wireless networks, critical infrastructure, and other industrial sectors where security and trust are vital. The committee also encourages the Secretary of Defense to continue pursuing additional means to secure microelectronics. These include split fabrication approaches, design and engineering innovations to defeat theft and compromise, and other measures to achieve security on networks and using devices that are not trusted.

Technical correction to Global Research Watch Program (sec. 234)

The committee recommends a provision that makes a technical correction to section 2365 of title 10, United States Code.

Additional technology areas for expedited access to technical talent (sec. 235)

The committee recommends a provision that would add rapid prototyping and infrastructure resilience to the technical areas eligible for the rapid contracting processes authorized under section 217 of the National Defense Authorization Act for Fiscal Year 2018 (Public Law 115–91). The committee notes that these processes are intended to give Department of Defense (DOD) officials expedited access to world-class technical talent at universities, for the purposes of providing technical analyses, engineering support, and other expert services. The committee notes that the Nation’s universities have significant capacity to support the DOD in these ways, as a complement to their current robust efforts in basic research, and that many university faculty and staff already work with industry, including the defense industry, in these kinds of activities. Finally, the committee notes that the Secretary of Defense has yet to comply with the mandate to establish a contractual mechanism to execute the original provision. The committee directs the Under Secretary of Defense for Acquisition and Sustainment and the Under Secretary of Defense for Research and Engineering to jointly deliver an annotated briefing to the congressional defense committees on actions taken to comply with this mandate, no later than February 1, 2020.

Sense of the Senate and periodic briefings on the security and availability of fifth-generation (5G) wireless network technology and production (sec. 236)

The committee recommends a provision that would express the sense of the Senate on the importance of secure fifth-generation (5G) wireless networks for the Department of Defense. The provision would also include a requirement for the Secretary of Defense to provide quarterly briefings to the congressional defense committees on Department of Defense (DOD) activities to develop and utilize secure 5G wireless networking technology. The committee understands that utilization of secure 5G wireless networking technology will be critical to achieving future warfighting advantages. The committee is frustrated by the slow pace of DOD research and adoption of these technologies and encourages the DOD to brief the committee on all efforts underway to advance secure 5G wireless networks.

Transfer of Combating Terrorism Technical Support Office (sec. 237)

The committee recommends a provision that would require, not later than March 1, 2020, the transfer of responsibilities for the authority, direction, and control of the Combating Terrorism Technical Support Office (CTTSO) from the Assistant Secretary of Defense for Special Operations and Low-Intensity Conflict to the Under Secretary of Defense for Research and Engineering

(USD(R&E)). The committee believes that the mission of the CTTSO to “identify and develop capabilities to combat terrorism and irregular adversaries and to deliver these capabilities to Department of Defense components and interagency partners through rapid research and development” is better aligned with the mission and responsibilities of the USD(R&E). Additionally, the provision would require the Secretary of Defense to report on CTTSO’s efforts in relation to the implementation of the National Defense Strategy.

Briefing on cooperative defense technology programs and risks of technology transfer to China or Russia (sec. 238)

The committee recommends a provision that would require the Secretary of Defense, in consultation with the Director of National Intelligence, to provide a briefing to the congressional defense committees on cooperative defense technology programs of the Department of Defense and mitigation of the risk of technology transfer, relevant to these programs, to the People’s Republic of China or the Russian Federation.

Modification of authority for prizes for advanced technology achievements (sec. 239)

The committee recommends a provision that would authorize the office of the Under Secretary of Defense for Acquisition and Sustainment to award prizes as part of competitions to develop or demonstrate technologies relevant to defense missions. The committee notes the Defense Advanced Research Projects Agency’s and the Services’ successful use of these types of prize competitions, which have spurred the advancement of robotics, driverless cars, and cybersecurity technologies.

Use of funds for Strategic Environmental Research Program, Environmental Security Technical Certification Program, and Operational Energy Capability Improvement (sec. 240)

The committee recommends a provision that would require the Secretary of Defense to expend specific amounts appropriated for fiscal year 2020 for the Strategic Environmental Research Program, Operational Energy Capability Improvement, and Security Technical Certification Program.

Funding for the Sea-Launched Cruise Missile-Nuclear analysis of alternatives (sec. 241)

The committee recommends a provision that would increase the amount of funding available by \$5.0 million for the Department of the Navy’s analysis of alternatives regarding a nuclear sea-launched cruise missile (SLCM–N). The provision would also require the Secretary of Defense to create a program of record for the SLCM–N, a capability that could be carried by U.S. nuclear submarines in the future.

Review and assessment pertaining to transition of Department of Defense-originated dual-use technology (sec. 242)

The committee recommends a provision that would require the Under Secretary of Defense for Research and Engineering to conduct a review of the Department of Defense science and technology enterprise's intellectual property and strategy for awarding exclusive commercial rights to industry partners and submit a report summarizing the results of this review to the congressional defense committees no later than May 1, 2020. This review would study: the Department's intellectual property and commercialization rights management; the Department's efforts to promote the commercialization of DOD-funded research; the potential for prize-based research as an alternative to traditional research funding; and the potential of DOD's funding of basic and applied research for public use and without commercialization monopolies, akin to the Extramural Research Program of the National Institutes of Health, as an alternative to traditional research funding.

The committee understands that much of the Department of Defense's (DOD) science and technology investment and especially its basic research—for example, some of the Defense Advanced Research Projects Agency's cybersecurity research—is predicated on the transfer of DOD-originated dual-use technology to members of the defense industrial base and the broader commercial sector. The committee is also aware of a growing body of economics research on the frictions associated with intellectual property and exclusive commercialization monopolies.

Budget Items

Army

Defense research sciences for counter unmanned aerial vehicle research

The budget request included \$298.0 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 61102A defense research sciences.

The committee notes the importance of basic research in meeting long-term national security needs and supports increased counter-unmanned aircraft systems (UAS) university research. The committee is aware of the proliferation and increased capabilities of UAS, and research is needed to respond to this growing threat.

Therefore, the committee recommends an increase of \$5.0 million, for a total of \$303.0 million, in RDT&E, Army, for PE 61102A for basic research.

3D printing research

The budget request included \$86.2 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 61104A university and industry research centers.

The committee notes the importance of increased basic research for fundamental scientific knowledge related to long-term national security needs, and the committee supports increased research for 3D printing.

Therefore, the committee recommends an increase of \$2.0 million, for a total of \$88.2 million, in RDT&E, Army, for PE 61104A for 3D printing research.

Cyber Collaborative Research Alliance

The budget request included \$5.0 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 61121A Cyber Collaborative Research Alliance.

The committee notes the importance of cyber basic research and supports increased cyber collaboration with the Cyber Collaboration Research Alliance. The committee believes that long-term science and technology cyber research is critical to developing capabilities that will enable the warfighter to maintain dominance in cyberspace in the long run.

Therefore, the committee recommends an increase of \$5.0 million, for a total of \$10.0 million, in RDT&E, Army, for PE 61121A for cyber basic research.

Multi-Domain Task Force for the Indo-Pacific region

The budget request included \$115.3 million in Research, Development, Test, & Evaluation (RDT&E), Army, for PE62143A Soldier Lethality Technology.

The committee recommends an increase of \$3.0 million, for a total of \$118.3 million, for RDT&E, Army, for PE 62143A for camouflage, concealment, and deception materiel in support of the Multi-Domain Task Force for the Indo-Pacific region. This increase would support essential capabilities for Multi-Domain Operations-Pacific as described in the Chief of Staff of the Army's unfunded priorities list.

The committee supports the efforts of the Army and U.S. Indo-Pacific Command (INDOPACOM) to develop capabilities and operational concepts to maintain or restore the comparative military advantage of the United States in the Indo-Pacific region and to reduce the risk of executing contingency plans of the Department of Defense. As it develops, the Multi-Domain Task Force will have significant implications for force posture, force structure, and procurement priorities. Going forward, the committee urges the Department of the Army and INDOPACOM to keep the committee fully apprised of developments relating to activities associated with the Multi-Domain Task Force.

Advanced materials manufacturing processes

The budget request included \$35.2 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 62144A ground technology.

The committee is aware that advances in novel manufacturing could allow for the development of materials and components with superior properties and performance. The committee understands that the application of modeling tools in the development of new manufacturing techniques, such as additive manufacturing, could enable the production of new materials that provide increased strength, hardness, and ductility. These alloys could be useful in applications such as armor and would be a critical enabling technology that could increase warfighter protection.

Therefore, the committee recommends an increase of \$2.0 million in RDT&E, Army, for PE 62144A for advanced materials manufacturing processes research.

Biopolymer structural materials research

The budget request included \$35.2 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 62144A ground technologies.

The committee notes the importance of earthen structures to support force protection missions for deployed forces. To improve the protective capacities of these structures, reduce potential harmful medical impacts of many structural materials, and reduce costs of building and maintaining these structures, the committee notes the value of research in the use of soil microbiological systems and biopolymers to improve native soils for military earthen structures construction. This type of research is also consistent with the Department of Defense's emphasis on the importance of synthetic biology and biotechnology to defense missions.

Therefore, the committee recommends an increase of \$2.0 million in RDT&E, Army, for PE 62144A for applied research on biopolymer structural materials.

Advanced materials for infrastructure

The budget request included \$35.2 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 62144A for applied research on ground technology.

The committee notes the importance of biology research to meet long-term national security needs and supports increased research on cellulose structural materials that will improve Army force projection capabilities through the development and deployment of rapidly manufacturable, lightweight, and low-cost construction materials, structural systems, and bridging systems, including identification and characterization of materials that could be sourced locally during deployment.

Therefore, the committee recommends an increase of \$2.5 million in RDT&E, Army, for PE 62144A for research in cellulose nanocomposite-based structural materials for light weight, lower life cycle and logistics costs, and increased use of local materials to meet Army requirements.

Next Generation Combat Vehicle technology

The budget request included \$219.0 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 62145A Next Generation Combat Vehicle Technology.

The Department of Defense faces growing challenges in providing increasingly efficient operational energy, when and where it is needed to meet the demands of the National Defense Strategy. The committee understands that the Energy Storage and Power Systems incorporate composite flywheel-based technology and may address several energy objectives for the Army, such as: (1) Increased power efficiencies; (2) Maximized use of renewables; (3) Reduced system energy consumption with improved size, weight, and power; (4) Extended operational duration, reducing the need for energy re-supply; and (5) Enhanced environmental characteristics.

Therefore, the committee recommends an increase of \$15.0 million in RDT&E, Army, for PE 62145A.

Composite tube and propulsion research

The budget request included \$74.3 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 62147A long range precision fires technology.

The committee notes the need for improved artillery tubes and improved propulsion for 105mm and 155mm howitzers. The committee believes that research to develop technologies for lighter, shorter tubes could potentially support stronger propulsion and extend the range of projectiles in support of the National Defense Strategy.

Therefore, the committee recommends an increase of \$10.0 million in RDT&E, Army, for PE 62147A for composite tube and propulsion research.

Printed armament components

The budget request included \$74.3 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 62147A long range precision fires technology.

The committee is aware of continued investment in additive manufacturing technologies to rapidly design, prototype, and manufacture critical novel printed armaments components. These technologies could be used to print replacement parts, customizable grenades, and embedded electronics. The committee is encouraged by progress made toward the eventual goal of fully printing munitions on a single production line in an ammunition plant.

Therefore, the committee recommends an increase of \$2.0 million in RDT&E, Army, for PE 62147A for applied research in long range precision fires technology.

C3I Applied Cyber

The budget request included \$18.9 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 62213A C3I Applied Cyber.

The committee believes that long-term science and technology cyber research is critical to developing capabilities that will enable the warfighter to maintain dominance in cyberspace in the long run.

The committee recommends an increase of \$5.0 million, for a total of \$23.9 million, in RDT&E, Army, for PE 62213A for applied cyber research.

Female warfighter performance research

The budget request included \$99.2 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 62787A medical technologies.

The committee notes the importance of leveraging academic research to better understand the unique challenges facing the female warfighter. The committee notes that additional research and technology development must be conducted to optimize equipment, protective gear, medical treatments, and nutrition for female warfighters. The committee also notes that there is a lack of data

on female warfighter performance in previous studies, which for the most part only included males as research subjects—leaving servicewomen largely unresearched and yielding a gap in the scientific literature on female performance outcomes under different stresses.

Therefore, the committee recommends an increase of \$3.0 million, for a total of \$102.2 million, in RDT&E, Army, for PE 62787A for additional research on performance of the female warfighter,

Long duration battery storage

The budget request included \$12.1 billion in Research, Development, Test, and Evaluation (RDT&E), Army, of which \$66.1 million was for the PE 0603119A Ground Advanced Technology.

The committee believes that, in order to improve combat capability and resilience on installations, the Department of Defense must invest in and acquire on-site long duration battery storage for at least 100 hours, in the event of an intentional or unintentional power outage.

Accordingly, the committee recommends an increase of \$10.0 million in RDT&E, Army, for PE 0603119A for the development and eventual demonstration of a 100-hour battery for distributed energy assets.

Computational manufacturing engineering

The budget request included \$12.6 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 63119A for ground advanced technology.

The committee understands that defense components are often designed and manufactured with assumptions made about the environment in which they will be used. The committee notes that collecting data on these systems can be used to optimize their designs through the use of computational materials engineering software.

Therefore, the committee recommends an increase of \$2.0 million in RDT&E, Army, for PE 63119A for computational manufacturing engineering.

Lightweight protective and hardening materials research

The budget request included \$12.6 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 63119A ground advanced technology.

The committee understands the importance of conducting material development research to develop lightweight protective and hardening materials usable as either a standalone or composite protective element. These materials can be applied to a wide range of field conditions and environments.

Therefore, the committee recommends an increase of \$3.0 million in RDT&E, Army, for PE 63119A for increased research in lightweight protective and hardening materials.

Robotic construction research

The budget request included \$12.6 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 63119A ground advanced technology.

The committee is aware of the challenges in constructing expeditionary structures for the Department of Defense (DOD). The current methods for building structures on the battlefield present numerous challenges to ensuring warfighter safety, security, and efficiencies. The committee understands that development of a robotic arm and robotic vehicle could potentially allow larger structures to be built. Therefore, the committee supports an increase in robotic construction research.

Therefore, the committee recommends an increase of \$5.0 million in RDT&E, Army, for PE 63119A for robotic construction research.

Ground vehicle sustainment research

The budget request included \$160.0 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 63462A Next Generation Combat Vehicle Advanced Technology Development.

The committee notes the potential for using emerging additive manufacturing techniques for on-demand production of replacement parts, in both depot repair and deployed environments. The committee notes that more work remains to be done to improve these manufacturing techniques, understand the materials being produced by these techniques, and ensure that the materials meet all safety and reliability standards.

Therefore, the committee recommends an increase of \$5.0 million in RDT&E, Army, for PE 63462A for ground vehicle sustainment research on the use of additive manufacturing for advanced technology development.

Next generation combat vehicle advanced technology for fuel cell propulsion and autonomous driving control

The budget request included \$160.0 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 63462A Next Generation Combat Vehicle Advanced Technology.

The committee notes the importance of hydrogen fuel cell propulsion and autonomous driving control and encourages the Department of Defense to continue research in this area to maintain a military advantage.

Therefore, the committee recommends an increase of \$20.0 million in RDT&E, Army, for PE 63462A for advanced technology development in fuel cell propulsion and autonomous driving control.

Hypersonics testing research

The budget request included \$174.4 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 63464A long range precision fires advanced technology.

The committee notes that the development of hypersonics capabilities is a key element of the National Defense Strategy and represents an area of intense technological competition between the United States, People's Republic of China, and Russian Federation.

Therefore, the committee recommends an increase of \$4.0 million in RDT&E, Army, for PE 63464A for hypersonics research and testing.

Future Long Range Assault Aircraft (FLRAA)

The budget request included \$459.3 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 63801A Aviation Advanced Development, of which \$31.9 million is for the Future Long Range Assault Aircraft (FLRAA) and Capability Set 3 (CS3).

The Army also identified on the unfunded priority list a shortfall in funding of \$75.6 million for PE 63801A to accelerate the CS3 program.

The committee notes that the current acquisition strategy for FLRAA/CS3 represents a traditional approach; however, the committee understands that the Army is considering multiple courses of action to accelerate this program through the use of acquisition reform authorities. Further, the committee understands that the Army recently completed the Joint Multi-Role Technology Demonstration effort that successfully demonstrated several transformational vertical lift capabilities and technologies. As such, the committee believes that the Army should be in a position to reasonably accelerate the FLRAA/CS3 schedule and acquisition strategy.

Therefore, the committee recommends an increase of \$75.6 million in RDT&E, Army, for PE 63801A.

Hypersonic weapon system

The budget request included \$228.0 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 64182A Hypersonics. The Chief of Staff of the Army identified a shortfall in funding for this program in his unfunded priorities list.

Therefore, the committee recommends an increase of \$130.6 million in RDT&E, Army, for PE 64182A to accelerate the development of hypersonic weapon systems.

Next Generation Squad Weapon—Automatic Rifle

The budget request included \$106.1 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 64601A Infantry Support Weapons, of which \$33.1 million is for Next Generation Squad Weapon—Automatic Rifle.

The Army also identified a shortfall in funding of \$19.9 million for PE 64601A to fund rapid prototyping agreements on the unfunded priority list.

The committee acknowledges the need to improve close combat lethality in support of the National Defense Strategy and the need to field weapon systems that improve standoff, ballistics, and penetrating power.

Therefore, the committee recommends an increase of \$19.9 million in RDT&E, Army, for PE 64601A.

Integrated Personnel and Pay System—Army

The budget request included \$142.8 million in Research, Development, Test, & Evaluation (RDT&E), Army, for PE 65018A Integrated Personnel and Pay System—Army.

The committee is concerned about unjustified cost growth and poor business process reengineering.

Accordingly, the committee recommends a decrease of \$142.8 million, for a total of \$0.0 million, in RDT&E, Army, for PE 65018A.

Army contract writing system

The budget request included \$19.7 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 65047A Army Contract Writing System.

The committee remains concerned about duplication among the Services in contract writing systems.

Accordingly, the committee recommends a decrease of \$19.7 million, for a total of \$0.0 million, in RDT&E, Army, for PE 65047A.

Indirect Fire Protection Capability Increment 2

The budget request contained \$243.2 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 65052A Indirect Fire Protection Capability (IFPC) Increment 2—Block 1. Of this, \$73.2 million was requested to support the interim IFPC solution and \$39.3 million was proposed to support the enduring solution, in accordance with section 112 of the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Public Law 115–232).

The committee notes that, while the Army in February 2019 issued a letter of intent to procure two batteries of Iron Dome to meet the requirement articulated in section 112 of the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Public Law 115–232) for an interim cruise missile defense capability, this decision was predicated on submission and approval of an above threshold reprogramming (ATR) by mid-April 2019. Because of the delay in submission of the ATR to the congressional defense committees, the committee is concerned that the Army will be unable meet the statutory requirement for interim base defense. Therefore, the committee recommends a realignment elsewhere in this report that would support procurement of two Iron Dome batteries with fiscal year 2020 funds. The committee notes that, should the ATR be fully approved before the end of fiscal year 2019, this realignment would no longer be necessary.

Accordingly, the committee recommends an increase of \$20.6 million in RDT&E, Army, for PE 65052A for IFPC Increment 2 for Iron Dome testing and delivery.

Indirect Fire Protection Capability Increment 2 EMAM

The budget request included \$243.2 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 65052A Indirect Fire Protection Capability (IFPC) Increment 2—Block 1. The request includes \$124.2 million for the development of the Expanded Mission Area Missile interceptor. The committee believes that funds for the development of the interceptor, before a defined solution for the enduring IFPC Increment 2 is selected, are ahead of need.

Therefore, the committee recommends a decrease of \$124.2 million in RDT&E, Army, for PE 65052A.

Multi-Domain Artillery

The budget request included \$243.2 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 65052A Indirect Fire Protection Capability (IFPC) Increment 2—Block 1. The

Chief of Staff of the Army requested funding for Multi-Domain Artillery in his unfunded priorities list.

The committee supports the efforts of the Army and U.S. Indo-Pacific Command (INDOPACOM) to develop capabilities and operational concepts to maintain or restore the comparative military advantage of the United States in the Indo-Pacific region and to reduce the risk of executing contingency plans of the Department of Defense. As it develops, the command's Multi-Domain Task Force will have significant implications for force posture, force structure, and procurement priorities. Going forward, the committee urges the Department of the Army and INDOPACOM to keep the committee fully apprised of developments relating to activities associated with the Multi-Domain Task Force.

Therefore, the committee recommends an increase of \$10.0 million in RDT&E, Army, for PE 65052A for multi-domain artillery.

Ground Robotics Squad Multipurpose Equipment Transport (S-MET)

The budget request included \$41.3 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 65053A Ground Robotics, Squad Multipurpose Equipment Transport (S-MET).

The Army has requested a zero sum realignment of \$12.8 million from PE 65053A within RDT&E, Army, for S-MET to line 138 of Other Procurement, Army (OPA).

Therefore, the committee recommends a decrease of \$12.8 million in RDT&E, Army, for PE 65053A.

Next Generation Combat Vehicle 50mm gun

The budget request included \$378.4 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 65625A Manned Ground Vehicle.

The Army also identified a shortfall in funding of \$40.0 million in RDT&E, Army, for PE 65625A on the unfunded priority list for the procurement of 15 XM-913 weapon systems (50mm gun, ammunition handling system, and fire control hardware).

The committee acknowledges the need to improve lethality for the Next Generation Combat Vehicle to retain overmatch in support of the National Defense Strategy and the need to field weapon systems that improve standoff and survivability.

Therefore, the committee recommends an increase of \$40.0 million in RDT&E, Army, for PE 65625A for 50mm gun upgrades.

Joint Light Tactical Vehicle

The budget request included \$2.7 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 65812A Joint Light Tactical Vehicle (JLTV) Engineering and Manufacturing Development.

The Army has requested a zero sum realignment of \$4.5 million from line number 6 of Other Procurement, Army (OPA), to PE 65812A in RDT&E, Army.

Therefore, the committee recommends an increase of \$4.5 million in RDT&E, Army, for PE 65812A.

Cybersecurity threat simulation research

The budget request included \$14.1 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 64256A Threat Simulator Development.

The committee notes the importance of cybersecurity to long-term national security needs and supports increased research in cybersecurity threat simulation to model emerging and proliferating threats to weapons systems and networks.

Therefore, the committee recommends an increase of \$2.0 million in RDT&E, Army, for PE 64256A.

Directed energy test capabilities

The budget request included \$334.5 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 65601A Army Test Ranges and Facilities.

The committee notes that directed energy is a key technology for the implementation of the National Defense Strategy. The committee further notes that the FY 2018–FY 2028 Strategic Plan for DOD T&E Resources indicated that the demand for directed energy test capabilities will soon expand from demand for testing to address specific objectives of laboratory demonstrations to demand for testing to address requirements for validating a weapon system for operational use. The plan also indicated that past and projected activities point to the necessity for growth in directed energy test capability and workforce and called for increased collaboration across the directed energy technology development and test communities.

Accordingly, the committee recommends an increase of \$15.0 million in RDT&E, Army, for PE 65601A to fund directed energy test range capabilities.

CD ATACMS

The budget request included no funding in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 23802A Other Missile Product Improvement Programs.

The committee notes that the Chief of Staff of the Army requested funding in his unfunded priorities list for Cross-Domain Army Tactical Missile Systems (CD ATACMS).

Therefore, the committee recommends an increase of \$24.1 million in RDT&E, Army, for PE 23802A for the CD ATACMS.

Nanoscale materials manufacturing

The budget request included \$59.8 million in Research, Development, Test, and Evaluation (RDT&E), Army, for PE 78045A End Item Industrial Preparedness Activities to support Army manufacturing technology activities.

The committee notes that the government-wide National Nanotechnology Initiative (NNI), which includes the Department of Defense, has highlighted that nanotechnology research, and the eventual nanomanufacturing of products, requires advanced and often very expensive equipment and facilities. Further the NNI program has indicated that, in order to realize the potential of nanotechnology, agencies should invest heavily in nanomanufacturing research and infrastructure.

Accordingly, the committee recommends an increase of \$3.0 million in RDT&E, Army, for PE 78045A to increase Army efforts in developing nanoscale materials manufacturing capabilities.

Navy

University Research Initiatives

The budget request included \$116.9 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 61103N University Research Initiatives.

The committee notes the importance of basic research in supporting long-term national security needs and supports increasing cyber basic research. The committee believes that long-term science and technology cyber research is critical to developing capabilities that will enable the warfighter to maintain dominance in cyberspace in the long run.

Therefore, the committee recommends an increase of \$10.0 million, for a total of \$126.9 million, in RDT&E, Navy, for PE 61103N for basic research.

Carbon capture increase

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$119.5 million was for PE 62123N Force Protection Applied Research.

The committee notes that elsewhere in this Act the committee recommends a provision that requires the Secretary of Defense, in coordination with the Secretary of Homeland Security, the Secretary of Energy, and the heads of such other Federal agencies as the Secretary of Defense considers appropriate, to carry out a program on research, development, testing, evaluation, study, and demonstration of technologies related to blue carbon capture and direct air capture.

Accordingly, the committee recommends an increase of \$8.0 million in RDT&E, Navy, for PE 62123N for electric propulsion research for carbon capture.

Electric propulsion research

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$119.5 million was for PE 62123N Force Protection Applied Research.

The committee supports increased electronic propulsion research to support the Navy's emerging need to align platform electric power systems with mission systems development and to address the importance of energy management and storage as part of integrated power and energy systems solutions for naval ships and vessels.

Therefore, the committee recommends an increase of \$2.5 million in RDT&E, Navy, for PE 62123N for electric propulsion research.

Energy resilience research

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$119.5 million was for PE 62123N Force Protection Applied Research.

The committee notes that, as the Navy develops and fields increasing numbers of high-power sensors and weapon systems, the importance of the energy resilience of these systems continues to increase. Energy resilient systems will improve performance, reduce costs, and reduce logistical burdens on operational forces.

Therefore, the committee recommends an increase of \$3.0 million in RDT&E, Navy, for PE 62123N for energy resilience research.

Force protection applied research

The budget request included \$119.5 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 62123N Force Protection Applied Research.

The committee supports a program reduction to increase coordination of activities in material research across the Department of Defense to reduce duplication of effort.

Therefore, the committee recommends a decrease of \$5.0 million in RDT&E, Navy, for PE 62123N.

Test bed for autonomous ship systems

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$119.5 million was for PE 62123N Force Protection Applied Research.

The committee understands that autonomous naval vessels could be required to operate for more than a month between performances of human-assisted maintenance. As a result, the machinery on such vessels must be robust, resilient, and reliable, requiring the ability to avoid failures, repair damage, and redirect systems as needed.

Accordingly, the committee recommends an increase of \$8.0 million in RDT&E, Navy, for PE 62123N.

Interdisciplinary cyber research

The budget request included \$56.6 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 62131M Marine Corps Landing Force Technology.

The committee notes the importance of cybersecurity to long-term national security needs and supports increased interdisciplinary cybersecurity research. The committee believes that long-term science and technology cyber research is critical for developing capabilities that will enable the warfighter to maintain dominance in cyberspace in the long run.

Therefore, the committee recommends an increase of \$3.0 million, for a total of \$59.6 million, in RDT&E, Navy, for PE 62131M for interdisciplinary cyber research.

Common picture applied research

The budget request included \$49.3 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 62235N Common Picture Applied Research.

The committee supports a program reduction in common picture applied research and encourages the Navy to increase coordination of space activities with other research activities throughout the Department of Defense.

Therefore, the committee recommends a decrease of \$5.0 million, for a total of \$44.3 million, in RDT&E, Navy, for PE 62235N.

Applied warfighter safety and performance research

The budget request included \$63.8 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 62236N Warfighter Sustainment Applied Research.

The committee notes the importance of warfighter safety and performance research in enhancing the individual performance of elite operators under adverse and extreme conditions. The committee is aware that research to study and mitigate the effects of stresses to human safety, performance, and resilience, especially undersea, will result in better care for warfighters conducting missions that require exposure to extreme environments. The committee supports increased research to address undersea diving stresses, including: pressure extremes, extended low temperature exposure, neurologic dysfunction, and chemical and oxygen toxicity. Therefore, the committee recommends an increase of \$2.0 million, for a total of \$65.8 million, in RDT&E, Navy, for PE 62236N for applied warfighter safety and performance research.

Electromagnetic systems applied research

The budget request included \$83.5 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 62271N Electromagnetic Systems Applied Research.

The committee supports a program reduction in electromagnetic systems applied research and encourages the Navy to increase coordination in electronic warfare activities with the rest of the Department of Defense's related activities to reduce duplication of effort.

Therefore, the committee recommends a decrease of \$5.0 million, for a total of \$78.5 million, in RDT&E, Navy, for PE 62271N.

Navy industry-university undersea vehicle technologies

The budget request included \$57.1 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 62747N Undersea Warfare Applied Research.

The committee notes that the Center for Strategic and Budgetary Assessment's recent report titled "The Emerging Era In Undersea Warfare" noted that "America's superiority in undersea warfare is the product of decades of research and development (R&D), a sophisticated defense industrial base, operational experience, and high-fidelity training. This superiority, however, is far from assured." The committee notes the importance of industry-university partnerships and recognizes their valuable role in advancing undersea vehicle technology to support undersea warfare capabilities. Therefore, the committee recommends an increase of \$7.5 million, for a total of \$64.6 million, in RDT&E, Navy, for PE 62747N for university-industry partnerships in applied research to support undersea warfare capabilities.

USMC Advanced Technology Demonstration (ATD)

The budget request included \$172.8 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 63640M United States Marine Corps Advanced Technology Demonstration.

The committee supports a program reduction in order to consolidate efforts in artificial intelligence, machine learning, and similar areas in which separate research and development activities are occurring across the Services and to ensure coordination and reduce duplication of effort across the Department of Defense.

The committee recommends a decrease of \$5.0 million in RDT&E, Navy, for PE 63640M.

Mobile Unmanned/Manned Distributed Lethality Airborne Network

The budget request included \$172.8 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 63640M United States Marine Corps Advanced Technology Demonstration.

The committee supports the development of capabilities to further the ability of aircraft, sensors, and command and control assets to share information and recognizes that the mobile un-

manned/manned distributed lethality airborne network, one such capability, is listed on the Chief of Naval Operations' unfunded priority list. The committee is concerned that the lack of funding in fiscal year 2020 will delay the development of an objective system.

Therefore, the committee recommends an increase of \$9.0 million in RDT&E, Navy, for PE 63640M for the continued maturation and development of the mobile unmanned/manned distributed lethality airborne network.

Innovative Naval Prototypes (INP) advance technology development

The budget request included \$133.3 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 63801N Innovative Naval Prototypes advance technology development.

The committee supports a program reduction in innovative naval prototype development in the area of electronic maneuver and encourages continued coordination of these efforts across the Department of Defense.

Therefore, the committee recommends a decrease of \$5.0 million, for a total of \$127.3 million, in RDT&E, Navy, for PE 63801N for naval prototype development in the area of electronic maneuver.

Littoral battlespace sensing autonomous undersea vehicle

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$32.6 million was for PE 63207N Air and Ocean Tactical Applications.

The committee understands that additional funding could provide for the procurement of 1 additional REMUS 600 littoral battlespace sensing autonomous undersea vehicle, which would accelerate the achievement of Navy inventory goals.

Accordingly, the committee recommends an increase of \$6.0 million, for a total of \$38.6 million, in RDT&E, Navy, for PE 63207N.

Large unmanned surface vessels

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$507.0 million was for PE 63502N Surface and Shallow Water Mine Countermeasures.

The committee notes that the budget request for this program element provides for the prototyping and testing of Large Unmanned Surface Vessels (LUSV), including procurement of two additional LUSVs in conjunction with a Strategic Capabilities Office (SCO) initiative, in project 3066. The committee understands that the two LUSVs procured by the SCO beginning in fiscal year 2018, at a cost of \$237 million, are sufficient to achieve the objectives of the SCO initiative, which is scheduled to be completed in the fourth quarter of fiscal year 2021.

The committee is concerned that the budget request's concurrent approach to LUSV design, technology development, and integration as well as a limited understanding of the LUSV concept of employment, requirements, and reliability for envisioned missions pose excessive acquisition risk for additional LUSV procurement in fiscal year 2020. The committee is also concerned by the unclear policy implications of LUSVs, including ill-defined international unmanned surface vessel standards and the legal status of armed or potentially armed LUSVs.

Additionally, the committee notes that the Navy's "Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020" acknowledges similar issues: "Unmanned and optionally-manned systems are not accounted for in the overall battle force[.] . . . The physical challenges of extended operations at sea across the spectrum of competition and conflict, the concepts of operations for these platforms, and the policy challenges associated with employing deadly force from autonomous vehicles must be well understood prior to replacing accountable battle force ships."

The committee believes that further procurement of LUSVs should occur only after the lessons learned from the current SCO initiative have been incorporated into the next solicitation to enable incremental risk reduction.

In addition, the committee believes that the LUSV program, which appears likely to exceed the Major Defense Acquisition Program cost threshold, would benefit from a more rigorous requirements definition process, analysis of alternatives, and deliberate acquisition strategy.

Accordingly, the committee recommends a decrease of \$372.5 million, for a total of \$134.5 million, in RDT&E, Navy, for PE 63502N.

Advanced submarine system development

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$148.8 million was for PE 63561N Advanced Submarine System Development.

The committee understands that emergent repairs are needed at the Acoustic Research Detachment located in Bayview, Idaho, to prevent delays in critical test programs.

Accordingly, the committee recommends an increase of \$5.0 million, for a total of \$153.8 million, in RDT&E, Navy, for PE 63561N.

Large Surface Combatant concept advanced design

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$81.8 million was for PE 63563N Ship Concept Advanced Design.

The committee notes that the Chief of Naval Operations stated in March 2019, referring to the next Large Surface Combatant (LSC) class of ships, that the “. . . first question that we have to do is prove to ourselves that we need a large surface combatant. What is the unique contribution of something like that in the face of all these emerging technologies? Right now the discussions point to the fact that it brings a unique capability in terms of hous[ing] larger types of weapons, larger missiles; you certainly get more aperture on a bigger sensor[.]”

Given the uncertain requirements for the next LSC class of ships and the lack of clarity on the new systems under consideration for such class, including the associated technical maturity of such systems, the committee believes that funding design efforts for a new LSC class is early to need.

The committee urges the Navy to identify capability gaps, set LSC requirements, and engage in robust component-level prototyping of potential new critical systems, including those related to propulsion, electrical distribution, radar, and missile launching systems, prior to initiating LSC design efforts.

Accordingly, the committee recommends a decrease of \$24.0 million, for a total of \$57.8 million, in RDT&E, Navy, for PE 63563N.

Large Surface Combatant preliminary design

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$69.1 million was for PE 63564N Ship Preliminary Design and Feasibility Studies.

The committee notes that the Chief of Naval Operations stated in March 2019, referring to the next Large Surface Combatant (LSC) class of ships, that the “. . . first question that we have to do is prove to ourselves that we need a large surface combatant. What is the unique contribution of something like that in the face of all these emerging technologies? Right now the discussions point to the fact that it brings a unique capability in terms of hous[ing] larger types of weapons, larger missiles; you certainly get more aperture on a bigger sensor[.]”

Given the uncertain requirements for the next LSC class of ships and the lack of clarity on the new systems under consideration for such class, including the associated technical maturity of such systems, the committee believes that funding design efforts for a new LSC class is early to need.

The committee urges the Navy to identify capability gaps, set LSC requirements, and engage in robust component-level prototyping of potential new critical systems, including those related to propulsion, electrical distribution, radar, and missile launching systems, prior to initiating LSC design efforts.

Accordingly, the committee recommends a decrease of \$46.6 million, for a total of \$22.5 million, in RDT&E, Navy, for PE 63564N.

Advanced surface machinery system component prototyping

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$25.4 million was for PE 63573N Advanced Surface Machinery Systems.

The committee notes the Chief of Naval Operations stated in March 2019, referring to the next Large Surface Combatant (LSC) class of ships, that the “. . . first question that we have to do is prove to ourselves that we need a large surface combatant. What is the unique contribution of something like that in the face of all these emerging technologies? Right now the discussions point to the fact that it brings a unique capability in terms of hous[ing] larger types of weapons, larger missiles; you certainly get more aperture on a bigger sensor[.]”

In addition, in testimony before the Subcommittee on Seapower on March 27, 2019, the Assistant Secretary of the Navy for Research, Development, and Acquisition stated in response to a question related to actions necessary to improve acquisition performance on lead ships, “The second piece is really improved sub-system prototyping like we have done on *Columbia*. Try and get everything prototyped as soon as we can. [The Navy] learn[ed] some lessons on *Ford* by not having land-based prototypes for all the sub-systems.” The committee supports the Assistant Secretary’s intent to improve sub-system prototyping well in advance of difficult-to-reverse ship design decision points.

The committee urges the Navy to identify capability gaps, set LSC requirements, and engage in robust component-level prototyping of potential new critical systems, including those related to propulsion, electrical distribution, radar, and missile launching systems, prior to initiating LSC design efforts.

Accordingly, the committee recommends an increase of \$125.0 million, for a total of \$150.4 million, in RDT&E, Navy, for PE 63573N for advanced surface machinery system component prototyping.

Columbia-class submarines

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$419.1 million was for PE 63595N *Columbia*-class submarines.

The committee understands that additional funding could enable reductions in the production time and cost of propulsor components for *Columbia*-class submarines through development of composites technology.

Accordingly, the committee recommends an increase of \$15.0 million, for a total of \$434.1 million, in RDT&E, Navy, for PE 63595N.

Littoral Combat Ship mission modules

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$108.5 million was for PE 63596N Littoral Combat Ship (LCS) mission modules.

The committee notes that an operational testing period of the surface warfare mission package was delayed from fiscal year 2018 to fiscal year 2019.

Accordingly, the committee recommends a decrease of \$5.0 million, for a total of \$103.5 million, in RDT&E, Navy, for PE 63596N for LCS mission modules.

U.S. Marine Corps Additive Manufacturing Logistics Software Pilot Program

The budget request included \$4.4 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 64289M Next Generation Logistics.

The committee notes that the U.S. Marine Corps (USMC) has fielded 165 3D Printers, 5 metal printers, and 1 prototype concrete printer across the fleet and is seeing great benefit from their use through innovative programs like Marine Maker. However, the digital infrastructure to create, support, document, and provide a digital thread, digital twin, and augmented reality capability for the parts being manufactured and used is non-existent. The USMC needs an Additive Manufacturing Logistics Software Pilot Program and formally highlighted this need in its unfunded priorities list. The pilot program would use commercial-off-the-shelf software and services to support several use cases and lay the groundwork for providing the digital infrastructure for all USMC next generation additive manufacturing activities. Funding would cover government costs, software procurement, and services support work at multiple US locations.

The committee recommends an increase of \$9.0 million, for a total of \$13.4 million, in RDT&E, Navy, for PE 64289M to fund the USMC Additive Manufacturing Logistics Software Pilot Program.

Nuclear sea-launched cruise missile

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$19.7 million was for PE 64659N for the Precision Strike Weapon Development Program. Of this, \$5.0 million was designated for a nuclear sea-launched cruise missile analysis of alternatives (AoA).

The committee recommends an increase of \$5.0 million for this AoA, for a total of \$24.7 million in RDT&E, Navy, for PE 64659N.

V-22 nacelle improvement program

The budget request included \$185.5 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 64262N for the V-22.

The committee recognizes the importance of the Common Configuration-Readiness and Modernization (CC-RAM) nacelle improvement program for better reliability and commonality across the fleet of V-22s. Reduced vibrations in nacelles decreases maintenance degraders and costs while increasing readiness rates. The committee encourages the Navy and Marine Corps to test, develop, and incorporate active vibration control systems for the V-22 nacelles as part of the overall nacelle improvement program.

Therefore, the committee recommends an increase of \$5.5 million in RDT&E, Navy, for PE 64262N for nacelle improvements on the V-22.

Mine Development—Quickstrike JDAM ER

The budget request included \$29.0 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 64601N Mine Development. The Chief of Naval Operations requested funding in his unfunded priorities list for the Quickstrike Joint Direct Attack Munition Extended Range (JDAM ER).

Therefore, the committee recommends an increase of \$71.3 million in RDT&E, Navy, for PE 64601N for the Quickstrike JDAM ER.

Information Technology Development

The budget request included \$384.2 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 65013N Information Technology Development, including \$55.4 million for Electronic Procurement System.

The committee is concerned about developing unnecessarily bespoke contract writing systems and processes.

Accordingly, the committee recommends a decrease of \$55.4 million in RDT&E, Navy, for PE 65013N.

CH-53K King Stallion program

The budget request included \$517.0 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 65212M CH-53K RDTE.

The committee recognizes that the U.S. Marine Corps validated a requirement for heavy-lift expeditionary rotary wing aviation to support ship-to-shore, shore-to-shore, and shore-to-ship movement of personnel and equipment. The committee recently approved an above-threshold reprogramming request for additional funding to continue developmental testing external to the fiscal year 2020 budgeting cycle.

Therefore, the committee recommends a decrease of \$10.0 million in RDT&E, Navy, for PE 65212M.

Ship to Shore Connector

The budget request included \$20.3 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$4.9 million was for PE 65220N Ship to Shore Connector.

The committee understands that additional funding could enable quality improvements and cost reductions in the Ship to Shore Connector and Landing Craft Air Cushioned programs through expanded development and use of composite materials.

Accordingly, the committee recommends an increase of \$15.0 million, for a total of \$19.9 million, in RDT&E, Navy, for PE 65220N.

Transformational Reliable Acoustic Path Systems

The budget request included \$20.4 billion in Research, Development, Test, and Evaluation (RDT&E), Navy, of which \$88.4 million was requested for PE 24311N Integrated Surveillance System.

The committee notes that, since fiscal year 2015, the Navy has utilized Transformational Reliable Acoustic Path Systems (TRAPS) in anti-submarine warfare missions. The committee understands that these deployable systems have performed satisfactorily and comprise a critical element of the Navy's overall integrated under-sea surveillance system. The committee is concerned that capability or capacity gaps may result if additional TRAPS units are not procured in fiscal year 2020.

Accordingly, the committee recommends an increase of \$15.0 million, for a total of \$103.4 million, in RDT&E, Navy, for PE 24311N for TRAPS.

Intelligent Power Management Systems

The budget request included \$37.8 million in Research, Development, Test, and Evaluation (RDT&E), Navy, for PE 26624M Marine Corps Combat Services Support, of which \$3.0 million is for Marine Air Ground Task Force (MAGTF) Combat Service Support Element & Supporting Establishment (CSSE & SE).

The committee recognizes the need for the Marine Corps to reduce logistical requirements in forward deployed areas. Intelligent Power Management Systems (IPMS) provide a robust, modular, and scalable solution to interconnect, control, store, and distribute power from various sources. As a result, with IPMS, power requirements will be met in a more efficient manner by matching power production to load demand, reducing spinning reserve, extending maintenance cycle times, and reducing fuel consumption.

Therefore, the committee recommends an increase of \$5.0 million in RDT&E, Navy, for PE 26624M for MAGTF CSSE & SE.

Air Force

High energy X-ray materials structures research

The budget request included \$128.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 62102F applied research in advanced materials.

The committee notes the importance of advanced materials high energy X-ray research for better understanding the characteristics and performance of advanced materials and structures for Air Force missions, including high temperature engine materials, advanced sensors, and aerodynamic systems. The committee notes that the Department of Defense would benefit from leveraging National Science Federation and Department of Energy investments in facilities to support Air Force research needs.

Therefore, the committee recommends an increase of \$4.0 million in RDT&E, Air Force, for PE 62102F for high energy x-ray materials structures research.

Materials research

The budget request included \$128.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 62102F applied research in materials.

The committee notes that there is duplicative funding for material research within the budget request and encourages increased coordination within the Department of Defense.

Therefore, the committee recommends a decrease of \$10.0 million in RDT&E, Air Force, for PE 62102F.

Aerospace Vehicle Technologies

The budget request included \$147.7 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 62201F aerospace vehicle technologies.

The committee believes that the increase of these activities is not fully aligned with other efforts and supports a reduction in program growth for aerospace vehicle technologies.

The committee recommends a decrease of \$10.0 million in RDT&E, Air Force, for PE 62201F.

Counter unmanned aerial systems research

The budget request included \$181.7 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 62788F dominant information sciences and methods.

The committee notes that counter-swarm capabilities are becoming more critical for Department of Defense (DOD) force protection. Currently, various development and acquisition activities are underway to counter the swarming unmanned aircraft systems (UAS) threat, and DOD entities are currently testing several potential system solutions, but, to date, no approach provides a complete answer to the threat. The committee further notes the importance of increased cyber research and supports increasing cyber and communications research to support counter-UAS capabilities.

Therefore, the committee recommends an increase of \$2.5 million in RDT&E, Air Force, for PE 62788F for counter-UAS research.

Cyberspace dominance technology research

The budget request included \$181.6 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 62788F dominant information sciences and methods.

The committee notes the importance of increased support for academic cyber institutes to meet long-term national security needs in support of the National Defense Strategy. The committee believes that long-term science and technology cyber research is critical to developing capabilities that will enable the warfighter to maintain dominance in cyberspace in the long run. The committee also understands that the Department of Defense requires technologies to deliver a full range of options in cyberspace, akin to its current air and sea dominance programs, to achieve cyber dominance.

Therefore, the committee recommends an increase of \$10.0 million in RDT&E, Air Force, for PE 62788F for research in cyberspace dominance technology research.

Quantum science research

The budget request included \$181.6 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 62788F dominant information sciences and methods.

The committee notes the importance of quantum science research for the implementation of the National Defense Strategy and in the priorities of the Under Secretary of Defense for Research and Engineering. This technical area shows great promise in enhancing de-

fense capabilities in communications, computing, cryptography, and countless other areas. The committee notes that there is a global competition for preeminence in this emerging field.

Therefore, the committee recommends an increase of \$5.0 million in RDT&E, Air Force, for PE 62788F for quantum science research.

High power microwave research

The budget request included \$44.2 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 62890F High Energy Laser Research.

The committee supports increased research in high power microwaves as an element of an emerging set of directed energy technologies that support the National Defense Strategy and the priorities of the Under Secretary of Defense for Research and Engineering. High powered microwave capabilities could defeat adversary electronics systems and create other battlefield effects.

Therefore, the committee recommends an increase of \$5.0 million in RDT&E, Air Force, for PE 62890F for additional high powered microwave research.

Metals affordability research

The budget request included \$36.6 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63112F Advanced Materials for Weapon Systems.

The committee notes that the Metals Affordability Initiative is a collaborative effort, which includes the entire domestic specialty aerospace metals industrial manufacturing base, to ensure the continued advancement of metals technologies for the defense and commercial sectors and continues to grow a robust and responsive aerospace metals domestic supply base that provides critical turbine engine, airframe, and space components at lower cost and with shortened production lead times.

Therefore, the committee recommends an increase of \$2.0 million, for a total of \$38.6 million, in RDT&E, Air Force, for PE 63112F for metals affordability research.

Acceleration of development of hypersonic quick reaction capability and hypersonic airbreathing weapon

The budget request included \$102.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63211F Aerospace Technology Development/Demonstration.

The committee notes that the development of hypersonics capabilities is a key element of the National Defense Strategy and represents an area of intense technological competition between the United States, People's Republic of China, and Russian Federation. The committee is encouraged by and supportive of the Air Force's activities in hypersonic weapons.

However, the committee is concerned that there is a lack of focus on air-launched and air-breathing hypersonic capability inside the Department of Defense. Therefore, the committee recommends an increase of \$75.0 million in RDT&E, Air Force, for PE 63211F for the continued development and transition of the Hypersonic Air Breathing Weapons Concept.

Shape morphing aircraft structures development

The budget request included \$102.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63211F Aerospace Technology Development/Demonstrations.

The committee notes ongoing research that supports the design and manufacture of shape-morphing aircraft control surfaces, including wings, winglets, inlets, and stabilizers that have demonstrated reduced drag, increased fuel savings, and decreased maintenance requirements for Air Force platforms. The committee believes that research in this area will support improving the performance of and reducing operational and life cycle costs for air platforms.

Therefore, the committee recommends an increase of \$5.0 million in RDT&E, Air Force, for PE 63211F for research in shape morphing materials for active winglets.

Combat Search and Rescue advanced prototyping

The budget request included \$102.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63211F Aerospace Technology Development/Demonstration.

The committee supports the Chief of Staff of the Air Force's request for additional funds for a high speed vertical lift demonstration, such as Agility Prime, to prove the employment of non-runway jet operations in a contested environment, which could be crucial to the Air Force's ability to develop a lethal, agile, and resilient force posture and employment.

Therefore, the committee recommends an increase of \$25.0 million in RDT&E, Air Force, for PE 63211F for the continued development of Agility Prime.

Low Cost Attributable Aircraft Technology

The budget request included \$102.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63211F Aerospace Technology Development/Demonstration.

The committee supports the Assistant Secretary of the Air Force for Acquisition, Technology, and Logistics' intent to accelerate the Air Force Research Laboratory's Low-Cost Attributable Aircraft Technology (LCAAT) program for collaborative pairing with manned platforms, potentially including the F-35. The committee views the combined application of commercial technology, autonomy, and artificial intelligence as an innovative solution to meeting the demands of the National Defense Strategy.

Therefore, the committee recommends an increase of \$100.0 million in RDT&E, Air Force, for PE 63211F for the continued development and transition of the LCAAT.

Aerospace propulsion and power technology

The budget request included \$114.0 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63216F Aerospace Propulsion and Power Technology.

The committee understands the importance of developing and demonstrating core engine technologies for small turbines used in current and future aircraft, missile, and remotely piloted aircraft propulsion systems. The committee believes that improved tech-

nologies in this area could reduce cost, improve mission flexibility, and increase aircraft range.

Therefore, the committee recommends an increase of \$10.0 million, for a total of \$124.0 million, in RDT&E, Air Force, for PE 63216F.

Electronic combat technology

The budget request included \$48.4 million for Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63270F Electronic Combat Technology.

The committee notes that there is duplicative electronic warfare and positioning, navigation, and timing research being performed across the Department of Defense and encourages increased coordination to reduce duplication of effort.

Therefore, the committee recommends a decrease of \$10.0 million, for a total of \$38.4 million, in RDT&E, Air Force, for PE 63270F.

Advanced spacecraft technology

The budget request included \$70.5 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63401F Advanced Spacecraft Technology.

The committee understands that the Department of Defense (DOD) relies extensively on weapons and communication systems that must operate in environments with high levels of ambient radiation. The committee notes a lack of commercially available technologies that meet these requirements and also notes the importance of DOD research on strategic radiation hardened microelectronic processors.

Therefore, the committee recommends an increase of \$3.0 million, for a total of \$73.5 million, in RDT&E, Air Force, for PE 63401F for advanced research on radiation-tolerant systems.

Advanced materials and materials manufacturing

The budget request included \$43.1 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63680F Manufacturing Technology Program.

The committee notes the importance of supporting mitigations for industrial base vulnerabilities, including those identified in the September 2018 Department of Defense report titled “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States” and the August 2018 MITRE Corporation report titled “Deliver Uncompromised: A Strategy for Supply Chain Security and Resilience in Response to the Changing Character of War.” The committee notes that strong partnerships between academia and the aerospace industry can support original equipment manufacturers with research and development in advanced materials.

Accordingly, the committee recommends an increase of \$7.0 million in RDT&E, Air Force, for PE 63680F.

Battlespace knowledge and development demonstration

The budget request included \$56.4 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 63788F Battlespace Knowledge Development and Demonstration.

The committee notes the importance of increased cyber applied research and supports increasing cyber and command and control research. The committee believes that long-term science and technology cyber research is critical to developing capabilities that will enable the warfighter to maintain dominance in cyberspace in the long run.

Therefore, the committee recommends an increase of \$10.0 million, for a total of \$64.4 million, in RDT&E, Air Force, for PE 63788F for increased cyber applied research.

M-Code acceleration—advanced component development & prototypes

The budget request included \$92.6 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 64201F Positioning, Navigation, and Timing Resiliency, Modifications, and Improvements.

The committee understands the importance of the ability of the Global Positioning System (GPS) to provide resilient position, navigation, and timing capability to the Joint Force and acknowledges GPS Military-Code receiver development's presence on the Chief of Staff of the Air Force's unfunded priorities list.

Accordingly, the committee recommends an increase of \$32.0 million in RDT&E, Air Force, for PE 64201F for Embedded GPS/Inertial Navigation System modernization.

Rapid repair and sustainability increase

The budget request included \$128.5 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 64858F Tech Transition Program.

The committee notes that advanced repair and qualification processes can repair parts damaged, worn, or corroded in service without introducing undesirable distortion. The committee further notes that additional funds are needed to establish a means to qualify repair components to increase readiness by bringing systems back into service faster.

Accordingly, the committee recommends an increase of \$6.0 million in RDT&E, Air Force, for PE 64858F for rapid repair and sustainability.

Ground-Based Strategic Deterrent

The budget request included \$570.4 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 65230F Ground-Based Strategic Deterrent (GBSD).

The committee understands that the Air Force has chosen to consolidate an existing program into a similar element of the GBSD and that this approach will reduce risk and may save \$850 million across the life of the programs.

Accordingly, the committee recommends an increase of \$22.0 million in RDT&E, Air Force, for PE 65230F.

Light Attack experiment

The budget request included \$35.0 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 27100F Light Attack Armed Reconnaissance Squadrons.

The committee supports the increase of combat capability and readiness at a reduced cost and the development of advanced capabilities for close air support, armed reconnaissance, strike coordination and reconnaissance, airborne forward air control, and interdiction. The committee also supports the Department of Defense's intent to lower the cost of countering violent extremism in accordance with the National Security Strategy. However, the committee is concerned that the pace of research and prototyping in this area has not kept pace with the threat or the current capability available to the Department.

Additionally, the committee is aware that, on a modern battlefield, it is expected that friendly forces will be in close proximity to the enemy and will require integrated joint fires in order to achieve the effects demanded by the Joint Force Commander. The committee believes that the Department of Defense has been slow to develop and field capabilities to provide battlefield situational awareness of enemy and friendly actors. The committee is also aware of current technical solutions that would provide the required identification of friend and foe in environments, like that in which close air support is demanded, in which the friendly forces are in close proximity to the enemy.

Therefore, the committee recommends an increase of \$50.0 million in RDT&E, Air Force, for PE27100F to conduct additional RDT&E.

Cyber National Mission Force capabilities

The budget request included \$198.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 36250F Cyber Operations Technology Development.

The committee is aware of the growing capabilities needed to counter adversaries in the cyberspace domain as highlighted in the National Defense Strategy. The committee supports continued development of capabilities for the cyber warfighter and understands the importance of improving the capabilities of the Cyber Mission Force. The committee therefore supports the request of U.S. Cyber Command to increase funding for the Cyber National Mission Force Capability Acceleration Plan.

Therefore, the committee recommends an increase of \$13.6 million in RDT&E, Air Force, for PE 36250F to accelerate the development of Cyber National Mission Force capabilities.

ETERNALDARKNESS program development

The budget request included \$198.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 36250F Cyber Operations Technology Development.

The committee is aware of the growing capabilities needed to counter adversaries in the cyberspace domain as highlighted in the National Defense Strategy. The committee supports continued development of capabilities for the cyber warfighter and understands the importance of improving the capabilities of the Cyber Mission

Force. The committee therefore supports the request of U.S. Cyber Command to increase funding to develop the ETERNALDARKNESS program.

Therefore, the committee recommends an increase of \$7.1 million in RDT&E, Air Force, for PE 36250F for the ETERNALDARKNESS program.

Joint Common Access Platform

The budget request included \$198.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 36250F Cyber Operations Technology Development.

The committee is aware of the growing capabilities needed to counter adversaries in the cyberspace domain as highlighted in the National Defense Strategy. The committee supports continued development of capabilities for the cyber warfighter and understands the importance of improving the capabilities of the Cyber Mission Force. The committee therefore supports the request of U.S. Cyber Command to increase funding to develop the Joint Common Access Platform to be used by the Cyber Mission Force.

Therefore, the committee recommends an increase of \$20.5 million in RDT&E, Air Force, for PE 36250F for the Joint Common Access Platform.

Protected Tactical Enterprise Service

The budget request included \$105.0 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 1206760F Protected Tactical Enterprise Service (PTES).

The committee is concerned that the prototype development of PTES, which constitutes \$72.5 million of the overall request, has experienced unjustified growth.

Therefore, the committee recommends a decrease of \$10.0 million in RDT&E, Air Force, for PE 1206760F.

Protected Tactical Service

The budget request included \$173.7 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 1206761F Protected Tactical Service (PTS).

The committee is concerned that the rapid prototyping of PTS, which constitutes \$111.8 million of the overall request, has experienced unjustified growth.

Therefore, the committee recommends a decrease of \$10.0 million in RDT&E, Air Force, for PE 1206761F.

ERWn

The budget request included \$246.2 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 64200F Aerospace Technology Development/Demonstration.

The committee acknowledges the importance of the mission of the Extended Range Weapons program; however, the committee understands that the Air Force is moving away from prototyping to an ongoing analysis of alternatives to better understand alternative technical solutions.

Therefore, the committee recommends a decrease of \$149.1 million in RDT&E, Air Force, for PE 64200F.

M-Code acceleration—system development & demonstration

The budget request included \$67.8 million in Research, Development, Test and Evaluation (RDT&E), Air Force, for PE 64201F Positioning, Navigation, and Timing Resiliency, Modifications, and Improvements.

The committee understands the importance of the ability of the Global Positioning System (GPS) to provide resilient position, navigation, and timing capability to the Joint Force and acknowledges GPS Military-Code receiver development's presence on the Chief of Staff of the Air Force's unfunded priorities list.

Accordingly, the committee recommends an increase of \$81.0 million in RDT&E, Air Force, for PE 64201F for system development and demonstration.

Space Fence

The budget request included no funding in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 1206426F Space Fence.

The committee understands that the Air Force is still considering procurement of a second Space Fence site, which is an option in the Department of Defense's Space Fence contract. Given the knowledge gained during the development of the first Space Fence site and the importance of developing an effective space situational awareness capability, the committee recommends that the Air Force evaluate construction of a second Space Fence site.

Accordingly, the committee recommends an increase of \$20.0 million in RDT&E, Air Force, for PE 1206426F for the completion of the second Space Fence design in order to fully understand its associated costs.

Major T&E Investment

The budget request included \$181.7 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 64759F Major Test and Evaluation Investment.

The committee recognizes the important role that space test infrastructure plays in initially testing and evaluating the capability and resilience of Department of Defense space systems in a contested environment. The committee also notes the presence of foundational infrastructure elements used to test both terrestrial and space-based assets on the Chief of Staff of the Air Force's unfunded priorities list. The committee believes that this infrastructure should support testing of a comprehensive survey of systems. Accordingly, the committee recommends an increase in \$36.0 million in RDT&E, Air Force, for PE 64759F for space test infrastructure.

Utah test range instrumentation

The budget request included \$181.7 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 64759F Major Test and Evaluation Investment.

The committee notes that the Department of Defense has indicated that the capability to conduct test and evaluation over broad geographic areas must include net-centric and distributed test capability. Modernized test facility data systems must integrate mod-

eling and simulation with operations, training, and flight tests to achieve the required level of complexity and realism.

The committee recommends an increase of \$15.0 million in RDT&E, Air Force, for PE 64759F for enhancements of Utah test range instrumentation for software-configurable test systems that address current and future Department of Defense data requirements.

Investment in hypersonic research and infrastructure

The budget request included \$717.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 65807F Test and Evaluation Support.

The committee notes that the development of hypersonic capabilities is a key element of the National Defense Strategy and represents an area of intense technological competition between the United States, People's Republic of China, and Russian Federation. The committee remains concerned that more attention needs to be focused on the expedient development and maturation of key hypersonic flight technologies. In addition to the need to improve ground-based test facilities such as wind tunnels, the Department of Defense (DOD) also needs to increase its flight test rate to expedite the maturation and fielding of hypersonic technologies. The combination of ground-based testing and flight testing is critical to fully maturing the fundamental technologies needed to field a hypersonic flight system. High-rate hypersonic flight test programs would help mature six critical technology areas:

- (1) Thermal protection systems and high temperature flight structures;
- (2) Seekers and sensors for hypersonic vehicles;
- (3) Advanced navigation, guidance, and control;
- (4) Communications and data links;
- (5) High speed aerodynamic characterization; and
- (6) Advanced avionics and vehicle communication systems for hypersonic vehicles.

To address this concern, the committee believes that the DOD must increase investment in research and test infrastructure. Therefore, the committee recommends an additional \$5.0 million in RDT&E, Air Force, for PE 65807F for the High-Speed Systems Test activity. Further, the committee directs the Secretary of Defense to report to the congressional defense committees, by June 1, 2020, on how the DOD plans to improve its test infrastructure and increase its flight test rate in fiscal year 2020 and beyond and the budget profile necessary to implement this plan.

5G Military Operational Test Capability

The budget request included \$717.9 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 65807F Test and Evaluation Support.

The committee notes the Defense Science Board's recommendation to build a secure fifth generation (5G) wireless network on a Department of Defense (DOD) installation. The committee recognizes the revolutionary effect that 5G technology will have on the Department but is concerned that the DOD lacks the ability to test

and develop tactics to leverage 5G technology as well as to negate enemy use of this advanced capability.

Therefore, the committee recommends an increase of \$49.0 million in RDT&E, Air Force, for PE 65807F for the establishment of a 5G test network and associated infrastructure at the Nevada Test and Training Range.

Advanced Battle Management System base architecture

The budget request included \$35.6 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 64003F Advanced Battle Management System (ABMS).

The committee notes the potential of secure fifth generation (5G) wireless networks for moving large amounts of data with very low latency. The Defense Science Board recommended building secure 5G wireless networks on a base in order to understand the potential of these advanced networks. The committee recognizes the revolutionary effect that 5G technology will have on the Department of Defense and the potential for use for data transfer for the ABMS. However, the committee is concerned that the Department lacks the base infrastructure to test, develop, and leverage 5G technology.

Therefore, the committee recommends an increase of \$49.0 million in RDT&E, Air Force, for PE 64003F for the establishment of a 5G base network that could be used for ABMS at an Air Force installation in the continental U.S.

Air Force Integrated Personnel and Pay System

The budget request included \$40.6 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 65018F Air Force Integrated Personnel and Pay System.

The committee is concerned about poor agile implementation and infrequent capability delivery.

Accordingly, the committee recommends a decrease of \$40.6 million, for a total of \$0.0 million, in RDT&E, Air Force, for PE 65018F.

HC-130 RDT&E

The budget request included \$17.2 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 65278F HC/MC-130 Recapitalization RDT&E.

The committee supports the program and the modernization of current aircraft to meet the requirements of the National Defense Strategy. The committee understands that the program requirements have changed and that the current request is above need for this fiscal year.

Therefore, the committee recommends a decrease of \$12.4 million in RDT&E, Air Force, for PE 65278F.

Airborne Launch Control System Replacement

The budget request included \$129.0 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 11213F Minuteman Squadrons, which includes the Airborne Launch Control System-Replacement (ALCS-R) program.

The committee understands that the Air Force has chosen to consolidate the ALCS-R program into the Ground-Based Strategic Deterrent program and that this approach will reduce risk and may save \$850 million across the life of the programs. The committee encourages the Air Force to ensure careful sustainment of the existing ALCS systems before they are replaced.

Accordingly, the committee recommends a decrease of \$22.0 million in RDT&E, Air Force, for PE 11213F.

Advanced data transport flight test

The budget request included \$0.0 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 31004F.

The committee supports the development of capabilities to advance the ability of aircraft, sensors, and command and control assets to share information. The committee also understands that the development of this type of capability requires live flight testing. Therefore, the committee recommends an increase of \$21.0 million in RDT&E, Air Force, for PE 31004F to conduct live flight testing of the concept and associated capabilities.

ISR automation

The budget request included \$19.0 million in Research, Development, Test, and Evaluation (RDT&E), Air Force, for PE 35022F Intelligence, Surveillance, and Reconnaissance Modernization and Automation Development.

The committee supports the idea of modernizing the intelligence, surveillance, and reconnaissance enterprise and the continued use of prototyping to reduce technological risk.

However, the committee is concerned with the fidelity of the current plan. Therefore, the committee recommends a decrease of \$19.0 million in RDT&E, Air Force, for PE 35022F.

Defense Wide

Defense Established Program to Stimulate Competitive Research

The budget request included \$48.9 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 61110D8Z basic research initiatives.

The committee notes the importance of basic research in meeting long-term national security needs and supports the Defense Established Program to Stimulate Competitive Research (DEPSCOR) efforts to expand the base of universities and states that support defense research and innovation missions. The committee notes that this program is attempting to engage faculty and students from DEPSCOR state universities through partnerships with defense research programs and defense laboratories.

Therefore, the committee recommends an increase of \$10.0 million, for a total of \$58.9 million, in RDT&E, Defense-wide, for PE 61110D8Z for DEPSCOR.

Submarine industrial base workforce development

The budget request included \$92.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 61120D8Z National Defense Education Program.

The committee notes the current shortfall in Columbia-class technical workforce and supports increased submarine industrial base workforce training and education to make up for this shortfall.

Therefore, the committee recommends an increase of \$10.0 million, for a total of \$102.1 million, in RDT&E, Defense-wide, for PE 61120D8Z for submarine industrial base workforce development.

Aerospace education and research

The budget request included \$30.7 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 61228D8Z basic research at historically black colleges and universities and minority institutions.

The committee notes the importance of fundamental scientific knowledge and the pipeline of highly qualified technical talent related to long-term national security needs. The committee supports increased funding for aerospace education and research activities at Historically Black Colleges and Universities/Minority Institutions to promote the expansion of the future aerospace technical workforce, especially among U.S. citizens and to enhance research in areas including fatigue damage tolerance, experimental aerodynamics, and the performance of materials and components under extreme environmental conditions.

Therefore, the committee recommends an increase of \$2.0 million, for a total of \$32.7 million, in RDT&E, Defense-wide, for PE 61228D8Z for aerospace education and research.

Computer modeling of PFAS

The budget request included \$62.2 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 62251D8Z applied research for the advancement of science and technology priorities.

The committee notes the potential for advanced computer modeling to improve the characterization and understanding of per- and polyfluoroalkyl substances (PFAS) and supports an increase in applied research in computational biology research efforts to meet long-term national security needs in support of the National Defense Strategy.

Therefore, the committee recommends an increase of \$2.0 million in RDT&E, Defense-wide, for PE 62251D8Z for government-university-industry partnerships in computer modeling of PFAS.

Cyber Security Research

The budget request included \$15.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 62668D8Z cyber security research.

The committee notes the importance of increased support for academic cyber institutes in meeting long-term national security needs in support of the National Defense Strategy. The committee believes that long-term science and technology cyber research is crit-

ical to developing capabilities that will enable the warfighter to maintain dominance in cyberspace in the long run.

Therefore, the committee recommends an increase of \$10.0 million, for a total of \$25.1 million, in RDT&E, Defense-wide, for PE 62668D8Z.

Artificial intelligence commercial solutions

The budget request included \$29.4 million in Research, Development, Test and Evaluation, Defense-wide, for PE 0603342D8Z Defense Innovation Unit (DIU).

The committee notes the importance of accelerating Artificial Intelligence (AI) applications in support of the Joint Artificial Intelligence Center's (JAIC) National Mission Initiatives, including disaster response and predictive maintenance. The committee supports the use of commercial artificial intelligence (AI) solutions and urges the DIU to coordinate with the JAIC to identify problem sets facing the Department of Defense and to seek commercial AI solutions.

Therefore, the committee recommends an increase of \$7.5 million for PE 0603342D8Z to accelerate AI commercial solutions.

Joint capability technology demonstrations

The budget request included \$107.4 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 63648D8Z joint capability technology demonstrations.

The committee supports a program reduction in joint capability technology demonstrations due to a lack of coordination of activities across the Department of Defense.

Therefore, the committee recommends a decrease of \$17.5 million, for a total of \$89.9 million, in RDT&E, Defense-wide, for PE 63648D8Z.

Emerging capabilities technology development

The budget request included \$80.9 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 63699D8Z emerging capabilities technology development.

The committee supports a program reduction in emerging capability technology development due to concerns about duplication of efforts across the Department of Defense.

Therefore, the committee recommends a decrease of \$10.0 million, for a total of \$70.9 million, in RDT&E, Defense-wide, for PE 63699D8Z.

SERDP increase

The budget request included \$5.2 billion in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, of which \$66.2 million was for PE 63716D8Z Strategic Environmental Research and Development Program (SERDP).

The committee notes that both SERDP and the Environmental Security Technology Certification Program (ESTCP) develop, demonstrate, and validate the most promising innovative technologies that can meet the Department's most urgent requirements, provide a return on investment, and are executed through free and open competitions. The committee directs the Department to use the in-

creases in SERDP to address the following urgent concerns: (1) Help ensure the safety and welfare of the servicemembers and their dependents by eliminating or reducing the generation of pollution and use of hazardous materials and reducing the cost of remedial actions and compliance with environmental laws and regulations, specifically as it relates to per- and polyfluoroalkyl substances; (2) Develop, demonstrate, validate, and field fluorine-free firefighting foam; (3) Develop, demonstrate, and validate long-term energy storage batteries tied to distributed energy assets; and (4) Develop other technologies deemed appropriate.

Accordingly, the committee recommends an increase of \$10.0 million in RDT&E, Defense-wide, for PE 63716D8Z for SERDP.

Program increase to support National Defense Strategy technologies

The budget request included \$175.6 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 63941D8Z test and evaluation science and technology.

The committee notes that the Department of Defense established the Test and Evaluation/Science and Technology Program in recognition of the development of advanced technology and transformational weapon systems, such as directed energy weapons and hypersonics, without corresponding advances in test technologies, such as means to measure directed energy effects or security testing of cloud computing environments. The committee further notes that in 2018 the People's Republic of China announced the construction of a 265 meter long wind tunnel, which is to be complete by 2020, to simulate the acceleration environment from Mach 10 to Mach 25. China already has tunnels capable of simulating conditions between Mach 5 to 9. In contrast, the committee notes that, although the U.S. has hypersonic tunnels, most are small and designed for tests lasting less than a few seconds.

The committee recommends an increase of \$10.0 million in RDT&E, Defense-wide, for PE 63941D8Z to fund development of test capabilities to support high-priority National Defense Strategy technology development efforts.

ESTCP increase

The budget request included \$5.2 billion in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, of which \$66.6 million was for PE 63851D8Z Environmental Security Technology Certification Program (ESTCP).

The committee notes that both the Strategic Environmental Research and Development Program (SERDP) and ESTCP develop, demonstrate, and validate the most promising innovative technologies that can meet the Department's most urgent requirements, provide a return on investment, and are executed through free and open competitions. The committee directs the Department to use the increases in SERDP to address the following urgent concerns: (1) Help ensure the safety and welfare of the servicemembers and their dependents by eliminating or reducing the generation of pollution and use of hazardous materials and reducing the cost of remedial actions and compliance with environmental laws and regulations, specifically as it relates to per- and

polyfluoroakyl substances; (2) Develop, demonstrate, validate, and field fluorine-free firefighting foam; (3) Develop, demonstrate, and validate long-term energy storage batteries tied to distributed energy assets; and (4) Develop other technologies deemed appropriate.

Accordingly, the committee recommends an increase of \$10.0 million in RDT&E, Defense-wide, for PE 63716D8Z for SERDP.

MDA special programs

The budget request included \$377.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 63891C for Missile Defense Agency (MDA) special programs.

The committee recommends an increase of \$125.0 million, for a total of \$502.1 million, in RDT&E, Defense-wide, for PE 63891C.

Neutral particle beam

The budget request included \$303.5 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, in PE 64115C for Missile Defense Agency (MDA) Technology Maturation Initiatives, of which \$34.0 million was for a Neutral Particle Beam program.

The committee notes that this program, intended for an on-orbit demonstration within 5 years, would constitute a space-based interceptor capability. The committee also notes that the 2019 Missile Defense Review (MDR) tasked the MDA with a study of development and fielding of a space-based intercept capability, to be delivered to the Under Secretaries of Defense for Policy and Research and Engineering. According to the MDR, this study will, along with another study directed by the Deputy Secretary of Defense on boost-phase intercept capability, inform considerations regarding a space-based intercept layer for boost-phase defense. The committee believes that proceeding with any single technology program is premature before these studies are completed, the associated policy decisions are made concerning the operation of such a capability in space, and the relevant space-based sensor architecture is finalized.

Accordingly, the committee recommends a decrease of \$34.0 million in PE 64115C, RDT&E, Defense-wide, Technology Maturation Initiatives, for a total of \$269.5 million.

Hypervelocity Gun Weapon System

The budget request contained \$1.3 billion in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 64250D8Z advanced innovative technologies of the Strategic Capabilities Office (SCO), of which no funds were requested for the Hypervelocity Gun Weapon System (HGWS).

The committee notes that this system may be a promising pathway to provide more cost-effective point defense in theater and encourages the SCO to continue to prove out the capability in order to facilitate transition to one or more military departments.

Accordingly, the committee recommends an increase of \$81.0 million in RDT&E, Defense-wide, for PE 64250D8Z for HGWS.

Strategic Capabilities Office

The budget request included \$1.3 billion in Research, Development, Testing, and Evaluation (RDT&E), Defense-wide, for PE 64250D8Z Advanced Innovative Technologies.

The committee notes that the Strategic Capabilities Office (SCO) was established to support rapid development, prototyping, and deployment of operational capabilities to meet emerging threats in the U.S. Indo-Pacific area of responsibility. Since then, the SCO has drifted from its original purpose and has seen significant budget growth not commensurate with its transition success and has undertaken projects with questionable technical merit and operational utility. The committee recommends reductions in the following projects, LiTE Saber, Quiet Riot, and StormSystem.

Therefore, the committee recommends a reduction of \$50.0 million in RDT&E, Defense-wide, for PE 64250D8Z.

Trusted and assured microelectronics

The budget request included \$542.4 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 64294D8Z trusted and assured microelectronics.

The committee notes the importance of trusted and assured microelectronics research for many applications, including fifth-generation wireless networking microelectronics. The committee believes that it is important to develop technologies that could help in supply chain risk management.

Therefore, the committee recommends an increase of \$5.0 million, for a total of \$547.4 million, in RDT&E, Defense-wide, for PE 64294D8Z.

Rapid prototyping program

The budget request included \$101.0 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 64331D8Z rapid prototyping program.

The committee notes that the Services and Defense Agencies are aggressively investing in prototyping activities, through programs using “Section 804” acquisition authorities, rapid capability offices, and shifting science and technology programs toward prototyping and away from innovation activities. The committee further notes that the Rapid Prototyping Fund, previously authorized by the Congress, is also funding prototyping activities. Finally, the committee notes that there is no central coordinating body in the Department of Defense to oversee its many prototyping efforts and ensure that they are focused on key issues, such as informing requirements development and assessing the technical feasibility of proposed technological approaches.

Therefore, the committee recommends a decrease of \$50.0 million, for a total of \$51.0 million, in RDT&E, Defense-wide, for PE 64331D8Z.

Space Development Agency missile defense programs

The budget request included \$85.0 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, in PE 1206410SDA, for Space Development Agency (SDA) Space Technology Development and Prototyping, of which \$15.0 million was

for a Space-Based Interceptor Study and \$15.0 million was for a Space-Based Discrimination Study.

The committee notes that the SDA was unable to provide further details on these two efforts at the time of the budget release. The committee further notes that elements of both studies appear to be duplicative of ongoing efforts within the Missile Defense Agency.

Accordingly, the committee recommends a decrease of \$30.0 million in PE 1206410SDA, RDT&E, Defense-wide, Space Technology Development and Prototyping, for a total of \$55.0 million.

Hypersonic and Ballistic Tracking Space Sensor

The budget request included \$27.6 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 1206895C Ballistic Missile Defense System (BMDS) Space Programs of the Missile Defense Agency (MDA), of which no funding was requested for a space-based sensor layer for missile defense purposes.

The committee is deeply concerned about the growing threat posed by hypersonic glide and cruise missiles, which challenge existing sensor capabilities for both homeland and theater missile defenses. Integral to any defense against this threat is the ability to track low-flying or maneuverable missiles and glide vehicles, a mission that can only be performed effectively from space. The committee also notes that the space-based sensor technology would be required before a space-based intercept layer—which was included in the budget request—could be deployed.

The committee notes that, after several years of consistent testimony from senior Department of Defense officials regarding the importance of space-based sensors for a missile defense capability, the Congress has strongly supported MDA's space-based sensor program. Both the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Public Law 115–232) and the Department of Defense Appropriations Act for Fiscal Year 2019 (Public Law 115–245) increased funding for the Space Sensor Layer program from \$0.0 to \$73.0 million.

Finally, the committee notes that this program, now called the Hypersonic and Ballistic Tracking Space Sensor, was included in the unfunded requirements lists of the MDA Director and the Commander of U.S. Strategic Command.

Accordingly, the committee recommends an increase of \$108.0 million, for a total of \$135.6 million, in RDT&E, Defense-wide, for PE 1206895C.

Joint Mission Environment Test Capability

The budget request included \$83.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 65100D8Z Joint Mission Environment Test Capability.

The committee notes the importance of cyber range development to meet future national security needs. The committee believes that cyber test range capabilities will be critical in training our warfighters to effectively counter the threats posed by our adversaries as specified in the National Defense Strategy.

Therefore, the committee recommends an increase of \$6.0 million, for a total of \$89.1 million, in RDT&E, Defense-wide, for PE 65100D8Z.

Technical Studies, Support, and Analysis

The budget request included \$18.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 65104D8Z for technical studies and analyses.

The committee recommends a reduction of \$5.0 million in RDT&E, Defense-wide, for PE 65104D8Z.

Systems engineering

The budget request included \$37.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 65142D8Z systems engineering.

The committee supports a program reduction in systems engineering due to the lack of coordination of efforts across the Department of Defense.

Therefore, the committee recommends a decrease of \$5.0 million, for a total of \$32.1 million, in RDT&E, Defense-wide, for PE 65142D8Z for management support.

Defense Digital Service development support

The budget request included \$1.0 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 66589D8W Defense Digital Service (DDS) Development Support.

The committee recognizes the importance of the Defense Digital Service in helping the Department of Defense to build, buy, and deploy technology and digital services.

Accordingly, the committee recommends an increase of \$5.0 million in RDT&E, Defense-wide, for PE 66589D8W for additional development support activities.

Advanced manufacturing systems

The budget request included \$10.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 67210D8Z Industrial Base Analysis and Sustainment Support.

The committee notes that the university research community has contributed significantly to the development of new defense capabilities, including in advanced manufacturing. The committee believes that the U.S. academic research enterprise should play a bigger role in promoting innovation in the defense industrial base.

Accordingly, the committee recommends an increase of \$5.0 million in RDT&E, Defense-wide, for PE 67210D8Z for interdisciplinary centers for research on advanced manufacturing.

Composite manufacturing technologies

The budget request included \$10.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 67210D8Z industrial base analysis and sustainment support.

The committee notes that the September 2018 Department of Defense report titled “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States” stressed the “imperative that producers and

supply chains of materials deemed essential to U.S. defense and civilian demand are robust, resilient, competitive, and responsive to support current and long-term economic security, current military operations, future wartime mobilization, and unanticipated surge demand.”

Accordingly, the committee recommends an increase of \$15.0 million in RDT&E, Defense-wide, for PE 67210D8Z to fund the development of composite manufacturing technologies.

Printed circuit boards

The budget request included \$10.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 67210D8Z industrial base analysis and sustainment support.

The committee notes that the September 2018 Department of Defense report titled “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States” stated, “90% of worldwide printed circuit board production is in Asia, over half of which occurring in China; and the U.S. printed circuit board sub-sector is aging, constricting, and failing to maintain the state of the art for rigid and rigid-flex printed circuit board production capability.”

Accordingly, the committee recommends an increase of \$15.0 million in RDT&E, Defense wide, for PE 67210D8Z to fund printed circuit board manufacturing.

Rare earths materials research

The budget request included \$10.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 67210D8Z industrial base analysis and sustainment support.

The committee notes the importance of supporting mitigations for continuous and growing industrial base shortfalls and vulnerabilities, including those identified in the September 2018 Department of Defense report titled “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States.” This report specifically recommended expanding direct investment in the lower tier of the industrial base through the Department’s Industrial Base Analysis and Sustainment program to address critical bottlenecks, support fragile suppliers, and mitigate single points-of-failure. It further noted that “China’s domination of the rare earth element market illustrates the potentially dangerous interaction between Chinese economic aggression guided by its strategic industrial policies and vulnerabilities and gaps in America’s manufacturing and defense industrial base.”

Accordingly, the committee recommends an increase of \$3.5 million in RDT&E, Defense-wide, for PE 67210D8Z to fund development of capability to produce rare earth elements from coal ash.

Sharkseer transfer

The budget request included \$289.1 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 33140G Information Systems Security Program.

The committee included a provision in the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Public Law

115–232) that required the Secretary of Defense to transfer the operations and maintenance for the Sharkseer cybersecurity program from the National Security Agency to the Defense Information Systems Agency.

Therefore, the committee recommends a decrease of \$1.9 million in RDT&E, Defense-wide, for PE 33140G for the Sharkseer program.

Sharkseer transfer

The budget request included \$42.8 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 33140K Information Systems Security Program.

The committee included a provision in the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Public Law 115–232) that required the Secretary of Defense to transfer the operations and maintenance for the Sharkseer cybersecurity program from the National Security Agency to the Defense Information Systems Agency.

Therefore, the committee recommends an increase of \$1.9 million in RDT&E, Defense-wide, for PE 33140K for the Sharkseer program.

Defense Counterintelligence and Security Agency activities

The budget request included \$2.4 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 0305128V Security and Investigative Activities.

The committee recommends an increase of \$15.0 million in RDT&E, Defense-wide, for PE 0305128V for the Defense Counterintelligence and Security Agency to carry out a set of activities relating to facilitating access by the Agency to local criminal records historical data.

Future Vertical Lift

The budget request included \$245.8 million in Research, Development, Test, and Evaluation (RDT&E), Defense-wide, for PE 1160403BB aviation systems, of which \$1.2 million is for the development and integration of special operations-unique equities and requirements into a multi-service future vertical lift (FVL) capability set 3 (CS3) aircraft.

The committee understands that U.S. Special Operations Command (SOCOM) is working with the Army to identify specific special operations-unique requirements early in the design phase of the FVL CS3 in order to reduce duplication of design, engineering, and post-production costs. The committee notes that the SOCOM Program Executive Officer-Rotary Wing and the Army Program Manager-FVL estimate that there could be approximately \$188 million in RDT&E savings resulting from this co-development approach as compared to making post-production modifications to the aircraft.

The committee also understands that the Army's decision to accelerate FVL CS3 development has resulted in a shortfall in SOCOM's related development efforts, an identified high priority unfunded requirement for the command. Therefore, the committee recommends an additional \$8.8 million in RDT&E, Defense-wide,

for PE 1160403BB, for the development and integration of special operations-unique equities and requirements into a multi-service FVL CS3 aircraft.

Next Generation Information Communications Technology (5G)

The budget request included no funding in Research, Development, Testing, and Evaluation (RDT&E), Defense-wide, for PE 64011D8Z Next Generation Information Communications Technology.

The committee believes that fifth-generation wireless networks and associated technologies will be a foundation for future economic growth, will have an important nexus with national security, and should be of high interest to the Department of Defense. The committee is aware that, in future wireless networks, the ability to use dynamic spectrum sharing technologies will be critical to more efficient spectrum use.

The committee recommends an increase of \$25.0 million, for a total of \$25.0 million, in RDT&E, Defense-wide, for PE 64011D8Z in support of a Department of Defense spectrum sharing program.

Transfer from OCO to Base

The budget request included \$102.6 billion for Research, Development, Test, and Evaluation (RDT&E) in base funding. The committee notes that the President's budget request included \$97.9 billion in the Overseas Contingency Operations (OCO) account for activities that are traditionally funded out of base accounts. The committee believes that OCO for Base funding should be transferred into the base accounts.

Accordingly, the committee recommends an increase of \$748.0 million to RDT&E base funding.

Items of Special Interest

Acquisition roadmaps for certain Navy unmanned systems

The committee notes that the Navy's fiscal year 2020 future years defense program (FYDP) includes a substantial increase in funding for various unmanned systems, including unmanned surface vessels (USVs) and unmanned underwater vessels (UUVs). The committee further notes that Navy leaders envision some of these systems' operating autonomously with the ability to employ weapons.

While recognizing the need for prototypes to reduce acquisition risk, the committee is concerned that the acquisition strategies for the Large USV, Medium USV, Orca UUV, and Snakehead UUV could lead to procurement of an excessive number of systems before the Navy is able to determine if the USVs and UUVs meet operational needs.

Therefore, the committee directs the Secretary of the Navy to submit a report to the congressional defense committees, not later than November 1, 2019, that provides acquisition roadmaps for the Large USV, Medium USV, Orca UUV, and Snakehead UUV. Each roadmap shall: (1) Identify the applicable requirements document (e.g., Top Level Requirements); (2) Describe the threshold and ob-

jective values for each characteristic, key performance parameter (KPP), or other measure in the applicable requirements document; (3) Identify increments of vessels in each program; (4) For each such increment, identify specific entrance and exit criteria that build toward the specified requirements (e.g., characteristic, KPP, or other measure), including demonstrated hardware and software functionality; (5) Identify the quantity of vessels needed in each increment to perform the required testing or meet operational needs; (6) Describe the concept of operations for each increment; (7) Identify the key pieces of hardware and software needed for each increment, including communications security material, off-board line-of-sight and satellite communications, and military datalinks; (8) Describe the extent to which each increment of vessels will be equipped with weapons, enumerate such weapons, and describe the associated target detect-to-engage sequence of events for each such weapon; (9) Provide the subsystem-level prototyping plan for each increment, including for each such effort the planned cost, schedule, and performance; and (10) Provide the acquisition plan for each increment, including the planned cost, schedule, and performance.

Advance power electronics

The committee supports the Navy's efforts in developing advanced power electronics, including silicon carbide power modules, which could reduce the size and weight of power conversion modules and other electronic systems needed to power advanced sensors and weapon systems. The committee recognizes that available space and power density will continue to be a concern when fielding naval systems on legacy Navy ships.

The committee encourages the Navy to continue its efforts to develop silicon carbide power modules to support planned deployment of high-power, mission critical systems on Navy platforms.

Army Futures Command research budget realignments

The committee understands that the Army has reorganized certain research offices, laboratories, and engineering centers within the Combat Capability Development Command (CCDC), a subordinate command of Army Futures Command. The committee is aware that, as part of this reorganization, certain program elements for basic research, applied research, and advanced technology development were realigned from research, development, and engineering centers to Army Futures Command headquarters. The committee directs the Secretary of the Army to enter into an agreement with the National Academy of Sciences to evaluate these changes and their impact on the Army's ability to efficiently and effectively develop and deploy needed capabilities and new technologies in the near, mid, and far terms. The review should also include recommendations for policy and organizational options that would better optimize the Army research enterprise to support Army missions in the near, mid, and far terms. The committee directs that this study be delivered to the congressional defense committees no later than February 1, 2021.

Artificial intelligence and sensor fusion for force protection

The committee acknowledges the success of ongoing rapid fielding of commercially-available technologies that use artificial intelligence and sensor fusion to deliver enhanced force protection for Department of Defense (DOD) personnel and installations. The committee notes that recent advances in commercially available technology, including artificial intelligence, computer vision, and sensor technology, have made it possible to develop, manufacture, and deploy reconnaissance, surveillance, and target acquisition technologies that are far more effective, more efficient, and lower cost than legacy systems. The committee is aware that artificial intelligence can significantly improve situational awareness and security for DOD personnel through faster and better processing and exploitation of sensor data, recognition and classification of potential threats, and dissemination of that information to human operators for the purposes of enhanced self-defense.

The committee believes that artificial-intelligence- and sensor-fusion-based technologies for personnel security and base defense will reduce manpower and improve operators' ability to detect, classify, and respond to threats. Accordingly, the committee directs the DOD to review the application of artificial intelligence that could improve the safety of DOD personnel and installations and prioritize such efforts as appropriate.

Artificial intelligence for Army air and missile defense

The committee supports the Army's efforts to conduct operationally realistic assessments of Army Air and Missile Defense (AMD) performance, identify system vulnerabilities, and develop mitigations against threats across the cyber and electromagnetic spectrum. The committee remains concerned about any potential vulnerabilities in AMD weapon systems and understands the importance of conducting periodic assessments of these weapon systems. The committee is also aware that the Army is developing tools, including modeling and simulation and virtual models of critical hardware and software to allow for testing in a lab environment. The committee encourages the Army to look at methods for incorporating artificial intelligence and machine learning into assessments of AMD weapon systems to help identify and mitigate current and future threats.

Back-packable Communications Intelligence System

The committee is aware of expressed support by United States Army Special Operations Command (USASOC) for continued development of the Back-packable Communications Intelligence System (BPCS), an ultra-capable, low size, weight, and power, high-frequency direction finding system currently managed by the U.S. Army. The committee understands that BPCS performance was demonstrated at the Special Operations Forces Acquisition, Technology and Logistics (SOF AT&L) Technical Experiment 18-3 and encourages USASOC to continue working in close coordination with SOF AT&L and the Army to advance BPCS development and testing.

Battlefield situational awareness

The committee is aware that, on a modern battlefield, it is expected that friendly forces will be in close proximity to the enemy and will require integrated joint fires in order to achieve the effects demanded by the Joint Force Commander. The committee believes that the Department of Defense has been slow to develop and field capabilities to provide battlefield situational awareness of enemy and friendly forces. The committee is also aware of current technical solutions that could provide the required identification of friend and foe in environments such as battlefield interdiction, close combat attack, or close air support.

Therefore, the committee directs the Chairman of the Joint Chiefs of Staff, in consultation with the service chiefs, to provide a briefing, no later than March 30, 2020, on a technical solution and an acquisition strategy that would provide the Joint Force with continuous battlefield situational awareness to identify friendly and enemy personnel in both highly contested and permissive environments.

Briefing on detection of uncharted wires and obstacles to prevent aviation incidents

Uncharted wires and obstacles pose a threat to rotary wing and tiltrotor aircraft particularly in degraded visual environments. This problem can be exacerbated for special operations and combat search and rescue (CSAR) aircraft that often operate in non-permissive conditions.

The committee understands that multiple systems that may increase visibility for aircrews in order to avoid obstacles in both low altitude flying and landing environments are currently in development. However, the committee is concerned that the Department of Defense has not taken demonstrable steps toward fielding such technology. Furthermore, the development and fielding of such a capability should be fully coordinated across the Services to expeditiously field this technology to aircrews.

Therefore, the committee directs the Under Secretary of Defense for Research and Engineering, in coordination with the Chief of Staff of the Army, the Chief of Staff of the Air Force, the Chief of Naval Operations, the Commandant of the United States Marine Corps, and the Commander, U.S. Special Operations Command, to provide a briefing to the committee no later than October 1, 2019, on efforts to identify, develop, and procure capabilities for rotary wing and tiltrotor aircraft to detect and avoid uncharted wires and obstacles. The briefing shall include an evaluation of current commercially available systems as well as an estimate of the funding required to, if necessary, develop and acquire such a system for rotary wing and tiltrotor aircraft.

Demonstration pilots to demonstrate cost savings and enhanced performance of anti-corrosion nanotechnologies

The committee is aware of new advances in nanotechnology being used in the commercial sector, particularly in the aviation and energy industries, that reduce corrosion, improve performance, and reduce costs. The committee is concerned that, although the fundamental science was developed in part by the Department of De-

fense, the Department has failed to even try these new materials that could significantly reduce the military's operating costs while improving readiness and performance.

Accordingly, the committee directs the Under Secretary of Defense for Acquisition and Sustainment and the Under Secretary of Defense for Research and Engineering to brief the committee, no later than February 1, 2020, on the economic, performance, and readiness impacts regarding the potential for testing and applying these technologies in various operating assets, like pipelines, heat exchangers, fuel storage tanks, water lines, aircraft, and others deemed appropriate by the Department.

Department of Defense artificial intelligence investment inventory

The committee believes that it is important that the Department of Defense (DOD) has accurate insight as to the nature and extent of investments made in artificial intelligence (AI). The committee is aware that one impediment to such insight is that AI Research, Development, Test, and Evaluation (RDT&E) is spread throughout generally titled program elements (PEs) and incorporated into funding for larger systems with AI components or even extends beyond RDT&E into Operation and Maintenance and Procurement.

The committee therefore directs the Under Secretary of Defense (Comptroller) to brief the congressional defense committees by September 1, 2019, on the total array of AI investments, to include PEs, line numbers, and funding amounts with sufficient detail and description of those investments. The committee also expects the Under Secretary to include the methodology for tracking AI investments in future budget requests. Further, the committee recommends that the Department consider summarizing these AI investments in the annual information technology budget exhibit.

Flame resistant military uniforms with multi-spectral sensor protection

The committee notes that infrared and multi-spectral sensor detection is an emerging threat to members of the Armed Forces. Soldiers, sailors, airmen, and marines are under an ever increasing threat of long-range detection by these sensors in use by hostile near-peer as well as non-state actors. Given recent technical developments in sensor technologies and sensor mitigation, the committee feels that it is in the best interest of the Services to explore multi-spectral sensor mitigation technologies and to incorporate them into the current suite of flame resistant (FR) uniforms presently in use by the Services.

Therefore, the committee directs the Secretary of the Army, in coordination with the Secretaries of the Navy and the Air Force, to conduct a feasibility study on incorporating these mitigation technologies into FR uniforms and to provide a briefing to the congressional defense committees on this study by December 1, 2019.

High powered microwave test range asset

The committee supports the transitioning of new and game-changing directed energy technologies to the warfighter. An enduring testing and evaluation capability for high powered microwaves

(HPM) would help the Services develop the doctrine and concepts of operation that will bring these technologies to operational use. Currently, an enduring frequency agile and tunable HPM asset is not available at Major Range and Test Facility Bases for evolving doctrine and HPM Directed Energy Concept of Operations. The committee supports the Air Force's development of such an asset at the Nation's test ranges.

Historically black colleges and universities support for minority women in science, technology, engineering and mathematics fields

The committee acknowledges the ongoing efforts of the Department of Defense (DOD) to increase the participation of women and other underserved populations in science, technology, engineering and mathematics-related (STEM) areas of research. The committee urges the DOD to continue funding for center of excellence efforts at historically black colleges and universities (HBCUs) that support training and education of minority women in STEM fields of interest to the military, particularly through research funding, fellowships, and internships and cooperative work experiences at defense laboratories. The committee recommends that the Department of Defense consider increasing investments in these kinds of activities in future budgets to support administration initiatives on HBCUs.

Hostile fire detection technology

The committee is aware of advancements in the development of hostile fire detection technology and the importance of these capabilities in providing deployed forces with the ability to quickly detect, locate, and discriminate hostile fire and related threats. The committee believes that efforts to reduce the size, weight, power requirements, and cost for hostile fire detection technologies could provide important benefits to battlefield effectiveness and survivability of our forces. The committee therefore directs the Commander of U.S. Special Operations Command (SOCOM) to provide to the committee a briefing not later than October 1, 2019, on SOCOM's current requirements for hostile fire detection and an assessment of available technologies that may fulfill these requirements.

Human factors modeling and simulation

The committee notes that section 227 of the John S. McCain National Defense Authorization Act for Fiscal Year 2019 (Public Law 115–232) required the Secretary of Defense to develop and provide for the execution of human factors modeling and simulation activities with the purpose of accelerating research and development that enhances capabilities for human performance, human-systems integration, and training for the warfighter.

The committee directs the Secretary to provide a briefing on the status of this requirement and activities taken to fulfill the requirement no later than 90 days after the date of the enactment of this Act. The briefing shall include information on the extent of the activities that are being carried out, the effects of these activities with respect to their purpose, activity participants, locations where

activities are being carried out, and the plan to sustain these activities in the future.

Hypersonic development

The committee understands that developing hypersonic technology is a high priority modernization effort for the Department of Defense (DOD). The committee recognizes that, in an effort to accelerate the development of hypersonics and to coordinate simultaneous development efforts across the DOD, the Under Secretary of Defense for Research and Engineering signed a memorandum of agreement with the Services, with each contributing to and collaborating on the land-, sea-, and air-based prototyping of hypersonic technology.

The committee notes that, for over 30 years, Sandia National Laboratories (SNL) has made significant contributions to the prototyping and testing of hypersonic vehicles. SNL houses experienced scientists and engineers in the development of this technology, who utilize SNL's hypersonic wind tunnel and advanced laser diagnostic technology. Over 7 years ago, Sandia conducted a successful flight test of a hypersonic concept for the U.S. Army Space and Missile Defense Command. This test provided SNL with significant additional data on hypersonic boost-glide technologies and test range performance for long-range atmospheric flight with an emphasis on aerodynamics, navigation, guidance and control, and thermal protection technologies.

SNL is now integrating artificial intelligence into the designing and planning stages, which may significantly expedite the development and design process.

The committee believes that the technical expertise at SNL and the laboratory has been and will continue to be instrumental to the development and eventual production of hypersonics. Therefore, the committee encourages the Department to utilize the technical and scientific expertise at labs, including SNL, necessary for the development of prototypes and to assist commercial industry in manufacturing.

Importance and use of United States Active Ionospheric Research Facilities

The committee recognizes the unique importance of U.S. active ionospheric research facilities, also known as "ionospheric heaters." These facilities transmit high frequency (HF) radio waves and play a crucial role in the research of ionospheric effects on national security systems. The research possible at these facilities is useful to national security in the realms of domain awareness, radar, atmospheric effects on space systems, and over-the-horizon communications. The committee recognizes that, while there are four ionospheric research facilities in the world, two are in the United States, including the High-frequency Active Auroral Research Program (HAARP) in Gakona, Alaska, and the HF heater at the Arecibo Observatory (AO) in Arecibo, Puerto Rico. Both of these centers are available to support scientific investigations and national security programs for the Department of Defense, Department of Energy, and the National Science Foundation.

The committee is aware that the HAARP has supported investigations of ionospheric effects on high latitude communications and navigation capabilities and the remediation of high energy “killer” electrons in the magnetosphere as a result of an extreme solar event or a high-altitude nuclear detonation. The HAARP facility supports strategic applications for over-the-horizon radar, global communication, and diagnostics for satellite communication. The committee is aware that the AO facility supports investigations of ionospheric effects at mid- and low latitudes with applications including radio communications and radar detection. These experimental sites provide insights and diagnostics for ionospheric effects that are extremely challenging to obtain.

The committee encourages continued use of these facilities and believes that these facilities can be used, when appropriate, to support the national security space program.

Interdisciplinary expeditionary cybersecurity research

The committee is encouraged by current research efforts to understand expeditionary cyber challenges. The committee understands the challenge of operating within a complex and evolving cyber and physical environment where warfighters are in close proximity and contact with adversaries and believes that this is simultaneously a growing threat and opportunity. The committee believes that an interdisciplinary approach to developing new capabilities for cyber systems while including consideration of the role of human behavior in the tactical cyber environment is critical. The committee encourages the Department of Defense to continue to conduct multidisciplinary research in the areas of: dynamic cyber defense; tactical cyberspace operations and signals intelligence; sensing; and computation and communications.

Light attack experiment

The committee supports the increase of combat capability and readiness at a reduced cost and the development of advanced capabilities for close air support, armed reconnaissance, strike coordination and reconnaissance, airborne forward air control, and interdiction. The committee also supports the Department of Defense’s intent to lower the cost of countering violent extremism in accordance with the National Security Strategy. However, the committee is concerned that the pace of research and prototyping in this area has not kept up with the threat or the current capability available to the Department.

Therefore, the committee directs the Secretary of the Air Force to deliver a briefing, no later than March 30, 2020, to the congressional defense committees on the acceleration of the light attack experiment using existing aircraft and any other aircraft that the Chief of Staff of the Air Force deems appropriate and capable of reaching initial operating capability by 2023.

Multifunction capability to provide communications in contested environments

The committee is concerned about the ability of the Department of Defense to maintain its advantage in full spectrum operations in the future. Recent conflicts have highlighted our adversaries’ in-

creasing abilities to geolocate, jam, and intercept electronic communications, putting at risk the U.S. military's ability to communicate and conduct effective command and control in contested environments.

To better prepare for future combat operations against a near-peer adversary, the committee believes that the DOD needs to expedite testing of multi-domain capabilities and systems that provide distributed, shared, full spectrum situational awareness and spectrum maneuver. This testing should include cognitive machine learning or artificial intelligence applications to assess new and unknown electronic signals in real-time. Such testing would also demonstrate advanced technologies, such as modern waveforms that are designed to be low-probability-of-intercept, low-probability-of-detection, and ultra-wideband radio frequency converged apertures that permit the U.S. to maintain spectrum dominance. These systems should also enable secure communications across networks with different security levels and between both legacy and advanced systems.

Therefore, the committee directs the Secretary of Defense to provide the congressional defense committees with a briefing, no later than March 1, 2020, on the plan for the conduct of live testing of technologies and capabilities designed to permit secure full spectrum operations in the fiscal years 2020–2021 timeframe.

Navy laser integration plans

The committee is greatly encouraged by the Navy's rapid demonstration of laser weapon systems on surface ships. In 2014, the Navy deployed a 30 kW Laser Weapon System (LaWS) on USS *Ponce*, which will be followed by a 150 kW LaWS on USS *Portland* (LPD-27), planned for 2019. The committee understands that the improvements in power and beam quality make the 150 kW LaWS nearly a 100-fold improvement in lethality.

The committee is also encouraged by the Navy's plans to integrate the 60 kW High Energy Laser and Integrated Optical-dazzler with Surveillance (HELIOS) program into *Arleigh Burke*-class destroyers beginning in 2021.

If the HELIOS effort succeeds, the committee believes there may be additional opportunities to integrate High Energy Laser (HEL) systems on large capital ships, including aircraft carriers and large amphibious ships, to increase the defensive capabilities and lethality of our carrier strike groups and expeditionary forces.

If the Navy has continued positive results at increased radiated power, there may also be broader applications of laser weapons for providing capability for fleet air defense from more Navy vessels.

Therefore, the committee directs the Secretary of the Navy to provide a briefing to the Senate Armed Services Committee, not later than October 1, 2019, describing the path forward for ship-board integration of HEL systems and the risk reduction plan to achieve improved technology and manufacturing readiness levels for such higher power systems. The committee also directs the Secretary to provide briefings on the progress of laser systems development and testing every 6 months through fiscal year 2021.

Production-ready sources for hypersonic materials

Hypersonic systems require high performance, heat resistant materials to survive demanding flight regimes. For mission critical structures such as radomes and apertures, currently available materials and manufacturing infrastructure cannot meet anticipated requirements for hypersonic systems. The committee notes that the September 2018 Report of the Interagency Task Force in fulfillment of Executive Order 13806 recommends that the Department of Defense expand direct investment in the lower tier of the industrial base through Title III of the Defense Production Act (Public Law 81-774), Department of Defense Manufacturing Technology, and Industrial Base Analysis and Sustainment programs to address critical bottlenecks, support fragile suppliers, and mitigate single points-of-failure. The committee strongly agrees with this recommendation and directs the Department to use the respective authorities and funding within these programs to accelerate material qualification and establishment of production ready sources for critical materials and components to support hypersonic systems.

Requirement for briefing on Advanced Battle Management System acquisition strategy

The committee is concerned with the progress of the Advanced Battle Management System (ABMS). The Air Force has taken a significant amount of time to hire what they refer to as an architect to analyze the problem and produce a solution that would be fielded at Robins Air Force Base. The committee understands that the problem is currently well-defined to include potential sensor and communication requirements for a disaggregated solution to battle management. However, the committee remains concerned that the ABMS comprises a number of programs and, as a result, may cross multiple program elements.

Therefore, the committee directs the Secretary of the Air Force to biannually provide briefings to the congressional defense committees on the progress of the ABMS acquisition. The first briefing shall be provided no later than January 1, 2020, and the subsequent briefings shall be provided once every 6 months until system is fielded.

These briefings shall include: (1) the ABMS acquisition strategy; (2) Progress made in meeting that strategy; (3) An unclassified plan that lays out a personnel transition strategy in order to develop the initial cadre for the ABMS from the current workforce, including active duty, Reserve, Air National Guard, and civilians, at Robins Air Force Base; and (4) The plan to fill the capability gap that could emerge post-JSTARS and pre-ABMS.

Use of commercial cloud services to support high performance computing needs

The committee notes that the Department of Defense (DOD) has many needs for high performance computing systems to support weapons design and testing, weather forecasting, scientific research, data analysis, and other missions. The committee further notes that commercial cloud computing services may provide a novel, efficient, and lower cost method for obtaining high performance computing capabilities. The committee directs the Under Sec-

retary of Defense for Research and Engineering (USD(R&E)) and the Chief Information Officer (CIO) to jointly develop a report analyzing the potential use of cloud computing capabilities, including commercial services, to help support the high performance computing needs of the DOD. The committee directs that the report be delivered to the congressional defense committees no later than January 1, 2021.