EXHIBIT 131

U.S. Exports of Marine Turbines and Engines to China

Turbines

Year	Number	Value
2000	16	198,834
2001	6	10,686
2002	45	960,342
2003	25	76,416
2004	3	7,410
2005	6	244,726
2006	44	699,214
2007	31	444,260
2008	121	898,752
2009	67	2,422,619
2010	2	187,333
2011	0	0
2012	4	106,700
2013	2	118,000
2014	5	695,298
2015	0	0
2016	3	19,887
2017	0	0
2018	8	615,831
2019	0	0
2020	0	0
2021	1	7,496
2022	0	0

Engines

Year	Number	Value
2000	75	8,001,621
2001	120	3,630,873
2002	69	1,231,633
2003	127	1,839,839
2004	146	5,010,678
2005	599	14,100,943
2006	822	24,172,224
2007	1,594	31,876,714
2008	1,529	42,525,268
2009	717	36,617,756
2010	885	24,896,219
2011	1,277	60,447,028
2012	835	30,661,291
2013	690	32,257,672
2014	563	29,294,747
2015	523	32,875,633
2016	253	6,608,821
2017	319	9,020,897
2018	194	5,747,560
2019	168	7,695,771
2020	105	4,597,880
2021	67	1,974,920
2022	96	5,554,496

Source: Trade DataWeb, U.S. domestic exports to China under 8406.10 (marine turbines) and 8408.10 (marine engines)

EXHIBIT 132

Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States

Report to President Donald J. Trump
by the Interagency Task Force in Fulfillment of
Executive Order 13806

September 2018

Contents

I. Executive Summary

Requirement

On July 21, 2017, President Donald J. Trump signed Executive Order (EO) 13806 on Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States. The EO directs the Secretary of Defense to conduct a whole-of-government effort to assess risk, identify impacts, and propose recommendations in support of a healthy manufacturing and defense industrial base – a critical aspect of economic and national security.[1] The EO 13806 effort was initiated by the White House Office of Trade & Manufacturing Policy led by the Department of Defense's Office of Industrial Policy in coordination with the Departments of Commerce, Labor, Energy, and Homeland Security, and in consultation with the Department of the Interior, the Department of Health and Human Services, the Director of the Office of Management and Budget, the Director of National Intelligence, the Assistant to the President for National Security Affairs, the Assistant to the President for Economic Policy, and the Assistant to the President for Trade & Manufacturing Policy.

America's manufacturing and defense industrial base ("the industrial base") supports economic prosperity and global competitiveness, and arms the military with capabilities to defend the

nation. Currently, the industrial base faces an unprecedented set of challenges: sequestration and uncertainty of government spending; the decline of critical markets and suppliers; unintended consequences of U.S. Government acquisition behavior; aggressive industrial policies of competitor nations; and the loss of vital skills in the domestic workforce. Combined, these challenges – or macro forces – erode the capabilities of the manufacturing and defense industrial base and threaten the Department of Defense's (DoD) ability to be ready for the "fight tonight," and to retool for great power competition. The following report explains the macro forces impacting the industrial base, identifies primary categories of risk, illustrates impacts within sectors, and provides recommendations for mitigation.

Methodology

The EO 13806 assessment evaluated risk based on current and planned operating priorities as of late 2017/early 2018. An Interagency Task Force, led by DoD, created sixteen working groups with over 300 subject matter experts from across the federal government. Nine working groups focused on traditional sectors; seven working groups assessed enabling, cross-cutting capabilities (Figure 1).

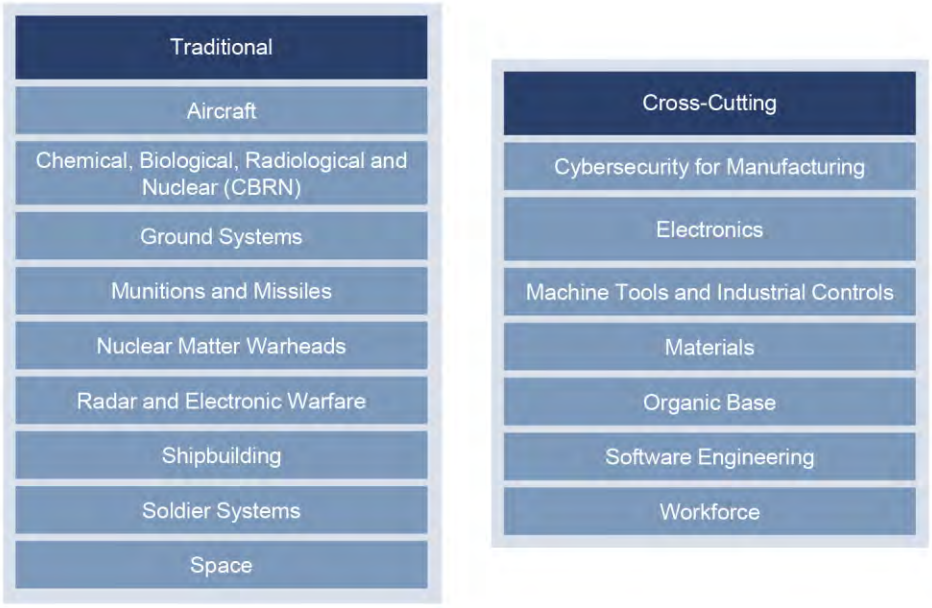

Figure 1: List of Traditional and Cross-Cutting Sectors

These macro forces collectively represent the root causes of ten risk archetypes distributed throughout the industrial base. The working groups identified discrete impacts within their sectors, many of which fall under more than one risk archetype, as illustrated in Figure 2.

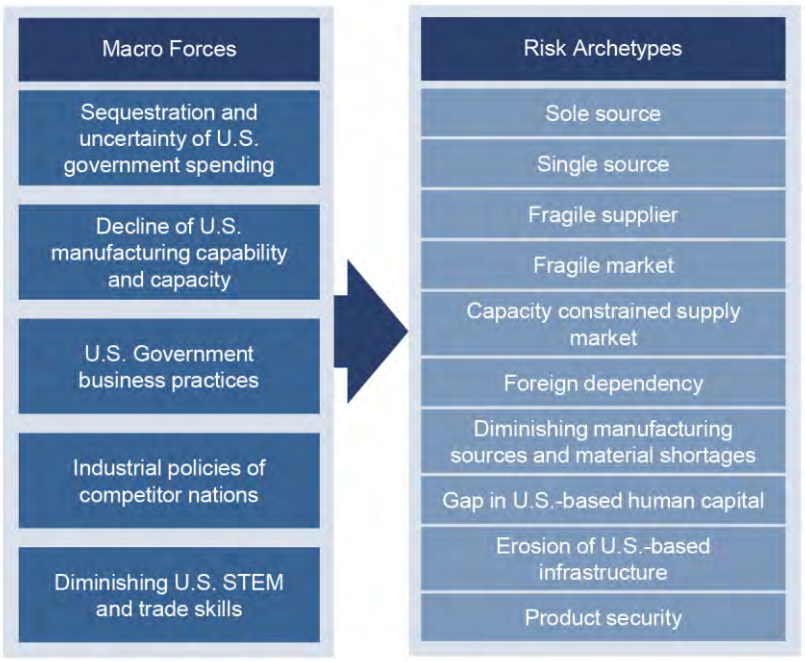

Figure 2: Macro Forces Map to Risk Archetypes

Findings

The risk framework used for the EO 13806 effort evolved from the working groups' assessments of their sectors. The assessment identified:

- Five macro forces shaping industrial base-wide trends and causing a deterioration in U.S. capabilities;
- Ten risk archetypes resulting from the macro forces, each of which contribute to insecurity in DoD's supply chain;
- Over 280 impacts across sectors, acutely affecting the vitality and resiliency of the industrial base.*

Major findings include:

- Macro forces have led to impacts primarily in the sub-tiers of the defense supply chain;
- A surprising level of foreign dependence on competitor nations exists;
- Workforce challenges face employers across all sectors; and
- Many sectors continue to move critical capabilities offshore in pursuit of competitive pricing and access to foreign markets.

* A classified spreadsheet provides a comprehensive list of impacts across risk archetypes for fifteen sectors; due to its proliferation across sectors, the software engineering working group assessed impacts across all sectors.

Recommendations

The DoD-led Interagency Task Force recognizes ongoing efforts to address the challenges identified in the EO 13806 assessment, including:

- Increased near-term DoD budget stability with the passage of the Bipartisan Budget Act of 2018, providing stable funding through Fiscal Year (FY) 2019
- Modernization of the Committee on Foreign Investment in the U.S. and investigations under Section 301 of the Trade Act of 1974 into Chinese intellectual property theft, to better combat Chinese industrial policies targeting American intellectual property
- Updates to the Conventional Arms Transfer policy and unmanned aerial systems export policy to increase U.S. industrial base competitiveness and strengthen international alliances
- Reorganization of the former Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, the work of the "Section 809 panel," and development of the adaptive acquisition framework all aim to streamline and improve defense acquisition processes
- Restructuring the Defense Acquisition University to create a workforce education and training resource to foster increased agility in acquisition personnel
- Response to Section 1071(a) of the National Defense Authorization Act for FY2018 which requires establishing a process for enhancing the ability to analyze, assess, and monitor vulnerabilities of the industrial base
- Creation of a National Advanced Manufacturing Strategy by the White House Office of Science and Technology Policy, focused on opportunities in advanced manufacturing
- Department of Labor's chairing of a Task Force on Apprenticeship Expansion to identify strategies and proposals to promote apprenticeships, particularly in industries where they are insufficient
- DoD's program for Microelectronics Innovation for National Security and Economic Competitiveness to increase domestic capabilities and enhance technology adoption
- DoD cross-functional team for maintaining technology advantage
- Implementation of a risk-based methodology for oversight of contractors in the National Industrial Security Program, founded on risk management framework principles to assess and counter threats to critical technologies and priority assets

In addition to the ongoing efforts outlined above, the DoD-led Interagency Task Force created a set of recommendations aligned to four levers: investment, policy, regulation, and legislation. The recommendations are organized by the Secretary, with DoD's recommendations provided in a classified Action Plan. In summary, the recommendations propose:

- Create an industrial policy in support of national security efforts, as outlined in the National Defense Strategy, to inform current and future acquisition practices

- Expanding direct investment in the lower tier of the industrial base through DoD's Defense Production Act Title III, Manufacturing Technology, and Industrial Base Analysis and Sustainment programs to address critical bottlenecks, support fragile suppliers, and mitigate single points-of-failure
- Diversifying away from complete dependency on sources of supply in politically unstable countries who may cut off U.S. access; diversification strategies may include reengineering, expanded use of the National Defense Stockpile program, or qualification of new suppliers
- Working with allies and partners on joint industrial base challenges through the National Technology Industrial Base and similar structures
- Modernizing the organic industrial base to ensure its readiness to sustain fleets and meet contingency surge requirements
- Accelerating workforce development efforts to grow domestic science, technology, engineering, mathematics (STEM), and critical trade skills
- Reducing the personnel security clearance backlog through more efficient processes
- Further enhancing efforts to explore next generation technology for future threats

A challenge this large demands a multifaceted approach. Therefore, the classified Action Plan also includes direction for DoD to conduct a comprehensive study on the industrial base requirements needed to support force modernization efforts, specifically focused on the technologies necessary to win the future fight.

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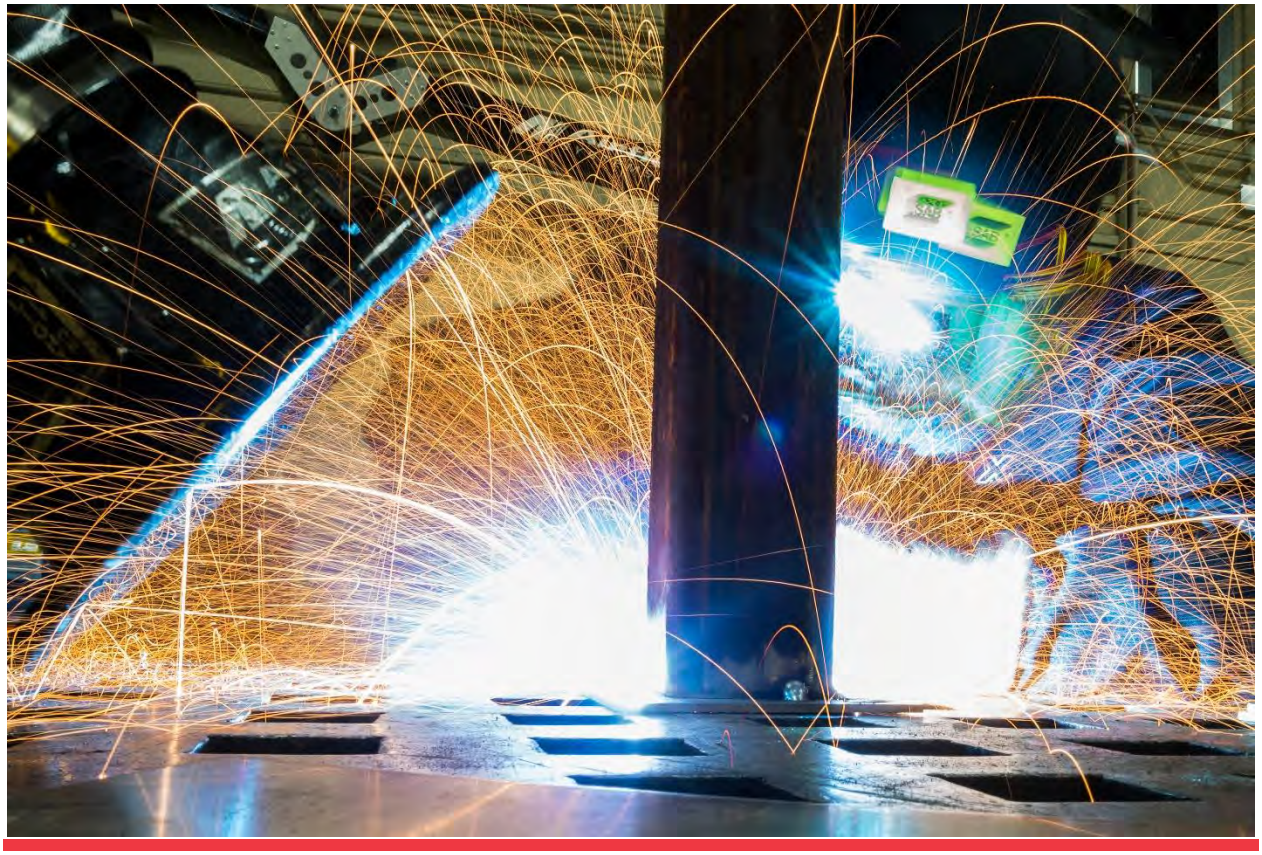

II. Introduction

"It would, also, be a material aid to manufactures of this nature, as well as a mean of public security, if provision should be made for an annual purchase of military weapons, of home manufacture, to a certain determinate extent, in order to the formation of arsenals; and to replace, from time to time, such as should be drawn for use, so as always to have in store the quantity of each kind which should be deemed a competent supply."

— Secretary of the Treasury Alexander Hamilton,
Report on the Subject of Manufactures (1791)

To provide for our national security, America's manufacturing and defense industrial base must be secure, robust, resilient, and ready. To ensure taxpayer dollars are frugally and wisely spent, the defense industrial base must be cost-effective, cost-efficient, highly productive, and not unduly subsidized. In the event of contingencies, the industrial base must possess sufficient surge capabilities. Above all, America's manufacturing and defense industrial base must support economic prosperity, be globally competitive, and have the capabilities and capacity to

rapidly innovate and arm our military with the lethality and dominance necessary to prevail in any conflict. As President Trump stated in the 2017 National Security Strategy:

> *"A healthy defense industrial base is a critical element of U.S. power and the National Security Innovation Base.[†] The ability of the military to surge in response to an emergency depends on our Nation's ability to produce needed parts and systems, healthy and secure supply chains, and a skilled U.S. workforce."*[2]

All facets of the manufacturing and defense industrial base are currently under threat, at a time when strategic competitors and revisionist powers appear to be growing in strength and capability. As stated in the National Defense Strategy:

> *"The central challenge to U.S. prosperity and security is the reemergence of long-term, strategic competition by what the National Security Strategy classifies as revisionist powers. It is increasingly clear that China and Russia want to shape a world consistent with their authoritarian model – gaining veto authority over other nations' economic, diplomatic, and security decisions."*[3]

At least five macro forces cause the risks now threatening America's industrial base. From FY2012 through FY2017, sequestration led to lower defense spending relative to levels projected before sequestration was put in place. Antiquated and counter-productive procurement practices induced contracting delays, deterred market entry, discouraged innovation, and increased costs to suppliers. Decreases in key production capabilities and declines in manufacturing employment, relative to the last time the U.S. faced a great power competition, left key weaknesses that threaten the nation's manufacturing capabilities. The industrial policies of foreign competitors have diminished American manufacturing's global competitiveness – sometimes as collateral damage of globalization, but also due to specific targeting by great powers like China. Finally, emerging gaps in our skilled workforce, both in terms of STEM as well as core trade skills (e.g., welding, computer numeric control operation, etc.) pose increasing risk to industrial base capabilities.[4]

Arising from these macro forces is a set of ten risk archetypes with discrete impacts on America's manufacturing and defense industrial base. These include the rise of single and sole source suppliers which create individual points of failure within the industrial base, as well as fragile suppliers near bankruptcy and entire industries near domestic extinction. Due to erosion that has already occurred, some manufacturing capabilities can only be procured from foreign suppliers, many of which are not domiciled in allied and partner nations. The concomitant gaps

[†] The National Security Strategy defines the National Security Innovation Base as the American network of knowledge, capabilities, and people—including academia, National Laboratories, and the private sector—that turns ideas into innovations, transforms discoveries into successful commercial products and companies, and protects and enhances the American way of life.

in U.S.-based human capital and erosion of domestic infrastructure further exacerbates the challenge. Ultimately, these negative impacts have the potential to result in limited capabilities, insecurity of supply, lack of R&D, program delays, and an inability to surge in times of crisis.

In recognition of these emerging threats, risks, and impacts, EO 13806,[5] initiated by the White House Office of Trade & Manufacturing Policy and signed by President Trump on July 21, 2017, directed the Secretary of Defense to conduct a whole-of-government assessment of America's manufacturing and defense industrial base. The Secretary of Defense was further directed to provide the President with a set of specific actions to address any identified risks and gaps. This report fulfills these directives.

Part III outlines the methodology used in this assessment of the industrial base. Part IV briefly describes America's manufacturing and defense industrial base. Part V describes five macro forces that collectively represent the root causes of the emerging threats to America's industrial base, driving risk at the market and firm level. Part VI explains each of the ten major risk archetypes identified by the DoD-led Interagency Task Force, with examples identified by the sector working groups. Part VII provides a blueprint for specific actions to begin mitigating risk and impacts within America's manufacturing and defense industrial base.

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III. Methodology

To meet the goals of EO 13806, the White House Office of Trade and Manufacturing Policy and the DoD's Office of Industrial Policy established an Interagency Task Force and authorized a set of working groups.[‡] Multiple organizations within DoD as well as the Departments of Commerce, Education, Energy, Homeland Security, and Labor contributed resources to the 16 working groups. Each working group, led by a sector specialist, assembled teams of subject matter experts – over 300 people in total – who identified manufacturing and industrial base risks, outlined sector-specific impacts, and recommended actions for mitigation.

The DoD-led Interagency Task Force identified and assessed nine traditional and seven cross-cutting sectors of the manufacturing and defense industrial base, listed in Figure 3. Sectors – ranging from aircraft and missiles to workforce and materials – were selected based on current operational priorities.[6] Appendix Two provides sector definitions and case studies outlining

[‡] DoD's Office of Industrial Policy (formerly known as Manufacturing and Industrial Policy) provides Congress with an Annual Industrial Capabilities report, which supplied a strong basis upon which to determine the sectors of focus for the EO 13806 effort. The Annual Industrial Capabilities report identifies risks but does not make recommendations, a major distinction between the two efforts.

examples of risk and impacts in each sector. To appropriately scope the EO 13806 effort, the Interagency Task Force recommended evaluation of next generation technologies as part of a follow-on effort.

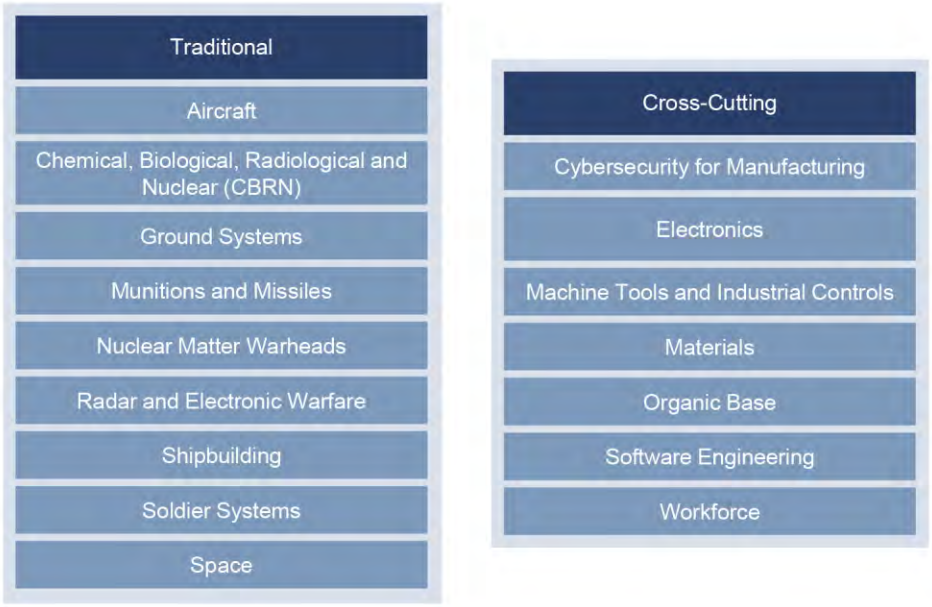


Figure 3: List of Traditional and Cross-Cutting (enabling) Sectors

To develop the manufacturing and defense industrial base assessment framework, the DoD-led Interagency Task Force tasked each working group to determine risks within their sectors based on their individual frameworks. After gathering and analyzing the disparate risks across the working groups, a pattern of macro forces and risk archetypes emerged, coalescing in a comprehensive risk framework (Figure 4) from which to address the health of the industrial base.

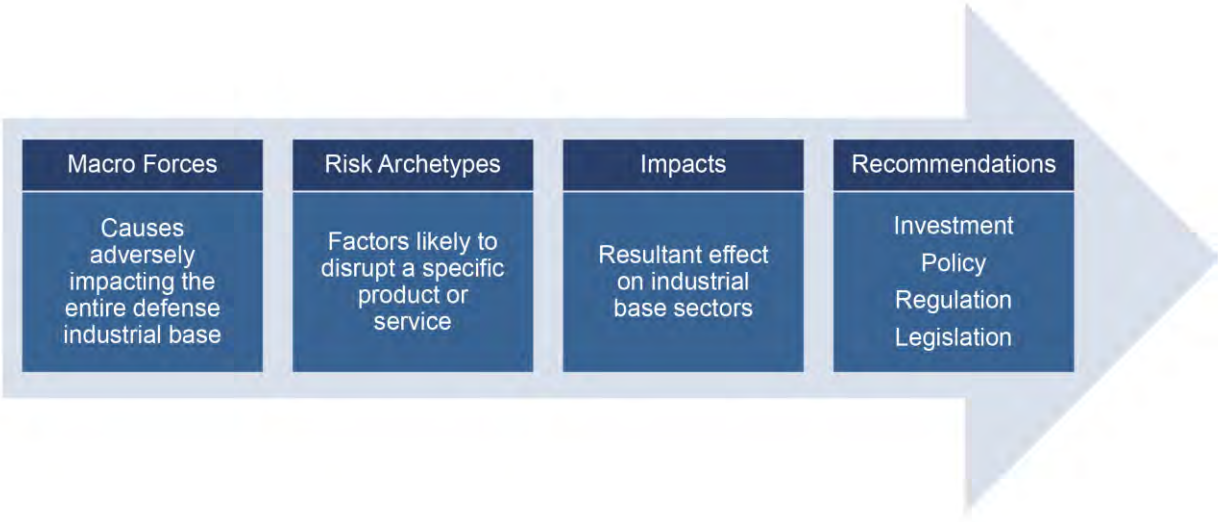


Figure 4: Manufacturing and Defense Industrial Base Risk Framework

Figure 5 provides additional detail regarding the risk framework. Columns one and two illustrate how macro forces such as budget sequestration or the decline of general U.S. manufacturing capabilities and capacity bear down on the manufacturing and defense industrial base to generate ten "risk archetypes" (e.g., reliance on a sole source, fragile supplier, foreign dependency, product security, etc.). The risk archetypes result in various impacts on the manufacturing and defense industrial base, outlined in column three. Finally, column four provides the various categories of recommendations to reduce or eliminate risk.

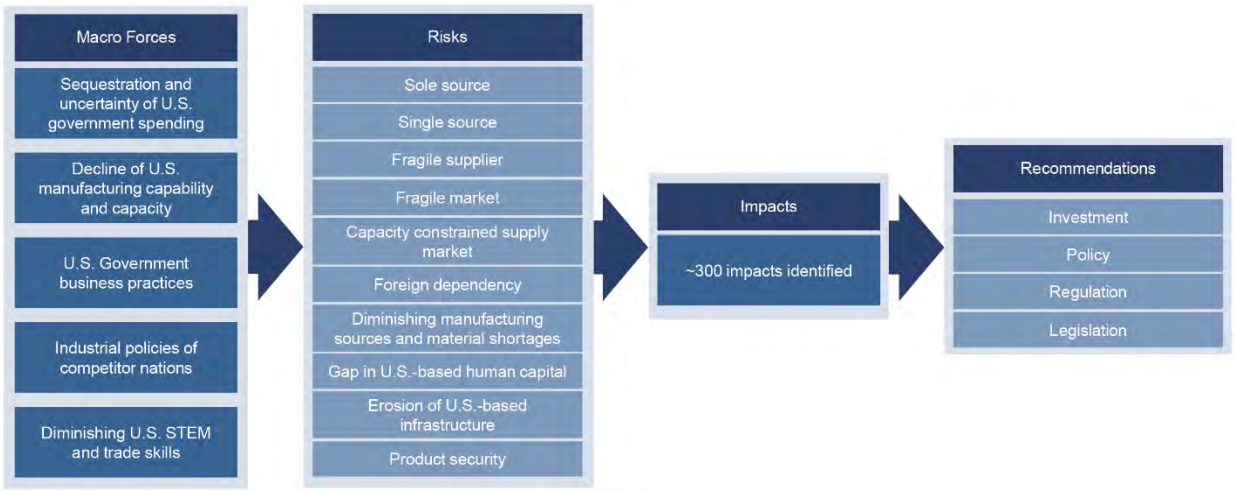


Figure 5: Detailed Outline of the Risk Framework

The risk framework illustrates the multifaceted mapping endemic in the 21st century manufacturing and defense industrial base. A single macro force, such as U.S. Government business practices or budget uncertainties, may map to multiple risk archetypes. Conversely, multiple macro forces may create a single risk archetype.

To demonstrate the interwoven aspects of the industrial base, consider the risks facing the aircraft sector, which include sub-sectors such as fixed wing, rotorcraft, and unmanned aerial systems. Each sub-sector faces challenges, including long product and system development timelines, high development and qualification costs, and production limitations. The challenges in the aircraft sector are driven by multiple risk archetypes, including single and sole source suppliers and gaps in U.S.-based human capital with expertise in critical hardware and software design capabilities. Collectively, these impacts could potentially reduce America's capability to produce and field an aircraft fleet with superior capabilities.

Such complex interactions between multiple risk archetypes are illustrated in Figure 6, which provides the count of each risk archetype by the sector working groups, found over the course of this assessment.

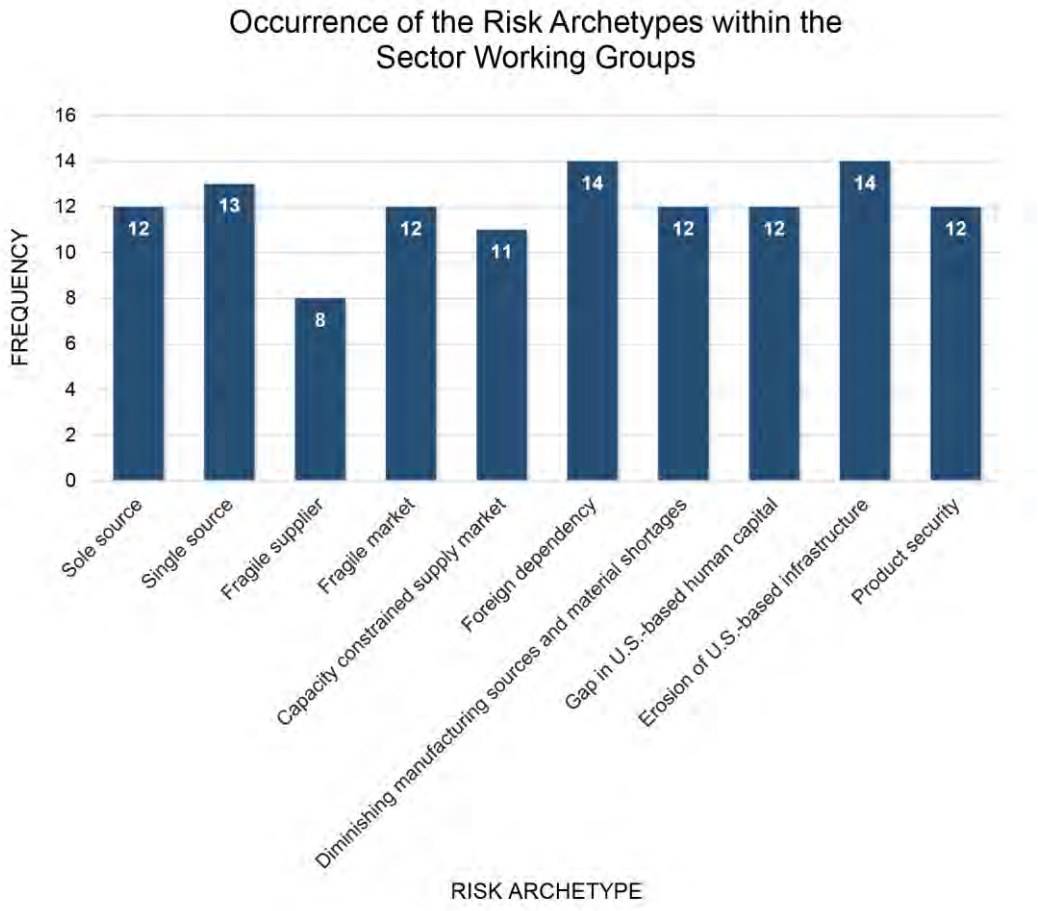
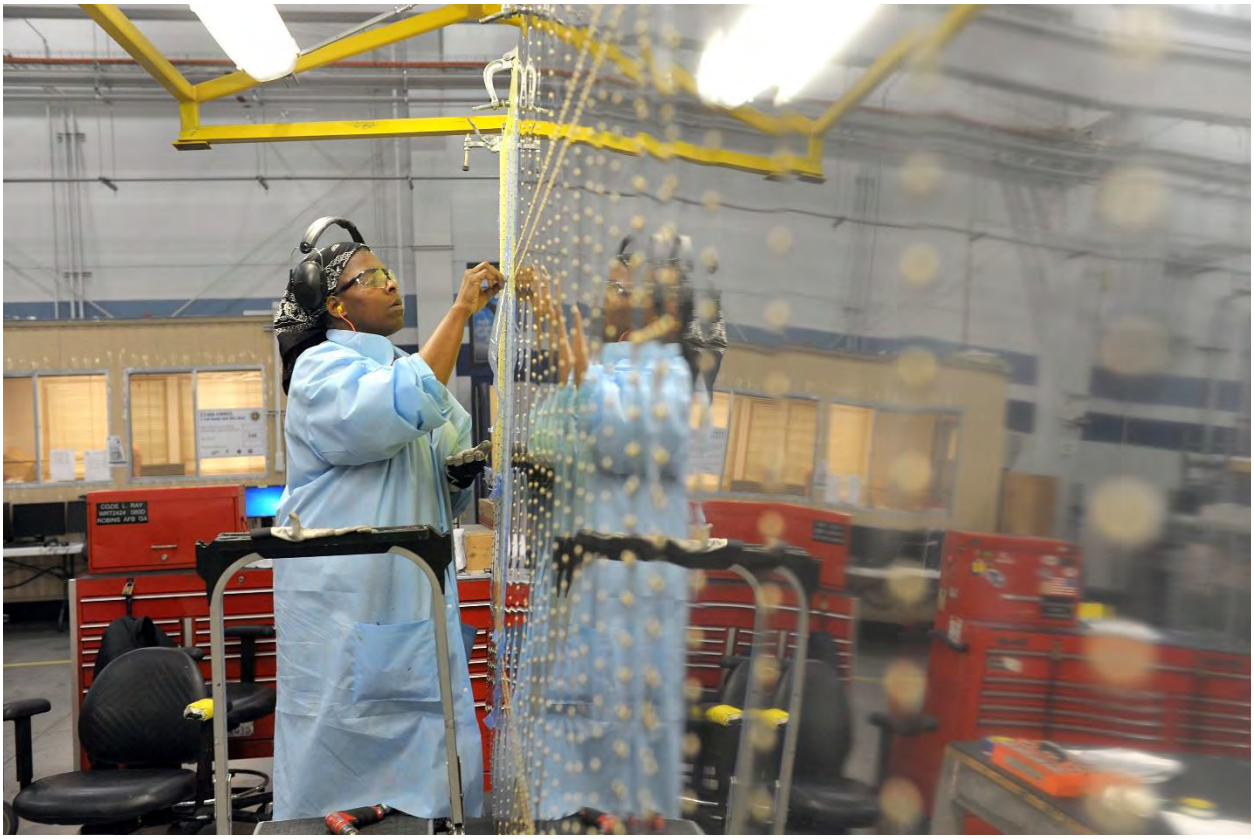


Figure 6: Risk Archetype Analysis across the Working Groups

In all, the working groups of the DoD-led Interagency Task Force identified almost 300 impacts across the ten risk archetypes in the manufacturing and defense industrial base. A classified spreadsheet with risk archetypes and impacts for all sixteen sectors is available.[§]

The ultimate goal of EO 13806 was to conduct a comprehensive assessment of the industrial base and develop a set of specific, actionable recommendations to mitigate or eliminate the identified impacts. In pursuit of this goal, the working groups relied on data and assessments from each of the coordinating agencies; qualitative feedback from industry listening sessions; support from the Defense Science Board; and modeling and analysis from the Institute for Defense Analyses, a federally-funded R&D center contracted by DoD for support of the assessment. Appendix Three lists the agencies and offices who supported the assessment; Appendix Four provides a full list of government resources referenced; Appendix Five lists the industry listening sessions.

[§] Given its proliferation throughout traditional sectors, the software engineering working group assessed impacts across sectors; as such, software risks are included in each of the sectors' inputs to the classified spreadsheet, not as its own inputs.



IV. An Overview of America's Manufacturing and Defense Industrial Base

America's manufacturing and defense industrial base consists of the end-to-end set of capabilities, both private and public, that design, produce, and maintain the platforms and systems (hardware and software) on which our Warfighter depends. With an extensive, multi-tiered global supply chain, the industrial base encompasses the extraction and refinement of primary materials, the manufacturing of components and parts, and the integration and sustainment of defense platforms and systems. It relies on a geographically and economically diverse network of private sector companies, R&D organizations, academic institutions, and government-owned facilities to develop and produce the technologies enabling U.S. military dominance and ensuring national security.

The Domestic Manufacturing and Defense Industrial Base

For the purposes of this assessment, the domestic industrial base includes two categories of producers of goods and services – the private sector and the organic industrial base. The private sector (also known as the commercial sector) includes prime system integrators, major sub-system suppliers, component suppliers, and service providers, from small to large companies. Across multiple tiers of the supply chain, private sector companies produce defense-specific products exclusively for use by DoD and approved foreign buyers, including platforms, weapons systems, and components hardened for defense uses. Private sector companies may also produce products specially designated as "dual-use," which have both military and nonmilitary applications and may be subject to export control, as well as commercial items without an explicit defense use.[7]

The organic defense industrial base (also known as the organic base, or the government or public sector) includes government-owned, government operated and government-owned, contractor operated facilities that provide specific goods and services for DoD. The organic base is composed of resource providers, acquisition and sustainment planners, and manufacturing and maintenance performers at depots, manufacturing arsenals, and ammunition plants. By law, some production and maintenance activities must be executed by organic base components.

The Global Manufacturing and Defense Industrial Base

The global elements of America's manufacturing and defense industrial base include enterprises from countries with formal supply relationships with the United States (U.S.) and those without.

The National Defense Authorization Act for FY1993 established the National Technology and Industrial Base, codifying the highly integrated defense industrial cooperation between the U.S. and Canada dating back to the Ogdensburg Declaration of 1940 and subsequent Hyde Park Declaration of 1941.[8] The National Defense Authorization Act for FY2017 added the United Kingdom of Great Britain and Northern Ireland and Australia to the definition of the National Technology and Industrial Base.[9] These types of agreements with partners and allies provide economies of scale and scope, help facilitate cost-effective defense production, and increase Warfighter interoperability.[10]

Some U.S. partners and allies outside the National Technology and Industrial Base are uniquely vetted and qualified to produce goods and services for DoD via secure defense procurement agreements. Bilateral Security of Supply arrangements allow DoD to request priority delivery for DoD contracts, subcontracts, or orders from companies in these countries, and allow the signatory nations to request priority delivery for their contracts and orders with U.S. firms. Security of Supply arrangements are conducted under the overarching Declarations of Principles for Enhanced Cooperation in Matters of Defense Equipment and Industry signed with participating nations. These arrangements encourage participating nations to acquire defense

goods from each other, promote interoperability, and provide assurance of timely delivery during peacetime, emergencies, and armed conflict. Security of Supply arrangements are currently in place with Australia, Canada, Finland, Italy, Netherlands, Norway, Spain, Sweden, and the United Kingdom.

Under Reciprocal Defense Procurement Agreements, countries afford each other certain benefits on a reciprocal basis, consistent with their national laws and regulations. Each Reciprocal Defense Procurement agreement provides a framework for ongoing communication between or among DoD and its respective counterparts regarding market access and procurement matters that contribute to effective defense cooperation. Key Reciprocal Defense Procurement agreement principles include: fair competition, reduced market barriers, transparent processes, and protection of intellectual property. In addition, U.S.-based subsidiaries of foreign defense companies are able to leverage the support, intellectual property, and design capabilities of their foreign parent companies, as well the U.S.-unique capabilities developed under special security agreements or a proxy voting trust. It should be noted that, in general, the U.S. maintains a positive trade balance for defense articles and services with countries who are signatories to Reciprocal Defense Procurement agreements.

Through the ongoing globalization of industrial supply chains and commodities markets, a number of countries without formal supply agreements support the manufacturing and defense industrial base with items such as strategic and critical materials, commercial off-the-shelf products, electronics, and some defense components. Countries in this category include Kazakhstan, Singapore, Jamaica, and strategic competitors like China.

The picture emerging from this geographically and economically diverse network of providers is of an American industrial base with multiple opportunities for growth and innovation, but increasingly dispersed and at risk from both domestic gaps and global forces.

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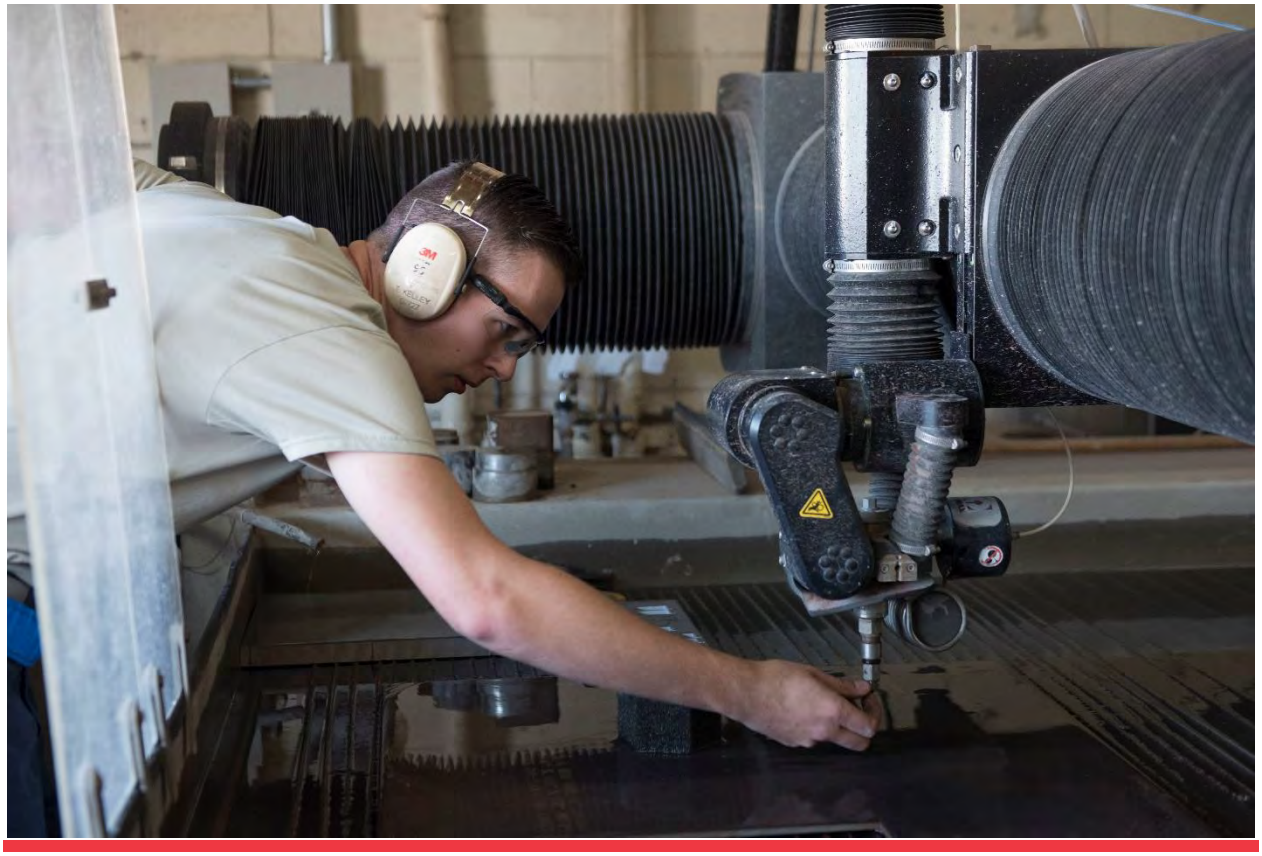

V. Five Macro Forces Driving Risk into America's Industrial Base

The micro-level sector analyses of the working groups led to identification of five inter-related, but conceptually distinct, macro forces (Figure 7). These macro forces collectively represent the root causes of the ten risk archetypes and associated impacts on America's manufacturing and defense industrial base. We must address the five causes, and mitigate the risks and threats to our industrial base, in order to prevent further erosion of America's military dominance.

Macro Forces	Definition
Sequestration and uncertainty of U.S. Government spending	Inconsistent appropriations, uncertainty about future budgets, macro-level ambiguity in U.S. Government expenditures, and the effects of the Budget Control Act create market instability
Decline of U.S. manufacturing base capabilities and capacity	Reductions across the U.S. manufacturing and defense industrial base affect the viability of suppliers, overall capacity, and capabilities available domestically
Deleterious U.S. Government business and procurement practices	Challenges working with DoD and other U.S. Government customers, including contracting regulations, policies, barriers to entry, qualification challenges, programmatic changes, and other problems, can lead to adverse effects on suppliers

Macro Forces	Definition
Industrial policies of competitor nations	Domestic industrial and international trade policies of competitor nations, notably the economic aggression of China, directly or indirectly degrade the viability, capabilities, and capacity of the U.S. National Security Innovation Base
Diminishing U.S. STEM and trade skills	Gaps in American human capital, including a lack of STEM talent and declining trade skills, diminish domestic capabilities to innovate, manufacture, and sustain

Figure 7: Definitions of the Five Macro Forces Driving Risks into America's Industrial Base

1. Sequestration and Uncertainty of U.S. Government Spending

Markets thrive on predictability, allowing businesses to make informed decisions and invest in the future. Defense spending inherently fluctuates with the arming for conflict and subsequent drawdown and decrease of program funding. But as illustrated in Figure 8, these swings in funding can be very dramatic, particularly in the funding streams for weapon systems procurement and research, design, test, and evaluation.

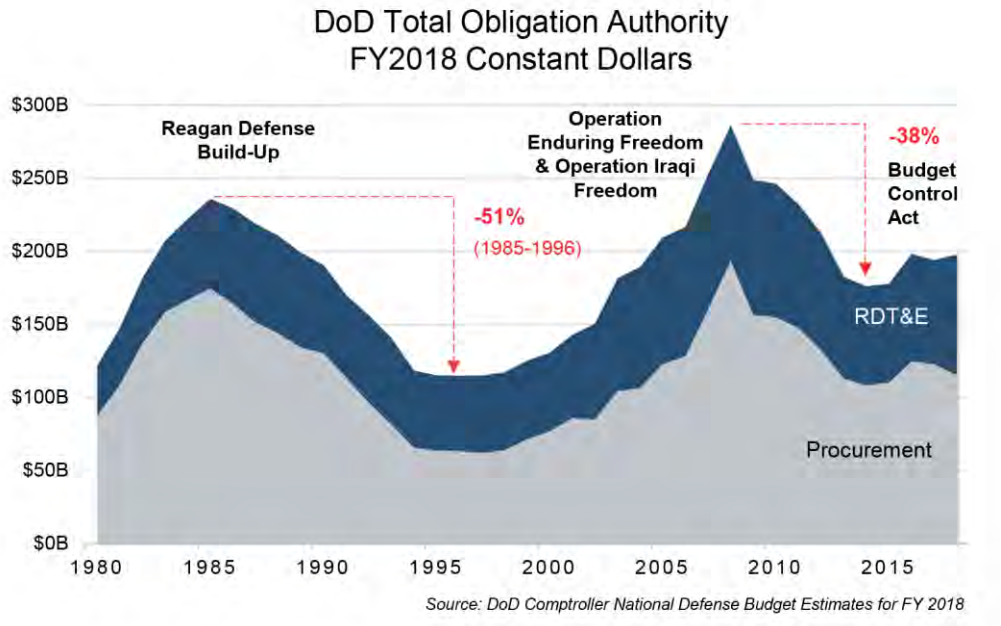

Figure 8: Defense Investment Spending From 1980 to 2017

A. Impacts of Budget Uncertainties

At the macroeconomic level, defense spending uncertainty makes predicting the overall market size difficult, impeding forecasting across every tier in the supply chain. Uncertainty in spending inhibits investment in capabilities even where the overall sector market size is increasing, impacting defense suppliers and leading to revenue fluctuation, capital investment

shortfalls, and suboptimal investment in R&D. Over time, spending instability also creates peaks of surge and valleys of drought – a pernicious, ambiguous pattern in which suppliers who build for scale production are left with excess capacity when programs end, creating long-term market distortion.

The decade-long reliance on Congressional continuing resolutions[11] has exacerbated uncertainty, both for DoD and across the supply chain. Combined with the adverse impacts of the Budget Control Act,[12] these fluctuations challenge the viability of suppliers within the industrial base by diminishing their ability to hire and retain a skilled workforce, achieving production efficiencies, and in some cases, staying in business. Without correcting or mitigating this U.S. Government-inflicted damage, DoD will be increasingly challenged to ensure a secure and viable supply chain for the platforms critical to sustaining American military dominance.

At the microeconomic level, DoD's budget within a specific sector does not imply uniform, stable, or even predictable funding for suppliers. Such uncertainty creates negative ramifications within specific industrial base sectors, even in periods with overall growth in spending. For example, when the Navy is unable to provide consistent orders for ships, niche suppliers of components such as controllers and actuators for nuclear powered ships cannot accurately project workloads, creating inconsistency and increasing risk for production capabilities.

Wrought aluminum plate, and specifically cold-rolled plate, is essential for armoring U.S. ground combat vehicles, constructing Navy ships, and building military aircraft. Unlike other more common forms of rolled aluminum materials, thick cold-rolled aluminum production capabilities and capacities are unique. DoD relies on domestic producers as well as capabilities available from ally countries in Europe. Due to U.S. Government budget uncertainties, unpredictable DoD demand, and other commercial market factors, the defense industrial base can face challenges when trying to balance diverse demands for cold-rolled plate production capacity while also informing long-term internal capital investment decisions.

Challenges facing the ground systems sector illustrate the relationship between budget uncertainty and diminishing workforce skills. Ground systems provide defense-unique products for mobility and firepower and are divided into tracked and wheeled vehicles for combat, combat support, and combat service support. Under the weight of budget uncertainties, the ground systems industrial base conducted incremental adoption of new technologies on legacy designs in order to maintain or modify current ground systems. While this approach allowed the military to defer the long schedules and high costs of new programs, it prevented ground systems development and maintenance personnel from experiencing the design to fielding lifecycle for a new system. This resulted in a generation of technicians, engineers, and scientists lacking experience in conceiving, designing, constructing, and integrating technologically advanced combat vehicles.

B. Production and Cost Inefficiencies

Fluctuations in defense procurement create production and cost inefficiencies. With confirmed procurement and investments, suppliers will take on high fixed costs to develop expensive new capacity in order to meet programmatic needs. When programs draw down, companies are left with highly specialized production capabilities that may go unused for decades. As defense-specific products require extensive qualification testing and procedures, suppliers face a costly decision to keep facilities open for potential future production, or to shutter facilities, incurring costs and forcing DoD to pay reconstituion costs when the need arises.

The "bullwhip effect" of DoD spending forces inefficiencies across the entire supply chain. As Figure 9 illustrates, the spike of recapitalization in space programs from 2000-2010, followed by a precipitous decline from 2010-2015, left suppliers with excess capacity.

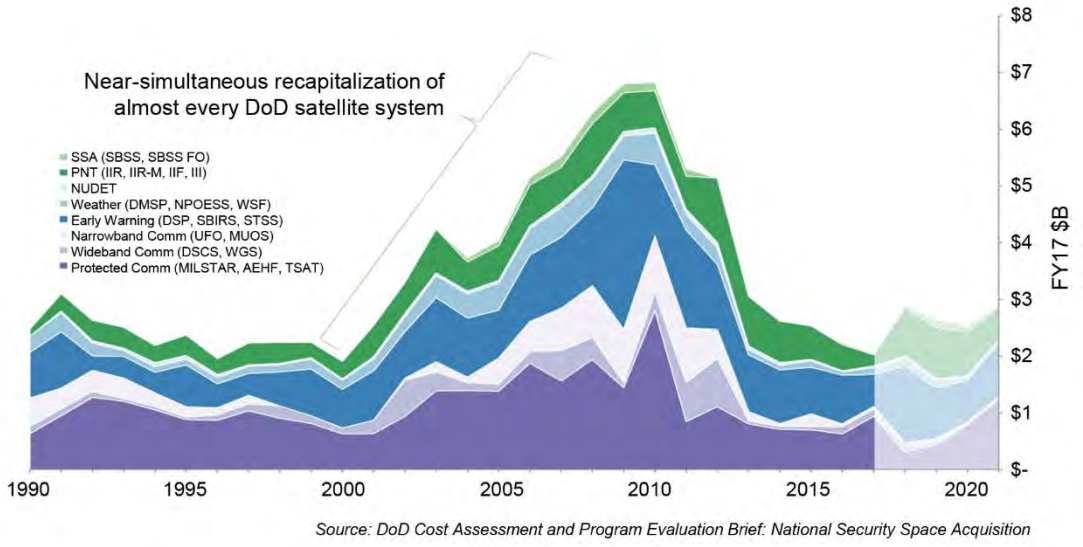

Figure 9: The Bullwhip Effect within the Space Programs

Fluctuations in capacity requirements acutely affect suppliers of maintenance and operations support services, to the detriment of readiness. For example, Navy ships have suffered maintenance availability delays and deferrals, reducing time underway and diminishing U.S. power projection. One study by the Rand Corporation found unpredictability in ship maintenance reduced incentives to invest in facilities and human capital, delaying needed modernizations and putting future surge maintenance capabilities at risk. Navy maintenance providers faced long periods of low workload coupled with short periods of surge, leading to cycles of hiring and layoffs that ultimately deterred skilled workers from the sector.[13]

A short history of the organic industrial base illustrates risk to overall readiness. The organic base, consisting of 17 major organic (government-owned, government operated) depot maintenance facilities and three manufacturing arsenals, provides maintenance and

manufacturing services to sustain approximately 440,000 vehicles, 780 strategic missiles, 278 combatant ships[14], and almost 14,000 aircraft.[15]

Since 2001, DoD has operated at a very high tempo with unprecedented system usage in support of global deployments, changing previously accepted formulas that compute maintenance requirements. Of $587.9 billion total DoD expenditures in FY 2015,[16] $73.4 billion was for maintenance – aircraft represented $25 billion, followed by ships at $16.8 billion, and vehicles at $7.7 billion.[17] Overuse and underfunding in infrastructure and workforce has eroded materiel readiness levels and facility conditions, directly impacting DoD's ability to repair equipment and materiel quickly to ensure availability for training and future deployments.

C. Harming Maintenance, Slowing Modernization

Continuing resolutions and the ongoing threat of sequestration exacerbate problems induced by defense spending uncertainty and hamper DoD's ability to develop a more lethal force. After the Budget Control Act of 2011, which introduced sequestration of the defense budget, DoD's procurement budget dropped 26% from its FY 2010 peak.[18] This rapid decrease in spending has negatively impacted operations, maintenance, and modernization of U.S. forces and directly impacted the viability of suppliers in the industrial base.

A recent study by the Center for Strategic and International Studies estimates that from 2001 to 2015, 17,000 companies ceased to be prime vendors for DoD.[19] Specialty manufacturers critical to the production of defense platforms have been especially hard hit and many are unable to make the modernization investments necessary to meet product requirements. For example, the single domestic source for large thin wall castings for rotary wing gearboxes filed for bankruptcy in 2016,[20] putting programs such as the AH-64E Apache, the V-22 Osprey, and the CH-53K Heavy Lift Replacement Helicopter at risk.

Unstable appropriations over the past decade created additional uncertainty in DoD's procurement plans, leading to unreliable demand signals to industry. Congress enacted over 30 continuing resolutions since 2009, with an average of 127 days each year under a continuing resolution (Figure 10), thus inhibiting long-term planning and postponing multi-year funding obligations to new programs.[21]

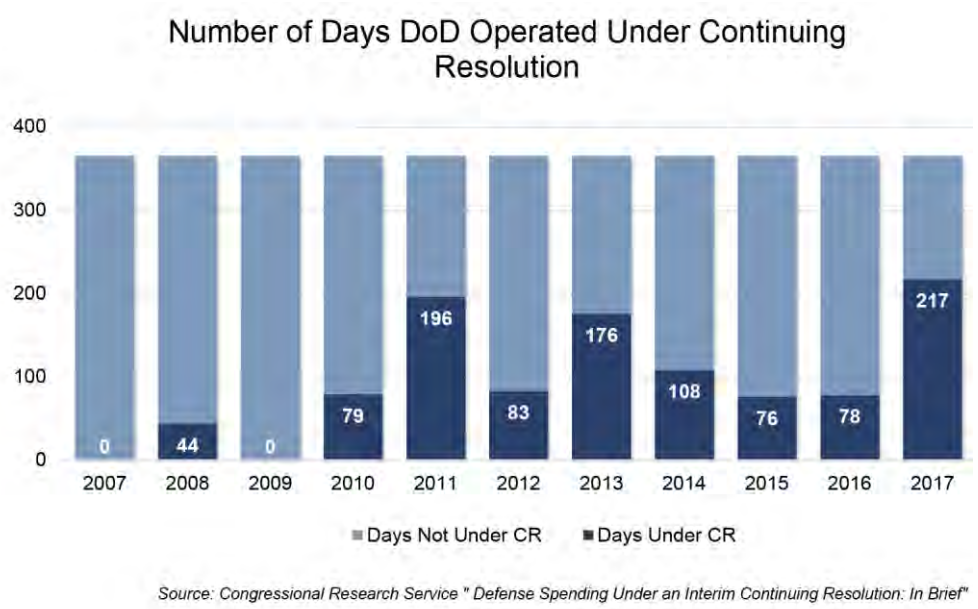

Figure 10: Duration of DoD Operations Subject to Continuing Resolution

D. Reducing Market Entry, Spurring Market Exits

In 2017, DoD found 75 new program starts that could not be executed while it continued to operate under a continuing resolution, with multiple tiers of the manufacturing and defense industrial base's supply chain taking the brunt of the impact.[22] Companies that do not have existing relationships are further deterred from entering into business with the DoD due to the level of cost and volatility associated with the engagement, thus impacting the potential of new entrants into the market.

The Government Accountability Office reported a "non-traditional" defense company that produces augmented reality products received funding to support engineering and development activities by the Army. However, due to budget sequestration, the funding was lost and the company is no longer pursuing business in the defense market.[23]

2. Decline of U.S. Manufacturing Capabilities and Capacity

The roots of America's defense industrial base are planted in the broader manufacturing ecosystem. Not only is the manufacturing sector the backbone of U.S. military technical advantage, but also a major contributor to the U.S economy, accounting for 9% of employment, 12% of GDP, 60% of exports, 55% of patents, and 70% of U.S. R&D.[24] The National Security Strategy highlights the importance of a vibrant manufacturing sector to comprehensive national power, while warning of the dangers inherent in the weakening of America's manufacturing base:

> *A healthy defense industrial base is a critical element of U.S. power and the National Security Innovation Base. The ability of the military to surge in response to an emergency depends on our Nation's ability to produce needed parts and systems, healthy and secure supply chains, and a skilled U.S. workforce. The erosion of American manufacturing over the last two decades, however, has had a negative impact on these capabilities and threatens to undermine the ability of U.S. manufacturers to meet national security requirements. Today, we rely on single domestic sources for some products and foreign supply chains for others, and we face the possibility of not being able to produce specialized components for the military at home. As America's manufacturing base has weakened, so too have critical workforce skills ranging from industrial welding, to high-technology skills for cybersecurity and aerospace. Support for a vibrant domestic manufacturing sector, a solid defense industrial base, and resilient supply chains is a national priority.*[25]

Between 2000 and 2010, over two-thirds of U.S. manufacturing saw production declines in terms of inflation-adjusted output.[26] While multi-factor productivity in manufacturing grew on an average of 2% per year from 1992-2004, productivity has declined an average of 0.3% per year from 2004 through 2016, implying diminishing economies of scale from inputs including labor, capital equipment, energy, materials, and purchased services.[27] Between 2000 and 2010 alone, the U.S. lost over 66,000 manufacturing facilities.[28] While the U.S. has seen an uptick in manufacturing, adding around 380,000 jobs since January 2017,[29] much work remains to be done to remedy years of decline in the sector.

From 2000-2018, many defense-relevant sectors have seen increased import penetration with rates more than doubling for the industrial controls and machine tools subsectors.[30] Since 2010, critical manufacturing and defense industrial base areas have seen fluctuations in obligations spending, creating variability in vendor counts and in many cases leading to lower domestic competition and further deteriorating DoD's supply chain (Figure 11). The negative effects of sequestration and the budget caps shocked the market and accelerated the downward trend in vendor counts, resulting in an estimated 20% decline in the number of prime vendors.[31]

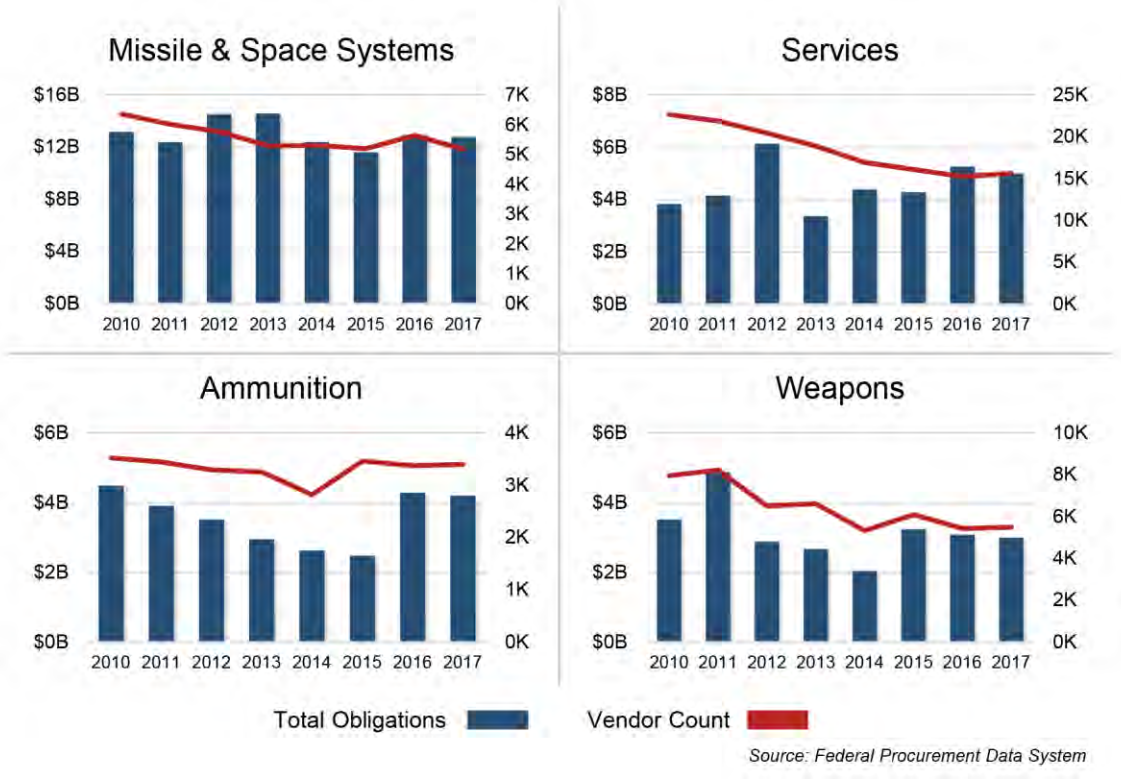

Figure 11: Falling Vendor Counts in Key Manufacturing and Defense Industrial Base Areas

Although America's traditional manufacturing base still accounts for an outsized benefit to the economy, decreases in key production capabilities, declines in manufacturing employment, and slow output growth for many manufacturing sectors have created key vulnerabilities and weaknesses that potentially threaten the nation's defense-related manufacturing capabilities. Since 1990, small and medium sized businesses – which make up a majority of U.S. manufacturing and employ a large portion of workers in the sector – reported declines in revenue growth, despite the largest manufacturing firms posting more than 2% annual growth.[32] The next generation of weapons will require advanced software, artificial intelligence, and machine learning, but traditional manufacturing processes continues to build the systems, platforms, and munitions that deliver kinetic effects. Both aspects of the industrial base are needed for long term economic growth and national security.

The decline in the U.S. manufacturing industry, relative to prior periods of great power, creates a variety of risks for America's manufacturing and defense industrial base and, by extension, for DoD's ability to support national defense. Risks range from greater reliance on single sources, sole sources, and foreign providers to workforce gaps, product insecurity, and loss of innovation.

A. Gaps in America's Manufacturing Workforce

With the weakening of the U.S. manufacturing sector, the American manufacturing workforce has suffered, with employment peaking in 1979 and job losses accelerating significantly in the 2000s.[33] As shown in Figure 12, the share of employment attributed to manufacturing has fallen

dramatically, from over 30% in the 1950s to less than 10% in 2017. From 1979 to 2017, the U.S. lost 7.1 million manufacturing jobs, 36% of the industry's workforce,[34] with more than 5 million manufacturing jobs lost since 2000 alone.[35] Job losses have been most pronounced in vital sectors subject to import competition, including primary metals, electronics, chemicals, and machinery.[36] Manufacturing and defense industrial base companies' inability to hire or retain U.S. workers with the necessary skill sets has led to significant gaps in skilled labor.

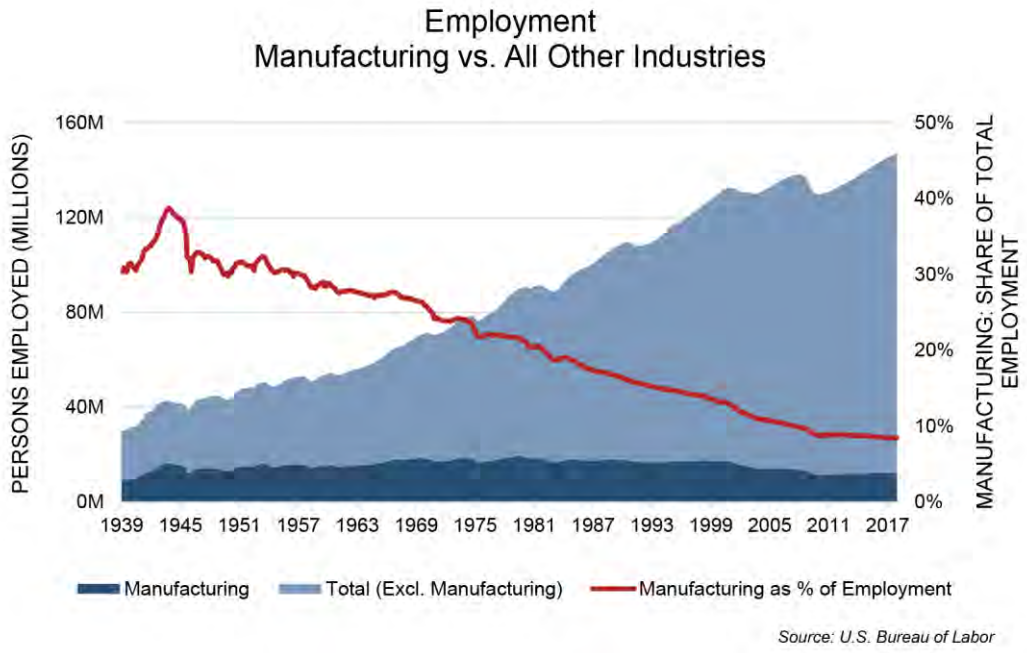

Figure 12: A Sharp Relative Decline in Manufacturing Employment in the U.S. Economy

A lack of skilled manufacturing workers and a decreasing number of jobs is destabilizing workforce readiness and leading to skill atrophy. As illustrated in Figure 13, such instability and atrophy further increase the gap between job openings and hires and accentuate the effects of a shrinking workforce, making worker placement more challenging even when labor is needed.

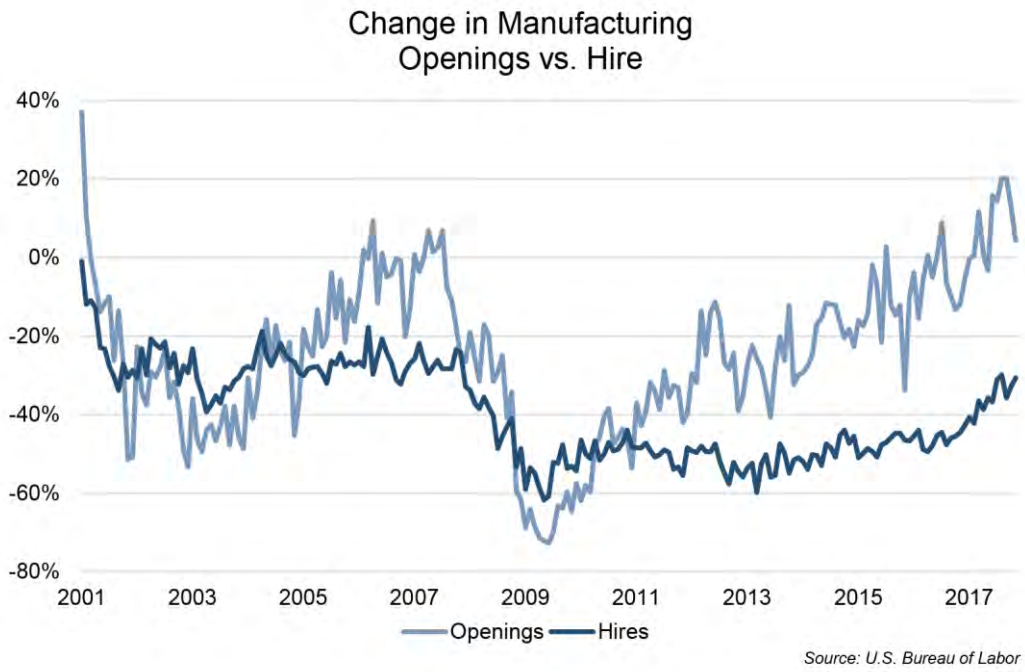

Figure 13: A Rising Gap between Job Openings and Hires

B. Decoupling of Design and Manufacturing

As U.S. companies lost their domestic supplier ecosystems, design decoupled from manufacturing and many firms shifted focus from designing and building products to designing and selling products. With increased offshoring of manufacturing, many companies have excised their process engineering capabilities, further reducing technical innovation and deterring future investment in next generation manufacturing.[37] Together, these effects jeopardize the ability of America's manufacturing base to supply innovative products and skilled workers to the industrial base, threatening capabilities needed for national security.

C. The Loss of Production of Strategic and Critical Materials

As part of the increasingly global manufacturing and defense industrial base, imports of strategic and critical materials, such as rare earths, have increased, causing a trade-off between supply dependency and lower costs. Rare earths are critical elements used across many of the major weapons systems the U.S. relies on for national security, including lasers, radar, sonar, night vision systems, missile guidance, jet engines, and even alloys for armored vehicles.[38] A 2016 study by the Department of Commerce's Bureau of Industry and Security reported that 66% of respondents, the majority of whom are vendors to DoD, indicated they imported rare earth or related materials.

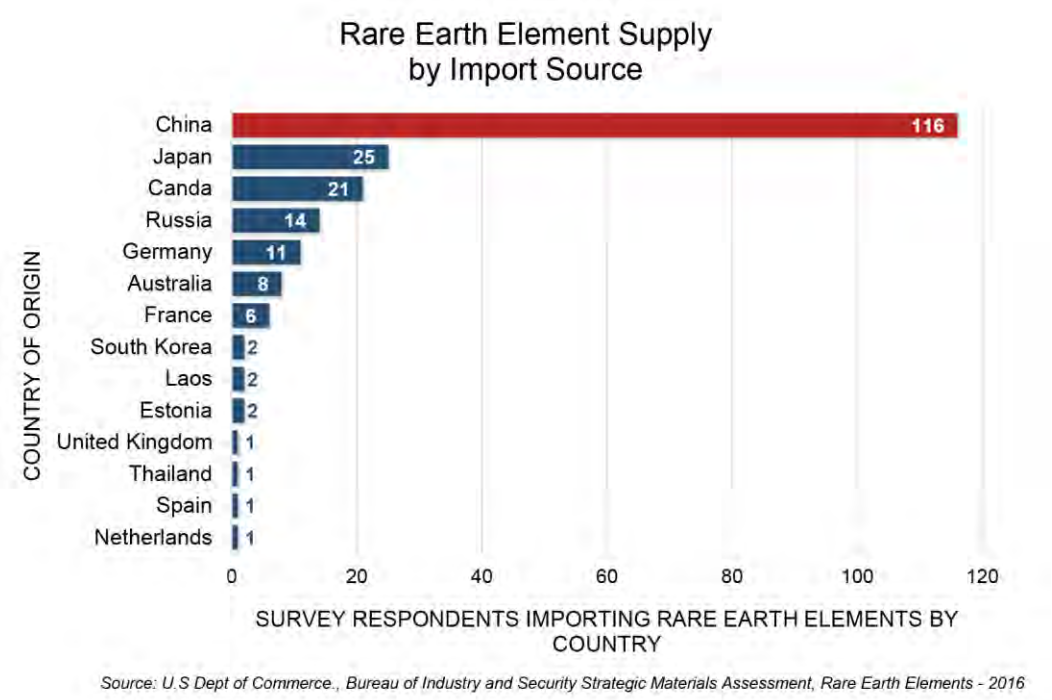

Figure 14: 2016 Rare Earth Element Imports

China's domination of the rare earth element market (Figure 14) illustrates the potentially dangerous interaction between Chinese economic aggression[39,40] guided by its strategic industrial policies and vulnerabilities and gaps in America's manufacturing and defense industrial base. China has strategically flooded the global market with rare earths at subsidized prices, driven out competitors, and deterred new market entrants. When China needs to flex its soft power muscles by embargoing rare earths, it does not hesitate, as Japan learned in a 2010 maritime dispute.[41]

D. Increased Risk of Counterfeits and Infiltration

A global industrial base means increased supply chain risk associated with foreign provision, including counterfeits, lack of traceability, and insufficient quality controls throughout supply tiers. The Department of Commerce's Bureau of Industry and Security surfaced several vulnerabilities in the electronics supply chain, including counterfeits (Figure 15), a lack of traceability, and insufficient quality controls throughout supply tiers. Imports of electronics lack the level of scrutiny placed on U.S. manufacturers, driving lower yields and higher rates of failures in downstream production, and raising the risk of "Trojan" chips and viruses infiltrating U.S. defense systems.[42]

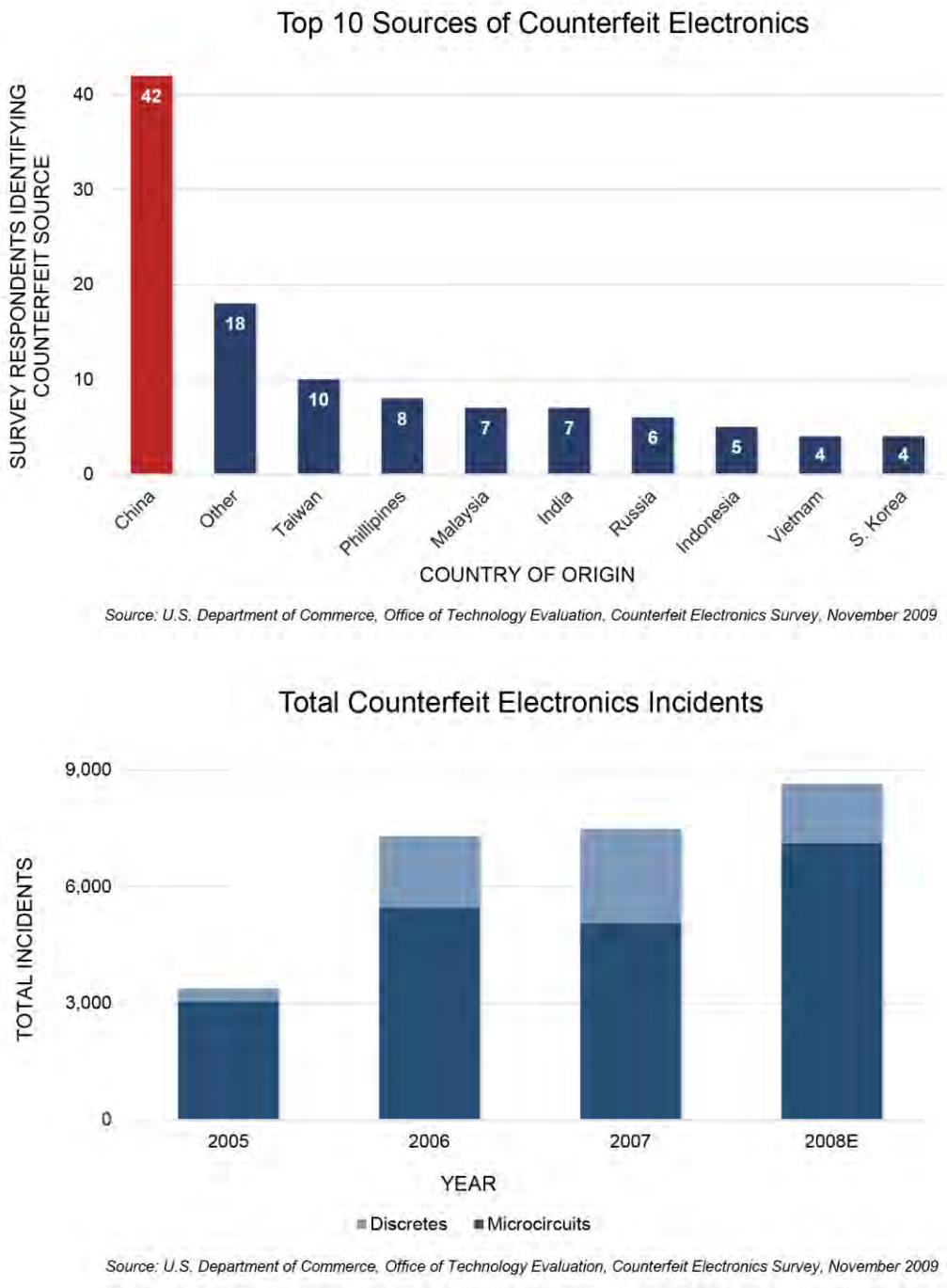

Figure 15: Counterfeit Electronics Dominated by China

E. Diminishing Technical Innovation Ecosystem

Decreased emphasis on domestic manufacturing threatens technical innovation and thereby America's ability to capture emerging technologies. A reduced domestic manufacturing footprint reduces incentives and the ability of companies to invest in new capabilities and

process improvements, further deteriorating industrial base capabilities critical to maintaining a global advantage.

Many technology-intensive multinational corporations have established R&D facilities in countries like India and China [43] for access to cheap, high skilled labor. As part of its industrial policy aggression, China has forced many American companies to offshore their R&D in exchange for access to the Chinese market.

As technical innovation moves abroad, changing rules around intellectual property development will impede U.S. access to the latest manufacturing technologies and decrease overall competitiveness. At risk is America's loss of leadership in industries of the future such as artificial intelligence, quantum computing, and robotics. Over the remainder of this century, these emerging industries will help redefine the battlefield.[44]

F. Reduced Competition

The shipbuilding sector illustrates how a decline in U.S. manufacturing, coupled with budget sequestration, impacts the industrial base. Shipbuilding includes construction and maintenance of Navy aircraft carriers, submarines, surface ships, and their associated weapons and command and control systems; today, the U.S. shipbuilding industrial base consists primarily of seven shipyards owned by four companies and their suppliers.

Shipyards – fixed facilities with dry-docks and fabrication equipment – support ship construction, repair, conversion and alteration, and the production of refabricated ship sections and other specialized services. The industry also includes manufacturing and other facilities beyond the shipyard, which provide parts and services for shipbuilding activities.

Industries involved in the manufacturing of shipbuilding components were among the hardest hit by the global shift in the industrial base over the last 20 years. Of the top ten highest grossing industries in Navy shipbuilding, six are in the manufacturing sector. Since 2000, these industries experienced a combined decline of over 20,500 establishments in the U.S.

Contraction of the shipbuilding sector limits competition among U.S. suppliers of Navy components. In many cases, competition has altogether vanished, forcing the Navy to rely on single and sole source suppliers for critical components. These companies struggle to survive and lack the resources needed to invest in innovative technology. Expanding the number of companies involved in Navy shipbuilding is important to maintaining a healthy industrial base that can fulfill the 355 ship fleet and support the Navy's long range shipbuilding plan.

Machine tools are power-driven machines used to shape or form parts made of metal, plastic, or composites to support both production and prototyping operations. Critical to creating modern defense and non-defense products, machine tools impact the entire supply chain and multiple sectors. The U.S. once led the world in the innovation and capacity of its high-end machine tools sector, but U.S. standing has dropped significantly since 2000. Key changes in machine tool consumption affected global patterns of production. Until the mid-2000s, China accounted

for no more than 15% of global machine tool consumption. By 2011, China's machine tool consumption accounted for 40% of the global total.[45] As its need for machine tools increased, China leveraged its low cost of capital and labor to build domestic machine tool factories and required foreign companies to execute joint ventures to access the Chinese market. The combined effects of the 2008 recession and a general trend of industry consolidation further reduced the number of machine tool manufacturers. In 2015, China's global machine tool production skyrocketed to $24.7B,[46] accounting for 28% of global production,[47] while the U.S. accounted for only $4.6B, after China, Japan, Germany, Italy, and South Korea.

These challenges to the overall manufacturing sector reduce the capability and capacity of U.S. defense production, with potential long term ramifications on the industrial base, national security, and the U.S. economy.

3. Deleterious U.S. Government Business and Procurement Practices

DoD business practices play a critical role in shaping the manufacturing and defense industrial base and can have an outsized effect on supplier behavior and viability.

Many of the current policies and practices of the U.S. Government, and DoD in particular, strain the industrial base and reduce incentives to supply to DoD,[48] resulting in an inability to meet national security demands, increasing foreign vulnerabilities, and a DoD challenged to meet its goals in an era of expanding strategic competition.[49]

A. Procurement Complexity and Lengthy Contract Timelines

In the late 1970s, DoD had 79 offices issuing procurement regulations totaling over 30,000 pages.[50] Currently, the Office of the Under Secretary of Defense for Acquisition and Sustainment is the single office issuing all Defense Federal Acquisition Regulation Supplement guidance. Consolidation of acquisition authority in one office, coupled with ongoing efforts supporting regulation reform such as the “Section 809 panel,” demonstrate increased vigor by DoD to streamline acquisition policy and processes. The “Section 809 panel,” created in the National Defense Authorization Act for FY2016, recently submitted the first of three volumes of its report outlining how DoD can further streamline acquisition processes.[51]

The Government Accountability Office notes that commercial companies are generally unaware of the best channels to propose business solutions to DoD. Overarching challenges noted by non-traditional companies seeking to conduct business with DoD include the complexity of the acquisition process, an unstable budget environment, lengthy contracting timelines, and inexperienced DoD contracting officials.[52] While some of the challenges may actually exist, opportunities abound to overcome misunderstandings about doing business with DoD, through education and communication between industry and the government.

B. Bespoke Accounting Standards and Burdensome Security Clearance Processes

In a recent study, the Defense Business Board highlighted the issue of DoD's Cost Accounting System[53] and emphasized Federal Acquisition Regulation Part 15 "Contract by Negotiation."[54] Federal Acquisition Regulation Part 15 is only one of many acquisition methods but is often inflexible and requires strict adherence to DoD's Cost Accounting System, which requires private sector partners to either replace preexisting accounting systems or develop a parallel system in order to comply with federal requirements. Given other accounting requirements levied on private sector companies, such as those outlined in the Sarbanes-Oxley Act of 2002, requiring a customized accounting system creates the need for additional resources, for which many companies cannot make the business case.

A 2017 Government Accountability Office report highlighted the excessive time and cost associated with obtaining key certifications necessary for doing business with DoD, including meeting IT and software requirements.[55] A similarly lengthy process associated with obtaining security clearances for facilities and their personnel, most of which is the result of a backlog of personnel security investigations processing, often impedes suppliers of both hardware and software from exploring DoD as a client. Furthermore, requirements levied on companies under foreign ownership, control, or influence can discourage their participation in the National Industrial Security Program altogether. Operational and information security standards and whistleblower protections are important, but nonetheless impose additional costs that may increase barriers to entry.

C. Lengthy Acquisition and Development Timelines

Since the late 1980s, the median cycle time required to develop a major defense acquisition program has held steady at approximately eight years.[56] During this time, DoD has grown increasingly dependent on electronics and the commercial electronics market, which moves at a much faster pace of development and production. This slow cycle time is leading to increased obsolescence issues.

For example, given the eight-year cycle time for a major defense acquisition program, the U.S. Army Aviation and Missile Research, Development, and Engineering Center estimates that 70% of electronics procured by DoD are obsolete prior to system fielding.[57] There exists an opportunity for finding balance between requirements for system development and keeping pace with technology.

D. Requirements-Driven Rather Than Solutions-Oriented Acquisition Process

The prevalent business approach and organizational culture of the U.S. Government favors a top-down and requirements-driven process, often to the detriment of innovation. While it is possible to achieve technological breakthroughs or innovative capabilities through such a process, requirements-driven acquisition solicits solutions for specific capabilities rather than for outcomes, potentially imposing an opportunity cost on innovation.

There appear to be few opportunities for companies to offer services or capabilities that do not already fit within the DoD's stated requirements and scope.[58] The tendency to focus on requirements versus solutions, compounded by the various barriers to entry, cost of doing business, and skewed market incentives can inhibit competition and new entrants. Companies successful in the government contracting space are often necessarily structured to comport to federal guidelines, rules, and regulations and are typically unlikely to be able or incentivized to challenge the requirements-driven process.

4. Industrial Policies of Competitor Nations

U.S. defense products enjoy a very successful export market with $41.93B in FY2017 sales,[59] further bolstered by the Administration's efforts to help facilitate this critical part of our economy. However, the erosion of parts of our industrial base, is, in part, attributable to the industrial policies of major trading partners that have created an unfair and non-reciprocal trade environment. Those policies contribute to the U.S. annual trade deficit in goods, the largest in the world at more than $796 billion.[60] Of this total, almost half of the U.S. trade deficit in goods is with China – roughly $375 billion in 2017.[61] The European Union accounts for another roughly $150 billion.[62]

A. A Challenging Economic Playing Field

Many nation states have implemented coherent investment plans and tax policies, such as Germany's Industry 4.0 initiative, forcing U.S. firms to compete against nation states with well-resourced policies to support their domestic industries. In this environment, the lack of a coherent U.S. industrial policy puts domestic suppliers at a disadvantage, amplified by the trade policies of some U.S. competitors that violate trade norms of reciprocity and open competition.

The risks now facing the soldier systems sector help illustrate these challenges. Soldier systems includes a broad and diverse collection of products necessary to maximize the Warfighter's survivability, lethality, sustainability, mobility, combat effectiveness, and field quality of life by considering the Warfighter as a system. Between 1995 and 2009, the U.S. textile industry suffered historic contraction, and though the sector has improved since then, Asian markets now dominate global textiles supply.[63] According to a recent Department of Commerce survey, the greatest competitive disadvantages in the clothing and textile subsector are related to the workforce and raw material cost and/or availability.[64] Though U.S. industry has invested heavily to compete, increasing labor productivity by 60% since 2000,[65] total sales and exports of U.S. manufactured clothing and textile products have been stagnant from 2012-2016.[66] As wage growth has increased the price of labor in China, lower wage countries such as Pakistan and Vietnam have seen the most rapid growth in textile exports, reaching 9% growth in 2016.[67]

While the United States is the fourth largest exporter of textile-related products in the world, there remain acute challenges across the more than 8,000 products the domestic textile industry supplies to DoD.[68] The single qualified domestic source for high-tenacity polyester

fiber used in many DoD tent systems dissolved its business due to its inability to compete in an increasingly competitive global fibers and textiles market.[69] Currently, there is no U.S. manufacturing capability for high-tenacity polyester fiber that allows for military specification qualification.

B. China's Military Expansion and Modernization

While multiple countries pursue policies to bolster their economies at the expense of America's manufacturing sector, none has targeted our industrial base as successfully as China. China is engaged in economic competition with the U.S. and our allies[70] over key sectors of the global economy,[71] and China's strategies of economic aggression and its complementary military modernization efforts are codified in its doctrine of civil-military fusion. By actively promoting the fusion of its military and civilian industrial and science and technology sectors, Beijing strives to reinforce the People's Republic of China's capabilities to build the country into an economic, technological, and military power while ensuring that overall control of these elements of national power remain firmly in the hands of the Communist Party of China.

Since joining the World Trade Organization in 2001, China's real gross domestic product has grown more than 300%, from $2.4 trillion in 2001 to $10.2 trillion 2017.[72] During that period, U.S. real gross domestic product grew less than 40%, from $12.8 trillion in 2001 to $17.3 trillion in 2017 (Figure 16).

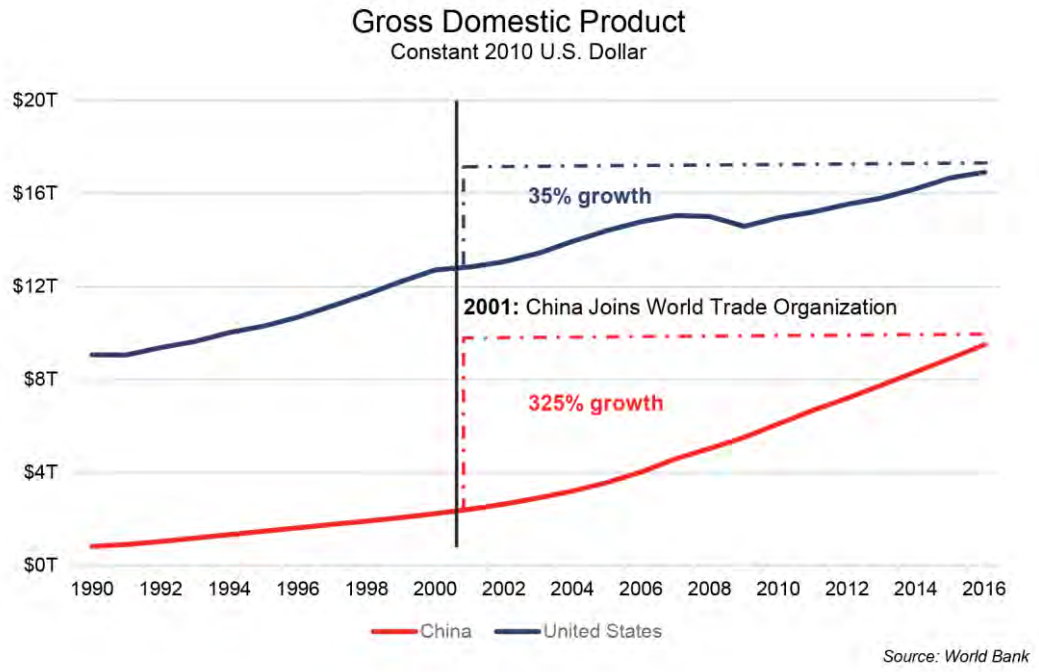

Figure 16: China Rapid Growth since Joining the WTO

China's economic growth has, in turn, helped finance its rapid military modernization. In 2001, China's annual military budget was less than $20 billion.[73] By 2017, it exceeded $150 billion,[74] second only to the U.S.

China's non-market distortions to the economic playing field must end or the U.S. will risk losing the technology overmatch and industrial capabilities that have enabled and empowered our military dominance – even as China seeks to raise its military capabilities to U.S. levels.

C. China's Strategies of Economic Aggression

One of the Chinese Communist Party's primary industrial initiatives, Made in China 2025,[75] targets artificial intelligence, quantum computing, robotics, autonomous and new energy vehicles, high performance medical devices, high-tech ship components, and other emerging industries critical to national defense.[76] In order to obtain the capabilities needed to support these advanced technologies, China relies on both legal and illicit means, including foreign direct and venture investments, open source collection, human collectors, espionage, cyber operations, and the evasion of U.S. export control restrictions to acquire intellectual property and critical technologies.

For example, China imposes conditional access to its domestic market to lure intellectual property, investment, and onshoring of manufacturing, using high tariffs and a complex web of non-tariff barriers, including restrictive customs barriers, burdensome licensing requirements, discriminatory regulatory standards, and local content requirements in government procurement to boost domestic manufacturing and production.[77] China also uses forced technology transfer[78] as a condition of access to the Chinese market.[79]

In an attempt to dominate critical global markets and manufacturing industries, China leverages policy tools such as low interest loans; subsidized utility rates; lax environmental, health, and safety standards; and dumping to boost its industry.[80] China also uses counterfeiting and piracy, illegal export subsidies, and overcapacity to depress world prices and push rivals out of the global market. It has implemented these tactics to capture much of the world's solar and steel industries and intends to extend its dominance to other industries such as automobiles and robotics.[81]

As a result of its successful assault on the U.S. solar industry,[82,83,84,85] China produces over 70% of the world's solar cells.[86] As the European Chamber of Commerce has documented, "for a generation, China has been the factory of the world," and by 2015, it already produced 24% of the world's power, 28% of the automobiles, 41% of the world's ships, over 50% of the refrigerators, over 60% of the color TV sets, over 80% of the air conditioners and computers, and over 90% of the mobile phones.[87]

A key finding of this report is that China represents a significant and growing risk to the supply of materials and technologies deemed strategic and critical to U.S. national security; a challenge shared by key allies such as Germany[88] and Australia.[89] In addition to China dominating many material sectors at the upstream source of supply (e.g., mining), it is increasingly dominating downstream value-added materials processing and associated manufacturing supply chains, both in China and increasingly in other countries. Areas of concern to America's manufacturing

and defense industrial base include a growing number of widely used and specialized metals, alloys and other materials, including rare earths and permanent magnets.

China is also the sole source or a primary supplier for a number of critical energetic materials used in munitions and missiles. In many cases, there is no other source or drop-in replacement material and even in cases where that option exists, the time and cost to test and qualify the new material can be prohibitive – especially for larger systems (hundreds of millions of dollars each).

From commodity materials to rare earths,[90] Chinese investment in developing countries in exchange for an encumbrance on their natural resources and access to their markets, particularly in Africa and Latin America,[91] adds an additional level of consideration for the scope of this threat to American economic and national security.

D. China's Soft Power Projection

Since China joined the World Trade Organization in 2001 and gained greater access to U.S. markets, the trade deficit in goods with China has grown from $83 billion to $375 billion in 2017.[92] China has historically used currency manipulation to artificially reduce the value of the yuan and increase the competitiveness of its exports.[93] To maintain its currency peg, China helps finance the chronic U.S. trade deficit through purchases of U.S. Government securities.[94] China has then leveraged its surplus-funded capital accounts to pursue aggressive trade and infrastructure policies such as the One Belt, One Road Initiative, a mercantile trade system promoting China's political domination of Eurasia and reducing U.S. market access.

Such policies further exacerbate the trade imbalance with the U.S. and have created similar imbalances with U.S. allies and partners – as illustrated in Figure 17.

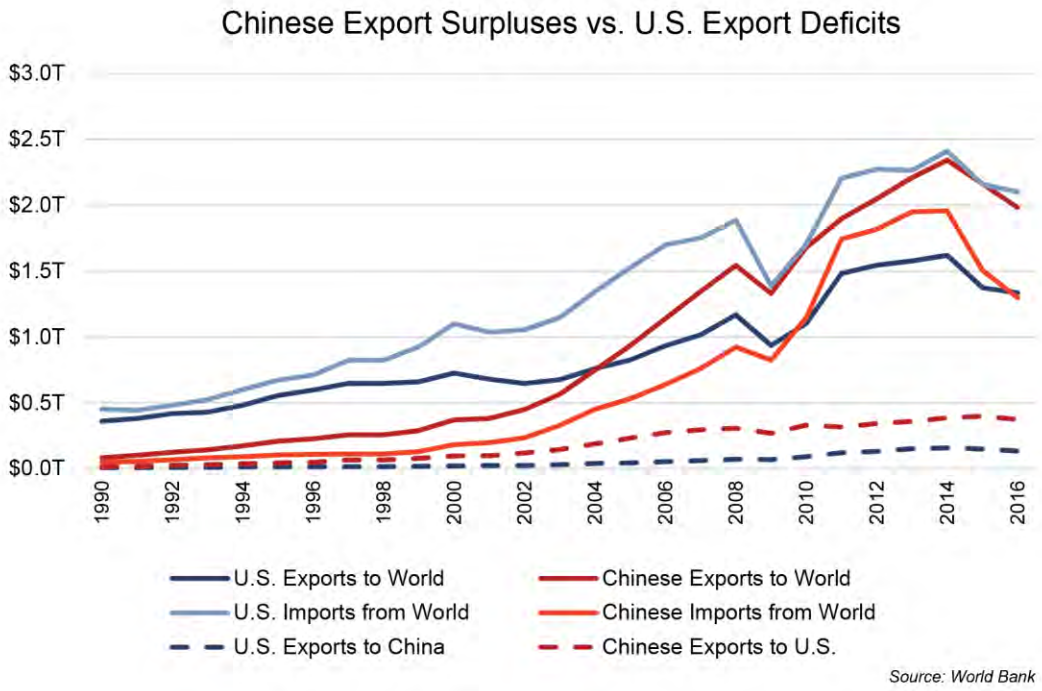

Figure 17: China's Trade Imbalances with the U.S. and Rest of the World

The significant asymmetry between the trade dependence of American allies in the Indo-Pacific versus China's economic dependence on these American allies and partners is further illustrated in Figure 18.[95] In recent years, China has not hesitated to leverage its asymmetric trade dominance to project soft power.

Country	% of Country's Exports Purchased by China	% of China's Exports Purchased by These Countries
Australia	33%	2%
Taiwan	26%	2%
South Korea	25%	5%
Japan	18%	6%
Malaysia	13%	2%
Singapore	13%	2%
Philippines	11%	<2%
Thailand	11%	2%

Source: World Bank

Figure 18: China's Rising Economic and Monopsony Power over American Allies

For example, after South Korea announced the placement of the U.S. Terminal High-Altitude Aerial Defense (THAAD) system, a key element of U.S. foreign policy and military strategy,

China undertook an aggressive economic warfare campaign against Seoul.[96] China's campaigns of economic coercion have also been observed against other U.S. allies and partners, including a ban on Philippine bananas over territorial disputes in the South China Sea;[97] the aforementioned restriction of rare earth exports to Japan following the Senkaku Islands dispute in 2010;[98] persistent economic intimidation against Taiwan;[99] and the recent ceding of a Sri Lankan port.[100]

China's trade dominance and its willingness to use trade as a weapon of soft power increases the risks America's manufacturing and defense industrial base faces in relying on a strategic competitor for critical goods, services, and commodities.

E. China's Research and Development Spending Strategy

Although the bulk of China's early exports were dependent on low value-added manufacturing, Beijing has recognized that it must innovate to obtain long term dominance, as documented in the 2006 Medium to Long Range Plan for Science and Technology.[101] This and other state-authored policies explicitly recognize the need to capture advanced commercial technologies with military applications, and China has directed both state-owned enterprises and private sector investors to advance the military's access to cutting edge civilian research.[102] To advance this goal, China's current five year plan calls for increasing research and design spending to 2.5% of gross domestic product, up from 2.1% in 2011-2015. As Figure 19 illustrates, Chinese R&D spending is rapidly converging to that of the U.S. and will likely achieve parity sometime in the near future.

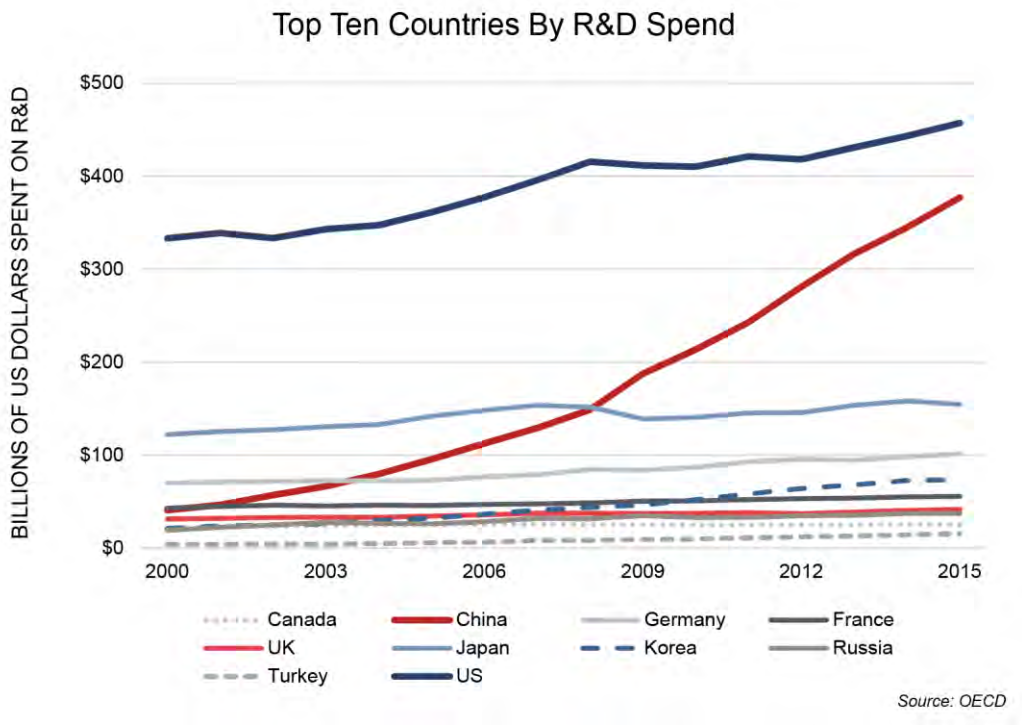

Figure 19: China's Rapid Growth in R&D Spending Relative to the Rest of the World

China's current plan also focuses on capturing a leading position in advanced foundational dual-use industries such as semiconductors, chip materials, robotics, aviation, and satellites. Additionally, China is investing in key foundational technologies—artificial intelligence, robotics, autonomous vehicles, augmented and virtual reality, financial technology, and gene editing—to enable a wide array of commercial and military applications. To advance its strategic goals, Beijing has unveiled several mega-projects (e.g., core electronics, high-end chips, quantum communications, next-generation broadband communications) that are likely intended to challenge the United States.[103]

As documented in the United States Trade Representative's *Findings Of The Investigation Into China's Acts, Policies, And Practices Related To Technology Transfer, Intellectual Property, And Innovation Under Section 301 Of The Trade Act Of 1974,*[104] China uses legal, extra-legal, and illicit[105] industrial policy tools and tactics to force or facilitate the transfer of technologies and intellectual property from U.S. and foreign companies to Chinese counterparts and competitors.[106] State-backed actors are buying and stealing differentiating intellectual property on an unprecedented scale, targeting key U.S. technology, infrastructure, and materials and exploiting the free-market system to access and acquire key components of the U.S. industrial base, leaving defense capabilities vulnerable.

In 2016, Chinese foreign direct investment in the U.S. was $46 billion, or triple the previous year and a ten-fold increase from 2011, demonstrating their all-of-nation long-term growth strategy in support of both economic and military power. China's cumulative foreign direct investment in the U.S. since 2000 now exceeds $100 billion.[107,108] Figure 20 illustrates how China is targeting key technology sectors with its state-supported foreign direct investment.

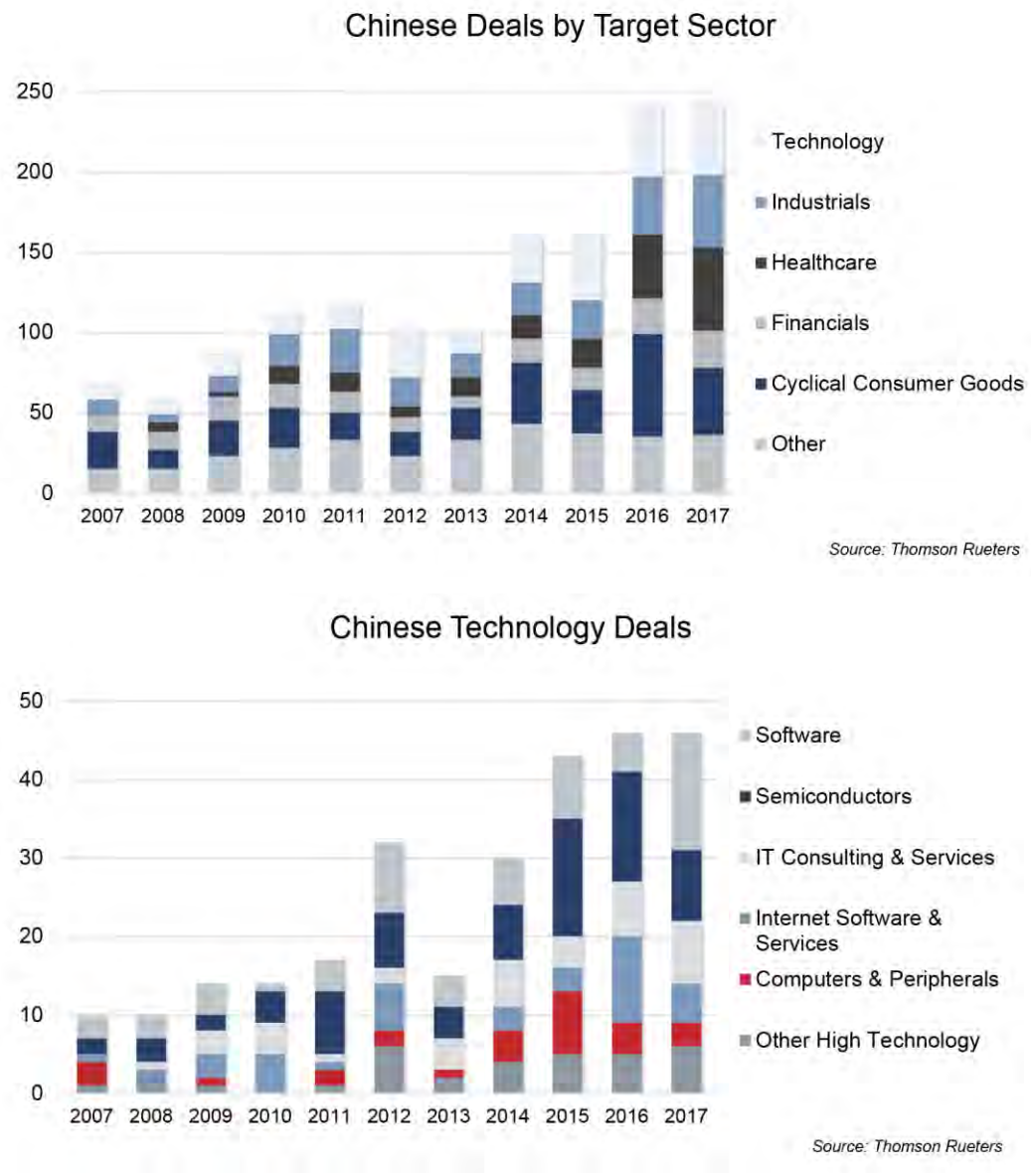

Figure 20: China Targets U.S. Technology with Its Outbound Foreign Direct Investment

China's capture of foreign technologies and intellectual property,[109] particularly the systematic theft of U.S. weapons systems[110] and the illicit and forced transfer of dual-use technology, has eroded the military balance between the U.S. and China.[111] Such transfers aid China's efforts to gain a qualitative technological advantage over the U.S. across key domains, including naval, air, space, and cyber.[112]

China's aggressive industrial policies have already eliminated some capabilities with critical defense functions, including solar cells for military use, flat-panel aircraft displays, and the processing of rare earth elements.[113] China's actions seriously threaten other capabilities, including machine tools; the production and processing of advanced materials like biomaterials, ceramics, and composites; and the production of printed circuit boards and semiconductors.[114]

As part of China's One Belt, One Road doctrine to project Chinese soft and hard power,[115] China has sought the acquisition of critical U.S. infrastructure, including railroads,[116] ports,[117] and telecommunications.[118]

China's economic strategies, combined with the adverse impacts of other nations' industrial policies, pose significant threats to the U.S. industrial base and thereby pose a growing risk to U.S. national security.

F. Strategic Materials and Printed Circuit Boards

Unlawful and otherwise unfair foreign trade practices (mostly by China) are injuring U.S. strategic and critical material manufacturers. Predatory practices – including state-sponsored dumping, public subsidies, and intellectual property theft – are destroying commercial product lines and markets of domestic DoD suppliers. The loss of commercial business can lead to the loss of domestic production capabilities essential to U.S. defense and essential civilian needs. Impacted materials are widely used across multiple DoD systems and all major defense sectors (land, sea, air, and space systems).

In multiple cases, the sole remaining domestic producer of materials critical to DoD are on the verge of shutting down their U.S. factory and importing lower cost materials from the same foreign producer country who is forcing them out of domestic production.

Without relief from unlawful and otherwise unfair trade practices, the U.S. will face a growing risk of increasing DoD reliance on foreign sources of vital materials.

The case of printed circuit boards likewise highlights the growing risks to the industrial base. The printed circuit board sub-sector provides the substrate and interconnects for the various integrated circuits and components that make up an electronic system. Today, 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.

With the migration of advanced board manufacturing offshore, DoD risks losing visibility into the manufacturing provenance of its products as many domestic manufacturers have offshore manufacturing facilities or relationships. In addition to the potential dissemination of design information, many of the offshore facilities do not meet or comply with DoD quality requirements.

5. Diminishing U.S. STEM and Trade Skills

Increasing globalization of the supply chain and a diminishing domestic manufacturing sector are combining to create human capital gaps and erosion of American capabilities. STEM knowledge and core trade skills are necessary to ensure the holistic and synergistic health of the

defense ecosystem. Skill gaps in both areas entail inherent risk, from a decline in production capacity to decreased innovation.

From 2006 to 2016, STEM occupations experienced large job growth – 52% of occupations grew in their total number of employees – while 74% of manufacturing occupations lost jobs.[119] Despite STEM occupations typically having greater educational requirements and hence drawing from a smaller labor pool, the top 10 occupations in those fields added more workers in absolute terms over the 2006-2016 time period than the top 10 manufacturing occupations, as ranked by absolute job growth (Figure 21).

Figure 21: STEM-Oriented Versus Core Manufacturing-Oriented Occupations

A. Demographic Challenge

While the population of manufacturing workers is aging at the rate of baby boomers across industry, the most concerning aspect of the manufacturing workers demographics is the decrease in workers in the 35-44 age range (Figure 22). In the prime of their careers and poised to internalize knowledge transfer from older workers, the loss of mid-career workers to other sectors poses a direct threat to the long-term viability of manufacturing. The risk that knowledge will fail to be transferred to new entrants into the labor market is rising, particularly in skilled production occupations, which account for over 50% of manufacturing workers.[120]

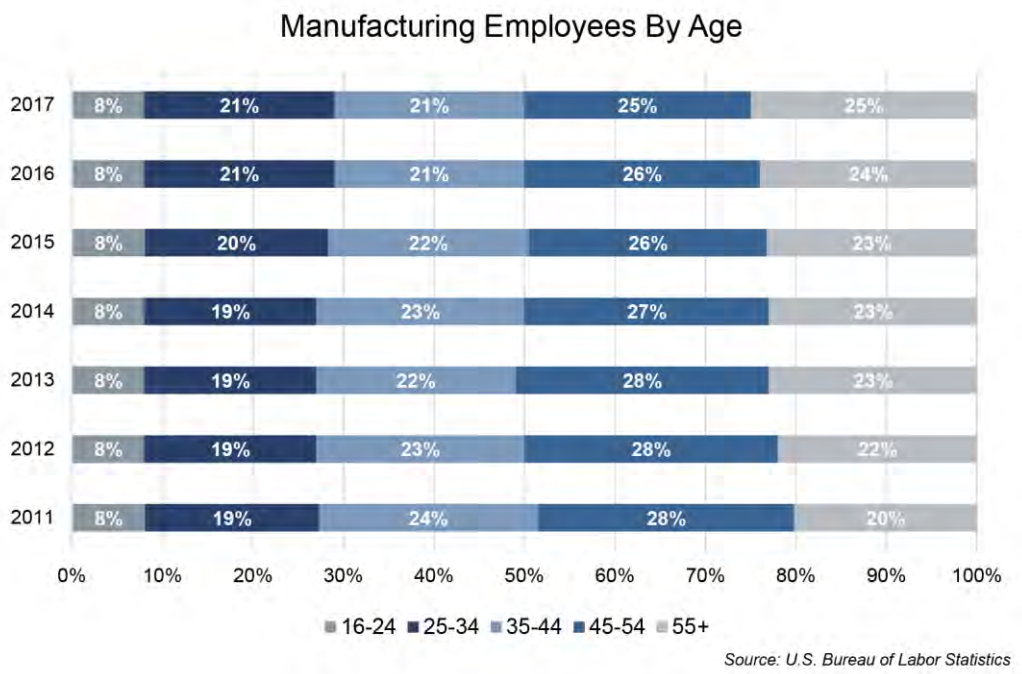

Figure 22: The Demographics of Manufacturing Employment

B. Growing Cultural Bias and Strategic Rivals

Some of the most challenging aspects in the manufacturing sector are recruitment and retention. In a recent manufacturing skills gap study conducted by the Manufacturing Institute and Deloitte, only one third of respondents indicated they would encourage their children to pursue a career in manufacturing. Gen Y (ages 19-33 years) respondents ranked manufacturing as their least preferred career destination.[121] Yet once a candidate is hired, the struggle continues. 79% of executives surveyed stated it is moderate to extremely challenging to find candidates to pass screening and/or the probationary period, [122] leaving them with employees unable to perform the work for which they were hired.

While the total number of bachelor's degrees in the U.S. has increased steadily in the last two decades, the number of STEM degrees conferred in the U.S. still pales compared to China.[123] In addition, the U.S. has seen an increase in students on temporary visas, many of whom would be unable to gain the security clearances needed to work in the defense ecosystem.[124]

Growth in advanced science and engineering degrees shows the U.S. graduating the largest number of doctorate recipients of any individual country, but 37% were earned by temporary visa holders[125] with as many 25% of STEM graduates in the U.S. being Chinese nationals.[126]

As the U.S. continues to attempt progress in STEM, ongoing Chinese support and influence continues to demonstrate strength in building a workforce of the future, while American universities are major enablers of China's economic and military rise.

VI. Ten Risk Archetypes Threatening America's Manufacturing and Defense Industrial Base

Figure 23 catalogues the ten risk archetypes, at the firm and market level, emerging from the EO 13806 assessment. While each of the risk archetypes may be viewed in isolation, sub-sets of risks tend to cluster and threaten American's manufacturing and defense industrial base.

The risk archetypes lead to a variety of negative impacts on America's industrial base, including reduced investment in both new capital and R&D; concomitant reductions in the rates of modernization and technological innovation; a loss of suppliers and potential bottlenecks across the many tiers of the supply chain; and lower quality and higher prices resulting from reduced competition.

At the production level, negative impacts also include cost inefficiencies, deferred maintenance, reduced reliability, and increased vulnerability to counterfeit components. Across the supply chain, these negative impacts can manifest as significant gaps in the industrial base, from single-points-of-failure and threatened capabilities to non-extinct and extinct capabilities. Ultimately, these negative impacts have the potential to result in diminished readiness, decreased lethality, insecurity of supply, program delays, and an inability to surge.

Risk Archetype	Definition
Sole source	Only one supplier is able to provide the required capability
Single source	Only one supplier is qualified to provide the required capability
Fragile supplier	A specific supplier is financially challenged / distressed
Fragile market	Structurally poor industry economics; potentially approaching domestic extinction
Capacity constrained supply market	Capacity is unavailable in required quantities or time due to competing market demands
Foreign dependency	Domestic industry does not produce the product, or does not produce it in sufficient quantities
Diminishing manufacturing sources & material shortages (DMSMS)	Product or material obsolescence resulting from decline in relevant suppliers
Gap in U.S.-based human capital	Industry is unable to hire or retain U.S. workers with the necessary skill sets
Erosion of U.S.-based infrastructure	Loss of specialized capital equipment needed to integrate, manufacture, or maintain capability
Product security	Lack of cyber and physical protection results in eroding integrity, confidence, and competitive advantage

Figure 23: Ten Risk Archetypes Threatening America's Manufacturing and Defense Industrial Base

The impacts identified by the working groups often fell into multiple risk archetypes – a financially distressed foundry may be both a sole source and single source, as well as illustrate a fragile market. In this section, we summarize illustrative examples from the working groups in each of the risk archetypes. Additional descriptions of the impacts can be found in the sector summaries (Appendix Two) and a full list of the nearly 300 impacts for all sixteen sectors is available in a classified appendix.

1. Sole Source

A sole source risk exists when only one supplier is able to provide the required capability. Sole source risk can occur at the prime level – such as one supplier capable of building nuclear aircraft carriers – but more often sole source manifests in the sub-tier of a sector.

Reduced competition, lack of innovation, and potential single points of failure in the production of chaff countermeasures underscore risks associated with a sole source. Chaff is composed of millions of tiny aluminum or zinc coated fibers stored on-board an aircraft in tubes. When an aircraft is threatened by radar tracking missiles, chaff ejected into the turbulent wake of air behind the plane creates confusion for the missile's radar system. Defense unique requirements and decreasing DoD demand drove out other suppliers, leaving one company as the only source for chaff.

Similarly, DoD acquisition policy modifications to meet demand and surge requirements from overseas operations have led to capacity issues within our organic arsenals. Due to policy

requirements, all large caliber gun barrels, howitzer barrels, and mortar tubes must be manufactured at a specific organic arsenal. Currently, there is only one production line that produces all these items, leading to a lack of capacity to meet current and near-term production demands.

2. Single Source

When only one supplier is qualified to provide a required capability, single source risk exists. The key distinction between sole source and single source is that for a single source, multiple potential vendors may exist, but only one source is qualified to produce materials for the U.S. Government.

Industries involved in the manufacturing of shipbuilding components were among the hardest hit by the global shift in the industrial base over the last 20 years. Of the top ten highest grossing industries in Navy shipbuilding, six are in the manufacturing sector. Since 2000, these industries experienced a combined decline of over 20,500 domestic establishments.** Contraction of the shipbuilding industrial base has limited competition among U.S. suppliers of Navy components and, in many cases, competition has altogether vanished, forcing the Navy to rely on single and sole source suppliers for critical components.

There currently exists only one domestic source of ammonium perchlorate – a chemical widely used in DoD propulsion systems. Foreign sources exists, but maintaining a domestic capability is critical to national security.

3. Fragile Supplier

A fragile supplier is an individual firm that is financially challenged or distressed.

Within the rotary wing industrial base, one company illustrates the interaction of single source risk and fragile supplier. The firm occupies a supply chain tier in the large and complex alloy castings segment of the aircraft sector, and is a source for upper, intermediate, and sump housing required for the manufacturing of a heavy lift platform for the Marines. In 2016, the company filed for bankruptcy, citing a decline in the military and commercial helicopter market.[127] Without a qualified source for these castings, the program will face delays, impeding the DoD's ability to field heavy lift support for Marine Corps expeditionary forces.

With the large movement of textile manufacturing to cheaper foreign markets, and fewer domestic companies producing textiles, soldier systems such as tents and uniforms face greater risk. Currently, only a few domestic sources can provide the specific material requirements for defense-specific textiles, especially for various types of highly engineered textile fibers (e.g.,

** The six industries are machinery; transportation equipment manufacturing; fabricated metal products; computer and electronic products; electrical equipment, appliance, and components.

high-tenacity polyester, nylon 6,6, etc.). During the course of the EO 13806 assessment, the single supplier for high-tenacity polyester fiber used in DoD tent systems dissolved its business. It was no longer able to compete in an increasingly competitive global fibers and textiles market, and now the U.S. lacks a manufacturing capability for high-tenacity polyester fiber that allows for military specification qualification.

4. Fragile Market

A fragile market occurs when domestic markets have structurally challenging economics and face a potential move toward foreign dependency. Fragile suppliers exist at the firm level, whereas fragile markets exist across an industry or sector.

Domestic printed circuit board manufacturing struggles to compete in the global marketplace. Since 2000, the U.S. has seen a 70% decline in its share of global production. Today, Asia produces 90% of worldwide printed circuit boards, and half that production occurs in China. As a result, only one of the top 20 worldwide printed circuit board manufacturers is U.S.-based. With the migration of advanced printed circuit board manufacturing offshore, DoD risks losing visibility into the manufacturing provenance of its electronics.

Also in the electronics sector, and ubiquitous in platforms and systems across the industrial base, strategic radiation-hardened microelectronics have no commercial applications. These components must be able to withstand short bursts of intense radiation and high temperatures in order to satisfy mission requirements. Being commercially unviable creates continual risk for this critical capability due to changing business conditions or technological obsolescence.

5. Capacity Constrained Supply Market

Capacity constrained supply markets arise where necessary capacity is unavailable in required quantities or time due to competing commercial market demands or insufficient defense specific capacity.

ASZM-TEDA1 impregnated carbon, a defense-unique material provided by a single qualified source, is subject to a single-point-of-failure and demonstrates a capacity constrained supply markets. A lack of competition with other potential sources precludes assurances for best quality and price. While ASZM-TEDA1 is used in 72 DoD chemical, biological, and nuclear filtration systems, the current sourcing arrangements cannot keep pace with demand.

The high operational tempo of the Navy in recent years, along with a lack of steady funding for maintenance and modernization, has resulted in a backlog of repair work across the nuclear and non-nuclear fleet. Coupled with increases in new ship construction, many suppliers are experiencing a shortfall in their capacity to perform work and manufacture products. The increased demand creates pressure on already-aging production equipment and could necessitate additional hiring in highly specialized fields, where it is often difficult to find suitable

candidates. Technical requirements for new ships, a large volume of mid-life availabilities, and a general lack of investment by industry in new dry-dock capacity will create a significant constraint for completing Navy ship maintenance. The combination of limited suppliers and an increase in workload could increase cost and potentially create schedule slips, impacting our Warfighting capability.

6. Foreign Dependency

Foreign dependency risk arises when domestic industry does not produce the item, or does not produce it in sufficient quantities. Not all foreign dependency is equal – the cases here illustrate dependency on both competitors and allies.

China is the single or sole supplier for a number of specialty chemicals used in munitions and missiles. In many cases, there is no other source or drop-in replacement material and even in cases where that option exists, the time and cost to test and qualify the new material can be prohibitive – especially for larger systems (hundreds of millions of dollars each).

Single foreign sources of unique and proprietary carbon fibers from Japan and Europe represent considerable DoD supply chain vulnerabilities. A sudden and catastrophic loss of supply would disrupt DoD missile, satellite, space launch, and other defense manufacturing programs. In many cases, there are no substitutes readily available. Replacing a carbon fiber factory is very expensive and time consuming. Of similar concern is the uncertainty of qualifying replacement suppliers and significant resource requirements.

U.S. military "night vision" systems are enabled by an image intensifier tube, a vacuum sealed tube that amplifies a low light-level scene to observable levels. The U.S. is reliant on a German supplier for the image intensifier tube core glass, a DoD-unique product with low demand compared to commercial glass production. While the German supplier manufactures the core glass in batches every few years to replenish a U.S. buffer stock, we still lack a domestic supplier, creating vulnerability in the night vision supply chain.

7. Diminishing Manufacturing Sources and Material Shortages

Diminishing manufacturing sources and material shortages risk is associated with obsolescence that may result from the decline in relevant suppliers.

In 2017, a semiconductor chip foundry used in a voltage control switch (used in all DoD missiles systems) was purchased by another foundry. A 5th tier supplier, the voltage control switch company notified its next tier customer of the foundry closing and received an end-of-life buy order for what was considered enough supply to allow time to qualify a replacement voltage control switch. DoD was not informed of the issue or consulted on the end-of-life quantity until the opportunity to stockpile had passed, at which point it became evident that the end-of-life buy, intended to last 3-5 years, would only last 6 months, putting U.S. missile systems at risk.

Trusted foundries, obsolescence, diminishing manufacturing sources and material shortages, and counterfeit issues are common to the broad defense electronics sector and prevalent for current and future radar systems, as well as systems in sustainment. One logistics center within the organic base identified over 4,000 diminishing manufacturing sources and material shortages items for just the radars maintained at that particular base. In addition to sustainment issues, the military is highly dependent upon the commercial sector for technology maturation, but the commercial sector is driven by revenue and high volume technology demands so development of technology for military use is not always feasible.

8. Gaps in U.S.-based Human Capital

When industry or the government is unable to hire or retain U.S. workers with the skills sets, or capabilities, needed to support the industrial base, gaps in U.S.-based human capital arise.

In December 2017, a survey of 662 manufacturing companies conducted by the National Association of Manufacturers found the inability to attract and retain a quality workforce the top business challenge, cited by 72.9% of respondents. To address this workforce challenge, 66% of respondents said they are increasing the workload of their existing employees. 34.4% stated their company had been unable to take on new business and had lost revenue opportunities because of the inability to attract and retain workers.[128] Given the number of manufacturers who exist in the supply chain of the industrial base, these numbers are significant.

The industrial base consistently competes with commercial industry for STEM talent, and the education pipeline is not providing the necessary resources to fully meet current or future demands in the commercial sector and defense ecosystem, such as software design engineers and biophysicists. In addition, the trade skills gap affects a wide range of occupations (e.g., industrial machinery mechanics and welders) which could have potentially significant impacts on production of critical defense-related materials, vehicles, and machinery, as well as other goods and services necessary to supply our nation's armed forces.

9. Erosion of U.S.-Based Infrastructure

The loss of specialized capital equipment needed to integrate, manufacture, or maintain a capability creates erosion of U.S.-based infrastructure.

A largely niche market, the chemical, biological, radiological, and nuclear sector relies heavily on DoD procurements for sustainability. One of the organic bases that provides chemical, biological, radiological, and nuclear technology lacks a sustainable workload, degrading readiness by creating a capabilities response lag time, increasing labor rates, and threatening critical manufacturing capabilities. Gaps in this sector can result in limited or non-existent domestic supply of critical protection for the Warfighter against specific threats.

Organic base depots are working capital funded activities and are required to reinvest and recapitalize equipment and facilities through their rate structure. While DoD's budget replaces and refurbishes plant equipment, and statute and policy direct follow-through on recapitalization, infrastructure investments have not been adequate often due to sensitivity to rate increases. Without significant future investment, the organic base will remain challenged by outdated equipment, tooling, and machinery. The erosion of organic infrastructure continues to impact turnaround time and repair costs of newly fielded weapon systems, reducing inventory, decreasing operational readiness, and impacting future deployment schedules.

10. Product Security

A lack of cyber and/or physical protection creates risk in product security, resulting in an erosion of integrity, confidence, and competitive advantage.

For example, one Chinese manufacturer accounts for 70% of the commercial unmanned aerial system market, including a dominance in the small unmanned aerial system subsector. Recently, due to concerns around security of the software associated with the platform, the U.S. Army issued a memo to cease use of applications created by the manufacturer.[129]

The defense manufacturing supply chain flows goods and critical supporting information through multiple organizations of varying size and sophistication to transform raw materials into components, subassemblies, and ultimately finished products and systems that meet DoD performance specifications and requirements. These supply chain operations rely on an infinite number of touch points where digital and physical information flows through multiple networks – both within and across many manufacturers' systems. In today's digitized world, every one of these supply chain touch points represents a potential product security risk.

According to private sector reports, in 2014 manufacturers received the greatest volume of targeted cyber-attacks of all industries globally,[130] primarily for espionage purposes,[131] although an increasing number of sophisticated cyber-espionage campaigns attempted to alter the automation of physical processes on manufacturing lines. The Department of Homeland Security reported in 2015 that the critical manufacturing sector reported the highest number of attacks on industrial control systems of any critical infrastructure sector, nearly twice the 2014 level. Since then, numerous threats have emerged with the potential to cause major disruption in manufacturing operations.

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VII. A Blueprint for Action

President Trump's historic EO 13806 provided DoD and its interagency partners a unique opportunity to assess the manufacturing and defense industrial base – one of the most critical assets to our national security. The work conducted by the over 300 members of the DoD-led Interagency Task Force lays the groundwork for important actions, mitigations, and ongoing monitoring that will result in America's ability to continue supporting a secure, robust, resilient, and ready industrial base.

Current Efforts

The DoD-led Interagency Task Force recognizes and supports ongoing efforts to address the challenges identified in the EO 13806 assessment, including:

- Increased near-term DoD budget stability with the passage of the Bipartisan Budget Act of 2018, providing stable funding through FY2019
- Modernization of the Committee on Foreign Investment in the U.S. and investigations under Section 301 of the Trade Act of 1974 into Chinese intellectual property theft, to better combat Chinese industrial policies targeting American intellectual property
- Updates to the Conventional Arms Transfer policy and unmanned aerial systems export policy to increase U.S. industrial base competitiveness and strengthen international alliances

- Reorganization of the former Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, the work of the "Section 809 panel," and development of the adaptive acquisition framework all aim to streamline and improve defense acquisition processes
- Restructuring the Defense Acquisition University to create workforce education and training resources that will foster increased agility in acquisition personnel
- Response to Section 1071(a) of the National Defense Authorization Act for FY2018 which requires establishing a process for enhancing the ability to analyze, assess, and monitor vulnerabilities of the industrial base
- Creation of a National Advanced Manufacturing Strategy by the White House Office of Science and Technology Policy, focused on opportunities in advanced manufacturing
- Department of Labor's chairing of a Task Force on Apprenticeship Expansion to identify strategies and proposals to promote apprenticeships, particularly in industries where they are insufficient
- DoD's program for Microelectronics Innovation for National Security and Economic Competitiveness to increase domestic capabilities and enhance technology adoption
- DoD's cross-functional team for maintaining technology advantage
- Implementation of a risk-based methodology for oversight of contractors in the National Industrial Security Program, founded on risk management framework principles to assess and counter threats to critical technologies and priority assets

Future Efforts and Recommendations

The Secretary of Defense strongly recommends the President sign an Executive Order directing DoD, and the Secretaries listed below, to promptly implement the proposed recommendations based on the EO 13806 assessment, submitted herein. Of the nearly 300 risks identified by the working groups across 16 sectors, the recommendations provided below and in the classified Action Plan address risks determined to currently be of critical importance, and propose actionable and reasonable mitigations. Each of the Secretaries will provide a status on implementation within 180 days of execution of the Executive Order.

Secretary of Defense

DoD recommendations are provided below and in a classified Action Plan. The recommendations include:

- Create an industrial policy in support of national security efforts, as outlined in the National Defense Strategy, to inform current and future acquisition practices
- Expand direct investment in the lower tier of the industrial base through DoD's Defense Production Act Title III, Manufacturing Technology, and Industrial Base Analysis and Sustainment programs to address critical bottlenecks, support fragile suppliers, and mitigate single points-of-failure

- Diversify away from complete dependency on sources of supply in politically unstable countries who may cut off U.S. access; diversification strategies may include reengineering, expanded use of the National Defense Stockpile program, or qualification of new suppliers
- Work with allies and partners on joint industrial base challenges through the National Technology Industrial Base and similar structures
- Modernize the organic industrial base to ensure its readiness to sustain fleets and meet contingency surge requirements
- Accelerate workforce development efforts to grow domestic STEM and critical trade skills
- Reduce the personnel security clearance backlog through more efficient processes
- Further enhance efforts exploring next generation technology for future threats

Secretary of Energy

- Submit legislative proposal for FY2020 to establish an Industrial Base Analysis and Sustainment program to address manufacturing and industrial base risk within the energy and nuclear sectors.

Secretary of Labor

- Work with the Departments of Defense, Education, and Commerce to determine critical manufacturing and defense industrial base occupations and their corresponding definitions in the 2018 Standard Occupational Classification System. Using historical data from the Bureau of Labor Statistics and demand data gathered from industry, determine specific occupations to target for current and future pipeline growth (e.g. systems engineers, computer numerically controlled tool operators, welders) and:
  - Assess potential incentives to recruit and retain workers to enter and/or stay in the industrial base, such as tuition reimbursement.
  - Create or foster comprehensive training and education programs in coordination with federal, state, academic, and local sponsors.
- Work with states to reduce occupational licensing barriers preventing qualified workers from quickly and efficiently meeting needs in other regions, thereby aiding geographic movement of individuals possessing critical skills to areas in need of human capital for production and maintenance (e.g. shipyards, depots, and production plants).

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APPENDICES

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Appendix One: Executive Order 13806

ASSESSING AND STRENGTHENING THE MANUFACTURING AND DEFENSE INDUSTRIAL BASE AND SUPPLY CHAIN RESILIENCY OF THE UNITED STATES

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered as follows:

Section 1. Policy. A healthy manufacturing and defense industrial base and resilient supply chains are essential to the economic strength and national security of the United States. The ability of the United States to maintain readiness, and to surge in response to an emergency, directly relates to the capacity, capabilities, and resiliency of our manufacturing and defense industrial base and supply chains. Modern supply chains, however, are often long and the ability of the United States to manufacture or obtain goods critical to national security could be hampered by an inability to obtain various essential components, which themselves may not be directly related to national security. Thus, the United States must maintain a manufacturing and defense industrial base and supply chains capable of manufacturing or supplying those items.

The loss of more than 60,000 American factories, key companies, and almost 5 million manufacturing jobs since 2000 threatens to undermine the capacity and capabilities of United States manufacturers to meet national defense requirements and raises concerns about the health

of the manufacturing and defense industrial base. The loss of additional companies, factories, or elements of supply chains could impair domestic capacity to create, maintain, protect, expand, or restore capabilities essential for national security.

As the manufacturing capacity and defense industrial base of the United States have been weakened by the loss of factories and manufacturing jobs, so too have workforce skills important to national defense. This creates a need for strategic and swift action in creating education and workforce development programs and policies that support job growth in manufacturing and the defense industrial base.

Strategic support for a vibrant domestic manufacturing sector, a vibrant defense industrial base, and resilient supply chains is therefore a significant national priority. A comprehensive evaluation of the defense industrial base and supply chains, with input from multiple executive departments and agencies (agencies), will provide a necessary assessment of our current strengths and weaknesses.

Sec. 2. Assessment of the Manufacturing Capacity, Defense Industrial Base, and Supply Chain Resiliency of the United States. Within 270 days of the date of this order, the Secretary of Defense, in coordination with the Secretaries of Commerce, Labor, Energy, and Homeland Security, and in consultation with the Secretaries of the Interior and Health and Human Services, the Director of the Office of Management and Budget, the Director of National Intelligence, the Assistant to the President for National Security Affairs, the Assistant to the President for Economic Policy, the Director of the Office of Trade and Manufacturing Policy, and the heads of such other agencies as the Secretary of Defense deems appropriate, shall provide to the President an unclassified report, with a classified annex as needed, that builds on current assessment and evaluation activities, and:

(a) identifies the military and civilian materiel, raw materials, and other goods that are essential to national security;

(b) identifies the manufacturing capabilities essential to producing the goods identified pursuant to subsection (a) of this section, including emerging capabilities;

(c) identifies the defense, intelligence, homeland, economic, natural, geopolitical, or other contingencies that may disrupt, strain, compromise, or eliminate the supply chains of goods identified pursuant to subsection (a) of this section (including as a result of the elimination of, or failure to develop domestically, the capabilities identified pursuant to subsection (b) of this section) and that are sufficiently likely to arise so as to require reasonable preparation for their occurrence;

(d) assesses the resiliency and capacity of the manufacturing and defense industrial base and supply chains of the United States to support national security needs upon the occurrence of the contingencies identified pursuant to subsection (c) of this section, including an assessment of:

(i) the manufacturing capacity of the United States and the physical plant capacity of the defense industrial base, including their ability to modernize to meet future needs;

(ii) gaps in national-security-related domestic manufacturing capabilities, including non-existent, extinct, threatened, and single-point-of-failure capabilities;

(iii) supply chains with single points of failure or limited resiliency, especially at suppliers third-tier and lower;

(iv) energy consumption and opportunities to increase resiliency through better energy management;

(v) current domestic education and manufacturing workforce skills;

(vi) exclusive or dominant supply of the goods (or components thereof) identified pursuant to subsection (a) of this section by or through nations that are or are likely to become unfriendly or unstable; and

(vii) the availability of substitutes for or alternative sources for the goods identified pursuant to subsection (a) of this section;

(e) identifies the causes of any aspect of the defense industrial base or national- security-related supply chains assessed as deficient pursuant to subsection (d) of this section; and

(f) recommends such legislative, regulatory, and policy changes and other actions by the President or the heads of agencies as they deem appropriate based upon a reasoned assessment that the benefits outweigh the costs (broadly defined to include any economic, strategic, and national security benefits or costs) over the short, medium, and long run to:

(i) avoid, or prepare for, any contingencies identified pursuant to subsection (c) of this section;

(ii) ameliorate any aspect of the defense industrial base or national-security- related supply chains assessed as deficient pursuant to subsection (d) of this section; and

(iii) strengthen the United States manufacturing capacity and defense industrial base and increase the resiliency of supply chains critical to national security.

Sec. 3. General Provisions. (a) Nothing in this order shall be construed to impair or otherwise affect:

(i) the authority granted by law to an executive department or agency, or the head thereof; or

(ii) the functions of the Director of the Office of Management and Budget relating to budgetary, administrative, or legislative proposals.

(b) This order shall be implemented consistent with applicable law and subject to the availability of appropriations.

(c) This order is not intended to, and does not, create any right or benefit, substantive or procedural, enforceable at law or in equity by any party against the United States, its departments, agencies, or entities, its officers, employees, or agents, or any other person.

DONALD J. TRUMP

THE WHITE HOUSE,

July 21, 2017.

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Appendix Two: Sector Summaries

Each of the working groups provided a summary of their respective sector in the following pages, including explanations of impacts the risk archetypes have on their sector's ability to support national security. The sector summaries focus on prime suppliers; information regarding risk below the prime tier is available for some sectors in the classified annex.

Traditional Defense Sectors

Aircraft Sector

Aircraft includes fixed wing, rotorcraft, and unmanned aerial systems required for air-to-air and air-to-ground military operations and transport. Fixed wing aircraft include fighters, bombers, cargo, transportation, and any manned aircraft that use a set of stationary wings to generate lift and fly. DoD rotorcraft operate in harsh battlefield environments, requiring robust, advanced capabilities and systems. Unmanned aerial systems include the necessary components, equipment, network, and personnel to control an unmanned aircraft; in some cases, unmanned aerial systems also include a launching element.

While large airframes and subsystems rely heavily on commercial technologies, processes, and products, defense-unique design and manufacturing skills are needed to meet the requirements of military weapon systems, produce next-generation aircraft, and maintain technological advantage. Six companies provide the majority of aircraft platforms and possess the full range of capabilities to bring a new weapon system from the research, design, and development phases into full production.

The rotorcraft industry consists of two major segments: defense and commercial. The mission and capability requirements between the two segments are substantially different. While military rotary wing funding peaked in 2011 and has since declined by over 40%, it is projected to increase again due to programs including Future Vertical Lift. The funding levels for the last decade have been historically high due to the high operational tempo and utilization in theater.

Diverse and complex, the unmanned aerial systems industry ranges from bird-size (classified as Group I) to 100+ foot wingspans (Group V) and includes both unmanned and manned-with-autonomy. The industry supporting unmanned aerial system production is wide-ranging and in a state of rapid transition, as civil end-users overtake military-specific users, with a significant shift in market development and production of small to medium-sized platforms (Groups I-III)

from U.S. sources to those based in China. As current conflicts wind down, there will be a reduction in planned military buys and more focus on evolving systems that can survive in an Anti-Access Areal Denial or defended airspace.

All three aircraft sub-sectors face challenges, including long product/system development timelines, high development and qualification costs, and production limitations. During the 1990s, a dramatic decline in aircraft procurement led to consolidation of prime suppliers in the sector. Consolidation continues today and has expanded into the sub-tiers of the supply chain, creating additional risks for single or sole source vendors. In addition, the sector is experiencing a shortage of workers with critical hardware and software design capabilities due to large retirement populations, limited platform knowledge transfer opportunities, and skyrocketing demand for software engineers outstripping supply in multiple product line sectors.

Case Studies: Aircraft Sector Impacts on National Security

Gaps in the aircraft sector directly reduce domestic capability to produce and field a fleet capable of providing superior offensive and defensive capabilities against adversaries. The case studies included below illustrate how trends in workforce, industry consolidation, and individual company risk impact the quality and quantity of U.S. military aircraft.

Aircraft Design and Engineering Human Capital

Defense-unique design skills are required to spur innovation and enable revolutionary platform development. Current modernization programs help sustain important capabilities but do not provide enough opportunities to maintain skills to dominate major design and next generation development work. With the approaching end of several advanced development programs, an absence of new requirements in the next five to seven years, and increasing numbers of retirees with critical experience, the industrial base workforce faces a shortage of critical design capabilities. Maintaining innovation becomes nearly impossible while facing the constant threat of skilled aerospace, mechanical, electrical, and software engineers leaving the workforce and not passing along critical knowledge of next-generation technologies and fifth/sixth generation enabling capabilities to new employees. Another endemic workforce weakness experienced across much of the aircraft sector is the original equipment manufacturers' inability to maintain innovation and design skill development due to a lack of consistent R&D funds.

Each subsector faces distinct challenges. In the fixed wing sector, keeping design teams active for next generation tactical air support fighters may become an issue because industry will not see a new program starts until the F-X and F/A-XX programs begin to take shape. Compounding this issue, most current tactical air support design engineering teams have employees at or near retirement age. Industry is working closely with the Defense Advanced Research Projects Agency on the Penetrating Counter Air and Next Generation Air

Dominance programs, efforts that will set the stage for next generation fighter aircraft capabilities and survivability and provide current teams with new design work, through which older employees can transfer unique skills and knowledge to the next generation.

Impacts of Limited Innovation

Without design competition, DoD will see limited innovation, increased cost, and additional time added to new starts. Production capacity could also become a concern as legacy programs end (F-15, F-16, & F-18) and production lines close. The facilities where these lines are located will likely be refitted for other purposes and space will be occupied with new workload or closed. If this occurs, it will have a limiting effect on industry's ability to surge production in the future. In rotorcraft, twelve legacy platforms are currently in production or sustainment and three are in engineering, manufacturing, and development. There have been no clean sheet program starts through production since 1983. As decisions on the Future Vertical Lift program are delayed, industry design teams and other industrial capabilities could be at risk. In unmanned aerial systems, only the MQ-25 is in engineering, manufacturing, and development, with limited public new design on the horizon. As time goes on, design teams could be in jeopardy, with domestic producers of smaller class unmanned aerial systems experiencing a shrinking market share.

Large, Complex Alloy Castings

There are currently four suppliers with the capability to manufacture large, complex, single pour aluminum and magnesium sand castings. These suppliers face perpetual financial risk and experience bankruptcy threats and mergers mirroring the cyclicality of DoD acquisition. The single qualified source for the upper, intermediate, and sump housing for a heavy lift platform for the Marines has experienced quality issues and recently went through bankruptcy proceedings. Without a qualified source for these castings, the program will face delays, impeding the U.S. ability to field heavy lift support to Marine Corps expeditionary forces.

Chemical, Biological, Radiological, and Nuclear Sector

Chemical, biological, radiological, and nuclear encompasses capabilities through science, engineering, testing, and logistics to create products that provide protection from threats and attacks.

The DoD Chemical and Biological Defense Program's mission is to enable the Warfighter and first responders to deter, prevent, protect, mitigate, respond, and recover from chemical, biological, radiological, and nuclear threats and effects as part of a layered, integrated defense. To support this mission, the Chemical and Biological Defense Program industrial base sustains the capabilities needed to support the three strategic readiness goals: 1) equip the force to successfully conduct military operations to prevent, protect, and respond to chemical, biological, radiological, and nuclear threats and effects; 2) develop new capabilities to counter emerging chemical, biological, radiological, and nuclear threats; and 3) maintain industrial capabilities in the form of workforce, infrastructure, testing, R&D, and manufacturing to achieve current and future National Security Strategy requirements.

The sector is composed of commercial and organic industry of all sizes to meet the Chemical and Biological Defense Program mission. It is also a niche market heavily dependent upon DoD procurements for sustainability and defined by the engineering, testing, logistics, and production capabilities to meet the following technical areas: medical countermeasures to address chemical, biological, radiological, and nuclear and emerging infectious diseases and threats through vaccines and antidote treatments; protection for the Warfighter through respirators, masks, decontamination kits, etc.; contamination avoidance through development and use of sensors, monitors, and detectors; guardian systems to provide support for first responders; and information systems that consist of integrated early warning, hazard prediction models, consequence management, and decision support tools. The 2017 National Security Strategy indicates the importance of the sector as it provides critical capabilities to counter

hostile states and terrorist groups increasingly trying to acquire nuclear, chemical, radiological, and biological weapons.

Case Studies: CBRN Sector Impacts on National Security

The case studies below illustrate how a capacity-constrained supply market, structurally poor industry economics, and the erosion of U.S.-based infrastructure create gaps in the sector that may lead to limited or non-existent domestic supply of capabilities to protect the Warfighter against current and future threats.

ASZM-TEDA1

ASZM-TEDA1 impregnated carbon is a defense-unique material provided by a single qualified source, subject to a single-point-of-failure. A lack of competition with other potential sources precludes assurances for best quality and price. While ASZM-TEDA1 is used in 72 DoD chemical, biological, and nuclear filtration systems, the current sourcing arrangements cannot keep pace with demand. DoD is using Defense Production Act Title III authorities to establish an additional source of this critical material.

Organic Base Arsenal

Inconsistent workload and future projections degrade the ability to sustain current capabilities and to develop capabilities for future requirements at an organic arsenal in support of Joint Forces readiness requirements. The difficulty in providing a sustainable workload to this organic production base negatively impacts the ability to retain and develop human capital, increases overhead costs, and limits the ability to surge or respond quickly to Chemical and Biological Defense Program requirements. In addition, the sustainment of the production facility in providing low volume legacy components and end items is vital.

Ground Systems Sector

Ground systems provide defense unique products for mobility and firepower, and are divided into tracked and wheeled vehicles for combat, combat support, and combat service support.

The ground systems sector is defined by a small set of prime suppliers engaged solely in production for both tracked and wheeled vehicles. There are two main suppliers for tracked tactical vehicles – one supplier specializing in steel fighting vehicles and another specializing mostly in aluminum armored vehicles. Wheeled combat service support vehicles are considered a defense-unique product, but the industrial base supporting this subsector is highly dependent on commercial automotive technology and production capabilities. Two domestic suppliers dominate tactical wheeled vehicle manufacture, but there are multiple qualified vendors for the repair, refurbishment, and modifications business.

There are only a few active programs within various development phases for legacy systems in the tracked vehicles subsector, including armored multi-purpose vehicles; amphibious assault vehicles; M1A1/ M1A2 vehicles; M109 vehicles; and armored tank retriever variants. The ground systems sector followed a strategy of incremental adoption of new technologies on legacy designs to maintain or modify current ground systems, allowing the military to defer the long schedules and high costs of new programs. However, this resulted in a generation of engineers and scientists that lack experience in conceiving, designing, and constructing new, technologically advanced combat vehicles.

Many current wheeled tactical vehicle fleets are in the middle of their lifecycles, which are generally planned for 20 years with a rebuild at the ten year mark, but this can vary with utilization. The existing vehicle fleets are healthy, as increased production has lowered the average age of the platforms, and Overseas Contingency Operations maintenance funding allowed for rebuilds and modifications to be applied at the same time. Advances in technology

and engineering innovation led to improvements in existing equipment, prolonging vehicle service life and increasing the capability of legacy vehicles.

Opportunities for new work, modernization, and recapitalization are important to keep prime suppliers competitive. The Army is preparing two programs that will provide much needed work to exercise design skills in the wheeled vehicle industrial base: 1) development of a replacement medium tactical vehicle; and 2) the Mobile Protected Firepower to design and field a more lethal armored fighting vehicle.

Fragility exists in the sector for systems with long lifecycles and equipment not used in ongoing combat operations or training. As a result, a lack of steady orders for vehicles leads prime vendors and their suppliers to reduce excess capacity in labor and facilities, leaving the ground systems sector at risk of not meeting service and combatant command requirements for modern, new, and additional equipment that can dominate the battlefield. Industrial facilities are not readily available to produce, the workforce is limited, and competition for common supply chain products and other materials would require prioritization across the ground vehicle supply chain as well as across services.

Case Studies: Ground Vehicle Sector Impacts on National Security

The following case studies illustrate how gaps in the ground vehicle sector directly reduce capabilities to maintain a forward military presence needed to deter and defeat any adversary, and adapt to new strategies and techniques of battle.

Wrought Aluminum Plate Production Capacity

Wrought aluminum plate, and specifically cold-rolled plate, is essential for armoring U.S. ground combat vehicles, constructing Navy ships, and building military aircraft. Unlike other more common forms of rolled aluminum materials, thick cold-rolled aluminum production capabilities and capacities are unique. DoD relies on domestic producers as well as capabilities available from ally countries in Europe. Due to U.S. Government budget uncertainties, unpredictable DoD demand, and other commercial market factors, the defense industrial base can face challenges when trying to balance diverse demands for cold-rolled plate production capacity while also informing long-term internal capital investment decisions. Other challenges facing the domestic industrial base include the effects of foreign competition. Under certain circumstances, the defense industrial base could potentially face production bottlenecks during a future surge in DoD requirements.

Manufacture of Gun Barrels, Howitzer Barrels, and Mortar Tubes

Legislation and DoD industrial policy requires DoD to manufacture all large caliber gun barrels, howitzer barrels, and mortar tubes at one organic DoD arsenal. There is only one production line at the arsenal for all of these items, and policy modifications to meet demand

and surge from overseas have led to a lack of capacity to meet current production requirements.

Capacity Shortfall for Future Armored Brigade Combat Team Goals

Over 80% of Army and Marine Corps combat vehicle production consolidated to one manufacturer at one assembly facility. Almost none of these vehicles have ever been completely manufactured at this facility. None have been manufactured simultaneously and the facilities capacity to support simultaneous manufacture is currently under examination.

Munitions and Missiles Sector

Munitions include 'dumb' bombs, ammunition, mortars, and tank rounds, etc., and missiles include 'smart' bombs, tactical (air-to-air, air-to-ground, surface-to-air, cruise) missiles, missile defense, and strategic missiles. The sector is primarily defense-unique and is subject to wartime needs – procurement ramps up during wartime and reduces when conflict ends. The market is defined by this conflict-reliant pattern, creating significant management and viability challenges for suppliers and their sub-tiers.

The missile sector has undergone significant consolidation in the past several decades. Two of the five prime contractors account for roughly 97% of DoD's missile procurement funding. As of the writing of this report, one of the prime contractors is attempting to acquire another prime. There are currently only two domestic suppliers for solid rocket motors used in the majority of DoD missile systems, with a single foreign supplier making up the balance.

Over the past two decades, DoD has fielded no completely new tactical missile designs. New programs have been upgrades to existing systems, but there have been no solid rocket motor improvements. The sector is also suffering a post-drawdown decline in procurement, resulting in loss of critical design and production skills. However, two new tactical missile programs are

entering development and, if they continue, will provide needed work to exercise the tactical missile industrial base design skills – the Advanced Anti-Radiation Guided Missile Extended Range and Long Range Precision Fires. There is also one new strategic missile program, Ground Based Strategic Deterrent, the LGM-30G Minute Man III Inter-Continental Ballistic Missile replacement. Numerous demonstration and validation programs have been funded over the past several years by the Ground Based Strategic Deterrent program, providing some design work to industry, particularly to the large solid rocket motor industrial base.

The ammunition and munitions base is critical to the life cycle management of more than 650 programs, over 1,200 end items, and over 1,300 components. Efficiencies in contracting and cost effectiveness have been gained with the Army as the Single Manager for Conventional Ammunition for all Services, including procurement from both organic and private sector suppliers. Private sector suppliers, the majority of which are domestic, are of crucial importance to conventional munitions production – which does not include missiles. Historically, 70-75% of procurement funding for munitions has been directed toward the private sector.

Case Studies: Munitions and Missiles Sector Impacts on National Security

Gaps in munitions and missiles directly reduce the U.S. capability to deliver kinetic effects against adversaries. The case studies below illustrate how risks have hampered U.S. mission goals in recent years, as well as the impact to immediate and long term U.S. wartime capabilities.

Silicon Power Switch

In 2017, the issue with the most impact was the obsolescence of a voltage controlled switch from a sub-tier supplier. The switch is used in electronic safe and arm devices, electronic ignition devices, and flight termination systems for all DoD missiles. The semiconductor chip foundry used in the voltage control switch was purchased by another foundry. A 5th tier supplier, the voltage control switch company notified their next tier customer of the foundry closing and received an end-of-life buy order for what was considered enough supply to allow time to qualify a replacement voltage control switch. DoD was not informed of the issue or consulted on the end-of-life quantity until two years after the event occurred. At that point, it became evident that the end-of-life buy, which was supposed to last 3-5 years, would only last 6 months. This left insufficient time to develop, test, integrate, and qualify the new switch before the old switches were depleted. Until new switches are qualified, affected DoD missile systems are at risk.

Advanced Medium Range Air-to-Air Missiles (AMRAAM)

After years of production, the supplier of the solid rocket motor for the Advanced Medium Range Air-to-Air missile encountered technical production issues. Subject matter experts from the government and industry were unable to determine the cause, leading to a

temporary work stop and potential loss for a critical solid rocket motor supplier. To keep the Advanced Medium Range Air-to-Air missile production line moving, the prime contractor for the missile pursued an alternative source for the solid rocket motor, and selected a Norwegian company to produce a new solid rocket for the missile.

Explosives Demand at Holston Army Ammunition Plant (HSAAP)

A government-owned, contractor operated facility is the only domestic source for most DoD explosives, and it can only produce 9 million pounds of a key DoD explosive per year. In early FY 2016, demand for this explosive for bomb fills abruptly increased to levels not seen in decades and the facility did not have sufficient capacity to meet demand. Foreign sources were not able to materially mitigate the capacity shortfall. A study determined that the facility's capacity would continue to be stressed for the foreseeable future, so a mitigation plan to increase capacity is being implemented at a cost of $500 million and with an estimated completion date of 2023.

Nuclear Matter Warheads Sector

The U.S. nuclear deterrent is a lynchpin in our defense planning and that of our allies and adversaries. Nuclear weapons are designed and produced to meet an "Always/Never" standard:

1. They must always work when authorized by proper authority, and
2. They must never work in any situation or environment (normal, abnormal, or adversarial) without authorization by proper authority.

Supply chain availability and integrity is crucial to achieving the "Always/Never" standard, but an increasing set of risks threaten the integrity of the enterprise. A summary is provided below, while a classified version of this report provides further details.

Major Risks: Nuclear Matter Warheads Sector

Skilled, Clearable Workforce

The U.S. faces a diminishing supply of clearable labor with the advanced education and training necessary for designing, producing, and stewarding nuclear weapons. The primary source of that labor, U.S. colleges and universities, generate insufficient U.S. citizen graduates in the STEM areas relevant to the nuclear enterprise. The U.S. also lacks labor with important trade skills, including welders. Additional challenges due to clearance requirements greatly reduce the available pool of labor.

Microelectronics/Electronic Components

Nuclear warheads depend on trusted sources of microelectronics and electronics. Because the supply chain is globalized and complex, it is challenging to ensure that finished assemblies, subsystems, and systems exclusively leverage trusted, discrete components due to diminishing U.S.-based microelectronic and electronic manufacturing capability.

Critical Materials

Various sole source materials, addressed through the Nuclear Posture Review, are unavailable through trusted sources in sufficient quantities to ensure a robust and independent nuclear capability throughout the weapons lifecycle. The problem is exacerbated by policies and requirements that either limit or place restrictions on procurement options, e.g., life of program buys.

Software Systems/Applications

Lack of trusted sources of software design tools, data management systems, manufacturing execution, and facility controls introduce risk to the nuclear weapons engineering environment. This problem is exacerbated by poor cybersecurity practices by many key software vendors.

Analytical and Test Equipment

Given current nuclear weapons test restrictions, specialized analytical and test equipment is essential to ensure the "Always/Never" standard of nuclear weapon performance. Components, subsystems, and systems must be tested to unique qualification standards, but the supplier base for certain test equipment is increasingly globalized and not trusted, leading to uncertainty in testing.

Radar and Electronic Warfare Sector

Military radars and electronic warfare systems play a significant role in meeting our national security objectives. Radar is essential to detecting the presence, direction, distance, and speed of targets such as aircraft, ships, and weapons, and for controlling flight and weaponry. Detection is achieved by transmitting electromagnetic waves that are then reflected off objects and return back to the receiver. Required to operate in the harshest environments in order to support combat operations, military radar system requirements are often more stringent than those imposed on commercial systems. Radar systems have many applications and can even be used to detect slight changes to surfaces over time – allowing such capability as detection of footprints of shallow depth. Recent technological advances have enabled the rise of the Synthetic Aperture Radar, which leverages signal data processing to integrate radar returns over time as a radar system moves, and is used for search and rescue, target search/acquisition/identification/tracking, and weapons engagement. Synthetic Aperture Radar capabilities have become a game changer for state of the art and next generation radar systems and platforms.

Electronic warfare systems continue to become a more integral element of military weapon systems. Electronic warfare refers to military action involving the use of electromagnetic energy and directed energy to control the electromagnetic spectrum or to attack the enemy. The purpose is to deny the opponent the advantage of, and ensure friendly unimpeded access to, the electromagnetic spectrum; it includes capabilities for electronic attack, electronic support, and electronic protection. The systems are dependent upon technologies similar to those found in radar systems, including receivers and transmitters, and include countermeasure technologies such as chaff and flares that can target humans, communications, radar, or other assets.

DoD has roughly 100 radar systems in development, production, or sustainment with a similar portfolio of electronic warfare systems. These systems perform functions in four operational domains; land, air, space and sea and provide critical mission capabilities. There are a total of

23 firms that produce or have produced radars for DoD. Three domestic suppliers dominate the domestic radar market and four domestic suppliers dominate electronic warfare systems.

Case Studies: Radar and Electronic Warfare Sector Impacts on National Security

Gaps in the radar and electronic warfare sector directly reduce American capability to detect, find, fix, acquire, track, and attack threat systems in the face of an ever increasingly complex digitally driven environment. The case studies illustrate areas on which the U.S. needs to avoid becoming out matched in a current or next generation warfare scenario, where we would rely on radar and electronic warfare systems as key enablers to ensure survivability and dominance in a multi-domain battle space.

Radar and Electronic Warfare Software Developers & Engineering Shortages

Of greatest concern in this sector is prime contractors' ability to attract and retain the necessary software developers and engineers to develop and sustain radar and electronic warfare systems. Traditional radar and electronic warfare systems are minimally automated, requiring an operator to manually configure the system to operate in static modes. As the operational environment continues to grow in complexity with regards to the types and number of targets, and as commercial and military spectrum usage increases, our systems are forced to be cognitive, agile, automated, and multi-purposed. As the commercial sector and adversaries field similar capabilities, U.S. forces encounter systems that can "hide in the noise" and frequency hop to avoid detection and characterization.

To attack, defend, and counter against an increasingly complex and networked threat scenario, we must have a robust, capable, and agile workforce to update and modernize our military systems in critical technologies such as radio frequency solid state, power, high speed data interconnects and networks, software, and algorithms. Decreasing numbers in domestic software systems engineers, developers, and design engineers force defense suppliers to compete for talent with each other and with non-defense industries. Recruitment, training, and retention become key employer capabilities to ensure companies have the manpower to conduct R&D, design, modernization, and system upgrades within tactically relevant timelines. Without the appropriate depth of skilled engineers, America's leading edge in hardware architectures and software/firmware coding will continue to erode.

Electronic, Microelectronic, and Material Issues

Trusted foundries, obsolescence, diminishing manufacturing sources and material shortages, and counterfeit issues are common to the broad defense electronics sector. These issues are prevalent for current and future radar and electronic warfare systems as well as systems in sustainment. One logistics center within the organic base identified over 4,000 diminishing manufacturing sources and material shortages items for just the radars maintained at that

particular base. In addition to sustainment issues, the military is highly dependent upon the commercial sector for technology maturation, but the commercial sector is driven by revenue and high volume technology demands. In the microwave tube industry, DoD has only two primary microwave tube sources because of the commercial sector's migration to solid state technologies, creating a fragile market. Additionally, technology performance requirements being driven by the general public do not always lead to the development of technology that is feasible for military use. Given the fluidity of the commercial sector, the U.S.'s ability to lead advancements and retain long-term support infrastructure to support defense-specific electronics and microelectronics technologies areas will continued to be stressed.

Chaff and Flare Issues

Of concern is the limited number of U.S. based sources for chaff and flare countermeasures – both integral for defensive capabilities. Chaff is composed of millions of tiny aluminum or zinc coated fibers stored on-board the aircraft in tubes. When an aircraft is threatened by radar tracking missiles, chaff ejected into the turbulent wake of air behind the plane creates confusion for the missile's radar system. Defense unique requirements and decreasing DoD demand drove out other suppliers, leaving a single qualified source for chaff.

Flares distract heat-seeking missiles by ejecting hot magnesium pellets from tubes to ignite in the wake behind an aircraft. They burn at temperatures above 2,000 degrees Fahrenheit, hotter than the jet engine nozzles or exhaust, and exhibit large amounts of infrared light. Over the past decade, capacity in the flare industry has declined and DoD demand has dropped, leaving two domestic suppliers with little incentive to invest in infrastructure. Recently, the two domestic suppliers both experienced explosive accidents at their production sites and the subsequent shutdowns limited DoD program offices' ability to acquire products on time. Both companies have experienced quality and delivery problems since the accidents. As program offices look to improve quality and cost, they are beginning to look offshore at more modern facilities, where there are fewer quality and safety concerns.

Reduced Competition and Innovation

The military faces risk of reduced competition and innovation for fighter aircraft tactical active electronically scanned array radar systems. While there are other suppliers who have the capability to develop and produce these systems, there are only two domestic suppliers who have the unique engineering and design requirements and capabilities for size, weight, operational environment, and power associated with a tactical fighter aircraft. While similar active electronic scanned array systems are being produced for other applications, once the F/A-18 production ends (roughly 2024), only a single qualified source of the systems will remain.

Shipbuilding Sector

Shipbuilding includes the industrial base required to construct and maintain Navy aircraft carriers, submarines, surface ships, and their associated weapons and command and control systems.

The shipbuilding sector consists primarily of seven shipyards owned by four companies and their suppliers. Shipyards are fixed facilities with dry-docks and fabrication equipment that support ship construction, repair, conversion and alteration, and the production of refabricated ship sections and other specialized services. The sector also includes manufacturing and other facilities beyond the shipyard, which provide parts and services for shipbuilding activities. The industrial base supporting shipbuilding is segmented by ship type: aircraft carriers, submarines, surface combatants, amphibious warfare, combat logistics force, and command and support vehicles.

Over the last 60 years, Navy procurement profiles have shown sharp peaks in shipbuilding followed by significant breaks or valleys in production, severely degrading the ability of shipyards to conduct long-term planning and respond to near-term changes in requirements. This created a boom and bust within the industry, degrading the industrial base and resulting in longer construction times and increased costs. The steady, sustainable baseline shipbuilding profiles in the Annual Long-Range Plan for Construction of Naval Vessels for FY 2019 will establish industrial efficiency and agility, and protect workforce skills, in order for the U.S. shipbuilding industrial base to remain cost effective and meet the demands of the 355 ship Navy required for national defense.

Case Studies: Shipbuilding Sector Impacts on National Security

The shipbuilding industrial base is a national asset and absolutely vital to America's ability to build and sustain the Naval fleet. The Navy is focused on improving the health of the industrial base to meet its requirement of a 355 ship fleet with a long range plan anchored by industrial stability. The analysis performed in response to EO 13806 identified five underlying risks: dependency on single/sole source suppliers, capacity shortfalls, lack of competition, lack of workforce skills, and unstable demand.

Dependency on Single/Sole Source Suppliers

Industries involved in the manufacturing of shipbuilding components were among the hardest hit by the global shift in the industrial base over the last 20 years. Of the top ten highest grossing industries in Navy shipbuilding, six are in the manufacturing sector. Since 2000, these industries experienced a combined decline of over 20,500 establishments[††] in the U.S. Contraction of the industrial base has limited competition among U.S. suppliers of Navy components and in many cases, competition has altogether vanished, forcing the Navy to rely on single and sole source suppliers for critical components. Expanding the number of companies involved in Navy shipbuilding is important to maintaining a healthy industrial base.

A sole source issue currently impacts the manufacturing and refurbishment of shafts for surface ships and submarines. The limited capacity of the equipment at the sole forge doing this work for the Navy hampers the forge's ability to meet demand. Further, it is difficult to recruit and retain qualified personnel to operate the equipment because technical schools have stopped training on the equipment, given its age. If the forge is not modernized, the facility may exit the market, causing disruptions to multiple Navy programs.

Capacity Shortfall

The high operational tempo of the Navy in recent years, along with a lack of steady funding for maintenance and modernization, has resulted in a backlog of repair work across the fleet. Coupled with increases in new ship construction, many suppliers are experiencing a shortfall in their capacity to perform work and manufacture products. This increased demand is applying stress to already-aging production equipment and could necessitate additional hiring in highly specialized fields, where it is difficult to find suitable candidates. The combination of limited suppliers and an increase in workload could increase cost and potentially create schedule slips, impacting American warfighting capability.

One risk in particular relates to Navy surface ship dry-docking requirements for maintenance and modernization work. New ship technical requirements, a large volume of mid-life availabilities, and a general lack of investment by industry in new dry-dock capacity will create a significant constraint for completing ship maintenance, requiring the Navy to adopt strategies that could potentially increase cost and schedule risk.

Lack of Competition

The primary cause decreasing competition in shipbuilding is the small comparative size of the U.S. commercial shipbuilding industry compared to the foreign shipbuilding industry, coupled with the Navy's unique military requirements. Products and services that lack competition are at a higher risk of being offered by a single or sole source supplier. Examples of lack of competition can be seen in many products critical to shipbuilding such as high voltage cable, propulsor raw material, valves, and fittings.

Lack of Workforce Skills

The skills needed to fabricate components for and build Navy ships, submarines, and their components are unique and specialized. As the shipbuilding industry has long been challenged by an eroding skill base, today's workforce will be challenged to meet the increased demand in the Annual Long-Range Plan for Construction of Naval Vessels for FY 2019. Additionally, the Department of Labor predicts that between 2018 and 2026, there will be a 6%–17% decrease in U.S. jobs in occupations critical to Navy shipbuilding, such as metal layout (ship-fitting), welding, and casting. As the amount of available jobs overall in the U.S. decreases, the number of workers entering into these fields will also decrease. Left unaddressed, a lack of skilled workers will significantly impact the shipbuilding industry's ability to meet the Navy's long term demand.

Unstable Demand

Due to uncertainties about future budgets and shipbuilding plans, the supplier base is limited in their ability to plan for future work, which limits production efficiencies, inhibits investment in facility improvements and workforce development, and reduces the level of independent R&D investment. Perhaps most significant, decreases and instability in demand can result in workforce reductions and production lines being shut down. When this happens, it is difficult to bring those skills back when they are needed, as it takes a significant amount of time to train a workforce to acquire the skills unique to the shipbuilding industry, and specialized production lines are often costly to reopen. Unstable demand drives cost, schedule delays, and quality issues throughout the industrial base, especially if not proactively managed.

[††] An establishment is a single facility regardless of ownership. For example Company "X" could own and operate five foundries in different states within the U.S.; this would count as five establishments.

Soldier Systems Sector

Soldier systems include products necessary to maximize the Warfighter's survivability, lethality, sustainability, mobility, combat effectiveness, and field quality of life by considering the Warfighter as a system. This sector includes the weapons, body armor, clothing, footwear, radios, sensors, power supply, shelters, food, and other Service-member support items essential to executing the many distinct U.S. military missions – from snipers to tankers to airmen to divers.

The soldier systems sector is composed of twelve subsectors; most have significant commercial overlap. The subsectors are vast – a recent Department of Commerce survey, exclusively studying the domestic clothing, textiles, and footwear industries, reported that 499 companies operate 764 domestic textile and/or apparel manufacturing sites and 44 companies operate 65 U.S. footwear manufacturing facilities.

The commercial market provides stabilizing peacetime revenue for existing defense contractors as well as opportunities for new players to modify commercial gear and enter the defense market. While access to the commercial market improves industrial base robustness, it also means the commercial market may drive demand and that DoD is not always the primary customer. When military and commercial requirements differ sufficiently, commercial market dominance can directly impact lead time, surge capacity, and the sustainment or development of industrial capabilities. Often, DoD is left to adapt to commercial market driven changes and only when unacceptable levels of industrial base risks arise, DoD may intervene in order to sustain critical industrial capabilities.

The soldier systems sector is emerging from a long-term war sustainment effort where the focus has largely been on fulfilling immediate needs. The challenge of meeting dynamic wartime demands consumed most of the available bandwidth and left little room for forward-looking investment and strategic planning. Many programs have met or are approaching their acquisition objectives, which triggers a natural peacetime cycle of decreased defense demand

leading to consolidation, reduction in capacity, loss of capability, reduced capital investment, and a transition toward commercial markets. Peacetime industrial readiness losses are largely anticipated, and have historically been recovered or replaced by alternatives once the U.S. enters another large scale military engagement.

As the war effort winds down, DoD and industry are pursuing some modernization efforts. Future soldier systems objectives include lightening the soldiers' load, capitalizing on lessons learned after years of fighting, developing modular/flexible/agile materiel solutions, and taking advantage of advancements in sensor technology and materials engineering. A skilled workforce and modernized industry is required to achieve advanced designs and develop novel industrial capabilities.

Case Studies: Soldier Systems Sector Impacts on National Security

Industrial capability gaps in the soldier systems sector directly reduce U.S. assurance that the Warfighter is adequately prepared to successfully execute defense missions in any operating environment. The case studies illustrate where industrial base risk has accumulated in ways that may exceed industrial base elasticity and the risk of permanent capability loss is enough to potentially warrant government action.

Erosion of U.S. Textiles Industry

Between 1995 and 2009, the U.S. textile industry suffered a historic contraction and Asian markets now dominate global textiles supply. According to a recent Department of Commerce survey, the greatest competitive disadvantages in the domestic clothing and textile subsector are related to workforce and raw material cost and availability. Since 2009, the domestic textiles industry has shown signs of recovery, but recent data indicate a potential stall: total sales and exports of U.S. manufactured clothing and textile products have been stagnant from 2012-2016. As an example of recent domestic erosion, the single qualified domestic source for high-tenacity polyester fiber used in many DoD tent systems dissolved their business due to inability to compete in an increasingly competitive global market. Currently, there is no U.S. manufacturing capability for high-tenacity polyester fiber at specific deniers (e.g., that allow for military specification qualification) and significant impact to multiple tent and fabric systems is anticipated. If risk in the clothing and textiles subsector is unacceptable, the industry recovery momentum must be sustained and the U.S. must undertake decisive efforts to modernize and revitalize the domestic fiber and textiles industry, including the workforce.

Erosion of U.S. Rechargeable and Non-Rechargeable Battery Industry

Characterized by irregular demand proportional to operational tempo, the military battery industrial base is diminishing. Military-unique requirements can depart from commercial demands in size, quality, safety, power density, weight, and environmental ruggedness. Lack of stable production orders has resulted in lost capability and capacity, increased surge lead

times, workforce erosion, and inhibited investments by remaining suppliers. Surge-capacity-limiting constraints occur at several points along the value chain, from raw material to final battery assembly. Additionally, foreign dependencies on essential raw minerals (e.g., lithium) may potentially impact the rechargeable and non-rechargeable battery supply chain.

Most battery configurations are produced by single sources of supply. Production of BA-5590 (i.e., preeminent non-rechargeable military battery) is currently single-sourced to a foreign-owned supplier in France, with one domestic production facility. Decline in demand for military-unique non-rechargeable batteries has resulted in capability and capacity loss and the supplier can no longer support any significant surge in demands. Even when there were two manufacturers, their combined output struggled to meet surge demands for Operation Iraqi Freedom and Operation Enduring Freedom.

Asian markets dominate the rechargeable battery industry. Domestic rechargeable battery producers cannot compete in production volume and labor availability and cost. Most domestic lithium ion cell packagers rely on foreign commercial lithium ion cell suppliers from countries such as South Korea, China, and Taiwan. Cell availability for military battery packaging is a risk across the board for rechargeable batteries as commercial cell manufacturers, often foreign-owned, are unwilling to divert production from their commercial customers to U.S. military battery manufacturers.

Foreign Reliance for Essential Night Vision Components

U.S. military "night vision" systems are enabled by an image intensifier tube, a vacuum sealed tube that amplifies a low light-level scene to observable levels. Although probability of interruption has proven low (surge demand during Operation Iraqi Freedom and Operation Enduring Freedom was met) and there is a stockpiling risk management strategy in place, the U.S. is reliant on foreign capabilities to supply image intensifier tube core glass from Germany and gallium arsenide photocathodes from Japan and Germany. Core glass is DoD-unique and demand is very low compared to commercial glass production; the foreign sole source manufactures the core glass in batches based on demand, every few years, to replenish a U.S. buffer stock. Gallium arsenide allows for a more efficient conversion of light to electrical energy at extremely low light-level so by adding gallium arsenide to the photocathode, a brighter and sharper image is achieved. Gallium arsenide risk is considered reduced as the number of global suppliers has increased over time.

Space Sector

The space sector (also known as National Security Space) includes satellites, launch services, ground systems, satellite components and subsystems, networks, engineering services, payloads, propulsion, and electronics.

National Security Space increasingly leverages the commercial space industry, both domestic and foreign. While commercial space has similar needs to DoD, it does not require the same level of robustness, reliability, and security in its products. Many National Security Space domestic products are commercially non-competitive, due to the leading-edge performance, high-level capabilities, and unique DoD requirements. Commercial space relies on satellite replacement rather than long-term mission capability and while National Security Space systems continue to leverage commercial space products, there are certain performance requirements and capabilities that are more demanding or unique and are not supported by the growing commercial space ecosystem. DoD and U.S. Government-wide studies and analyses have identified at-risk capabilities, fragile suppliers, and stress in the lower tiers of the space industrial base. Primary areas of concern, as identified in the Defense Production Act Title III Presidential Determination (15 June 2017) include: aerospace structures and fibers, radiation-hardened microelectronics, radiation test and qualification facilities, and satellite components and assemblies.

The DoD space industrial base remains a niche market with very specialized and capital-intensive capabilities that are not efficiently managed through individual program investments. Many systems currently in planning and development rely on dated technology, skills, and fragile sources. Individual programs are reluctant to invest in and qualify new technology and sources, creating a need to sustain fragile domestic sources and to qualify new technologies and sources for next-generation systems, which are essential to address ever-increasing threats in the space domain.

The Space Industrial Base Working Group[##] maintains critical technology lists from member agencies which are integrated and prioritized to establish space industrial base risk mitigation projects. Prioritized, but unfunded, mitigations for over a dozen of the top issues have been developed, along with tracking of over 100 additional lower risk issues. DoD must remain vigilant of sources of vulnerability and maintain critical capabilities that are specialized for military applications.

Space systems provide an emergent capability and strategic advantage to U.S. forces yet, due to DoD business practices, market trends, supply chain globalization, and manufacturing costs, future access to space qualified domestic industrial sources, including microelectronics, is uncertain. Increasing cyber-threats, non-trusted supply-chains, foreign acquisitions, reliance on vulnerable foreign sources, industrial policies of competitor nations (in the form of subsidies, domestic preference, etc.), and erratic demand is threatening the loss of essential space capabilities and critical skills.

Case Studies: Space Satellite Sector Impacts on National Security

Gaps in the space sector result in a limited or degraded domestic supply of qualified critical materials and components to support National Security Space missions. The case studies below illustrate how high-performance and high-reliability requirements, long development cycles with low and inconsistent demand, and erratic funding further reduce the strategic advantage of the U.S. in the space sector.

Precision Gyroscopes

Precision gyroscopes are a critical component of the attitude determination and stabilization and inertial navigation system on spacecraft, launch vehicles, and missiles. Three or more individual gyroscope inertial sensors are typically packaged in an internally redundant inertial measurement unit. Three different types of gyroscopes (ring laser, hemispherical resonating, and fiber optic) are generally employed in space systems, each with varying industrial base issues. Hemispherical resonating gyroscopes are an older technology mainly used on non-agile satellites and only one domestic provider remains with limited production capacity (one or two units per month). As a result, this low volume item is frequently impacted by obsolescence issues and long lead times which can impact unit delivery if failures are found in testing.

The fiber optic gyroscope is the main technology employed in high performance agile spacecraft and missile applications. While there are currently three domestic suppliers, fiber optic gyroscopes rely on key components – integrated optics chips and laser diodes –

[##] The Space Industrial Base Working Group includes DoD's Office of Industrial Policy, Air Force Space and Missile Systems Center, Missile Defense Agency, and National Reconnaissance Office; the National Aeronautics and Space Administration is also an active participant.

experiencing supply issues which threaten the viability of domestic product lines. The sub-components used in integrated optics chips are increasingly manufactured overseas and laser diode suppliers are consolidating and also moving manufacturing offshore.

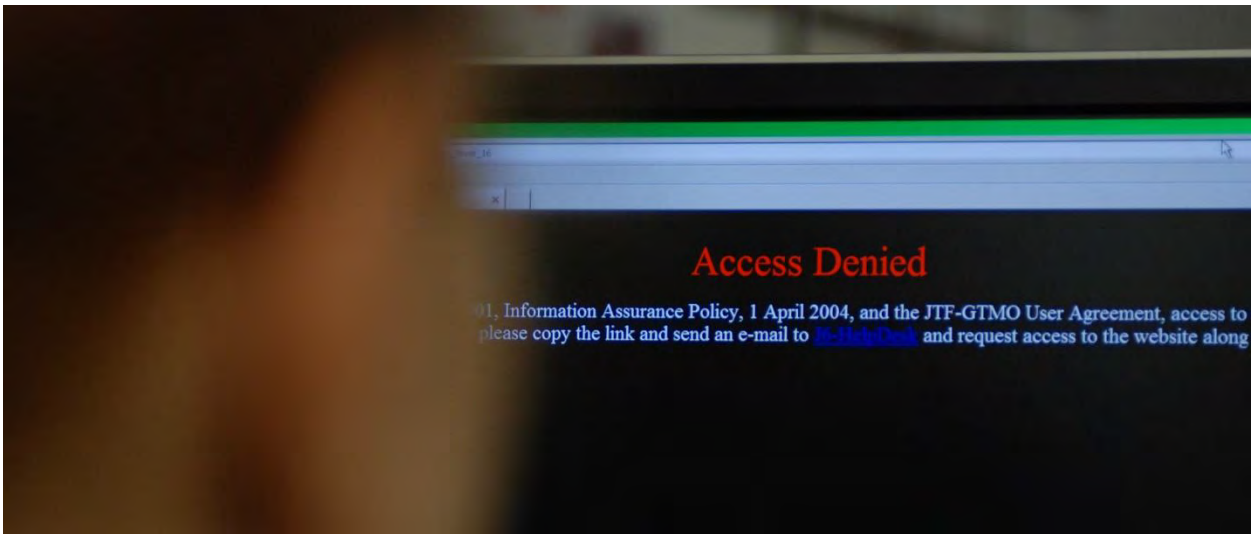
Space Qualified Infrared Focal Plan Arrays

The manufacture of space infrared detectors is dependent on a single foreign source for high quality substrates, and driven by low volume and long periods between orders, resulting in quality and workforce issues. Space infrared detectors rely on both mercury cadmium telluride and cadmium zinc telluride substrates. Despite a Defense Production Act Title III investment over the past few years used to establish a domestic provider and improve manufacturing capability for cadmium zinc telluride substrates, any disruption of more than a few months could essentially shut down production of large, strategic quality, mercury cadmium telluride infrared focal plane arrays and impact quality and long lead items for space satellites. A complimentary Industrial Base Analysis and Sustainment program is aiming to sustain the two U.S. foundries through process improvements, as well as demonstrate that domestic cadmium zinc telluride substrate-based detectors are equivalent in performance to focal plane arrays utilizing off-shore substrates.

The potential loss of domestic read-out integrated circuits sources for space applications due to low volume production will force systems to foreign vendors or to limited performance technologies that will severely impact on-orbit lifetime. This could also result in loss of domestic read-out integrated circuits design expertise, critical to integration into the sensor chip assemblies which make up focal plane arrays utilized for missile early warning, missile defense, space surveillance, and awareness in space systems. Radiation hardened, digital, capacitance trans-impedance amplifier based read-out integrated circuits have no commercial applications, resulting in extremely low volume production. The space market for read-out integrated circuits is extremely small, representing less than 1% of business for existing suppliers.

Cross-Cutting Sectors

Cybersecurity for Manufacturing Sector



Cybersecurity for manufacturing is a complex and challenging issue with immediate impacts to all facets and sectors of the industrial base. It includes information technology and operational technology within and across the supply chain.

The defense manufacturing supply chain flows goods and critical information among multiple organizations – of varying size and sophistication – to transform raw materials into components, subassemblies, and ultimately finished products and systems to meet DoD performance specifications and requirements. These supply chain operations rely on an infinite number of touch points where information flows through a network – both within and across the many manufacturers' systems that constitute the supply chain. In today's digital world, every one of these supply chain touch points represents a potential vulnerability to the security of our nation's defense production.

According to private sector reports, in 2014, manufacturers received the greatest volume of targeted cyber-attacks of all industries globally,[132] primarily for espionage purposes.[133] In 2015, the Department of Homeland Security reported the manufacturing sector received the highest number of attacks on industrial control systems of any critical infrastructure sector, at nearly twice the 2014 level. Sophisticated cyber-espionage campaigns seeking to alter the automation of physical processes on manufacturing lines continue to pose a significant threat.

Of the approximately 347,000 manufacturers in the United States, 99% are small and medium-sized manufacturers, yet more than 50% lack basic cyber controls. An assessment by Bureau of Industry and Security illustrated the cybersecurity vulnerability of small manufacturers. The survey of over 9,000 "classified contract facilities" documented that 6,650 small facilities lagged

medium and large firms across a broad range of 20 cybersecurity measures. It also found that fewer than half of the small firms had cybersecurity measures in place.[134]

Certain defense manufacturing supply chain operations occur in classified and very tightly controlled environments, but most information generated, stored, and exchanged is not classified. The protection of such unclassified, covered defense information (including controlled unclassified information) presents an enormous and complex challenge and vulnerability. Most of the manufacturing data of interest to adversaries is essentially controlled unclassified information. This includes design information; performance specifications; shop floor execution data; factory support information (e.g., financials, system status, and personnel); and supply chain operational information (e.g., invoicing, pricing, and contract volume).

Both the public and private sectors recognize the importance of safeguarding informational and operational assets from cyber risks; however, cybersecurity has not become an ingrained norm in manufacturing, especially in small and medium-sized manufacturers.[135] Many small and medium-sized manufacturers are unaware of federal requirements and may lack the financial and technical capabilities required to manage cybersecurity risks.[136] Defense Federal Acquisition Regulations Supplement clause 252.204-7012 requires defense contractors and subcontractors to have implemented the information security protections described in the National Institute of Standards Special Publication 800-171 Rev 1, "Protecting Unclassified Information in Nonfederal Information Systems and Organizations" by December 31, 2017, but initial compliance by sub-tier suppliers has been low.

Case Studies: Cybersecurity for Manufacturing Impacts on National Security

Gaps in the cybersecurity sector lead to pervasive and persistent vulnerabilities to the industrial base, contributing to the erosion of manufacturing and decreasing economic competitiveness and national security. The case studies below illustrate how unauthorized access to any facet of manufacturing information could create rippling effects and cause innumerable negative economic and national security situations.

Inadequate Approaches to Cybersecurity Risk and Inadequate Cybersecurity Defense

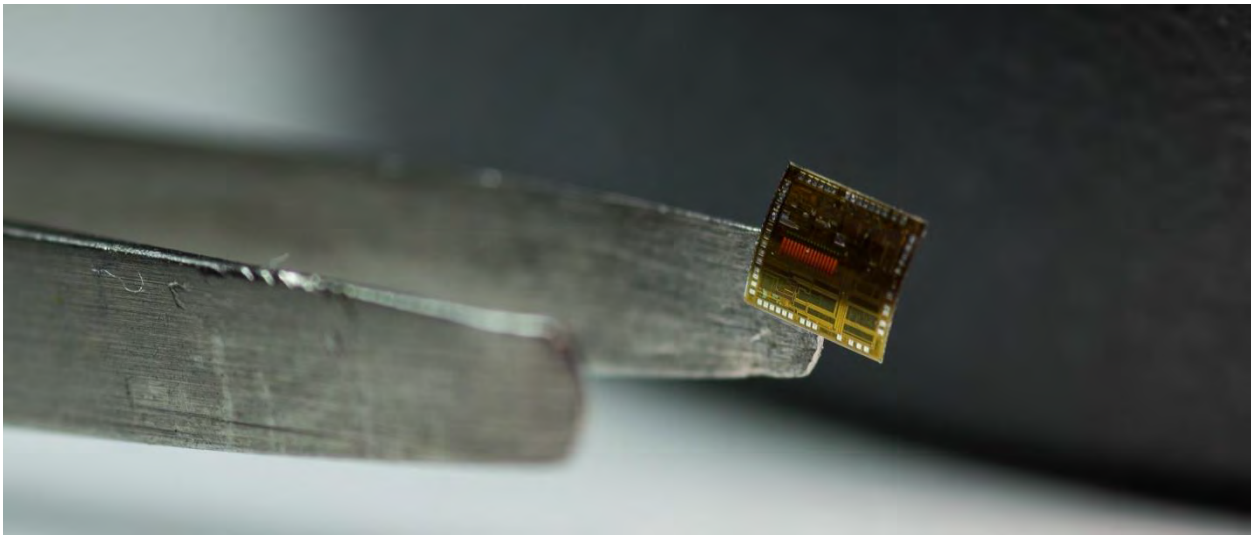
Cybersecurity risks impact all facets of manufacturing supply chain operations, from product and process data flowing within and across factories, to supply chain operations and logistics, to the reliability of tools and equipment used within manufacturing enterprises. Multiple approaches exist to manage cybersecurity risks within the industrial base, but not all approaches are appropriate or even adequate to meet the national security need to protect covered defense information and controlled unclassified information. Three key issues – lack of uniform security implementation; inconsistent implementation of adequate security by defense suppliers; and reliance on self-attestation – expose manufacturing to cybersecurity risks. Interactions with over 1,000 small manufacturers by the Department of Commerce

Manufacturing Extension Partnership National Network in 2017 revealed a significant lack of awareness of the Defense Federal Acquisition Regulations Supplement cybersecurity requirement, and a deficiency of financial and technical resources to manage cyber security risks. In addition, many sub-tier suppliers are unaware they are in the DoD supply chain and others who are aware are subject to conflicting interpretations of the requirement by agencies and upper tier customers.

Inadequate Cybersecurity Defense for the Defense Manufacturing Supply Chain

Manufacturing is the most heavily attacked sector in the economy after finance, so the industrial base is subject to continuous, coordinated cyber-attack campaigns by nation states. As new types of cyber threats and vulnerabilities targeting manufacturing supply chain-specific information and operational systems emerge, the U.S. cannot rely on small and medium-sized manufactures to protect against attacks from nation states. Unfortunately, most cybersecurity research and development is focused on information systems, without specific emphasis on the unique needs and operational aspects of the manufacturing sector. If unaddressed, the industrial base faces a higher likelihood of serious and exploitable vulnerabilities, as well as a substantial reduction in the number of suppliers compliant with requirements and thereby eligible to provide products and services to DoD. Further, commercial firms considering entrance into the defense market will be deterred. This combination of risks will impact both the resiliency of existing suppliers and the integrity of the supply chain.

Electronics Sector



Greater than $1.5T, the electronics sector manufactures products for a wide variety of end user markets, including consumer electronics, computers, automotive, industrial equipment, medical equipment, telecommunications, aerospace, and defense. Electronic systems and components

are ubiquitous throughout all DoD weapons systems, but global military production represents only 6% of a market dominated by commercial devices.[137] While significant compared to overall worldwide military spending, total U.S. military spending on electronic systems in 2017 is insignificant compared to the overall aerospace and defense marketplace, as well as the commercial market, giving DoD limited leverage over the direction of the industry.

In electronics, staying competitive requires a significant investment in R&D, new production facilities, and new equipment. The U.S. semiconductor industry spends 18.5% of sales on R&D, more than any other U.S. industry, with the exception of pharmaceuticals and biotechnology,[138] and the sector is driving industry consolidations and offshoring. At the prime contractor level, approximately 50% of contract expenditures related to computer and electronic product manufacturing went to the top five suppliers, including three major defense contractors.[139] Below the prime contractor level, electronics is a global industry, with a supply chain spanning multiple countries and regions, creating a high degree of interdependence among suppliers and profound implications for DoD.

Printed circuit boards provide the substrate and interconnects for the various integrated circuits and components that make up an electronic system. Like the overall electronics market, the global printed circuit board market has experienced explosive growth – from $30 billion in 2000 to $60 billion in 2015.[140] However, this growth has mainly been driven by China, which now captures 50% of the global market share, while the U.S. share has reduced from 25% in 1998 to less than 5% in 2015.[141]

Microelectronic integrated circuits are the most technologically advanced level of the electronics supply chain. Since 1996, the global market for semiconductors has increased from $132 billion to $339 billion in 2016, with the Asia Pacific market outside of Japan accounting for the vast majority of this growth. The market quintupled in size from approximately $39 billion in 1996 to $208 billion in 2016, including a $107.6 billion market in China alone (approximately 9 % increase over 2014). Asia, where much of electronics production takes place, is by far the largest customer base for U.S. semiconductor companies, accounting for approximately 65% of all U.S. sales, with sales to China accounting for slightly more than 50%. U.S. companies continued to hold a majority of the Chinese semiconductor market in 2016 with 51% share, marking a drop from 56% in 2015.[142] Maintaining access to the Chinese market is a critical concern for U.S. semiconductor companies.

The U.S. continues to hold a strong position in semiconductor manufacturing and has become a leader in microelectronics design by using the fabless model, focusing on integrated circuit design, and outsourcing fabrication to dedicated foundries.[143] Increasingly, however, fabless companies are investing in design capabilities and services offshore. To address these threats, DoD is investing in trusted foundry capabilities to serve critical defense needs, and is working with interagency partners to develop the Microelectronics Innovation for National Security and Economic Competitiveness strategy to address current and future microelectronics needs, threats to assured access to a robust industrial base, and continued U.S. leadership.

Case Studies: Electronics Sector Impacts on National Security

Gaps in the electronics sector reduce the ability deliver technological advantage in capability, performance, and reliability against adversaries. The case studies below illustrate the increasing divergence of commercial business models and defense requirements in electronics.

Strategic Radiation Hardened Microelectronics

Strategic radiation hardened microelectronics are a critical component of the nuclear deterrent; they must be able to withstand short bursts of intense radiation and high temperatures in order to satisfy mission requirements not commonly required commercially. Strategic radiation hardened and DoD defense-unique requirements have no commercial applications and are commercially unviable, creating continual risk for this critical capability due to changing business conditions or technological obsolescence.

DoD continues to ensure a domestic source of strategic radiation hardened microelectronics through investing in R&D on radiation hardening design techniques and radiation effects on state-of-the-art and state-of-the-practice semiconductor technologies. Additionally, DoD is broadening the strategic microelectronics supplier base by developing alternate trust models, processes, and techniques, and continuing to work closely with partners in the strategic community.

Printed Circuit Board Manufacturing

U.S. printed circuit board manufacturing struggles to remain current and relevant in the global marketplace. Today, 90% of worldwide printed circuit board production is in Asia, over half of which occurs in China. The United States accounts for only 5% of global production, representing a 70% decrease from $10 billion in 2000 to $3 billion in 2015. As a result of this decline, the U.S. industrial base is aging, shrinking, and failing to maintain the state of the art for rigid and rigid-flex printed circuit board production capability. Capability indicators (such as laser drills and direct imaging tools) are not prevalent across many domestic manufacturer facilities, with some advanced high density interconnect products simply not producible in the U.S. While commercial technology advances are frequently developed in the U.S., they are resolved to practice offshore.

With the migration of advanced board manufacturing offshore, DoD risks losing visibility into the manufacturing provenance of its products. In addition to the potential dissemination of design information, many of the offshore facilities do not meet or comply with DoD quality requirements. The DoD Executive Agent for Printed Circuit Board Technology has provided technical assistance activities with domestic manufacturers and observed awareness gaps among manufacturers related to International Traffic in Arms and other Export Control regulations, leading to the potential for further unintended dissemination of sensitive information. As the equipment and materials supply chain has followed the migration of the manufacturer base, supply chain and supplier management is becoming a risk driver for access and availability.

Machine Tools and Industrial Controls Sector

Machine tools are power-driven machines used to shape or form parts made of metal, plastic, or composites to support both production and prototyping operations. They are critical to creating modern products for defense and industry, and impact transportation, aerospace, electronics, energy generation and distribution, and other critical infrastructure sectors.

Machine tools provide the factory floor foundation for leveraging advances in robotics, high precision automation, specialty materials, precision components, and additive, subtractive, and hybrid machining. Controlled via manual inputs, analog systems, or digital controls, machine tools require inputs from a variety of sources: ferrous and non-ferrous metals and alloys, including forgings and castings of various sizes; rubber, plastics, and composites; high-precision screws, nuts, and bolts; bearings; and motors, drives, and computer numeric control capabilities. Modern machine tools leverage sophisticated industrial control systems, process parameter monitoring systems, and networked sensors. Many also incorporate advanced materials and precision components, as well as advanced lubricants, bearings, sensors, and coatings.

Case Studies: Machine Tools and Industrial Controls Sector Impacts on National Security

Loss of key capabilities within the domestic machine tools industry erodes U.S. ability to maintain manufacturing dominance, which underpins technical and economic superiority, fundamental elements of national security. The case studies below illustrate how decreasing U.S. manufacturing market share, reductions in the needed workforce, and reduced competitiveness in the global market impact the machine tool sector in the U.S.

Inadequate U.S. Skilled Labor Supply

The U.S. machine tools sector lacks assured access to a sufficiently large pool of skilled labor. Many skilled workers are exiting the workforce due to age, and there are too few technical educational programs to train those who could take their place. Without concerted action that provides both a ready workforce and a continuously-charged pipeline of new employees, the U.S. will not be able to maintain the large, vibrant, and diverse machine tools sector needed to produce the required number and types of products when needed.

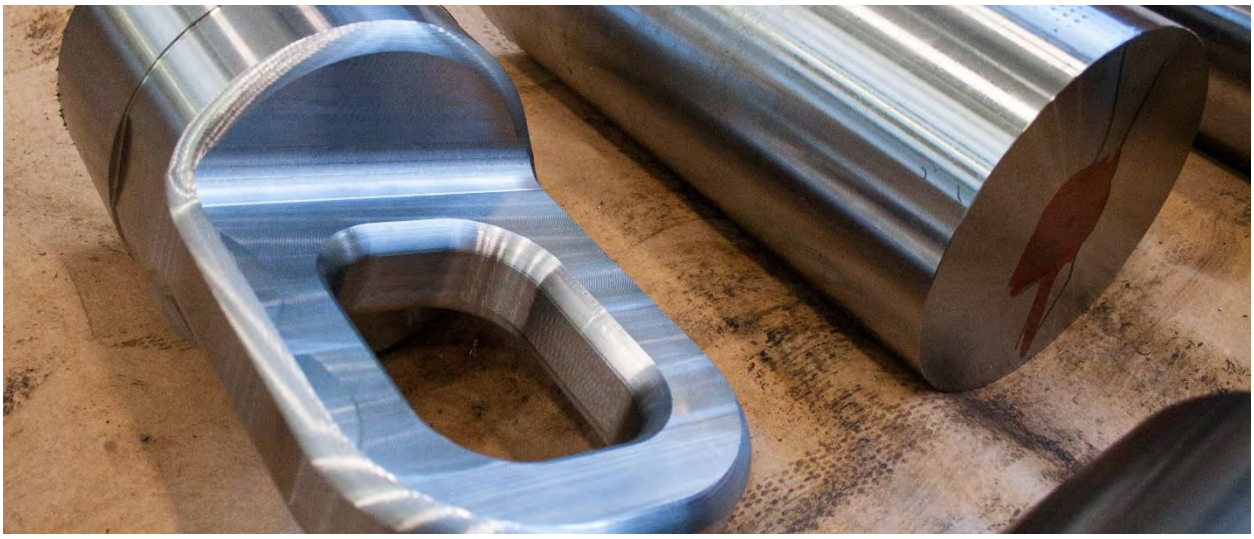
Market Forces Decreasing Domestic Capabilities

The U.S. machine tools sector has been shrinking since at least the 1980s due to a number of primary and contributing factors,[144] with the U.S. standing dropping significantly since 2000. In this mature, highly commercialized market, competition on price and quality[145] is fierce, and many firms have found themselves in a poor position to leverage emerging computer numerical control capabilities. Until the mid-2000s, China accounted for no more than 15% of global machine tool consumption. By 2011, China's machine tool consumption accounted for 40% of the global total.[146] As its need for machine tools increased, China leveraged its low cost of capital and labor to build domestic machine tool factories and required foreign companies to execute joint ventures to access the Chinese market. The combined effects of the 2008 recession and a general trend of industry consolidation further reduced the number of machine tool manufacturers. In 2015, China's global machine tool production skyrocketed to $24.7B,[147] accounting for 28% of global production,[148] while the U.S. accounted for only $4.6B, after China, Japan, Germany, Italy, and South Korea. According to the U.S. Census Bureau data, in 2015 there were 1,028 machine tool firms employing 27,919 people.

Cybersecurity Risks

While the cybersecurity industry has placed heavy emphasis on protecting traditional information technology systems used in manufacturing enterprises, far less attention has been paid to the operational technology systems that actually manufacture products. This includes machine tools and industrial control systems, which are increasingly being linked through internet protocol addresses for valid business reasons. The unintended result is a dramatic, potentially decisive, increase in the manufacturing cyberattack surface. A significant constraint on DoD's ability to respond to all cybersecurity risks is a lack of visibility into the lower tiers of the supply chain.[149]

Materials Sector



Materials are vital to national defense and economic security. While defense demand may often represent a small fraction of overall domestic and foreign supply, there are important subsectors that are heavily defense dependent. It is 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.

The sector includes both raw and "downstream" materials produced by a global supply chain of value-added processing and manufacturing companies. These and other materials are combined into intermediate, semi-processed, and finished materials and eventually produced into end-items (e.g., parts, components, or structures) and incorporated into subsystems and integrated systems.

The range of materials is broad and includes metals and nonmetallic minerals produced from mining of primary materials or as a byproduct (e.g., rhenium from copper mining), or reclamation (e.g., recycling rare metals from electronics).[150] Of equal or greater importance to raw material supply is industrial-scale capabilities and sustainable capacity to extract elements from mined materials and to produce value-added products. Examples include separating elements, processing compounds, smelting metal, alloying, and further downstream production (e.g., castings, forgings, and rolled products), particularly for the processing of rare earth elements. Important defense applications include high-performance aluminum and steel for ground vehicles and Navy ships; titanium and beryllium for military aircraft; tungsten for radars and communication systems; rare earths for guided munitions and computers; and ceramics for body armor and microelectronics. Another subsector is highly engineered synthetic materials and their composites, such as carbon fibers for missiles, aircraft, and space system structures; fibers and textiles for protective apparel and vehicle survivability; and synthetic materials

including energetics for explosives and propellants. Newer materials of increasing importance include carbon nanotubes and additive manufacturing materials.[151]

Within the materials sector, risk includes shortfalls that impact the production of defense items to support current military operations; high U.S. import reliance on foreign countries who may become adversaries and cutoff supply during conflicts (e.g., trade embargo or war damage);[152] reliance on single foreign sources of proprietary materials that would be difficult to replace; injurious foreign trade impacts (e.g., dumping and illegal subsidies) on key DoD suppliers; DoD reliance on commercial materials that become obsolete; and dependence on domestic single-point-of-failure producers.

Case Studies: Materials Sector Impacts on National Security

Highlighted below are three case studies which highlight important materials-related risk impacts. Please see the limited distribution annex for further details about specific materials risks, estimated shortfalls, and mitigation recommendations.

Over Reliance on Sole Foreign Sources for Unique and Proprietary Advanced Materials

Single foreign sources of unique and proprietary carbon fibers from Japan and Europe represent considerable DoD supply chain vulnerabilities. A sudden and catastrophic loss of supply would disrupt DoD missile, satellite, space launch, and other defense manufacturing programs. In many cases, there are no substitutes readily available. Replacing a carbon fiber factory is very expensive and time consuming. Of similar concern is the uncertainty of qualifying replacement suppliers and significant resource requirements.

Injurious Foreign Trade Impacts on Critical U.S. Material Manufacturers

Unlawful and/or otherwise unfair foreign trade practices, mostly by China, are injuring critical U.S. materials-related manufacturers. Predatory practices – including state-sponsored dumping, market distorting government subsidies, and intellectual property theft – are destroying commercial product lines and markets of domestic DoD suppliers. In some cases, U.S. suppliers have lost much, and at times all, of their commercial markets supporting dual-use production lines that manufacture key materials and components for U.S. weapon systems. The loss of commercial business can lead to the loss of domestic production capabilities essential to U.S. defense and essential civilian needs. In multiple cases, the sole remaining domestic producer of DoD-critical materials are on the verge of shutting down their U.S. factory and importing lower cost materials from the same foreign producer county who is forcing them out of domestic production. Without relief from unlawful and otherwise unfair foreign trade, the U.S. will face a growing risk of increasing DoD reliance on foreign sources of critical materials. Examples include domestic producers of specialized metals, alloys and other materials that are widely used across multiple DoD programs and all major

defense sectors (e.g., land, sea, air, and space systems).[153] Of special concern are U.S. imports that undermine domestic producers of materials protected under the Buy American Act, Berry Amendment and Specialty Metals Clause.[154] [155]

Overreliance on China for Strategic and Critical Materials

A key finding of this report is that China represents a significant and growing risk to the supply of materials deemed strategic and critical to U.S. national security. In addition to China dominating many material sectors at the upstream source of supply (e.g., mining), it is increasingly dominating downstream value-added materials processing and associated manufacturing supply chains, both in China and in other countries.[156] Areas of concern to America's manufacturing and defense industrial base include a growing number of both widely used and specialized metals, alloys and other materials, including rare earths and permanent magnets.

Organic Industrial Base Sector

The organic industrial base, a subset of the larger defense industrial base, is comprised of resource providers, acquisition and sustainment planners, and manufacturing and maintenance performers. While commercial industry is the dominant component of the industrial base, government-owned, government operated maintenance depots, shipyards, and manufacturing arsenals are critical to U.S. defense. They provide the assurance of a ready and controlled source of technical capabilities necessary to maintain weapon systems free from many of the economic vulnerabilities and influences that exist in the private sector. This means that every military ship, plane, vehicle, and weapon is accompanied by a government-owned ecosystem that includes expertise to perform deep repair, the means to provide repair parts to the shop floor, and the ability to deliver repaired systems to the time and place of the fight. The organic base complies with legislation to provide core logistics capabilities, including personnel,

equipment, and facilities that are government-owned, government operated. The law prescribes these capabilities as inherently governmental and has allowed for the development of highly capable depot artisans and military logisticians.

The organic industrial base provides maintenance and manufacturing services to sustain approximately 440,000 vehicles, 780 strategic missiles, 278 combatant ships[157], and almost 14,000 aircraft.[158] Of $587.9 billion total DoD expenditures in FY 2015,[159] $73.4 billion was for maintenance. Aircraft represented the greatest expenditure at $25 billion, followed by ships at $16.8 billion, and vehicles at $7.7 billion.[160] DoD currently operates 17 major organic (government-owned, government operated) depot maintenance facilities and three manufacturing arsenals.

DoD maintenance is performed by a military and civilian workforce spread throughout the world. DoD materiel maintenance is performed at different organizational levels, ranging in complexity from daily system inspection to rapid removal and replacement of components, to the complete overhaul or rebuild of weapon systems. Depot-level maintenance entails the major overhaul or complete rebuild of weapons systems and requires skills or equipment not commonly available at lower levels of maintenance. Organic depot-level maintenance also includes software maintenance and sustainment, which incorporates correcting defects, improving performance, upgrading, and modifying software to adapt the fielded software baseline to a changing or changed environment.

Twenty years of intermittent conflict and war have driven a very high operating tempo and unprecedented system usage that has changed previously accepted formulas used to compute maintenance requirements. The levels of funding and the manner in which funding has been made available and allocated to these sustainment operations have degraded our ability to achieve expected performance results. The organic industrial base has suffered from overuse and underfunding in its infrastructure and the evidence is clearly reflected in materiel readiness levels and facility condition indices. Workforce issues have been exacerbated by sequestration, gaps in critical skills, and gaps in hiring. Diminishing manufacturing sources and material shortage, counterfeit, foreign manufacturing, and single source of supply issues represent further risks to the ability of the organic base to influence materiel readiness through the degradation of supply chain integrity and availability of critical materials and human capital necessary to maintain weapon systems.

Case Studies: Organic Base Sector Impacts on National Security

Gaps in the organic base sector directly impact the ability to repair equipment and materiel as quickly as possible and ensure its availability for training and future deployments. The case studies below illustrate the critical need to ensure continuity of operational readiness during times when the private sector may not be able to meet surge requirements.

Deficiencies in Maintenance Facility Material Condition

Currently, a lack of available and effective capacity within government owned industrial activities, coupled with a high near-term workload, is causing a capacity to workload mismatch. This mismatch continues to drive maintenance delays and an increased loss in operational days.

DoD has accelerated investments in its Capital Improvement Programs and the replacement and modernization of minor property to better align with industry recapitalization standards. These efforts and review of work backlogs, stoppages, and cost and schedule metrics are targeted to reduce lost operational days, to facilitate on-time availability completions, to provide adherence to training schedules, and to ready forces to meet deployment and surge requirements.

Maintenance

DoD is operating many of its weapon systems well beyond their original designed service lives. Coupled with increased operating tempo and exposure to harsh environmental conditions, these platforms require engineering and overhaul processes far more extensive than those performed under historical organic industrial base infrastructure alignments. The infrastructure has not been refreshed to adequate levels of repair and technology modernization.

Organic base depots are Working Capital Funded activities and required to reinvest and recapitalize equipment and facilities through their rate structure. Sensitivity to rate increases limits each depot's ability to modernize and restore infrastructure to the extent required. While DoD's budget replaces and refurbishes plant equipment, and statute and policy direct follow-through on recapitalization, infrastructure investments have not been adequate. Without significant future investment, the organic base will remain challenged by outdated equipment, tooling, and machinery. The erosion of organic infrastructure continues to impact turnaround time and repair costs of newly fielded weapon systems, reducing inventory, decreasing operational readiness, and impacting future deployment schedules.

Workforce Recruitment, Retention, and Onboarding

The DoD Maintenance Enterprise faces workforce skill gaps across the board. The emergence of new weapon technologies coupled with retirements has caused a significant mismatch between skill requirements and workforce capabilities. Recruitment and retention of critical skill sets are concerns, partially because of sharp competition for labor with the private sector and due to a lack of defense specific skills. Training the new workforce is essential, and improving the organic industrial base's opportunity to recruit already trained artisans would have significant and immediate impacts on productivity and readiness. Exacerbating the issue is the lack of policy to authorize security clearance "transfer in status" when technicians who have clearances are hired; the statutory requirement outlined by 5 U.S. Code 3326

prohibiting the hire of military technicians for 180 days after separating from the military; and government shutdowns and furloughs which diminish the ability to recruit, hire, and retain talented STEM personnel.

Software Engineering Sector

The software engineering discipline has evolved rapidly over the past several decades, creating a crisis within the industrial base. Software engineering is the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software. Software engineering capability includes the processes, resources, infrastructure, and workforce competencies to enable systems to meet operational mission requirements and evolving threats.

Software is virtually in every piece of electronics from firmware, operating systems, and applications. This includes DoD weapon systems, mission support systems, maintenance systems, business systems, etc. Today's modern weapon systems rely heavily on software to provide functionality. The F-35 is estimated to rely on 90% of its avionics specification requirements on software; this has grown significantly over the last four decades when the F-15A had just 35% software reliance in 1975. Unlike physical hardware, software can be delivered and modified remotely, greatly facilitating rapid adaptation to changes in threats, technology, mission priorities, and other aspects of the operating environment.

Unfortunately, software for many weapon systems is being sustained with processes developed decades ago for hardware-centric systems. In addition, much of DoD policy remains hardware-centric, despite software providing an increasingly larger percentage of system functionality. In today's fast pace changing environments with mounting cyber threats, software engineering for our software intensive systems should look to utilize agile software development processes accompanied with appropriate contracting practices capable of rapidly delivering incremental and iterative changes to the end-user.

As a result of the paradigm shift from hardware to software intensive systems, a significant need for a more software savvy acquisition workforce is essential. Policy, roles, and responsibilities for software engineering at the DoD level are not clearly established to effectively represent software equities at the acquisition policy and program levels. A lack of unified policy has resulted in various interpretations and implementations across the Services. Currently, there exists limited focus and priority on explicitly addressing software engineering sustainability of software intensive systems during the requirements process, design, and development of systems. The inventory of software that DoD currently possesses is immense and continually growing, but there is limited visibility and understanding at the enterprise level of the total size, complexity, and characteristics of the inventory, which may be exceed one billion line of custom developed software code. A unified source of clear software engineering policy would aid in a unilateral implementation of appropriate practices across the industrial base.

Exacerbating the need to strengthen organic software expertise is the issue of a national STEM shortage. Today's education pipeline is not providing the necessary software engineering resources to fully meet the demand in the commercial and defense sectors, and resources required to meet future demands continue to grow. Until the STEM crisis is rectified, recruiting, hiring, and retaining qualified personnel will continue to be challenging.

Case Studies: Software Engineering Impacts on National Security

The software engineering skills gap affects a wide range of occupations and could have potentially significant impacts on production of critical defense-related materials, vehicles, and machinery, as well as other goods and services necessary to supply our nation's armed forces. The below case studies provide specific examples.

F-35 Schedule Delays and Cost Overruns

F-35 provides an example where complexities of highly integrated hardware and software systems have led to high risks of program delays related to the release of software, further delaying the capabilities required in the field. Hardware and software delays associated with the Block 3F release, required to declare Air Force initial operating capability, resulted in a five-month delay and projected $532M cost overrun.

B-52 Mission Planning Agile Software Development

Organic software professionals in the Air Force implemented agile software development processes for B-52 Mission Planning as a pilot project in 2010. The agile processes streamlined rapid, iterative performance from development to fielding, resulting in the delivery of the project on schedule, at a cost of $28M, and included additional major capabilities. In addition, major defects discovered during the first operational test were reduced by 93% compared to similar programs. Initially, a contract was awarded to industry for this effort at $54M in 2007, but was cancelled three months later due to budget shortfalls.

Personnel Recovery Command and Control Agile Software Development

In 2014, organic sustainment engineers implemented agile software development processes for personnel recovery command and control systems. Implementation overcame poorly defined requirements while improving response time to changing needs by field units. In addition, defects found during acceptance testing were reduced by 88%.

Workforce Sector

Workforce includes the occupations for the full lifecycle development and support of defense products and inputs, including R&D, design, manufacturing, production, and maintenance.

Around 1.6 million workers have jobs that, at least in part, support national defense,[161] accounting for approximately 1.3% of private sector employment. Within the industrial base, the largest occupational groups are production workers (e.g., manufacturers such as welders and machinists) and STEM workers. The industrial base also includes workers in transportation, business and financial services, management, and office and administrative support.

Manufacturing represents a critical part of the industrial base workforce. The advanced weaponry and supporting equipment necessary to dominate in modern warfare require highly sophisticated manufacturing, yet the domestic workforce has suffered for decades. The U.S saw a sharp decline in manufacturing beginning in the 1970's, with only a moderate uptick in more recent years. The manufacturing sector lost 6 million jobs from 1998 to 2010 and while the sector has seen some gains – in January 2018, there were 12.6 million manufacturing jobs, up approximately 1 million from early 2010 – it still lost 5 million jobs since 1998.[162] The skill atrophy accompanying such loss can have profound short and long term effects on industrial capabilities.

A National Association of Manufacturers survey of 662 manufacturing companies, conducted in December 2017, found the inability to attract and retain a quality workforce is the top business challenge, cited by 72.9% of respondents. To address this workforce challenge, 66% of respondents said they are increasing the workload of their existing employees. 34.4% stated their company had been unable to take on new business and had lost revenue opportunities because of the inability to attract and retain workers.[163] Given the number of manufacturers who exist in the industrial base supply chain, these numbers are significant.

However, the manufacturing and defense industrial base does provide strong employment opportunities for growth. In January 2018, the National Association for Manufacturers reported 427,000 manufacturing job openings, with 360,000 workers hired – continuing a strong trend in hiring since August 2017.[164] Although the number of workers engaged in many traditional production occupations, such as assemblers, machine setters, and mold makers, is projected to continue to decline over the coming decade, several other occupations that enable and support the modern, automated manufacturing facility are expected to surge.

While the total number of bachelor's degrees in the U.S. has increased steadily in the last two decades, the number of STEM degrees conferred in the U.S. still pales compared to China.[165] In addition, the U.S. has seen an increase in students on temporary visas, many of whom would be unable to gain the security clearances needed to work in the defense ecosystem.[166]

Growth in advanced science and engineering degrees shows the U.S. graduating the largest number of doctorate recipients of any individual country, but 37% were earned by temporary visa holders[167] with as many 25% of STEM graduates in the U.S. being Chinese nationals.[168]

Case Studies: Workforce Sector Impacts on National Security

The skills gap affects a wide range of occupations and could have significant impacts on production of critical defense-related materials, vehicles, and machinery, as well as other goods and services necessary to supply our nation's armed forces. Examples include a lack of industrial machinery mechanics for motor vehicles, welders for surface and subsurface vehicles, and biophysicists for physiological sensor systems. In many of the traditional sectors, workforce issues were identified as key impacts – the below case studies merely add to that narrative.

Challenges to Recruit and Retain

Many companies in the industrial base recognize that significant skills gaps exist across multiple occupations, creating the potential to interfere with efficient acquisition of a wide variety of military equipment and other goods and services. Still more difficulties may be posed during a surge in defense production. A study by the Bureau of Industry and Security shows that companies with access to classified material – a potential indicator of a company's membership in the defense ecosystem – face significant workforce shortages. The review of

9,634 facilities found that 41% of the facilities cited labor availability/costs, 31% cited worker/skills retention, and 15% cited an aging workforce as concerns.[169]

Traditional vs Future Trade Skills

Although the number of workers engaged in many traditional production occupations, such as assemblers, machine setters, and mold makers, is projected to continue to decline over the coming decade, several other occupations that enable and support the modern, automated manufacturing facility are expected to surge. Occupations expected to grow often require the technical skills to program, maintain, troubleshoot, and repair increasingly sophisticated production machinery. For example, the number of computer-controlled machine operators and programmers are projected to grow by more than 17% by 2024, adding an additional 25,000 operators and more than 4,000 programmers. The number of machinists needed to set up and repair machine tools is expected to reach 343,200 nationwide by 2024, a 7.8% increase over 2014 employment levels. An expected 13.2% increase in industrial machinery mechanics would increase the ranks of such workers to nearly 201,000 nationwide over the next decade. And while the number of industrial production managers is expected to shrink through 2024, 55,500 replacement workers with appropriate skills will be needed to fill existing positions.

The Bureau of Labor Statistics projects that STEM jobs will see an increase of 962,000 jobs by 2026. This 11% increase is much higher than the average occupational rate increase, which is expected to be 7.4% between 2016 and 2026.[170]

Security Clearances

Ongoing challenges face DoD and its suppliers in getting personnel cleared to work on classified projects or in classified spaces. Concerns about the integrity of the investigation process coupled with diminished resources have created an ever growing backlog of employees waiting for clearances. However, a major effort is underway to address the issue. Pursuant to the National Defense Authorization Act for FY 2018, DoD recently stood up the Defense Vetting Directorate within the Defense Security Service. The newly announced directorate will oversee the creation and execution of a comprehensive personnel vetting strategy, to renew the entire personnel security clearance process. As part of streamlining efforts, the directorate will utilize the National Background Investigative System, which will include automated records checks as well as risk assessment protocols and other capabilities. The system will be founded on advanced analytics and sounds risk assessment to serve as key capabilities, ensuring a timely, trustworthy, loyal, and reliable workforce clearance process.

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Appendix Three: Contributing U.S. Government Agencies

Department of Defense

Air Force (USAF)

- Air Combat Command (ACC)
  - Warfare Center (USAFWC)
- Air Staff (AF)
  - Strategic Plans and Programs (AF/A5/8)
    - Air Reserve Assessments Division (A5SM)
- Materiel Command (AFMC)
  - Life Cycle Management Center (LCMC)
  - Research Laboratory (AFRL)
    - Electronics and Sensors Branch (RXME)
    - Materials (Materials)

- Technical Engineering Services Directorate (EZAD)

- Secretary of the Air Force (SAF)
  - Office of the Assistant Secretary of the Air Force for Acquisition, Technology & Logistics (AQ)
    - Logistics and Product Support (AQD)
    - Missiles and Munitions Program Element Monitor (M&M PEM)
  - Space Command (AFSPC)
    - Space and Missile Systems Center (SMC)

Army (USARMY)

- Headquarters (HQDA)
  - Logistics Directorate (HQDA G-4)
- Intelligence and Security Command (INSCOM)
  - National Ground Intelligence Center (NGIC)
- Materiel Command (AMC)
  - Chemical Materials Activity (CMA)
  - Chief Information Officer – Information Assurance (CIO-IA)
  - Joint Munitions Command / Joint Munitions and Lethality Life Cycle Management Command (JMC/JM&L)
  - Research, Development and Engineering Command (RDECOM)
    - Armament Research, Development and Engineering Center (ARDEC)
    - Aviation and Missile Research Development and Engineering Center (AMRDEC)
    - Communications-Electronics Research, Development and Engineering Center (CERDEC)
      - Intelligence and Information Warfare Directorate (I2WD)
    - Contracting Command (ACC)
      - Aberdeen Proving Ground Plans, Analysis, and Integration Office (APG PAIO)
    - Edgewood Chemical Biological Center (ECBC)
    - Natick Soldier Systems Center (NSSC)
    - Research Laboratory (ARL)
  - Tank-Automotive and Armaments Command (TACOM)
    - Life Cycle Management Command (LCMC)
      - Materiel Systems Organization (MSO)
      - Integrated Logistics Support Center (ILSC)
        - Chemical / Biological Defense Product Support Integration Directorate (Chem/Bio PSID)

- Office of the Assistant Secretary of the Army for Acquisition, Logistics & Technology (ASA (ALT))
  - Joint Program Executive Office for Chemical Biological Defense (JPEO CBD)
  - PEO Ground Combat Systems (GCS)
  - PEO Missiles and Space
  - PEO Soldier

Defense Contract Management Agency (DCMA)

- Industrial Analysis Group (IAG)

Defense Intelligence Agency (DIA)

Defense Logistics Agency (DLA)

- Acquisitions
  - Strategic Sourcing

Joint Chiefs of Staff (JCS)

- Strategic Plans & Policy (J5)

Marine Corps

- Headquarters (HQMC)
  - Installations and Logistics (DC, I&L)
- Logistics Command (LOGCOM)
- Systems Command (MARCORSYSCOM)
  - PEO Land Systems (LS)
    - Ground Air Task Oriented Radar (G/ATOR)

Massachusetts Institute of Technology Lincoln Laboratory (MITLL)

Missile Defense Agency (MDA)

- Electronic Counter-Measures (ECM)
- Office of the Assistant Director for Assurance Integration
  - Quality, Safety, and Mission Assurance (QS)
- Office of the Director of Engineering (DE)

National Reconnaissance Office (NRO)

- Advanced Systems & Technology Directorate (AS&T)
- Systems Engineering Directorate (SED)

Navy (USN)

- Office of the Chief of Naval Operations (OPNAV)
  - Office of the Assistant Secretary of the Navy for Research, Development, and Acquisition (ASN(RDA))

- Deputy Assistant Secretary of the Navy for Air Programs (DASN AIR)
- DASN for Ships (DASN SHIPS)
- PEO for Integrated Warfare Systems (IWS)
  - Rotating Radar Program Office (2R1E)
- Naval Air Systems Command (NAVAIR)
- Naval Sea Systems Command (NAVSEA)
  - Naval Surface Warfare Center – Crane (NSWC Crane)
  - Naval Surface Warfare Center – Dahlgren (NSWC Dahlgren)

Office of the Secretary of Defense (OSD)

- Office of the Under Secretary for Acquisition and Sustainment (A&S)
  - Logistics and Materiel Readiness (L&MR)
    - Office of the Deputy Assistant Secretary of Defense for Supply Chain Integration (SCI)
    - Office of the Deputy Assistant Secretary of Defense for Maintenance Policy and Programs (MPP)
  - Office of the Deputy Assistant Secretary of Defense for Industrial Policy (IndPol)
  - Office of the Assistant Secretary of Defense for Acquisition (ASD(A))
    - Office of Space, Strategic, and Intelligence Systems (SSI)
      - Ground-Based Strategic Deterrent (GBSD)
      - Long Range Strike Office (LRSO)
      - Military Satellite Communication (MILSATCOM)
      - Missile Defense
      - NRO Systems
      - Space-Based Infrared System
- Office of the Under Secretary for Research and Engineering (R&E)
  - Office of Systems Engineering (DASD SE)
- United States Special Operations Command (USSOCOM)
- Defense Microelectronics Activity (DMEA)
- Defense Security Service (DSS)

Central Intelligence Agency (CIA)

Department of Commerce (DOC)

- Bureau of Industry and Security (BIS)
  - Office of Technology Evaluation (OTE)
  - Office of the Deputy Assistant Secretary for Export Administration

- International Trade Administration (ITA)
  - Office of the Deputy Assistant Secretary for Manufacturing
- National Institute of Standards and Technology (NIST)
  - Industry & Innovation Services (I&IS)
    - Manufacturing Extension Partnership (MEP)

Department of Energy (DOE)

- National Nuclear Security Administration (NNSA)
- Office of Energy Efficiency and Renewable Energy (EERE)
  - Advanced Manufacturing Office (AMO)
- Office of Environmental Management (EM)
  - Chief of Nuclear Safety (CNS)
  - Los Alamos National Laboratory (LANL)
- Office of Science
  - Oak Ridge National Laboratory (ORNL)

Department of Health and Human Services (HHS)

- Office of the Assistant Secretary for Preparedness and Response (ASPR)
- Office of the Senior Counselor to the Secretary

Department of Homeland Security (DHS)

- Office of Trade and Transportation Policy

Department of the Interior (DOI)

- United States Geological Survey (USGS)

Department of Labor (DOL)

- Office of the Assistant Secretary for Administration and Management (OASAM)
- Office of the Assistant Secretary for Policy (OASP)

Department of State (DOS)

- Policy Planning Staff (S/P)

Department of the Treasury (DOT)

- Office of International Affairs

International Trade Commission (ITC)

National Aeronautics and Space Administration (NASA)

National Science Foundation (NSF)

- National Center for Science and Engineering Statistics

National Security Agency (NSA)

Office of the Director of National Intelligence (ODNI)

- National Counterintelligence and Security Center (NCSC)

White House / Executive Office of the President (WH/EOP)

- National Security Council (NSC)
  - Director for International Trade and Investment
  - Director for Nonproliferation and Strategic Trade
- Office of Management and Budget (OMB)
  - National Security Division
    - Defense Science and Technology Examiner
- Office of Policy Development
  - Domestic Policy Council
  - National Economic Council (NEC)
    - Director for International Economic Affairs
- Office of Science and Technology Policy (OSTP)
- Office of Trade and Manufacturing Policy (OTMP)

Non-U.S. Government Organizations

- ANSER
- Institute for Defense Analyses (IDA)
- Manufacturing USA NextFlex Institute

Appendix Four: U.S. Government Sources

Department of Defense

Air Force (AF)

- Air Force Annual Industrial Base Assessment
- Air Force ManTech AESA Radar Roadmap: A Sub-Tier Industrial Base Perspective
- Air Force Research Laboratory (AFRL)
  - Sustainment Overview
  - AFRL Materials and Manufacturing Directorate Electronics and Sensors Branch (RXME)
    - Industrial Base Assessment Aerospace Applications for Carbon Nanotubes
    - Industrial Base Assessment AESA Suppliers – Market Survey and Issues
    - Industrial Base Assessment APG-68(V)9/(V)10 and APS-143G(V)1 Radar Systems
    - Industrial Base Assessment KC-46 Supplier Chain Risk Assessment
    - Industrial Base Assessment Multifunctional Materials Assessment

  - Industrial Base Assessment North American Military and Commercial Engine Assessment
  - Industrial Base Assessment Remotely Piloted Aircraft
  - Industrial Base Assessment Three-Dimensional Expeditionary Long-Range Radar Sub-tier Supplier Industrial Base Potential Issues
  - Industrial Base Assessment Unmanned Systems Integrated Roadmap, FY2013-2038
  - Industrial Base Assessment Update to AESA Suppliers – Market Survey and Issues
- Capital Investment Study on Air Force Depots

Army (USARMY)

- Aerospace Casting Study
- Aerospace Composite Analysis
- Analysis of H-47 Supply Chain Risks
- Armed Scout Helicopter Divestiture Industrial Base Report
- Aviation and Missile Research Development and Engineering Center (AMRDEC)
  - Aerospace Bearing Industry Sector Analysis
  - Puma/Raven Unmanned Aircraft System (UAS) Supplier Analysis
- Avionics Sector Analysis
- B-52H Re-engine Alternate Supplier Market Research
- Body Armor Working Group Data
- CH-47 Block II Analysis of Alternatives Industrial Capabilities Assessment
- Defense Industrial Base E-Repository
- Gray Eagle Industrial Capabilities Assessment
- Industrial Base Baseline Assessments
- Industrial Base Data Warehouse
- Missile and Aviation Supply Chain Operations Tool
- Program Executive Officer Ground Combat Systems (PEO GCS)
  - Industrial Base Considerations for Increased Vehicle Production to the Chief of Staff of the Army
- Rotorcraft Engine Industrial Base Sector Analysis
- Rotorcraft Forging Industrial Base Sector Analysis
- Specialty Steel Sector Analysis
- Supplier Risk Tracker
- Tank-Automotive and Armaments Command (TACOM)
  - Industrial Base Baseline Assessment
    - UAS Sector Analysis

Defense Contract Management Agency (DCMA)

- A-10 Wing Replacement Program Rate Analysis

- Active Electronically Scanned Array (AESA) Design Skills Assessment Report
- Annual Aircraft Industry Economic Forecast Assessment
- eTools Delegation Data
- eTools Industrial Base Integrated Data System
- eTools Supplier Risk System
- Ground Combat Systems Manufacturing Capacity Assessment
- Industrial Analysis Center Tactical Airborne AESA Radar White Paper
- Industrial Capabilities Assessment: Advance Digital Data Set
- Industrial Capabilities Assessment: Advanced Airborne Sensor
- Industrial Capabilities Assessment: Aircraft Sector
- Industrial Capabilities Assessment: Body Armor
- Industrial Capabilities Assessment: BQM-177A Subsonic Aerial Target
- Industrial Capabilities Assessment: CH-53K King Stallion
- Industrial Capabilities Assessment: F-35 Long Lead Material Supplier Assessment
- Industrial Capabilities Assessment: Future Vertical Lift
- Industrial Capabilities Assessment: Infrared Search and Track System (F-18)
- Industrial Capabilities Assessment: Microwave Tube
- Industrial Capabilities Assessment: MQ-1C Gray Eagle UAS
- Industrial Capabilities Assessment: MQ-4C Triton UAS
- Industrial Capabilities Assessment: MQ-4C Triton UAS Addendum
- Industrial Capabilities Assessment: MQ-8 Fire Scout UAS
- Industrial Capabilities Assessment: Multi-Spectral Camouflage Netting
- Industrial Capabilities Assessment: Next Generation Jammer
- Industrial Capabilities Assessment: Night Vision
- Industrial Capabilities Assessment: Parachutes
- Industrial Capabilities Assessment: RQ-21A Integrator Small Tactical Unmanned Aircraft System
- Industrial Capabilities Assessment: Small Arms
- Infrared Decoy Industrial Base Assessment
- Military Rotary Wing Design and Engineering Capabilities Assessment
- Munitions Industry Production Analysis Report

Defense Logistics Agency (DLA)

- Casting Industry Assessment
- Defense Strategic and Critical Materials Operations Report To Congress
- Fragility and Criticality Assessments Army Robotics
- Fragility and Criticality Assessments Body Armor
- Fragility and Criticality Assessments Critical Energetic Materials
- Fragility and Criticality Assessments F-18

- Fragility and Criticality Assessments F-22 (Sustainment)
- Fragility and Criticality Assessments Fixed Wing Aircraft
- Fragility and Criticality Assessments Focal Plane Arrays
- Fragility and Criticality Assessments Gray Eagle
- Fragility and Criticality Assessments Ground Combat Systems
- Fragility and Criticality Assessments Ground Robotics
- Fragility and Criticality Assessments Ground Vehicles
- Fragility and Criticality Assessments Military Satellite Communications Systems
- Fragility and Criticality Assessments Navy Shipbuilding
- Fragility and Criticality Assessments Radar
- Fragility and Criticality Assessments Rotary Wing
- Fragility and Criticality Assessments Space
- Fragility and Criticality Assessments Tobyhanna Army Depot Skills
- Fragility and Criticality Assessments Vertical Lift Design Skills
- Fragility and Criticality Assessments Warfighter Information Network-Tactical Increment 1
- Steel & Specialty Metals Pricing Analysis

Missile Defense Agency

- Fragility and Criticality Assessments Missile Seekers
- Fragility and Criticality Assessments Missiles

Navy (USN)

- Naval Air Systems Command (NAVAIR)
  - Military Aviation Industrial Base Review (Tactical Aircraft Design)
  - Supplier Database
  - Tactical Combat Training System Analysis
- Naval Sea Systems Command (NAVSEA)
  - Rare Earth Metals & Usage in Microwave Tubes Briefing

Office of the Secretary of Defense (OSD)

- Annual Aviation Inventory and Funding Plan, FY 2017-2046
- Annual Industrial Capabilities Report to Congress FY2013
- Annual Industrial Capabilities Report to Congress FY2014
- Annual Industrial Capabilities Report to Congress FY2015
- Annual Industrial Capabilities Report to Congress FY2016
- Annual Industrial Capabilities Report to Congress FY2017
- Annual Industrial Capabilities Report to Congress FY2018
- Critical Energetic Materials Working Group Data
- Defense Innovation Unit Experimental (DIUx)

  - Defense Innovation Capital
- F-16 AESA Radar Upgrade Acquisition Strategy Paper
- Federal Procurement Data System
- Fuze Integrated Product Team Data
- Joint Industrial Base Working Group Data
- Industrial Policy (IndPol)
  - Body of Knowledge Electronic Warfare
  - Body of Knowledge Fixed Wing Aircraft
  - Body of Knowledge Rotary Wing Aircraft
  - Body of Knowledge UAS
  - Identifying and Mitigating the Impact of the Budget Control Act on High Risk Sectors and Tiers of the Defense Industrial Base
  - Impact of the Budget Control Act on the Defense Industrial Base
  - Program Management Review Meeting Defense Production Act Title III Tungsten Rhenium Wire Production Sustainment Project
  - Proposed Acquisition of Sikorsky Aircraft by Lockheed Martin
- National Defense Strategy
- Nuclear Posture Review

Congressional Research Service

- China's Mineral Industry and U.S. Access to Strategic and Critical Minerals: Issues for Congress
- Rare Earth Elements in National Defense: Background, Oversight Issues, and Options for Congress
- The Buy American Act—Preferences for "Domestic" Supplies: In Brief
- The Specialty Metal Clause: Oversight Issues and Options for Congress

Department of Commerce

- Bureau of Industry and Security (BIS)
  - Cost-Metric Assessment of Diminishing Manufacturing Sources and Material Shortages
  - Critical Facilities Survey Data
  - Critical Technology Assessment: Fine Grain, High-Density Graphite
  - Critical Technology Assessment: Impact of U.S. Export Controls on Green Technology Items
  - Critical Technology Assessment: Night Vision Focal Plane Arrays, Sensors, and Cameras
  - Cybersecurity Framework Manufacturing Profile
  - Defense Industrial Base Assessment of Counterfeit Electronics

  - Defense Industrial Base Assessment of Rocket Propulsion
  - Defense Industrial Base Assessment of the Telecommunications Industry Infrastructure
  - Defense Industrial Base Assessment of the U.S. Underwater Acoustics Transducer Industry
  - Defense Industrial Base Assessment of U.S. Textiles, Apparel, and Footwear
  - Framework for Improving Critical Infrastructure Cybersecurity
  - Industrial Base Assessment of Consumers of U.S. Electro-Optical Satellite Imagery
  - National Aeronautics and Space Administration's (NASA) Human Space Flight Industrial Base in the Post-Space Shuttle/Constellation Environment
  - National Security Assessment of the C-17 Globemaster Cargo Aircraft's Economic & Industrial Base Impacts
  - National Security Assessment of the Cartridge and Propellant Actuated Device Industry: 4th Review
  - Reliance on Foreign Sourcing in the Healthcare and Public Health Sector: Pharmaceuticals, Medical Devices, and Surgical Equipment
  - Sector to Sector, Tier to Tier Data
  - The Effect of Imports of Aluminum on the National Security, an Investigation Conducted under Section 232 of the Trade Expansion Act of 1962, as Amended
  - The Effect of Imports of Steel on the National Security, an Investigation Conducted under Section 232 of the Trade Expansion Act of 1962, as Amended
  - U.S. Bare Printed Circuit Board Supply Chain Assessment
  - U.S. Integrated Circuit Design and Fabrication Capability
  - U.S. Space Industrial Base "Deep Dive" Assessment: Employment in the U.S. Space Industrial Base
  - U.S. Space Industrial Base "Deep Dive" Assessment: Impact of U.S. Export Controls on the Space Industrial Base
  - U.S. Space Industrial Base "Deep Dive" Assessment: Small Businesses in the Space Industrial Base
  - U.S. Strategic Material Supply Chain Assessment: Carbon Fiber Composites
  - U.S. Strategic Material Supply Chain Assessment: Select Rare Earth Elements
  - U.S. Strategic Material Supply Chain Assessment: Titanium
- National Institute of Standards and Technology (NIST)
  - National Institute of Standards and Technology (NIST) Manufacturing Extension Partnership Cybersecurity Self-Assessment Handbook For Assessing NIST SP 800-171 Security Requirements in Response to Defense Federal Acquisition Regulations Cybersecurity Requirements

Department of Energy

- Critical Materials Strategy

Department of the Interior

- Managing Materials for a Twenty-First Century Military
- Mineral Commodity Summaries
- U.S. Geological Survey Data and Reports

Department of Labor

- Bureau of Labor Statistics Data

Government Accountability Office

- Defense Supply Chain: The Department of Defense Needs Complete Information on Single Sources of Supply to Proactively Manage the Risks
- Nuclear Weapons: The National Nuclear Security Administration Needs to Determine Critical Skills and Competencies for Its Strategic Materials Programs

Joint Army Navy NASA Air Force Interagency Propulsion Committee

- Bi-Annual Propulsion Industrial Sector Integrated Program Plan and Key Decision Points

White House / Executive Office of the President

- National Security Strategy
- Office of Trade & Manufacturing Policy (OTMP)
    - China's Strategies of Economic Aggression: How China Threatens the Intellectual Property and Technologies of America and the World

U.S. Government-Sponsored Sources

- A.T. Kearney Combat Vehicle Industrial Base Study
- Institute for Defense Analyses (IDA) Assessment Activities for Industrial Policy in Support of Executive Order 13806
- IDA Munitions Resilience Study
- MFORESIGHT America's Next Manufacturing Workforce
- MFORESIGHT Cybersecurity for Manufacturers
- MFORESIGHT Democratizing Manufacturing
- MFORESIGHT Ensuring American Manufacturing Leadership Through Next-Generation Supply Chains
- MFORESIGHT Metamaterials Manufacturing

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Appendix Five: Industry Listening Sessions

The below list includes the industry listening sessions the Interagency Task Force conducted. Many of the sessions were hosted and facilitated by trade associations, allowing the working groups a breadth of industry representatives in one meeting.

Date	Host	Session Title	Sector(s) Addressed
Dec. 15, 2017	National Defense Industrial Association	Industry Listening Session	Electronics
Jan. 22, 2018	Center for Strategic and International Studies	Charting a New Course for the Industrial Base	Macro forces
Jan. 25, 2018	Association for Manufacturing Technology and Georgia Tech Global Learning Center	AMT Machine Tools Data Gathering Workshop	Machine Tools
Jan. 26, 2018	Association for Manufacturing Technology	Advanced Manufacturing Workshop	Machine Tools

Date	Host	Session Title	Sector(s) Addressed
Jan. 31, 2018	Professional Services Council	Leadership Summit	Workforce
Feb. 7, 2018	Cowen Inc.	Aerospace and Defense Conference	Macro forces
Feb. 8, 2018	University of California San Diego 21st Century China Center	New Approaches to Reviewing and Regulating Chinese High Tech Investment	Macro forces
Mar. 1, 2018	National Defense University	Foundation Breakfast Briefing	Macro forces
Mar. 7, 2018	National Institute of Standards and Technology Manufacturing Extension Program	Advisory Board Meeting	Macro forces
Mar. 20, 2018	Precision Strike Association	Annual Review	Munitions & Missiles
Mar. 28, 2018	Aerospace Industries Association	Industry Listening Session	Aircraft
Mar. 28, 2018	Aerospace Industries Association	Industry Listening Session	Space
Mar. 29, 2018	Aerospace Industries Association	Industry Listening Session	Munitions & Missiles
Mar. 29, 2018	Aerospace Industries Association	Industry Listening Session	Radar & EW
Apr. 3, 2018	National Defense Industrial Association	Industry Listening Session	Ground Systems

Critical to the cybersecurity working group efforts were a series of nearly thirty sessions hosted by the National Institute of Standards and Technology Manufacturing Extension Partnership program from January - December 2017. Many of the sessions, which were conducted in over twenty states and reached over 1,000 U.S. manufacturers, included participation from DoD Procurement Technical Assistance Centers. The sessions familiarized small and medium size companies with the DFARS requirement to ensure adequate cybersecurity protections are in place by implementing the security controls contained in NIST SP 800-171. Direct personal interactions that occurred during the sessions regarding the challenges small and medium manufacturers face in terms of defensive and offensive cybersecurity, informed the cybersecurity in manufacturing working group's inputs and recommendations as part of the EO 13806 effort.

Appendix Six: Agreements with Foreign Governments

Security of Supply Agreements

DoD has entered into arrangements with several nations to ensure the mutual supply of defense goods and services. These bilateral Security of Supply arrangements allow the DoD to request priority delivery for DoD contracts, subcontracts, or orders from companies in these countries. Similarly, the arrangements allow the signatory nations to request priority delivery for their contracts and orders with U.S. firms.

Conducted under the overarching Declarations of Principles for Enhanced Cooperation in Matters of Defense Equipment and Industry that have been signed with certain nations, Security of Supply arrangements implement the "Meeting National Defense Requirements" section. The arrangements recognize the potential for a certain degree of mutual interdependence of supplies needed for national security, and calls for the parties to explore solutions for achieving assurance of supply. Reciprocal industrial priority systems encourage partner nations to acquire

defense goods from each other, promote interoperability, and provide assurance of timely delivery during peacetime, emergency, and armed conflict.

The following countries are party to Security of Supply agreements with the United States: Australia, Canada, Finland, Italy, Netherlands, Norway, Spain, Sweden, and the United Kingdom.[171]

Cooperative International Agreements

DOD has a highly structured process governing the development, negotiation, coordination, and implementation of cooperative international agreements:

- Memoranda of Understanding;
- Memoranda of Agreement;
- Projects Agreements and Arrangements; and
- Equipment and Material Transfer Arrangements

International agreements are used to establish information exchanges; personnel exchanges and assignments; cooperative research, development, test and evaluation projects; cooperative acquisitions; cooperative production (including licensed coproduction); or cooperative or reciprocal logistics support.

Any international agreement between the U.S. and another nation constitutes a commitment binding in international law on the part of the U.S. and the foreign government. The agreements obligate both governments to commit resources – funds, equipment, labor, information, or action – and outline the authorization and approval process to ensure the U.S. only commits to a course of action that is implementable and in its best interest.

Reciprocal Defense Procurement Agreements

Title 19, U.S. Code, Section 2512(a) directs the President to prohibit the procurement of foreign products from any country that is not a party to the Trade Agreements Act of 1979, so as to provide appropriate reciprocal competitive government procurement opportunities to U.S. products and suppliers of U.S. products. Title 19, U.S. Code, Section 2512(b) allows the President to authorize the Secretary of Defense to waive the prohibition on procurement of foreign products of any country that enters into a reciprocal procurement agreement with DoD. A Reciprocal Defense Procurement agreement is an example of such an agreement.

Under a Reciprocal Defense Procurement agreement, countries afford each other certain benefits on a reciprocal basis, consistent with their national laws and regulations. Each Reciprocal Defense Procurement agreement provides a framework for ongoing communication between or among DoD and its respective counterparts regarding market access and procurement matters that contribute to effective defense cooperation. Key Reciprocal Defense

Procurement agreement principles include: fair competition, reduced market barriers, transparent processes, and protection of intellectual property.

The authority to conclude a Reciprocal Defense Procurement agreement is found at Section 2531 of Title 10, U.S. Code. A country that has concluded a Reciprocal Defense Procurement agreement with DoD is termed a "qualifying country" in the DoD Federal Acquisition Regulation Supplement.[172] The DoD has Reciprocal Defense Procurement agreements in effect with the following 27 countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Egypt, Estonia, Finland, France, Germany, Greece, Israel, Italy, Japan, Latvia, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Sweden, Switzerland, Turkey, and the United Kingdom.

Reciprocal Government Quality Assurance Agreement

Paragraph (h) of Section 2761 of title 22, U.S. Code, provides the legal authority for an agreement for the performance of quality assurance services on a reciprocal no-charge basis between DoD and its counterparts for any contract or subcontract for defense articles, defense services, or design and construction services. Government Quality Assurance agreements promote the use of common quality assurance standards and protocols whereby each government supports purchases of defense equipment from its industry by the other government, and by defense contractor performing work for the other government. Such agreements help promote the interoperability and standardization of conventional defense equipment used by the U.S. Armed Forces and the partner's armed forces, and facilitate cooperation between our defense industries.

Government Quality Assurance agreements take either the form of a Government Quality Assurance annex to the Reciprocal Defense Procurement agreement that DoD has with the partner government, or as a stand-alone document. DoD has Government Quality Assurance agreements with the following 21 countries: Australia, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Israel, Italy, Republic of Korea, Netherlands, Norway, Poland, Romania, Spain, Slovakia, Sweden, Turkey, and the United Kingdom.[173]

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[86] As reported by the "Findings of the Investigation Into China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation Under Section 301 of the Trade Act of 1974," Office of the U.S. Trade Representative, 03/22/18, p. 158-159, https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF: "In 2012, while SolarWorld was litigating a petition it had filed against solar imports from China, the 3PLA stole thousands of sensitive files from SolarWorld. According to the indictment, these files included: "(i) cash-flow spreadsheets that would enable a competitor to identify how long SolarWorld would be able to withstand a market shock; (ii) detailed manufacturing metrics, technological innovations, and production line information that would enable a competitor to imitate SolarWorld's proprietary production capabilities; (iii) production costs for manufacturing inputs that would enable a competitor to undermine SolarWorld financially through underpricing of solar products; and, (iv) privileged attorney-client communications regarding SolarWorld's ongoing trade litigation with China, including confidential Question and Answer documents submitted to the [Department of Commerce] that were not discoverable by the Chinese respondents. According to the indictment, "such information would have enabled a Chinese competitor to target SolarWorld's business operations aggressively from a variety of angles."

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[88] Arne Delfs and Patrick Donahue, "German Spy Chief Says China's Tech Takeovers Are a Security Risk," *Bloomberg*, 24 June 2018.

[89] The Associated Press, "Australia Bans Huawei From 5G Network Over Security Concerns," *The New York Times*, 23 August 2018.

[90] This strategy has already been highly successful. China controls over 95% of the world's rare earth minerals; see "Rare earths: Battling China's monopoly after Molycorp's demise," *Mining.com,* 10 September 2016. http://www.mining.com/rare-earths-battling-chinas-monopoly-after-molycorps-debacle/

[91] China's highly successful neo-colonial approach to securing global resources is documented in Peter Navarro and Greg Autry, *Death By China*, Pearson FT Press, May 2011, Chapter 7. See also "2017 Annual Report," US-China Economic and Security Commission, 15 November 2017.

[92] United States Census Bureau, "Trade in Goods with China," 1985-2017. https://www.census.gov/foreign-trade/balance/c5700.html

[93] Demand for U.S. dollars to buy U.S. Treasuries drives up the value of the U.S. dollar relative to the yuan. For discussion, see, for example, Global Finance School, "How China Keeps the Yuan Undervalued," Undated. https://www.globalfinanceschool.com/blog-post/how-china-keeps-yuan-undervalued As this missive notes: "How does China keep the Yuan weak? By buying US currency and treasury notes on the open market, China keeps demand for the US dollar high. They can afford to buy and hold so much US currency due to their huge trade surplus with America, and they buy US currency roughly equal to this surplus. To keep the influx of dollars from increasing the Chinese money supply, China "sterilizes" the dollar purchases by selling bonds to Chinese investors like commercial banks. By boosting the dollar, still one of the most powerful worldwide currencies, the Yuan looks weak in relation."

[94] For a discussion generally of how foreign governments help finance U.S. trade deficits, see John Benedetto, "Who Financed Recent Trade Deficits?" United States International Trade Commission, *Journal of International Commerce and Economics,* May 2014. https://www.usitc.gov/publications/332/journals/volume_vi_u_s_trade_deficit.pdf

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[96] Christine Kim and Ben Blanchard, "China, South Korea Agree to Mend Ties After THAAD Standoff," *Reuters*, 30 October, 2017.

[97] Andrew Higgins, "In Philippines, Banana Growers Feel Effect of South China Sea Dispute," *Washington Post,* 10 June 2012.

[98] *The Japan Times*, "No Improvement in China's Rare Earths Ban," 13 October 2010.

[99] Ralph Jennings, "China's Efforts to Increase Pressure on Old Foe Taiwan Are Backfiring," *Forbes*, 28 June 2017.

[100] Kai Schultz, "Sri Lanka, Struggling With Debt, Hands a Major Port to China," *The New York Times,* 12 December 2017.

[101] Chamber of Commerce of the United States of America, "China's Drive for 'Indigenous Innovation' A Web of Industrial Policies," 2010. https://www.uschamber.com/sites/default/files/documents/files/100728chinareport_0_0.pdf

[102] Center for Strategic and International Studies, "Made in China 2025," 1 June 2025. https://www.csis.org/analysis/made-china-2025

[103] *Ibid.*

[104] Office of the U.S. Trade Representative, "Findings of the Investigation into China's Acts, Policies, and Practices Related to Technology Transfer, Intellectual Property, and Innovation Under Section 301 of the Trade Act of 1974," 22 March 2018. https://ustr.gov/sites/default/files/Section%20301%20FINAL.PDF

[105] China's illegal activities include cyberattacks, cyber theft, and industrial espionage. State-backed hackers steal, on average, $300 billion of intellectual property per year. While cyber theft has garnered most public attention, the FBI has cited a rise in industrial espionage: caseloads grew 53% from 2013-2015, with 95% of cases believed to be perpetrated by China. One source estimates that China employed 250,000-300,000 cyber spies in 2010 and 30,000 to 50,000 humans engaged in insider industrial espionage. Source: Intellectual Property Commission, "2017 Update to the IP Commission Report," February 2017. http://www.ipcommission.org/ The 2013 Intellectual Property Commission Report estimated that 96% of global cyber espionage originated in China and has led to $100 billion in lost sales and 2.1 million lost jobs. Together, these strategies will give China access to the world's most advanced capabilities and will erode our technological dominance over time.

[106] China uses five major means to acquire the IP and technologies of America. These include: (1) industrial espionage and sabotage through traditional spycraft, cyber espionage, and reverse engineering, counterfeiting, and piracy; (2) evasion of U.S. restrictions on technology transfers; (3) coercive regulatory gambits to force technology transfers from U.S. companies, typically in exchange for limited access to the Chinese market; (4) state-sponsored strategic Chinese investment in the U.S. through vehicles such as

acquisitions, greenfield investment, and venture capital financing, often involving elaborate front companies and shell corporations and opaque investor networks; and (5) the harvesting of America's national security innovation base through a massive open source collection campaign; the presence of large cadres of state-directed Chinese nationals at America's universities, national labs, and other centers of innovation; and a highly coordinated and government-financed program of talent recruitment aimed at business, finance, science, and technology experts. As is apparent, some of these techniques are illegal either at the national or multilateral (WTO) level, and some are not. For discussion, see the Office of Trade and Manufacturing Policy's report on Chinese economic aggression, January 2018.

[107] Rhodium Group, "Two-Way Street: 2017 Update US-China Direct Investment Trends," May 2017.

[108] Michael Brown and Pavneet Singh, "China's Technology Transfer Strategy: How Chinese Investments in Emerging Technology Enable A Strategic Competitor to Access the Crown Jewels of U.S. Innovation ," Defense Innovation Unit Experimental, January 2018, p. 4, https://admin.govexec.com/media/diux_chinatechnologytransferstudy_jan_2018_(1).pdf.

[109] *Ibid.*

[110] In addition to sensitive reporting, the U.S. Department of Defense has discussed these issues in its various reports to Congress on China's military developments. The most recent report is available at: https://www.defense.gov/Portals/1/Documents/pubs/2017_China_Military_Power_Report.PDF

[111] For a discussion of the U.S.-China military balance in the open source, see the most recent U.S. Department of Defense report to Congress on China's military developments, It is available at: https://www.defense.gov/Portals/1/Documents/pubs/2017_China_Military_Power_Report.PDF

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[113] Department of Defense, "Report to Congress: Annual Industrial Capabilities." 16 March 2017. http://www.businessdefense.gov/Portals/51/Documents/Resources/2016%20AIC%20RTC%2006-27-17%20-%20Public%20Release.pdf?ver=2017-06-30-144825-160

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[115] Daniel Kliman, Testimony before the U.S.-China Economic and Security Review Commission, 25 January 2018. https://www.uscc.gov/sites/default/files/Kliman_USCC%20Testimony_20180119.pdf

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[117] Adam Davidson, "Most U.S. Port Terminals Are Foreign-Run," National Public Radio, 26 February 2006. https://www.npr.org/templates/story/story.php?storyId=5234177

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[119] Data provided by Institute for Defense Analyses.

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[121] *Ibid*, pg 15.

[122] *Ibid*, pg 13.

[123] National Science Foundation, Science and Engineering Indicators, 2018. https://www.nsf.gov/statistics/2018/nsb20181/digest/sections/u-s-and-global-stem-education

[124] National Science Foundation, Science and Engineering Indicators, 2014. https://www.nsf.gov/statistics/seind14/index.cfm/chapter-2/c2s2.htm#s2-2

[125] *Ibid.*

[126] *Ibid.*

[127] Matthew Patane, "Creston helicopter parts maker Fansteel files for bankruptcy," *Des Moines Register,* September 2016. https://www.desmoinesregister.com/story/money/business/2016/09/15/creston-helicopter-parts-maker-fansteel-files-bankruptcy/90407356/

[128] National Association of Manufacturers, Manufacturers Outlook Survey, December 2017. http://www.nam.org/Data-and-Reports/Manufacturers-Outlook-Survey/2017-Fourth-Quarter-Manufacturers-Outlook-Survey/

[129] Ben Watson, "The US Army Just Ordered Soldiers to Stop Using Drones from China's DJI," *Defense One*, 4 August 2017.

[130] Internet Security Threat Report, Symantec, 2015.

[131] Data Breach Investigations Report, Verizon, 2015.

[132] Manufacturers received 20% of all attacks across all industries globally in 2014. Symantec. "Internet Security Threat Report," 2015, pg 13.

[133] Cyber-espionage consisted of 60% of all attacks on manufacturers in 2014. In fact, manufacturers received more cyber-espionage attacks than any other industry globally in 2014 (27.4%, p. 52). Other motivations for attacks on manufacturers were crimeware (malicious software designed to carry out or facilitate illegal online activity, 34%), insider misuse (4%) and web-app attacks (1%) (p. 34). Verizon, "Data Breach Investigations Report," 2015.

[134] Studies by organizations such as the National Defense Industry Association, Defense Science Board, Alliance for Manufacturing Foresight, and McKinsey Global Institute have also highlighted (1) the centrality of small and medium manufacturers to the U.S. manufacturing supply chain for domestic economic growth, (2) small and medium manufacturers criticality to the DIB for national security, and (3) small and medium manufacturers vulnerability to cybersecurity threats and breaches.

[135] While multiple size standards exist for different industry sectors, the U.S. Small Business Administration generally considers small and medium-sized manufacturers to have fewer than 500 employees at a location.

[136] NDIA, "Cybersecurity for Manufacturing Networks," 2017.

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[142] Semiconductor Industry Association, "2017 Factbook," May 2017.

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[154] Congressional Research Service, The Buy American Act—Preferences for "Domestic" Supplies: In Brief, CRS Report No. R43140, 2016. https://www.hsdl.org/?abstract&did=792493

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[156] Congressional Research Service, China's Mineral Industry and U.S. Access to Strategic and Critical Minerals: Issues for Congress, CRS Report No. R43864 2015. https://fas.org/sgp/crs/row/R43864.pdf

[157] Naval Registry.

[158] Vehicle, missiles, and aircraft numbers derived from Service Property Book data repositories.

[159] Log Cost Baseline calculation.

[160] Maintenance and Availability Data Warehouse.

[161] Bureau of Labor Statistics.

[162] Federal Reserve Bank of St. Louis, FRED. https://fred.stlouisfed.org/series/MANEMP. Not all manufacturing job loss represents diminished U.S. manufacturing; some has been caused by automation within manufacturing facilities that have remained in the United States.

[163] National Association of Manufacturers, Manufacturers Outlook Survey, December 2017. http://www.nam.org/Data-and-Reports/Manufacturers-Outlook-Survey/2017-Fourth-Quarter-Manufacturers-Outlook-Survey/

[164] National Association of Manufacturers, *Economic Report*, March 2018. http://www.nam.org/Newsroom/eNewsletters/Monday-Economic-Report/2018/Monday-Economic-Report---March-19--2018/

[165] National Science Foundation, Science and Engineering Indicators, 2018. https://www.nsf.gov/statistics/2018/nsb20181/digest/sections/u-s-and-global-stem-education

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Office of the Under Secretary of Defense
for Acquisition and Sustainment

Office of the Deputy Assistant Secretary of Defense
for Industrial Policy

EXHIBIT 133

United States Government Accountability Office

Report to Congressional Committees

July 2022

DEFENSE INDUSTRIAL BASE

DOD Should Take Actions to Strengthen Its Risk Mitigation Approach

GAO-22-104154

July 2022

DEFENSE INDUSTRIAL BASE

DOD Should Take Actions to Strengthen Its Risk Mitigation Approach

GAO Highlights

Highlights of GAO-22-104154, a report to congressional committees

Why GAO Did This Study

A healthy defense industrial base that provides the capacity and capability to produce advanced weapon systems is critical to maintaining U.S. national security objectives. The U.S. industrial base currently consists of over 200,000 companies. Mitigating risks—such as reliance on foreign and single-source suppliers—is essential for DOD to avoid supply disruptions and ensure that the industrial base can meet current and future needs.

Since 2017, the White House has issued executive orders directing DOD and other agencies to assess risks to the defense industrial base and high priority supply chains such as semiconductors.

Congress also directed DOD to develop an analytical framework for mitigating risks and included a provision for GAO to review DOD's efforts. This report assesses (1) DOD's strategy for mitigating industrial base risks, and (2) the extent to which DOD is monitoring and reporting on its progress in mitigating risks. GAO analyzed DOD policies and reports and interviewed DOD officials.

What GAO Recommends

GAO is making six recommendations, including that DOD develop a consolidated and comprehensive strategy to mitigate industrial base risks; develop and use enterprise-wide performance measures to monitor the aggregate effectiveness of its efforts; and report on its progress in mitigating risks. DOD generally concurred with the recommendations and identified some actions to address them.

View GAO-22-104154. For more information, contact W. William Russell at (202) 512-4841 or RussellW@gao.gov.

What GAO Found

The Department of Defense's (DOD) Industrial Base Policy office does not yet have a consolidated and comprehensive strategy to mitigate risks to the industrial base—the companies that develop and manufacture technologies and weapon systems for DOD. The office is using a combination of four previously issued reports that were created for other requirements because it devoted its resources to completing other priorities. Collectively, the reports do not include several elements GAO has previously identified that would help DOD achieve results, evaluate progress, and ensure accountability (see figure).

Elements Not Fully Addressed in DOD's Industrial Base Strategy

Source: GAO-04-408T and GAO analysis of Department of Defense (DOD) documents. | GAO-22-104154

DOD must update its industrial base strategy following the submission of the next National Security Strategy Report, which is expected to be issued later in 2022. By including all elements in a consolidated strategy, DOD could better ensure that all appropriate organizations are working toward the same priorities, promoting supply chain resiliency, and supporting national security objectives.

DOD is carrying out numerous efforts to mitigate risks to the industrial base. This includes more than $1 billion in reported efforts under Navy submarine and destroyer programs and $125 million to sustain a domestic microelectronics manufacturer. However, DOD has limited insight into the effectiveness of these efforts and how much progress it has made addressing risks. For example:

- The Industrial Base Policy office and military services have not established enterprise-wide performance measures to monitor the aggregate effectiveness of DOD's mitigation efforts.
- DOD's annual Industrial Capabilities Reports do not include information about the progress the department has made in mitigating risks.

GAO's prior work on enterprise risk management establishes that agencies should monitor and report on the status and effectiveness of their risk mitigation efforts. Without key monitoring and reporting information, DOD and Congress do not have sufficient information to help determine whether industrial base risks have been mitigated and what additional resources or actions may be needed.

Contents

Abbreviations

DOD	Department of Defense
ERM	Enterprise Risk Management
OMB	Office of Management and Budget

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
441 G St. N.W.
Washington, DC 20548

July 7, 2022

Congressional Committees

Each year, the Department of Defense (DOD) spends billions of dollars acquiring and sustaining weapon systems to ensure that it can meet U.S. national security objectives and maintain military superiority. A critical element of U.S. power is a healthy defense industrial base–that is, one that has secure supply chains and skilled workers that are able to develop and produce new technologies and advanced weapon systems. Currently, the U.S. defense industrial base consists of over 200,000 companies that provide the capacity and capability to produce advanced weapon systems. Supporting a vibrant domestic manufacturing sector and resilient supply chains is a national priority and key to ensuring that DOD has access to industrial capabilities to meet current and future needs.

However, for decades, DOD has reported on complex challenges that the defense industrial base is experiencing that necessitate continued and accelerated focus. These challenges include relying on foreign and single-source suppliers for critical materials, replacing obsolete parts on weapon systems that could be in operation for decades, and protecting weapon systems from cybersecurity threats, among others.

The U.S. has also lost significant domestic manufacturing capacity over the past several decades that threatens the resilience of the defense supply chain. For example, DOD reported that capacity and competition in the shipbuilding sector declined significantly over the past 50 years, with 14 shipyards that built Navy ships closing. Three other shipyards also exited the defense industry, and just one new shipyard opened—leaving only seven shipyards owned by four prime contractors. Similarly, for the semiconductor sector, DOD determined that from 1990 to 2019, domestic semiconductor production capacity decreased from 37 to 12 percent of the global total manufacturing market, while Asia controls nearly 80 percent of the outsourced aspects of semiconductor production.[1] Industry groups have also reported on the declining health of the defense industrial base, specifically with DOD's supply chain and

[1]Department of Defense, *Fiscal Year 2020 Industrial Capabilities Report to Congress* (Washington, D.C.: January 2021).

production capacity and surge readiness—areas that are critical to U.S. national security interests.[2]

Over the past 5 years, the White House issued executive orders aimed at improving DOD's ability to identify and navigate supply chain disruptions, such as with semiconductors.[3] Congress also enacted legislation, including section 845 of the National Defense Authorization Act for Fiscal Year 2020 that directs DOD to develop a comprehensive analytical framework for risk mitigation across the acquisition process.[4] The act includes a provision for us to assess DOD's efforts to mitigate defense industrial base risks. This report assesses (1) DOD's strategy for mitigating defense industrial base risks, and (2) the extent to which DOD is monitoring and reporting on its progress in mitigating risks.

To assess DOD's strategy for mitigating defense industrial base risks, we compared information in documents that DOD identified as its strategy to desirable characteristics for a national strategy that we identified in prior work.[5] We also reviewed key legislation, statutes, and executive orders related to mitigating defense industrial base risks and interviewed officials from the Office of the Assistant Secretary of Defense for Industrial Base Policy (Industrial Base Policy).

To assess the extent to which DOD is monitoring and reporting its progress in mitigating risks, we reviewed relevant DOD policies, guidance, and charters to identify what requirements, if any, existed for DOD organizations to monitor and report the outcomes and progress of its risk mitigation efforts. To understand monitoring efforts, we reviewed examples of project documentation from fiscal years 2018 to 2021 from department-wide investment programs to identify how DOD monitors the effectiveness of industrial base projects individually and collectively. To

[2]National Defense Industrial Association, *Vital Signs 2022, the Health and Readiness of the Defense Industrial Base* (Arlington, Va.: February 2022). Center for Strategic and International Studies, *Mapping the National Security Industrial Base: Policy Shaping Issues* (Washington, D.C.: May 2021).

[3]Exec. Order No. 14017, America's Supply Chains, 86 Fed. Reg. 11849 (Mar. 1, 2021). Department of Defense, Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States: Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806 (Washington, D.C.: September 2018).

[4]Pub. L. No. 116-92, § 845 (2019).

[5]GAO, *Combating Terrorism: Evaluation of Selected Characteristics in National Strategies Related to Terrorism*, GAO-04-408T (Washington, D.C.: Feb. 2004).

understand DOD's reporting efforts, we reviewed DOD's annual Industrial Capabilities Reports for fiscal years 2018 through 2020 and the statute governing these reports, section 4814 of title 10, U.S. Code. We selected two of 16 defense industrial base sectors—shipbuilding and microelectronics—as case studies for detailed analysis. We also interviewed officials from the Office of Industrial Base Policy, military services, and DOD-wide industrial base investment programs. A more detailed description of our scope and methodology assessment is included in appendix I.

We conducted this performance audit from March 2020 to July 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

The U.S. defense industrial base includes a combination of people, technology, institutions, technological know-how, and facilities used to design, develop, manufacture, and maintain the weapons needed to meet U.S. national security objectives. The defense industrial base can be divided into several tiers: top tiers that include prime contractors and major subcontractors, and lower tiers that include suppliers of parts, electronic components, and raw materials.

DOD determined that a healthy and robust defense industrial base is essential to meeting U.S. national security objectives. Accordingly, risks to the industrial base—any event or condition that may disrupt or degrade DOD supplier capabilities or capacity needed to equip or sustain military forces now and in the future—are seen as threats to U.S. national security. To address these risks, DOD has spent billions of dollars to implement mitigation efforts. Recently, for example, the ongoing COVID-19 pandemic highlighted vulnerabilities in the defense industrial base, primarily in the aviation, space, shipbuilding, and microelectronics sectors. We reported that DOD planned to use $687 million in Defense Production Act Title III funding, appropriated by Congress in the CARES Act, to address risks and offset the financial distress in the defense

industrial base.[6] In one instance, DOD reported awarding a project valued at nearly $30 million to sustain and expand the continued operations of the only domestic manufacturer of neodymium iron boron rare earth magnets, which are crucial components in many DOD aircraft, submarines, and missiles.

DOD Organizations Involved with Industrial Base Risk Mitigation Efforts

The Assistant Secretary of Defense for Industrial Base Policy is DOD's principal advisor within the department for issues affecting the industrial base across the DOD enterprise.[7] Among other things, the Industrial Base Policy office conducts DOD-wide industrial base risk assessments, coordinates certain industrial base investments, and reports annually on assessments of the defense industrial base and associated risks and mitigation efforts. The office incorporates inputs from other DOD organizations, including the military services, Defense Logistics Agency, department-wide investment programs, and industrial base forums to perform its responsibilities.

DOD often relies on the military service acquisition executives, system commands, and program offices to execute risk mitigation efforts. Within the departments, the service acquisition executives implement risk mitigation efforts across their respective enterprises. These senior officials include the Assistant Secretary of the Air Force for Acquisition, Technology and Logistics for Air Force and Space Force programs; the Assistant Secretary of the Army for Acquisition, Logistics, and Technology for Army programs; and the Assistant Secretary of the Navy for Research, Development, and Acquisition for Navy and U.S. Marine Corps programs.

Generally though, it is DOD's practice to delegate risk mitigation activities to the lowest level possible—the program offices—as these offices are the most knowledgeable about the changing risks and must address them

[6]The CARES Act provided DOD $1 billion specifically for Defense Production Act purchases to prevent, prepare for, and respond to COVID-19, domestically or internationally. Pub. L. No. 116-136. (2020). The Defense Production Act, enacted in 1950, facilitates the supply and timely delivery of products, materials, and services to military and civilian agencies during times of peace as well as in times of war.

[7]Congress created the position of the Assistant Secretary of Defense for Industrial Base Policy in January 2020, which replaced the Deputy Assistant Secretary of Defense for Industrial Policy. William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283, § 903 (2021). DOD established the position and an office to support it in February 2022. The Office of the Assistant Secretary of Defense for Industrial Base Policy is part of the Undersecretary of Defense for Acquisition and Sustainment organization.

to help meet cost, schedule, and performance goals. DOD policy instructs program offices to incorporate industrial base analysis into their acquisition planning, which includes identifying risks and potential mitigation efforts.[8] Recently, we reported that nearly half of 59 DOD acquisition programs that we surveyed identified that they were tracking industrial base risks, with some programs reporting that those risks contributed to cost and schedule challenges.[9] However, nearly half of the programs tracking industrial base risks reported that they did not plan for an industrial base assessment.

According to DOD officials we interviewed for this current review, system commands and program offices typically elevate industrial base risks to their military service acquisition executive office or the Industrial Base Policy office if a risk affects multiple programs or military services, or if additional funding is needed to mitigate the risks. Officials from the military services said they identified shared risks through informal communication with other service officials or through industrial base working groups.

DOD leverages various forums and working groups——comprised of officials from Industrial Base Policy, the military services, and other DOD organizations——to exchange industrial base information, prioritize risks, and decide on mitigation efforts, among other things. For example:

- The Industrial Base Council is DOD's executive level forum. The council assesses risks, prioritizes efforts, leverages DOD-wide mitigation efforts, and develops defense policy to address critical risks. For example, the council approved the use of CARES Act funding for projects to mitigate defense industrial base risks associated with the COVID-19 pandemic. Established in October 2015, the council is chaired by the Under Secretary of Defense for Acquisition and Sustainment and consists of 12 voting members and 14 advisory members from various DOD organizations engaged in acquisitions, sustainment, technology development, contracting, and operations.
- The Joint Industrial Base Working Group is DOD's primary mechanism for exchanging information about industrial base matters

[8]Department of Defense, *DOD Instruction 5000.85, Major Capability Acquisition* (Aug. 6, 2020) (Incorporating Change 1, Nov. 4, 2021).

[9]GAO, *Weapon Systems Annual Assessment: Challenges to Fielding Capabilities Faster Persist*, GAO-22-105230 (Washington, D.C.: June 8, 2022).

across the department. The working group is co-chaired by staff from the Industrial Base Policy office and the Defense Contract Management Agency and receives information from dozens of other working groups focused on specific industrial base sectors. It was established in December 2019 and is tasked with maintaining a repository of industrial base data and assessments, encouraging the use of standard analytical approaches across DOD, recommending priority areas for risk mitigation, and monitoring risk management actions, among other things. When necessary, this working group elevates risks—identified by its DOD-wide representatives—to the Industrial Base Council.

- The Supply Chain Resiliency Working Group was established in August 2021 to develop new tools and processes to address long-term barriers currently limiting DOD's supply chain visibility, resiliency assessments, and mitigation efforts.[10] This working group is tasked with developing a methodology for supply chain visibility over a 2-year period. Among other things, the working group plans to identify DOD's current analytical capabilities, propose and test a framework to quantify enterprise resiliency, and develop a supply chain resiliency strategy and implementation plan.

DOD also administers three department-wide investment programs within the Office of the Secretary of Defense to help mitigate risks——Defense Production Act Title III, Industrial Base Analysis and Sustainment, and Manufacturing Technology. DOD reported receiving $2.3 billion for these programs from fiscal years 2018 to 2021 and funded 134 risk mitigation projects. According to DOD officials, each investment program has its own focus for mitigating risks.

- **Defense Production Act Title III:** focuses on projects that establish, expand, maintain, or restore domestic production capacity for critical components and technologies.
- **Industrial Base Analysis and Sustainment:** seeks to maintain or improve the health of essential parts of the defense industry by addressing critical capability.
- **Manufacturing Technology:** strives to anticipate and close gaps in manufacturing capabilities.

[10]Under Secretary of Defense for Acquisition and Sustainment memorandum, *Supply Chain Resiliency Working Group* (Aug. 30, 2021).

Executive Orders and Congressional Mandates Related to Mitigating Defense Industrial Base Risks

Over the past several years, the White House and Congress directed DOD to take steps to improve its ability to oversee the industrial base and mitigate risks. Table 1 provides a description of key executive orders and legislation that we considered as part of this review.

Table 1: Key Executive Orders and Legislative Mandates Related to the Defense Industrial Base

Executive orders and legislative mandates	Effective date	Description
Executive Order 13806	July 2017	Directed the Department of Defense (DOD) to conduct a whole-of-government effort to assess risks, identify impacts, and propose recommendations in support of a healthy manufacturing and defense industrial base.
Executive Order 14017	February 2021	Directed DOD to lead a 100-day review to identify supply chain risks for critical minerals and other identified strategic materials, and to make policy recommendations to address the risks. Also directed DOD to submit a report on defense industrial base supply chains that updates DOD's Executive Order 13806 report and builds on DOD's annual Industrial Capabilities Report.
Section 2501 of title 10, U.S. Code[a]	Various	Requires DOD to develop a National Security Strategy for the National Technology and Industrial Base that includes a prioritized assessment of risks and challenges to the defense industrial base to achieving national security objectives.
Section 2504 of title 10, U.S. Code[b]	Various	Requires DOD to annually report on assessments of the U.S. defense industrial base, including mitigation strategies necessary to address gaps or vulnerabilities in the industrial base.
Section 845 of the National Defense Authorization Act for Fiscal Year 2020[c]	December 2019	Directed DOD to create an analytical framework for mitigating risk across the acquisition process and to streamline and digitize its approach for identifying and mitigating industrial base risks. Also required DOD to provide Congress with an implementation plan and schedule for carrying out the framework within 90 days of the enactment of the act.

Source: GAO analysis of executive orders and legislative provisions. | GAO-22-104154

[a]Section 2501 of title 10, U.S. Code, was renumbered as section 4811 of title 10, U.S. Code.

[b]Section 2504 of title 10, U.S. Code, was renumbered as section 4814 of title 10, U.S. Code.

[c]Pub. L. No. 116-92, § 845 (2019).

In addition, DOD provides various defense industrial base reports to Congress, including the Combined Resource and Policy Strategy to Address U.S. Defense Industrial Base Vulnerabilities and an Annual

Report on the Unfunded Priorities of the National Technology and Industrial Base.[11]

Assessment of Defense Industrial Base Risks

In response to Executive Order 13806 on strengthening the U.S. defense industrial base, DOD issued a report in September 2018 in which it assessed its industrial base risks. In the Executive Order, the President noted that the health of the manufacturing and defense industrial base—which is essential to U.S. economic strength and national security—had been weakened by the loss of more than 60,000 American factories and companies and almost 5 million manufacturing jobs since 2000.[12] The President directed DOD, in coordination with other federal agencies, to assess the manufacturing capacity, defense industrial base, and supply chain resiliency of the U.S. and make recommendations to strengthen the industrial base.

In its report, DOD identified nearly 300 risks, including 35 priority risks, across 16 defense industrial base sectors.[13] DOD officials stated it was the first time since World War II that DOD assessed these risks from an enterprise-wide, strategic perspective. The report identified five root causes shaping industrial base-wide trends and causing a deterioration in U.S. capabilities, as well as 10 risk types resulting from the root causes that contribute to DOD supply chain insecurity.[14] Figure 1 describes the five root causes and 10 risk types, which DOD continues to use to identify and assess risks.

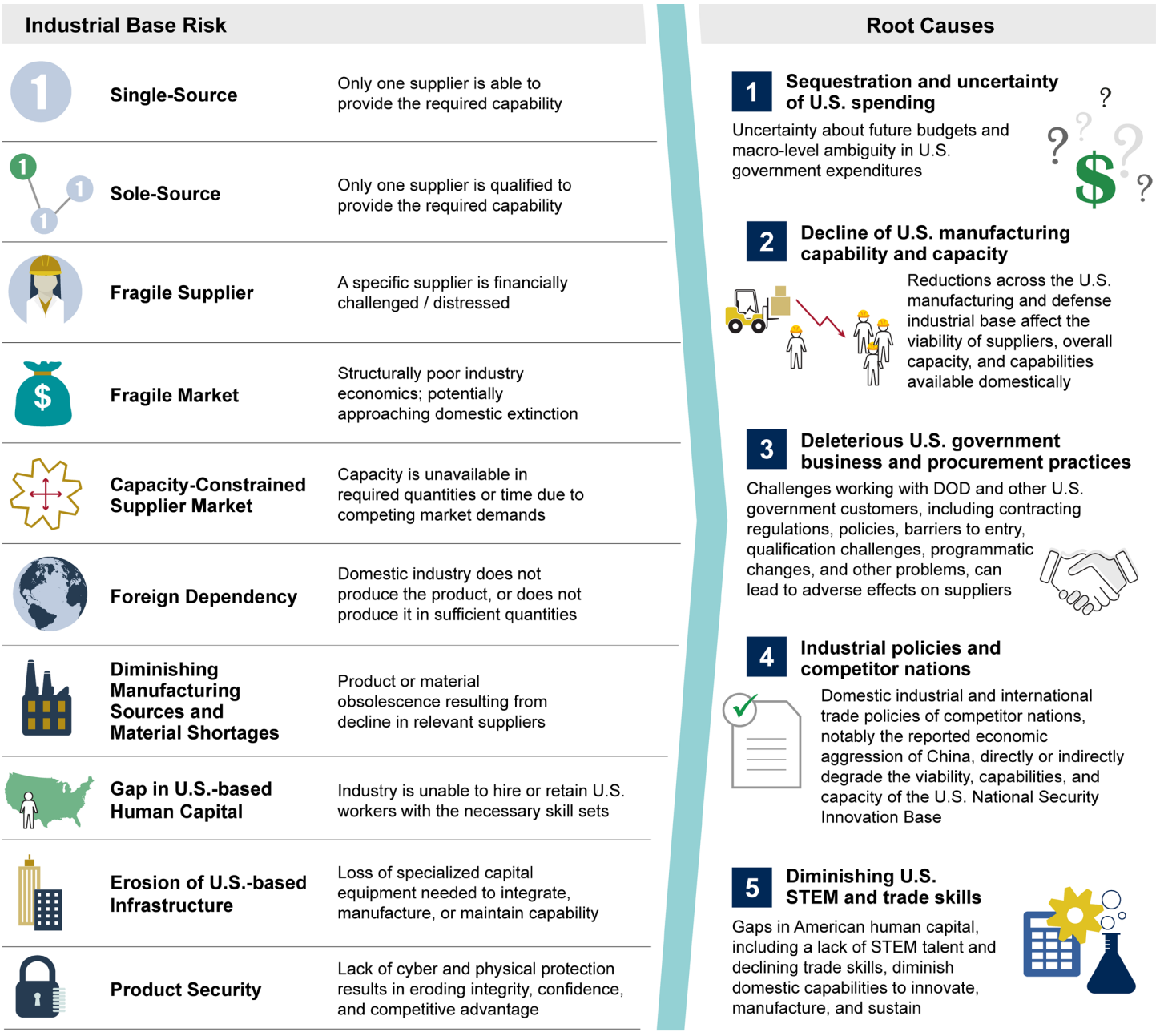
[11]Senate Report 116-103 directed DOD to submit to the congressional defense committees the combined resource and policy strategy to address U.S. defense industrial base vulnerabilities. Section 4815 of title 10, U.S. Code, requires DOD to identify priorities to address gaps and vulnerabilities in the defense industrial base not funded in the President's Budget.

[12]Exec. Order No. 13806, *Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States,* 82 Fed. Reg. 34597 (July 26, 2017).

[13]*Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States (Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806).* We refer to this as the Department of Defense's 2018 assessment throughout this report.

[14]The five root causes refer to the challenges that affect the capabilities of the manufacturing and defense industrial base and threaten DOD's ability to be ready for the fight tonight, and to retool for great power competition. The 10 risk types are a product of the root causes, each of which contribute to insecurity in DOD's supply chain.

Figure 1: Department of Defense-Identified Industrial Base Risk Types and Root Causes



Source: GAO analysis of Department of Defense (DOD) information. | GAO-22-104154

Assessments of Key Supply Chains

In June 2021 and February 2022, DOD and other federal agencies issued industrial base assessments in response to Executive Order 14017 on strengthening America's supply chains. In the Executive Order, the President noted that the U.S. needs resilient, diverse, and secure supply chains to ensure its economic prosperity and national security.[15] Further, these supply chains face significant threats, including cyberattacks, geopolitical and economic competition, and pandemics. To improve U.S. supply chains, the President directed DOD and other federal agencies to conduct a series of assessments on four key supply chains and make recommendations to strengthen their resilience. The supply chains included: (1) critical minerals and materials; (2) semiconductor manufacturing and advanced packaging; (3) large capacity batteries; and (4) pharmaceuticals and active pharmaceutical ingredients. DOD was also required to update its 2018 assessment.

In response to the Executive Order, DOD and other agencies issued 100-day assessments on the four supply chains in June 2021.[16] DOD was designated the lead agency for the critical minerals and materials review and participated in the other three supply chain reviews that were led by the Departments of Commerce, Energy, and Health and Human Services, respectively.

In February 2022, DOD also issued a report to update its 2018 assessment.[17] Instead of assessing industrial base risks for all 16 defense sectors as it did for its 2018 assessment, DOD assessed and made recommendations to mitigate risks associated with five defense supply chains—(1) microelectronics; (2) castings and forgings; (3) kinetic capabilities; (4) energy storage; and (5) strategic and critical materials. It also assessed and made recommendations related to four strategic enablers—workforce, cyber posture, small business, and manufacturing. According to the report, the supply chains and strategic enablers align to

[15]Exec. Order No. 14017, *America's Supply Chains*, 86 Fed. Reg. 11849 (Mar. 1, 2021).

[16]White House Report, *Building Resilient Supply Chains, Revitalizing American Manufacturing, And Fostering Broad-Based Growth:100-Day Reviews under Executive Order 14017* (Washington, D.C.: June 2021).

[17]S*ecuring Defense-Critical Supply Chains: An action plan developed in response to President Biden's Executive Order 14017* (February 2022). We refer to this as the 2022 assessment of key defense supply chains throughout this report.

DOD's operational priorities and were selected through ongoing supply chain analysis across the department, interagency, and White House.

Analytical Framework for Risk Mitigation

In the Conference Report accompanying Section 845 of the National Defense Authorization Act for Fiscal Year 2020, conferees observed that DOD was not appropriately considering certain risks to the defense industrial base, such as risks related to cybersecurity, company ownership, and supplier fragility.[18] Conferees further noted that even in cases where DOD made an industrial base risk a priority, its existing acquisition processes and procedures did not support timely or effective risk mitigation. Congress directed DOD to develop an analytical framework for industrial base risk mitigation across the acquisition process. DOD was also required to issue an implementation plan and schedule for developing the analytical framework by March 2020.[19]

As of March 2022, Industrial Base Policy officials stated that DOD had not yet issued the implementation plan and schedule for developing an analytical framework for mitigating industrial base risks across the acquisition process. The Joint Explanatory Statement to accompany the National Defense Authorization Act for Fiscal Year 2022 directed DOD to provide a briefing on the framework implementation to the congressional defense committees by June 1, 2022.

Enterprise Risk Management

To help federal leaders manage their complex missions, the Office of Management and Budget (OMB) issued an update to OMB Circular A-123 in July 2016. The circular requires federal agencies to implement an enterprise risk management capability that is coordinated with their strategic planning and review processes.[20] By doing so, agencies can improve mission delivery, reduce costs, and focus corrective actions toward key risks.

According to the circular, enterprise risk management is an effective agency-wide approach for addressing risks because organizations consider the combined impact of internal and external risks as an interrelated portfolio, rather than addressing risks only within silos. Enterprise risk management also addresses other internal control topics

[18]Conference Report to Accompany the National Defense Authorization Act for Fiscal Year 2020, H.R. Rep. No. 116-333 (Dec. 9, 2019).

[19]Pub. L. No. 116-92, § 845 (2019).

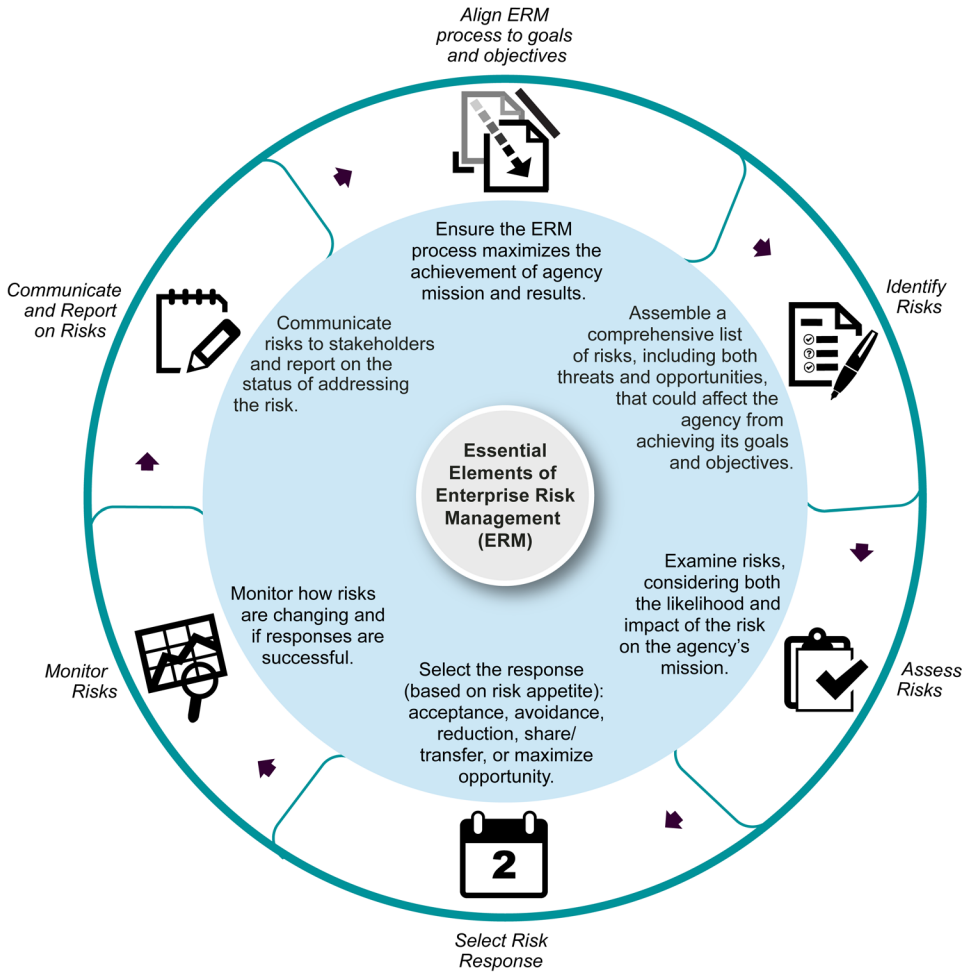
[20]Office of Management and Budget, *Management's Responsibility for Enterprise Risk Management and Internal Control*, Circular No. A-123 (July 15, 2016).

such as setting strategy, governance, communicating with stakeholders, and measuring performance. The principles of enterprise risk management apply to all levels of an organization and across all functions—such as to organizations and activities that manage defense industrial base risks.

In 2016, we updated our risk management framework to (1) reflect changes to OMB Circular A-123; (2) identify essential elements of federal enterprise risk management; and (3) incorporate recent federal experience and agencies' good practices for enterprise risk management.[21] In our updated framework, we identified six essential elements of enterprise risk management, as shown in figure 2.

[21]GAO, *Enterprise Risk Management: Selected Agencies' Experiences Illustrate Good Practices in Managing Risks,* GAO-17-63 (Washington, D.C.: Dec. 1, 2016).

Figure 2: Essential Elements of Federal Government Enterprise Risk Management



Source: GAO. | GAO-22-104154

We also noted that it is not possible to eliminate all risks, but agencies can better plan for and manage them by using enterprise risk management. This forward-looking risk management approach can assist federal leaders in anticipating and managing risks, as well as considering how multiple risks can present even greater challenges and opportunities when examined as a whole.

DOD Lacks Strategic Direction for Its Industrial Base Risk Mitigation Efforts

DOD does not yet have a consolidated and comprehensive strategy to guide its industrial base risk mitigation efforts. While DOD identified and prioritized its risks in a strategy, it has not identified elements such as milestones, performance measures, resources, responsible organizations, and implementation plans for mitigating the risks. The Industrial Base Policy office, which provides strategic direction, devoted limited resources to developing a strategy due to competing priorities and workforce issues. It also experienced significant turnover of senior leadership.

DOD's Current Industrial Base Mitigation Strategy Does Not Include Key Information to Support Implementation

DOD is required to develop a National Security Strategy for the National Technology and Industrial Base, including a prioritized assessment of risks and challenges to the defense industrial base.[22] However, DOD does not yet have a consolidated and comprehensive strategy to mitigate risks. Our prior work has shown that strategic planning is the foundation for defining what an agency seeks to accomplish, identifying the strategies it will use to achieve desired results, and determining how well it will succeed in reaching results-oriented goals and achieving objectives. Combined with effective leadership, strategic planning that results in a consolidated and comprehensive strategy enables decision makers to better guide program efforts and determine if these efforts are achieving the desired results.[23]

In March 2021, the department reported to Congress that it was using four previously developed reports and assessments to satisfy the requirements of a strategy. According to Industrial Base Policy officials, DOD used existing documents for the strategy because it prioritized its resources on other efforts. The assessments and reports were issued between September 2018 and January 2021 to meet other specific executive orders, congressional mandates, and statutory requirements. Table 2 provides a list of the four documents and each of their original requirements.

[22]10 U.S.C. § 4811. The National Technology and Industrial Base comprises of the United States, Canada, the United Kingdom, and Australia.

[23]GAO, *Defense Logistics: A Completed Comprehensive Strategy Is Needed to Guide DOD's In-Transit Visibility Efforts*, GAO-13-201 (Washington, D.C.: February 2013).

Table 2: Documents That Comprise DOD's 2021 Industrial Base Strategy

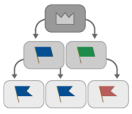
Reports and Assessments	Issue Date	Source of Work
Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States	September 2018	Executive Order 13806 directed DOD to conduct a whole-of-government effort to assess risks, identify impacts, and propose recommendations in support of a healthy manufacturing and defense industrial base.
The Combined Resource and Policy Strategy to Address U.S. Defense Industrial Base Vulnerabilities	July 2020	Senate Report 116-103 directed DOD to submit to the congressional defense committees the combined resource and policy strategy to address U.S. defense industrial base vulnerabilities.
Annual Report on the Unfunded Priorities of the National Technology and Industrial Base	September 2020	Section 2504a of title 10, U.S. Code (later moved to section 4815 of title 10, U.S. Code) required DOD to identify priorities to address gaps and vulnerabilities in the defense industrial base not funded in the President's Budget.
The Fiscal Year 2020 Industrial Capabilities Report to Congress	January 2021	Section 2504 of title 10, U.S. Code (later moved to section 4814 of title 10, U.S. Code) required DOD to annually identify gaps or vulnerabilities in, and assessments of, the U.S. defense industrial base.

Source: Department of Defense (DOD) reports. | GAO-22-104154

We analyzed these four documents to determine the extent to which the documents, individually or collectively, include elements of a set of six desirable characteristics we previously identified that agencies should consider when developing a national strategy.[24] The desirable characteristics cover actions an agency should consider from conception to implementation of a strategy to help it achieve results, evaluate progress, and ensure accountability. As shown in figure 3, we found that the strategy fully incorporates elements of two characteristics, but is missing elements in the other four characteristics, which limits its usefulness in guiding DOD's risk mitigation efforts.

[24]GAO-04-408T.

Figure 3: Elements of Desirable Characteristics Not Included in the Department of Defense Industrial Base Strategy

Desirable characteristics for a national strategy	Elements addressed	Elements not addressed
 **The purpose of the strategy, and the scope and methodology used**	• Purpose • Scope • Methodology	None
 **The problems the strategy intends to address and an assessment of threats and vulnerabilities**	• Problems • Risk assessment	None
 **The goals of the strategy, priorities, milestones, and performance measures to gauge results**	• Some goals • Some milestones • Priorities	• All strategy goals • All milestones • Performance measures
 **Resources and investments needed and where they should be targeted**	• Potential resources and investments needed for some industrial base sectors • Where some resources should be targeted	• Sources and types of resources and investments needed for all efforts, including an overall cost estimate • Where all resources should be targeted
 **Roles of organizations responsible for implementing the strategy and how they will coordinate efforts**	• General description of organizations that are implementing the strategy, their roles, and mechanisms for coordinating efforts	• Information on which organizations are responsible for mitigating specific risks
 **Relationship and integration of the strategy to other strategies (relevant documents), and implementation plans**	• How the strategy relates to other strategies	• Implementation plans

Source: GAO-04-408T and GAO analysis of Department of Defense documents. | GAO-22-104154

DOD's 2018 assessment—in response to Executive Order 13806——was the primary document that addressed most of the elements DOD included in its strategy. For example, the 2018 assessment fully addressed two characteristics by (1) describing DOD's approach for evaluating and categorizing risks, and (2) identifying nearly 300 risks in its 16 industrial base sectors, including 35 priority risks.[25] The assessment also identified

[25]According to Industrial Base Policy officials, priority risks evolve over time, and some of the 35 risks identified in the 13806 report may have been mitigated and are no longer a priority.

the key organizations that oversee risk mitigation efforts, which partially addressed another desirable characteristic.

The content of the other three documents provided limited additional information that would address the elements of a national strategy. For example:

- The Combined Resource and Policy Strategy provides an overview of the key organizations that oversee risk mitigation efforts and how they are to coordinate with each other.
- The Unfunded Priorities report identified the unfunded projects and investments needed in the defense sectors to address some priority risk areas as of September 2020. This report listed a number of unfunded, high priority items identified because of the COVID-19 pandemic. For strategic planning purposes, this type of information would be useful when combined with other resource data to determine total resource needs.
- The Fiscal Year 2020 annual Industrial Capabilities Report provides examples of mitigation efforts DOD is pursuing to address supply chain gaps and vulnerabilities. It also identified the key organizations that oversee risk mitigation efforts.

The documents collectively do not include other elements that are key to developing a comprehensive strategy, such as identifying

- implementation plans that provide specific details to guide efforts;
- performance measures to gauge progress and results;
- the overall resources required to mitigate the risks and where to target them; and
- the organizations responsible for leading each mitigation effort.

Moreover, since the strategy is dispersed among several documents instead of consolidated in one, its effectiveness as a planning tool for implementing organizations and for informing Congress about the pace, costs, and intended results of risk mitigation efforts is limited.

DOD is required to submit a defense industrial base strategy within 180 days after the date of submission of the National Security Strategy Report, which is required under section 108 of the National Security Act

of 1947 and is expected to be issued later in 2022.[26] In its March 2021 report to Congress, DOD stated that its next strategy would be included in a consolidated document. However, in April 2022, an Industrial Base Policy official told us that it was too soon to determine if the department would develop a consolidated strategy or continue to rely on multiple documents. Further, the Industrial Base Policy office had not determined what information the next strategy will contain; therefore, it is too early to tell if all elements of the desirable characteristics that we identified will be included.

By including all elements of the desirable characteristics—the purpose, risks, milestones, performance measures, required resources, responsible organizations, and implementation plan for mitigating industrial base risks—in a consolidated strategy, DOD could better ensure the likelihood of successful implementation. Without including comprehensive information in a consolidated document, DOD cannot ensure that all appropriate DOD organizations are working toward the same priorities, promoting supply chain resiliency, and supporting national security objectives.

Industrial Base Policy Office Identified Resource Challenges and Experienced Leadership Turnover

According to Industrial Base Policy officials, DOD did not develop a consolidated strategy because it prioritized its resources on completing other efforts—such as the 2018 and 2022 assessments and annual Industrial Capabilities Reports—and supporting the procurement of medical supplies for the COVID-19 pandemic. The office also experienced significant turnover of senior leadership.

Industrial Base Policy officials stated that the office has insufficient resources to handle and oversee all assigned responsibilities in a timely manner. Officials stated that as a result, the office is behind schedule in developing the Section 845 analytical framework and implementation plan that was due in March 2020. Although the office can contract for short-term support services based on its budget allocation, an Industrial Base Policy official said its current workforce, which included 51 government employees and 148 contractors as of March 2022, is not enough to keep up with the growing workload. The official also stated that high levels of senior leadership turnover also resulted in constantly shifting priorities and resources for the office. For example, the official stated that there has been considerable turnover in the Deputy Assistant Secretary of Defense

[26]10 U.S.C. § 4811.

position, as nine officials held that senior leadership position between 2018 and 2022.

Recent legislation created the position of the Assistant Secretary of Defense for Industrial Base Policy, which will replace the position of the Deputy Assistant Secretary of Defense for Industrial Policy.[27] Conferees to the legislation noted that the newly created office was intended to help DOD with the significantly increasing workload of the office due to the pandemic and associated efforts to support the defense industrial base and expand its industrial capacity, among other things. Industrial Base Policy officials stated that elevating the position will help prioritize industrial base issues within the department and provide much needed stability in the position. Further, officials said the elevated position may also help the office compete internally for additional resources. As DOD works through its challenges and assumes new leadership, it will be important for the department to have a consolidated and comprehensive strategy to guide its risk mitigation efforts now and in the future.

DOD Has Limited Insight into Its Progress Mitigating Industrial Base Risks

Various DOD organizations monitor the results of individual risk mitigation efforts they fund, but the Office of Industrial Base Policy and the military services do not have performance measures that would allow them to monitor the aggregate effectiveness of the billions of dollars spent on these mitigation efforts. This shortfall in enterprise-wide monitoring, in turn, has limited DOD's ability to report on its progress toward mitigating industrial base risks.

DOD Does Not Monitor the Aggregate Effectiveness of Its Efforts to Mitigate Risks

DOD has limited enterprise-wide insight into its progress addressing industrial base risks because it does not monitor the aggregate effectiveness of numerous, ongoing risk mitigation efforts. Instead, Industrial Base Policy and military service officials stated that lower-level organizations, such as systems commands, program offices, and DOD-wide investment programs, monitor their individual mitigation efforts to determine if they have been completed and achieved intended outcomes. For example, these organizations may monitor the qualification of new suppliers for projects mitigating sole-source risks, the installation of new equipment and production lines for projects mitigating domestic production constraints, or the creation of training programs for projects mitigating workforce risks.

[27]William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. No. 116-283, § 903 (2021).

The charter for DOD's Industrial Base Council states that the Industrial Base Policy office, the military services, and other stakeholder organizations are responsible for monitoring industrial base risk mitigation efforts carried out across the DOD enterprise and providing aggregate assessments of the industrial base. According to DOD officials, within this context, the military services are responsible for mitigating and monitoring the industrial base risks within their respective service enterprises. They then work with the Industrial Base Policy office and other stakeholders to mitigate risks that extend across the DOD enterprise or require substantial funding to address.

However, Industrial Base Policy officials stated that their office does not currently monitor how much progress, if any, has been made in addressing industrial base risks across the department as risk mitigation efforts are carried out. Army, Air Force, Navy, and Marine Corps officials similarly stated that they do not monitor service-wide progress in addressing their respective industrial base risks. These officials indicated that monitoring information currently available within their military service does not provide them with robust information about how their service-wide risks changed over time based on their mitigation efforts.

In our prior work, we found that when agencies conduct enterprise risk management activities such as these, they should monitor how risks change and if risk mitigation efforts are successful.[28] To do so effectively, we found it is a good practice for agencies to establish enterprise-wide performance measures that indicate the aggregate effect of mitigation efforts and any corresponding progress in addressing risks. Agencies can then determine if they successfully addressed risks or if additional mitigation efforts are necessary.

We found that the Industrial Base Policy office and the military services are not able to conduct enterprise-wide monitoring because they have not established performance measures against which the aggregate effectiveness of implemented mitigation efforts can be assessed. In particular, Industrial Base Policy officials stated that their office does not have DOD-wide performance measures that they can use to monitor progress in addressing industrial base risks across the department as mitigation efforts are carried out. Officials from the Air Force, Army, Navy, and Marine Corps similarly stated that they do not have service-wide performance measures against which they can monitor progress in addressing their military service's respective risks. Figure 4 describes

[28]GAO-17-63.

examples of gaps in enterprise-wide monitoring that have limited DOD's insights into the effectiveness of billions of dollars spent on mitigation efforts.

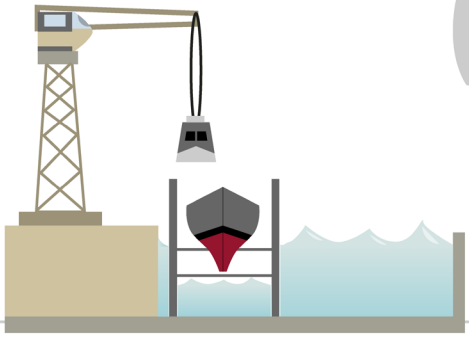
Figure 4: Examples of Department of Defense (DOD) Risk Mitigation Efforts and Monitoring Gaps, Fiscal Years 2018-2022

Shipbuilding sector

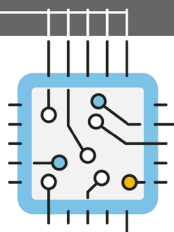
The Navy and other DOD organizations have implemented numerous mitigation efforts to help address risks in the shipbuilding sector, For example,

- → Submarine and destroyer programs have budgeted nearly $900 million and $130 million, respectively, to address existing suppliers' capacity and workforce risks and to develop additional supply sources.
- → DOD reported using $236 million in CARES Act Defense Production Act Title III funding to address fragile Navy suppliers' financial risks, which were exacerbated by the COVID-19 pandemic.
- → DOD officials reported that the Navy has used $28 million in Industrial Base Analysis and Sustainment Program funding to develop training partnership programs since 2019 to address workforce risks.

In fiscal years 2019 and 2020, DOD started describing the risks in the shipbuilding sector as remaining "stable" or "steady," although it did not describe how it made this determination. According to Navy officials, their military service does not have enterprise-wide performance measures to monitor progress in addressing risks.



Microelectronics sector

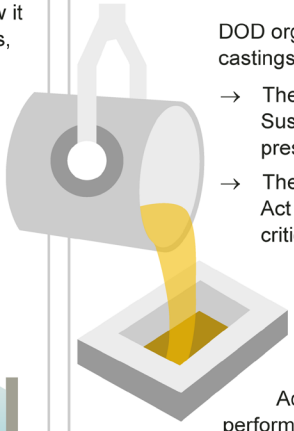


Various DOD organizations have implemented efforts on their own and in coordination with other federal agencies to mitigate microelectronics sector risks. For example,

- → DOD reported using $125 million in Defense Production Act Title III funding since fiscal year 2021 to sustain a domestic microelectronics manufacturer.
- → In fiscal year 2022, the Air Force reported using $885 million to make a lifetime buy of certain microelectronics components because manufacturing lines were closing.
- → DOD is coordinating with the Department of Commerce and other federal agencies to implement government-wide efforts—potentially costing up to $52 billion—to incentivize domestic production of semiconductors for microelectronics.

According to DOD officials, DOD does not have enterprise-wide performance measures to monitor progress in addressing risks.

Castings and forging supply chain



DOD organizations have implemented efforts to mitigate risks in the castings and forgings supply chain.[a] For example,

- → The Navy reported working with the Industrial Base Analysis and Sustainment program in fiscal year 2018 to invest $5.5 million to preserve casting capabilities at a key shipbuilding supplier.
- → The Army reported using $15.7 million from the Defense Production Act Title III program to modernize the production capabilities of a critical castings supplier in fiscal year 2019.

In 2021, the Industrial Base Policy office identified this supply chain as a DOD-wide priority focus area after determining that several organizations across DOD were experiencing similar risks and needed to coordinate their mitigation efforts.

According to DOD officials, DOD does not have enterprise-wide performance measures to monitor progress in addressing risks.

Source: GAO analysis of Department of Defense information. | GAO-22-104154

[a]Cast and forged parts are metal parts used in the development, procurement and sustainment of all major defense systems, such as ships, aircraft, ground combat vehicles, missiles, guns, and ammunition. Casting is the process used to create complex parts by pouring molten or high-temperature metal or composites into a mold. Forging is the process used to develop metal parts by pounding, pressing, or squeezing metals under great pressure.

Officials from the Industrial Base Policy office and the military services generally recognize the need to improve enterprise-wide monitoring of DOD's progress in mitigating risks, and they identified new initiatives that may help their monitoring efforts going forward. For example, the Navy created a Shipbuilding Industrial Base Task Force in 2020, in part to coordinate mitigation efforts across the Navy's shipbuilding enterprise. DOD also created a Defense Microelectronics Cross-Functional Team and a castings and forgings working group in 2021 to coordinate numerous efforts in those supply chains. DOD officials stated that all of these groups are attempting to improve enterprise-wide management of industrial base risks in their areas of responsibility, but it is too soon to determine what changes will be made to DOD's monitoring practices in those areas.

Officials from Industrial Base Policy and each military service also stated that there are initiatives to improve DOD's industrial base data. Officials said such data initiatives are needed because neither Industrial Base Policy nor the military services have centralized databases to collect, integrate, and share data on defense industrial base risks and mitigation efforts. As a result, officials stated that they have not been able to efficiently access and integrate all of the data they would need for enterprise-wide monitoring efforts. Examples of ongoing data initiatives include:

- The Industrial Base Policy office is leading a Supply Chain Resiliency Working Group to catalog available DOD industrial base data, identify data gaps, standardize data collection, and develop proposals to integrate disparate data sources into a centralized database.
- Air Force officials stated they are developing a new industrial base risk register that would integrate information on supply chain vendors, risks, and mitigation efforts from several existing data sources. According to Air Force officials, their goal is to better identify industrial base risks that affect multiple Air Force acquisition programs and share information about ongoing mitigation efforts across their military service.

We reported on previous DOD attempts to create a centralized industrial base database and identified its challenges to doing so, such as workforce issues and integrating disparate data sources. We made two recommendations to improve DOD's industrial base data efforts, one of

which DOD is still working to implement.[29] According to Industrial Base Policy and military service officials, their data initiatives continue to face a number challenges, which they said need to be addressed in order to successfully implement them. For example, officials stated that they need to secure funding for these efforts, gain access to disparate data sources, standardize the data, and ensure their workforce is able to access and analyze the data, among other things. Given these challenges, officials noted that it could take several years to improve DOD's industrial base data.

DOD's efforts to create working groups and improve its industrial base data, however, will not be enough to enable the department to monitor its progress in mitigating industrial base risks. Until the Industrial Base Policy office and the military services establish performance measures to monitor the aggregate effectiveness of implemented risk mitigation efforts, they will continue to have limited insight into DOD's progress in mitigating industrial base risks. Further, DOD will continue to be at risk of investing billions of dollars in risk mitigation efforts without an accurate understanding of whether these investments successfully addressed risks or what additional actions and resources may be needed.

Annual Industrial Capabilities Reports Do Not Identify DOD's Progress in Mitigating Industrial Base Risks

DOD issues annual Industrial Capabilities Reports on the defense industrial base, but the reports do not include DOD's progress in mitigating its industrial base risks. DOD is required to annually provide Congress a summary of its recent industrial base assessments and risks, and describe necessary mitigation efforts, among other things.[30] According to DOD officials, these reports are DOD's primary department-wide reporting tool for spotlighting industrial base risks and the mitigation efforts for addressing risks.

We reviewed DOD's annual Industrial Capabilities Reports for fiscal years 2018 through 2020 and found that each report contained over 100 pages of information. For example, the reports included summary assessments

[29]GAO, *Defense Industrial Base: Integrating Existing Supplier Data and Addressing Workforce Challenges Could Improve Risk Analysis*, GAO-18-435 (Washington, D.C.: June 13, 2018). In our 2018 report, we made two recommendations to DOD to: (1) determine a solution to make better use of existing lower-tier supplier information from program offices, and (2) identify the appropriate workforce mix with the requisite skills and capabilities needed to collect and analyze business-sensitive proprietary data. As of April 2022, DOD has taken action to implement the second recommendation, but has not yet implemented the first recommendation. We are continuing to monitor DOD's efforts to address our recommendation.

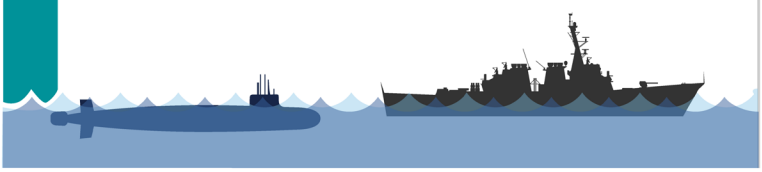
[30]10 U.S.C. § 4814.

of defense industrial base sectors, examples of mitigation efforts, and projects funded by DOD-wide investment programs. We also found that generally the focus of the annual reports changed over time. For example, the fiscal years 2018 and 2019 annual reports included the status of some mitigation efforts identified in DOD's 2018 assessment. The fiscal year 2020 report shifted to discussing new assessments prompted by the COVID-19 pandemic. Industrial Base Policy officials said the focus of the fiscal year 2021 report will shift to highlighting information on the five supply chains identified in DOD's 2022 assessment of industrial base risks and a few other selected supply chains.

As part of our analysis, we examined information included in the fiscal years 2018 to 2020 Industrial Capabilities Reports about microelectronics and shipbuilding—sectors that DOD identified as priority areas—to assess the extent to which DOD reported on its progress for mitigating risks in these sectors. In both cases, DOD did not report on the status of most mitigation efforts or the extent to which sector risks were mitigated over this period. Figure 5 provides additional details of our analysis.

Figure 5: Selected Examples of Risk Mitigation Information in the Department of Defense's (DOD) Annual Industrial Capabilities Reports, Fiscal Years 2018-2020

	Navy Shipbuilding	Microelectronics
Risks	The annual reports consistently identified: **(1)** dependency on single- and sole-source suppliers; **(2)** capacity shortfall; **(3)** lack of competition; **(4)** lack of skilled workforce; **(5)** unstable demand; and **(6)** fragile market as risks in the shipbuilding sector, which includes both contractor-owned new construction shipyards and Navy-owned repair shipyards.	The annual reports consistently identified: **(1)** fragile market; **(2)** capacity-constrained supply market; **(3)** foreign dependency; **(4)** diminishing manufacturing sources and material shortages; **(5)** erosion of U.S.-based infrastructure; and **(6)** product security as risks. Dependency on sole-source suppliers, lack of skilled workforce, and the COVID-19 pandemic were also identified as risks in the microelectronics sector in some, but not all of the reports.
Mitigation efforts	Overall, DOD identified 30 total efforts intended to address shipbuilding risks in the fiscal years 2018 to 2020 reports. Of these, two efforts were mentioned in all three annual reports, 10 efforts were mentioned in two reports, and 18 were mentioned in one report. The reports clearly identified at least six shipbuilding projects that had been completed, but did not identify the extent to which risks had been addressed on an aggregate level. The reports did not indicate if other projects had been completed or what, if any, risks had been mitigated from one year to the next.	Overall, DOD identified 55 total efforts intended to address microelectronics risks in the fiscal years 2018 to 2020 reports. Of these, four efforts were mentioned in all three annual reports, 17 efforts were mentioned in two reports, and 34 were mentioned in one report. The reports clearly identified at least seven microelectronics projects that had been completed, but did not identify the extent to which risks had been addressed on an aggregate level. The reports did not indicate if other projects had been completed or what, if any, risks had been mitigated from one year to the next.
Examples	A $5.5 million project funded by the Industrial Base Analysis and Sustainment program to maintain and protect domestic production of Navy submarine and surface ship propulsors was described as an accomplished effort in the fiscal year 2019 report. However, the report did not communicate the effectiveness of the effort at an enterprise level or what, if any, additional actions might be needed to address risks in the sector. The Navy's Shipyard Infrastructure Optimization Program—a $21 billion program that began in 2018—was identified in the fiscal year 2019 report as an important effort to revitalize four public shipyards. This ongoing program aims to restore outdated facilities, such as its dry docks and reduce total personnel and material travel and movement. The fiscal year 2020 report did not mention the program though it is still ongoing. The Navy anticipates receiving $625 million for this program in fiscal year 2022, highlighting the importance of providing annual status updates.	A $21.9 million project funded by the Defense Production Act Title III program to scale up production of a nano-sized material that can enhance the performance of polymers for a variety of applications, such as radiation shielding and coatings for space-survivable microelectronics, was described as a completed effort in the fiscal year 2018 report. However, the report did not communicate the effectiveness of the effort at an enterprise level or what, if any, additional actions might be needed to sufficiently address the risks within the sector. The Air Force indicated in the fiscal year 2020 report that it had assessed the semiconductor ecosystem and value chain and that its findings would be used to advise DOD and the whole-of-government on activities in the sector. The assessment indicated that DOD would develop and implement an action plan pursuing "low hanging fruit," but did not clarify what specific mitigation efforts it would take. Further, as one of two sectors prioritized to reshore the defense industrial base, the report did not state how much risk DOD can mitigate by following a low hanging fruit approach.



Source: GAO analysis of the Department of Defense's Fiscal Year 2018-2020 Industrial Capabilities Reports. | GAO-22-104154

Our prior work on enterprise risk management establishes that when agencies communicate risks with internal and external stakeholders and incorporate their feedback, they are better able to identify and manage risks.[31] Reporting information on results informs stakeholders about the status of identified risks and the progress of associated mitigation efforts. It also assures them that agency leaders are managing the risks effectively. Further, agencies increase transparency and accountability to Congress and taxpayers regarding their actions. Our past work also found it is a good practice for agencies to communicate risk information through a dedicated risk management report, such as the annual Industrial Capabilities Report used by DOD. However, as described in figure 5, DOD has not consistently communicated information about its progress in mitigating risks in its annual Industrial Capabilities Reports.

According to Industrial Base Policy officials, DOD has not included information about its progress in mitigating risks in the annual Industrial Capabilities Reports for a few reasons. First, they stated that because the reports are publicly available, DOD is limited in the amount of detail it can report on sensitive mitigation efforts or multiyear progress. However, GAO's enterprise risk management framework takes into consideration increased concerns about sharing sensitive information or risk responses. Specifically, agencies can alleviate concerns by establishing safeguards, such as communicating information only to appropriate parties, encrypting data, authorizing users' levels of rights and privileges, and providing information on a need-to-know basis. For example, DOD previously used non-publicly available appendixes in the annual Industrial Capabilities Reports to provide Congress additional sensitive information related to projects funded by DOD-wide investment programs and assessments by various DOD organizations.

Second, officials said that DOD does not currently have the information it needs to report on its progress in mitigating industrial base risks. As discussed earlier, Industrial Base Policy and the military services do not have performance measures to help them monitor the aggregate effect of mitigation efforts carried out across DOD. Air Force officials described the information in the annual reports as qualitative assessments based on professional judgement instead of measurable quantitative metrics. Industrial Base Policy officials stated that they develop the annual Industrial Capabilities Reports by compiling information from various DOD

[31]GAO-17-63.

organizations, but do not analyze the information on an aggregate level to communicate DOD's progress in mitigating risks.

Industrial Base Policy officials stated that they plan to improve the usefulness of the department's annual reports by identifying specific and actionable recommendations to address its industrial base risks. However, these officials told us they have yet to determine whether DOD would provide updates on the implementation of such recommendations in its future reports. Until DOD ensures its industrial base reports communicate its progress in mitigating industrial base risks, Congress and DOD will continue to have incomplete information about the extent to which defense industrial base risks have been mitigated and what additional actions or resources may be needed to better manage risks.

Conclusions

DOD recognizes the importance of maintaining a healthy industrial base to support U.S. national security goals and is well versed at identifying risks. However, the Industrial Base Policy office has struggled to provide the leadership and strategic vision needed to mitigate risks, some of which have been known for decades, such as in the shipbuilding and microelectronics sectors. DOD's current industrial base strategy, spread out over four different reports, does not contain some desirable characteristics that our prior work shows are essential for guiding the investment of billions of dollars to mitigate risks, including an implementation plan. By addressing in a single document all desirable characteristics of a national strategy—the purpose, risks, milestones, performance measures, required resources, responsible organizations, and implementation plan for mitigating risks—DOD can better ensure its organizations are working toward the same priorities, promoting supply chain resiliency, and ensuring the industrial base supports national security objectives.

Congress and other stakeholders have limited insight on how effectively DOD used the billions of dollars it spent on risk mitigation efforts since fiscal year 2018. This is because the Industrial Base Policy office and the military services have not developed performance measures to gauge their enterprise-wide progress or consistently reported on DOD's efforts through the annual Industrial Capabilities Report. DOD acknowledged these shortcomings and is working on ways to consolidate available data in its various information systems that could facilitate better monitoring and reporting. Such data efforts could be helpful but are years away from completion. Until DOD makes improvements to its monitoring and reporting practices, it will continue to be at risk of investing billions of dollars in mitigation efforts without an accurate understanding of how

successful these efforts are in addressing industrial base risks or what additional actions and resources may be needed.

Recommendations for Executive Action

We are making the following six recommendations to DOD:

The Secretary of Defense should ensure that the National Technology and Industrial Base strategy is in a consolidated document and comprehensive, such as by including required resources and an implementation plan. (Recommendation 1)

The Secretary of Defense should ensure that the Assistant Secretary of Defense for Industrial Base Policy, in coordination with the Industrial Base Council, develops and uses performance measures to monitor the aggregate effectiveness of mitigation efforts for DOD-wide industrial base risks. (Recommendation 2)

The Secretary of the Air Force should ensure that the Assistant Secretary of the Air Force for Acquisition, Technology and Logistics develops and uses performance measures to monitor the aggregate effectiveness of mitigation efforts for Air Force and Space Force industrial base risks. (Recommendation 3)

The Secretary of the Army should ensure that the Assistant Secretary of the Army for Acquisition, Logistics, and Technology develops and uses performance measures to monitor the aggregate effectiveness of mitigation efforts for Army industrial base risks. (Recommendation 4)

The Secretary of the Navy should ensure that the Assistant Secretary of the Navy for Research, Development, and Acquisition develops and uses performance measures to monitor the aggregate effectiveness of mitigation efforts for Navy and Marine Corps industrial base risks. (Recommendation 5)

The Secretary of Defense should ensure that DOD reports its progress toward mitigating industrial base risks. For example, this information could be included in DOD's annual Industrial Capabilities Reports, which already include sector risk assessments. (Recommendation 6)

Agency Comments

We provided DOD a draft of this product for review and comment. In its written comments, reproduced in appendix II, DOD and the military services concurred with five recommendations. DOD stated that it is aware of the need for performance measures to monitor the aggregate effectiveness of mitigation efforts for DOD-wide industrial base risks and

that it is actively developing metrics aligned to the five focus areas in the Executive Order 14017 report. The Navy also stated that it is working to establish measures to track industrial base supply efforts within the military service. Further, DOD plans to identify the best way to report progress based on the metrics and performance measures.

DOD partially concurred with recommendation 1. DOD stated that it agrees with the importance of a comprehensive National Technology and Industrial Base strategy that includes (among other things) resourcing and an implementation plan. With the reorganization of Industrial Base Policy, DOD also plans for more routine and consolidated reports to streamline responses to existing reporting requirements. Particularly, DOD stated that it will evaluate ways to streamline similar reports that cover aspects of the National Technology and Industrial Base strategy into other industrial base analytical products for a cohesive picture of the problem and strategy. DOD noted, however, that a separate strategy document is not necessary as information is already provided in other existing required reports and would unnecessarily divert limited resources. As DOD works to make its strategy more comprehensive and cohesive, we will monitor its efforts to implement the recommendation.

We are sending copies of this report to the appropriate congressional committees and the Secretary of Defense, Secretaries of the Air Force, Army, and Navy as well as Assistant Secretary of Defense for Industrial Base Policy. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-4841 or russellw@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made key contributions to this report are listed in appendix III.

W. William Russell
Director, Contracting and National Security Acquisitions

List of Committees

The Honorable Jack Reed
Chairman
The Honorable James M. Inhofe
Ranking Member
Committee on Armed Services
United States Senate

The Honorable Jon Tester
Chair
The Honorable Richard Shelby
Ranking Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Adam Smith
Chairman
The Honorable Mike Rogers
Ranking Member
Committee on Armed Services
House of Representatives

The Honorable Betty McCollum
Chair
The Honorable Ken Calvert
Ranking Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

Appendix I: Objectives, Scope, and Methodology

The National Defense Authorization Act for Fiscal Year 2020 included a provision that directed GAO to review the Department of Defense's (DOD) efforts to establish an analytical framework for defense industrial base risk mitigation across the acquisition process. At the time of this review, DOD had not issued this analytical framework. This review assesses: (1) DOD's strategy for mitigating defense industrial base risks, and (2) the extent to which DOD is monitoring and reporting on its progress in mitigating risks.

To address both of these objectives, we collected information on DOD's defense industrial base risks, and the general process for identifying, prioritizing, and mitigating risks. In support of this effort, we reviewed key DOD industrial base assessments and reports issued since fiscal year 2018, including annual Industrial Capabilities Reports and DOD's reports in response to Executive Order 13806 (*Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States*) and Executive Order 14017 (*America's Supply Chains*).

We also conducted interviews with officials across DOD who have a role in managing and mitigating defense industrial base risks. This included officials from the Office of Industrial Base Policy; the military services (Air Force, Army, Navy, and Marine Corps); the DOD-wide industrial base investment programs (Defense Production Act Title III program, Industrial Base Analysis and Sustainment program, and Manufacturing and Technology program); and other stakeholder organizations.

To assess DOD's strategy for mitigating defense industrial base risks, we reviewed four documents that DOD identified as its defense industrial base strategy in a March 2021 report to Congress. The reports and industrial base assessments include:

- Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States: Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806 (September 2018);
- Combined Resource and Policy Strategy to Address U.S. Defense Industrial Base Vulnerabilities (July 2020);
- Report on the Unfunded Priorities of the National Technology and Industrial Base (September 2020); and
- The Fiscal Year 2020 Industrial Capabilities Report to Congress (January 2021).

We analyzed the four documents as DOD's strategy and compared them to the desirable characteristics of effective national strategies that we previously reported that agencies should consider in their strategic plans. The previous report identified examples of elements that comprise these desirable characteristics to aid responsible parties in further developing and implementing the strategies—and to enhance their usefulness in resource and policy decisions and to better assure accountability. For our purposes, we reviewed and adapted elements that were relevant to our assessment of DOD's risk mitigation strategy. Table 3 describes the desirable characteristics and the elements we used in our review.

Table 3: Six Desirable Characteristics of Effective National Strategies

Desirable Characteristic	Brief description	Elements
Purpose, scope, and methodology	Addresses why the strategy was produced, the scope of its coverage, and the process by which it was developed.	• Statement of broad or narrow purpose, as appropriate. • What major functions, mission areas, or activities it covers. • Impetus for strategy, e.g., statutory requirement or event. • Process to produce strategy.
Problem definition and risk assessment	Addresses the particular national problems and threats the strategy is directed toward.	• Discussion or definition of problems, their causes, and operating environment. • Risk assessment, including an analysis of threats and vulnerabilities.
Goals, subordinate objectives, activities, and performance measures	Addresses what the strategy is trying to achieve, steps to achieve those results, as well as the priorities, milestones, and performance measures to gauge results.	• Overall results desired, i.e., end-state. • Priorities, milestones, and outcome-related performance measures.
Resources, investments, and risk management	Addresses what the strategy will cost, the sources and types of resources and investments needed, and where resources and investments should be targeted based on balancing risk reductions with costs.	• Resources and investments associated with the strategy. • Types of resources required.
Organizational roles, responsibilities, and coordination	Addresses who will be implementing the strategy, what their roles will be compared to others, and mechanisms for them to coordinate their efforts.	• Roles and responsibilities of specific federal agencies, departments, or offices. • Lead, support, and partner roles and responsibilities. • Specific processes for coordination and collaboration.
Integration and implementation	Addresses how a national strategy relates to other strategies' goals, objectives, and activities, and to subordinate levels of government and their plans to implement the strategy.	• Integration with relevant documents from implementing organizations (vertical). • Implementation guidance.

Source: GAO-04-408T. | GAO-22-104154

We developed a summary analysis of the DOD documents to identify which elements of the characteristics the documents addressed or did not address. We also reviewed recent key legislation, statutes, and presidential directives related to mitigating defense industrial base risks.

In addition, we interviewed Industrial Base Policy officials on the challenges they experienced when developing the strategy and DOD's plans for developing a new strategy. DOD is required to submit a new strategy within 180 days after the date of submission of the national security strategy report, which is required under section 108 of the National Security Act of 1947 and is expected to be issued later in 2022.

To assess the extent to which DOD's monitoring practices provide insight into its progress addressing industrial base risks, we reviewed DOD policy, guidance, and charters to identify what requirements, if any, exist for DOD organizations to monitor the outcomes and effectiveness of risk mitigation efforts. For example, we reviewed the Industrial Base Council Charter to determine the role of the Office of Industrial Base Policy, the military services, and other stakeholders in monitoring industrial base risks and mitigation efforts across the DOD enterprise. We also reviewed DOD and military service policies for acquisition management and industrial base assessments to determine which officials have a role in monitoring industrial base risks and how such monitoring efforts are incorporated in the acquisition process, if at all. Additionally, we reviewed guidance for the DOD-wide industrial base investment programs and reviewed examples of project documentation from fiscal years 2018 to 2021 to identify how the programs monitor the outcomes of their projects.

To further understand how DOD officials monitor progress addressing industrial base risks, we interviewed officials from the Office of Industrial Base Policy, the military services, and the DOD-wide industrial base investment programs. Through these interviews, we collected information about current enterprise-wide (i.e., DOD-wide or service-wide) monitoring tools and processes, efforts to monitor the outcomes of individual mitigation efforts, and the use of performance indicators to facilitate monitoring. In addition, we identified examples of risk mitigation measures from fiscal years 2018 to 2021 in DOD's annual Industrial Capabilities Reports and budget documents and discussed with DOD officials the extent to which current monitoring practices provide insight into the effectiveness of such efforts. We also discussed new DOD initiatives to improve monitoring of industrial base risk mitigation efforts and any challenges that could impede the implementation of these new efforts. Finally, to determine the extent to which DOD's approach to monitoring

risk mitigation efforts reflects good practices, we compared DOD's monitoring practices to GAO's framework for enterprise risk management.[1]

To assess the extent to which DOD's reporting provides insight into its progress addressing industrial base risks, we reviewed DOD's annual Industrial Capabilities Reports for fiscal years 2018 through 2020 and the statute governing these reports.[2] According to Industrial Base Policy officials, the annual reports are DOD's primary mechanism for communicating industrial base risks.[3] We selected two industrial base sectors included in these reports—shipbuilding and microelectronics—as case studies for detailed analysis. We selected these specific sectors as case studies based on their identification by DOD in the fiscal year 2020 Industrial Capabilities Report as two priority areas in its efforts to reshore the defense industrial base and defense supply chains to the U.S. and its allies. These case studies provide illustrative examples of DOD's reporting on progress in addressing industrial base risks and are not generalizable to all sectors.

We analyzed the reports to determine the extent to which DOD identified priority risks in these sectors, proposed risk mitigation efforts, and described the status of these efforts and their effectiveness in mitigating risks over time.

We also interviewed officials from the Office of Industrial Base Policy, the military services, DOD-wide industrial base investment programs, and other DOD organizations, including the Shipbuilding Industrial Base Task Force and the Defense Microelectronics Cross-Functional Team. Through these interviews, we collected and analyzed information on DOD's current reporting practices, including which DOD organizations contribute to the annual Industrial Capabilities Reports and the type of information included in the reports. We also discussed new DOD initiatives to improve reporting of industrial base risk mitigation efforts, including proposals to change the formatting and content of the annual Industrial Capabilities Report to improve transparency, traceability, and utility. Finally, to determine the extent to which DOD's approach to risk mitigation reporting

[1]GAO, *Enterprise Risk Management: Selected Agencies' Experiences Illustrate Good Practices in Managing Risks,* GAO-17-63 (Washington, D.C.: Dec. 1, 2016).

[2]Formerly cited as 10 U.S.C. § 2504, now found at 10 U.S.C. § 4814.

[3]At the time of this review, DOD's Fiscal Year 2021 annual Industrial Capabilities Report had not been issued.

reflects good practices for enterprise risks management, we compared DOD's reporting practices to GAO's framework for enterprise risk management.

We conducted this performance audit from March 2020 to July 2022 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Appendix II: Comments from the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

Mr. W. William Russell
Director, Contracting and National Security Acquisitions
U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

Dear Mr. Russell:

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) Draft Report GAO-22-104154, "Defense Industrial Base: DOD Should Take Actions to Strengthen Its Risk Mitigation Approach," dated May 12, 2022 (GAO Code 104154).

The Department is providing the enclosed official written comments for inclusion in the report. DoD partially concurs with Recommendation 1 and concurs with Recommendations 2 and 6. The Departments of the Air Force, Army, and Navy concur with Recommendations 3, 4, and 5 respectively.

Sincerely,

NAJIEB-LOCKE.HALIMAH.A.1598514581
Digitally signed by NAJIEB-LOCKE.HALIMAH.A.1598514581
Date: 2022.06.22 11:10:46 -04'00'

Halimah Najieb-Locke
Deputy Assistant Secretary of Defense for
Industrial Base Resilience

Enclosure:
As stated

GAO DRAFT REPORT DATED MAY 12, 2022
GAO-22-104154 (GAO CODE 104154)

"DEFENSE INDUSTRIAL BASE: DOD Should Take Actions to Strengthen Its Risk Mitigation Approach"

DEPARTMENT OF DEFENSE COMMENTS TO THE GAO RECOMMENDATIONS

RECOMMENDATION 1: The Secretary of Defense should ensure that the National Technology and Industrial Base strategy is in a consolidated document and comprehensive, such as including required resources and an implementation plan.

DoD RESPONSE: Partially concur.

DoD agrees with the importance of a comprehensive National Technology and Industrial Base (NTIB) strategy that includes (among other things) resourcing and an implementation plan. However, the Department does not believe it necessary to present that strategy in a separate document from our existing required reports. Every year, DoD responds to overlapping reporting requirements on the NTIB from the White House, Congress, and elsewhere, and those responses collectively and effectively outline the strategy. With the reorganization of Industrial Base Policy we are strengthening our analytical capabilities by expanding the analytic office, which will allow for more routine and consolidated reports to streamline responses to existing reporting requirements

In particular, the Executive Order (E.O.) one-year report, Securing Defense-Critical Supply Chains (released in February 2022) and the annual Industrial Capabilities Report (expected to be released in the summer of 2022) show our steps toward streamlining as together they present a cohesive, flexible, and responsive strategy to the constantly changing supply chain problem. The two reports describe the challenges in key sectors, offer strategic recommendations for mitigating those challenges, and provide a roadmap for implementing and tracking progress in building resilience in those areas. They examine the problem broadly and comprehensively, and they recommend solutions that are being implemented in coordination with U.S. Government, industrial, and international partners.

Similar reports cover other aspects of the Department's NTIB strategy and we will evaluate ways to streamline this information into other industrial base analytical products for a cohesive picture of the problem and strategy. DoD therefore believes that a separate NTIB strategy document would be duplicative and that the effort required to develop one would unnecessarily divert limited resources.

RECOMMENDATION 2: The Secretary of Defense should ensure that the Assistant Secretary of Defense for Industrial Base Policy, in coordination with the Industrial Base Council, develops and uses performance measures to monitor the aggregate effectiveness of mitigation efforts for DOD-wide industrial base risk.

DoD RESPONSE: Concur. DoD is aware of the need for performance measures to monitor the aggregate effectiveness of mitigation efforts for DOD-wide industrial base risk. The E.O. 14017 report calls for improved internal supply chain visibility and data analysis. DoD is actively developing metrics aligned to the five focus areas in E.O. 14017 that will measure efforts to mitigate supply chain risk. DoD will continue to create and monitor these metrics to assess mitigation efforts over time.

RECOMMENDATION 3: The Secretary of the Air Force should ensure that the Assistant Secretary of the Air Force for Acquisition, Technology and Logistics develops and uses performance measures to monitor the aggregate effectiveness of mitigation efforts for the Air Force and Space Force industrial base risks.

DoD RESPONSE: The Department of the Air Force concurs without comment.

RECOMMENDATION 4: The Secretary of the Army should ensure that the Assistant Secretary of the Army for Acquisition, Logistics, and Technology develops and uses performance measures to monitor the aggregate effectiveness of mitigation efforts for the Army industrial base risks.

DoD RESPONSE: The Department of the Army concurs without comment.

RECOMMENDATION 5: The Secretary of the Navy should ensure that the Assistant Secretary of the Navy for Research, Development and Acquisition develops and uses performance measures to monitor the aggregate effectiveness of mitigation efforts for Navy and Marine Corp industrial base risks.

DoD RESPONSE: The Department of the Navy (DON) concurs. The ASN RD&A is working to establish Measures of Effectiveness (MOEs) to track industrial base supply efforts within the Department of the Navy while remaining aligned with OASD(IBP) initiatives.

RECOMMENDATION 6: The Secretary of Defense should ensure that DOD reports its progress toward mitigating industrial base risks. For example, this information could be included in DOD's Annual Industrial Capabilities Reports, which already include sector risk assessments.

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DoD RESPONSE: Concur. As DoD develops metrics and performance measures to track mitigation efforts it will identify the best way to report on their progress.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

W. William Russell, (202) 512-4841 or russellw@gao.gov

Staff Acknowledgments

In addition to the contact named above, Cheryl Andrew, Assistant Director; Sameena Ismailjee, Analyst-in-Charge; Christopher Allison; Lorraine Ettaro; Philip Farah; Lori Fields; Kurt Gurka; Stephanie Gustafson; Almir Hodzic; Heather Lemley; Timothy Moss; and Jillian Schofield made key contributions to this report.

EXHIBIT 134

Manufacturing Capability Expansion & Investment Prioritization (MCEIP) Overview

Anthony Di Stasio
Director, MCEIP

Manufacturing Capability Expansion and Investment Prioritization

- **Incentivizes the creation, expansion and/or preservation of domestic industrial manufacturing capabilities and materials needed to meet national and homeland security requirements**

- **Manufacturing Capability Expansion and Investment Prioritization (MCEIP) is comprised of two portfolios: Innovation Capability and Modernization (ICAM) and Defense Production Act Investments (DPAI)**
  - Together these portfolios provide **complementary** flexible authorities to incentivize and strengthen the Defense Industrial Base

- **The ICAM portfolio oversees the execution of the Industrial Base Analysis and Sustainment (IBAS) authorities**
  - IBAS authorities are leveraged to improve the readiness and competitiveness of the domestic industrial base by establishing high-priority domestic capabilities for new supply chains needed for national security and mitigating exposure to global supply chain risks

- **The DPAI portfolio oversees the execution of Defense Production Act (DPA) Title I and Title III authorities**
  - The purpose of DPA Title I is to ensure the timely availability of industrial resources to meet national defense and emergency preparedness requirements through the Defense Priorities and Allocations System (DPAS)
  - DPA Title III is an investment authority committed to ensuring resilient, robust domestic supply chains in order to reduce reliance on foreign manufacturing and correct domestic shortfalls in the defense industrial base

Executive Order (E.O.) 14017, America's Supply Chains

- **Executive Order 14017** required a **whole-of-government effort** to assess risk, identify impacts, and propose recommendations in support of a healthy manufacturing and defense industrial base – a critical aspect of economic and national security.

  - **Select Kinetic Capabilities**
    - On-shore or secure US source for DoD critical chemicals
    - Improve industrial base to support the building and deployment of strategic and quick strike weapons
  - **Energy Storage and Batteries/Strategic and Critical Materials**
    - Re-establishing domestic mine-to-magnet production
    - Onshore critical minerals for DOD
  - **Microelectronics (ME)**
    - Maintain U.S. share of global semiconductor production to strengthen and secure DIB
    - Develop and sustain domestic capabilities for radiation-hardened manufacturing and testing
  - **Castings and Forgings**
    - Expansion of sole source supplier for aerospace grade magnesium and aluminum
    - Rebuild the industrial base to support shipbuilding activities

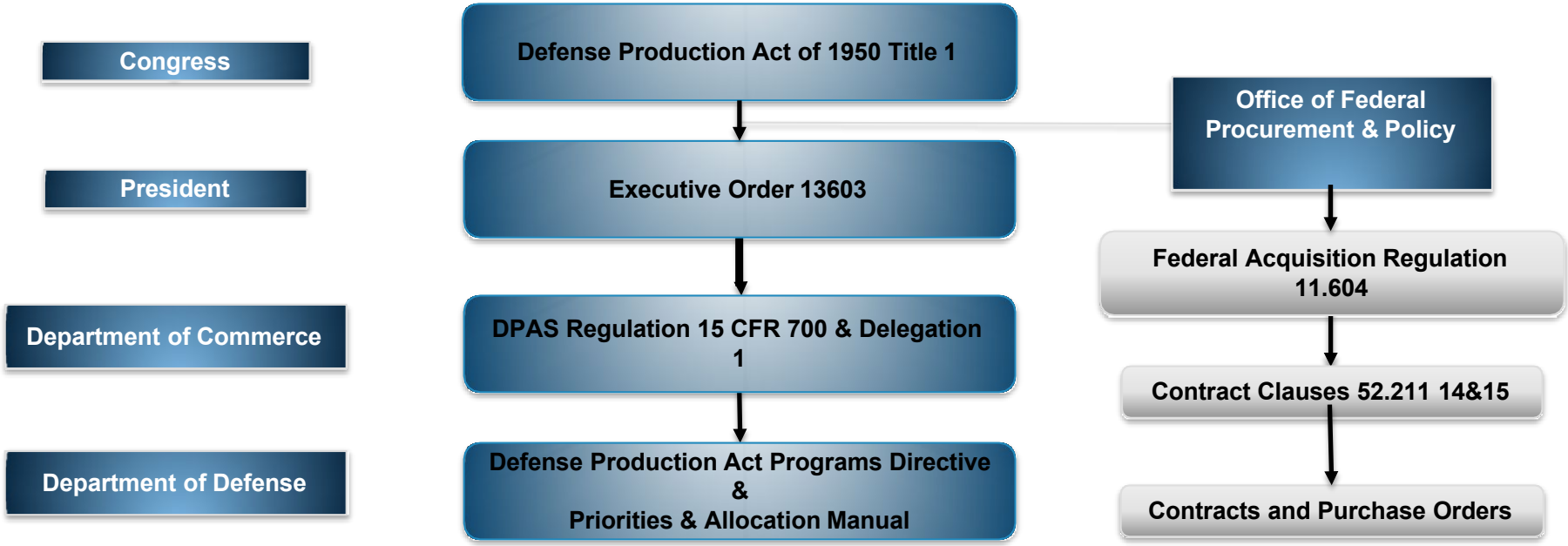
Defense Production Act (40 U.S.C. 4501 et seq.)

- The Defense Production Act (DPA) authorizes the **President** to **ensure the availability of U.S. and Canadian industry for U.S. defense, essential civilian, and homeland security requirements**.
- The **House Committee on Financial Services** and the **Senate Committee on Banking, Housing, and Urban Affairs** have jurisdiction over DPA.

DPA Authorities		
Title I	Title III	Title VII
Priorities and Allocations	Expansion of Productive Capacity and Supply	General Provisions
• Prioritize Federal contracts over all other orders • Control distribution of scarce materials within the civilian economy • Allocate scarce materials against Federal or private contracts • Prevent hoarding of scarce materials	• Incentives to develop, maintain, modernize, and expand production capacity or critical technologies: – Loans/ loan guarantees – Purchases/ purchase commitments – Grants and subsidies	• Mandatory survey authority of any U.S.-registered business entity • Anti-trust immunity for industry, to develop and implement national emergency preparedness plans • Committee on Foreign Investment in the U.S. (CFIUS) • Civilian Executive Reserve, called into Federal service during a national emergency

Defense Production Act Title I

Title I provides a powerful set of authorities to influence & shape the Defense Industrial Base



The Defense Priorities and Allocations System (DPAS)

- **Ensures** the timely availability of industrial resources to meet national defense and emergency preparedness requirements
- **Prioritizes** defense orders in support of programs of the highest national urgency that have demonstrated a need within the Industrial Base, ensuring programs experiencing disruption receive the appropriate prioritization to meet their program objectives during day-to-day operations, and in national emergencies

DPA Title I
Priority Rating for DoD & Partners

The Defense Priorities and Allocations System (DPAS) is administered by the Department of Commerce. The DPAS establishes two levels of priority rating – "DO" and "DX". When there are competing requirements at one or more vendors for a limited industrial resource, Special Priorities Assistance (SPA) is a more appropriate mechanism than a "DX" rating.

"DO" Priority Ratings

A "DO" rating gives the DoD priority over all unrated (commercial) orders. DO rated orders have equal priority to each other

Because of DoD's mission, all procurement contracts should contain a "DO" rating

There is no approval process for a "DO" rating – **THIS SHOULD BE DONE AUTOMATICALLY**

Can be used for orders of production and construction equipment (DD Form 691)

Education & Negotiation

If a supplier cannot meet a requested delivery date, there should be education and negotiation between the supplier and customer to attempt to resolve without USG intervention.

If the issue cannot be resolved by the supplier/customer, DoD and DOC will attempt to coordinate further education and negotiation before an SPA is pursued.

Special Priorities Assistance (SPA)

Expedite delivery at any level of the supply chain to meet a specific need

Accelerate delivery of a rated order due to change in military urgency

Resolve delivery conflicts between multiple rated orders and request rating authority for items not automatically ratable using the Priority Allocation of Industrial Resources (PAIR) taskforce

Expedite procurement of manufacturing equipment and prioritization at test facilities and ranges

OASD(IBP) is the approval authority

When an SPA is issued, the order may be placed in front of a DX rated order

"DX" Priority Ratings

Preference over "DO" and unrated orders with identical delivery dates

WILL NOT move orders ahead of orders with earlier delivery dates, unless the DX order cannot be fulfilled in time

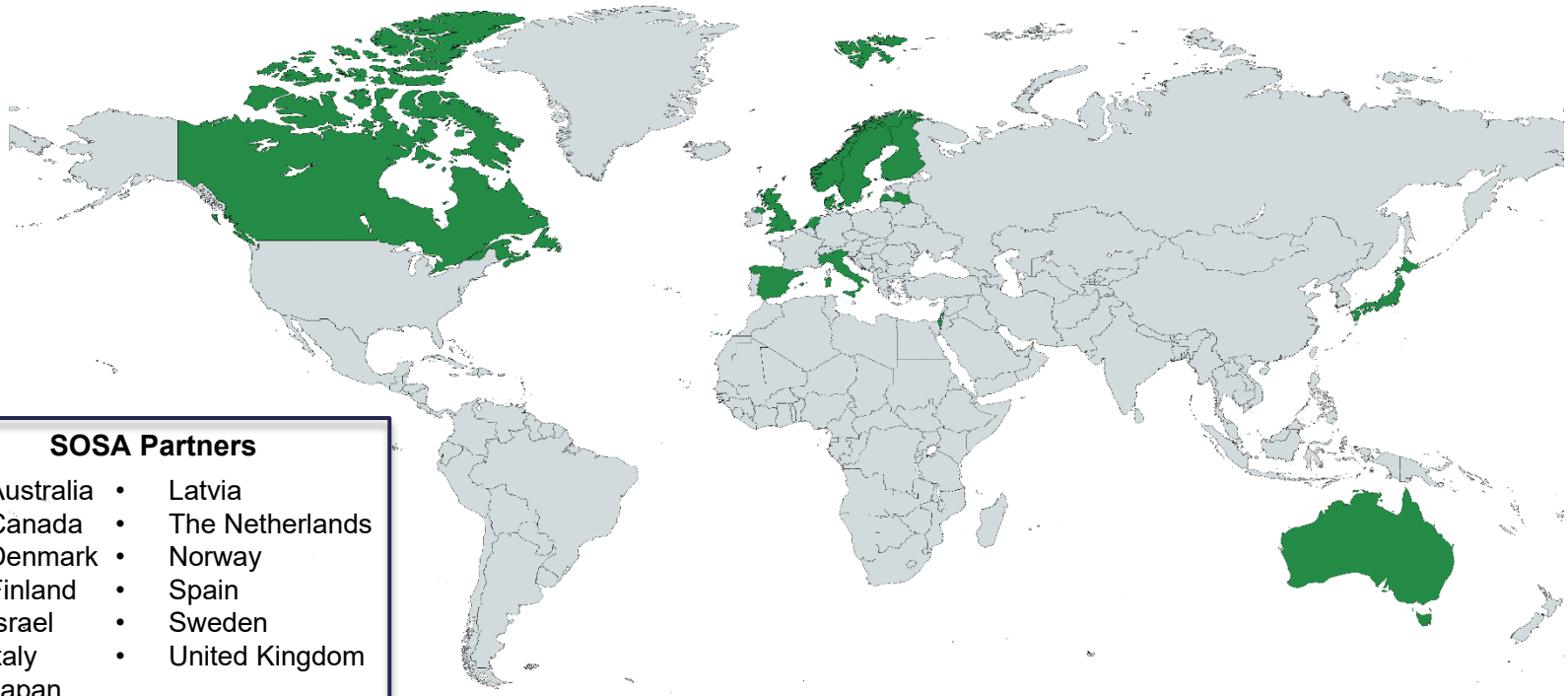
ONLY SECDEF and DEPSECDEF may grant a "DX" rating designation

Only used for programs of the highest national defense urgency that are **experiencing major production delays**

Priority Rating Within the DoD

- DoD priority rates ~350,000 prime contracts every year; the majority are DO rated
- DoD and its delegate agencies have 14 DX rated programs

Security of Supply Arrangement (SOSA)



SOSA Partners

- Australia
- Canada
- Denmark
- Finland
- Israel
- Italy
- Japan
- Latvia
- The Netherlands
- Norway
- Spain
- Sweden
- United Kingdom

- SOSAs are bilateral, voluntary agreements which allow DoD to request priority delivery for DoD contracts, subcontracts, or orders from companies in these countries
- SOSAs also allow signatory nations to request priority delivery for contracts and orders with U.S. firms
- DoD has entered into 13 SOSAs, with four SOSAs signed in the last six months, and is in the process of negotiating additional arrangements
- Reciprocal industrial priority arrangements encourage partner nations to acquire defense goods from each other, promote interoperability, and provide assurance of timely delivery

DPA Title III Authorities and Priority Areas

PE: 0902199D8Z

Authorities

Loan Guarantees §301 (50 U.S.C. 4531)	Loans §302 (50 U.S.C. 4532)	Purchase Commitments §303 (50 U.S.C. 4533)	Purchases §303 (50 U.S.C. 4533)
• May be extended when credit is not available to the loan applicant under reasonable terms and conditions sufficient to finance the activity • Prospective earning power of the loan applicant and the character and value of the security pledged provide a reasonable assurance of repayment of the loan to be guaranteed	• May be extended when private financing is beyond the risk of the commercial market • Projected earnings following the loan are sufficient to cover repayment costs	• Create a guaranteed demand to reduce risks for industry to make their own investments	• Provide direct subsidies to companies to assist in establishing production capabilities including: – Purchase and installation of production equipment in privately owned or Government owned facilities – Engineering support to improve quality and yield of production facilities – Sample quantities for process validation and customer qualification testing

Priority Areas §303 (50 U.S.C. 4533)

Sustain Critical Production	Commercialize Research and Development Efforts	Scale Emerging Technologies
"To create, maintain, protect, expand, or restore domestic industrial capabilities essential for National Defense"	"From Government sponsored research and development to commercial applications" and "from commercial research and development to National Defense"	"For the increased use of emerging technologies in security program applications and the rapid transition of emerging technologies"

DPA Title III Statutory Criteria

PE: 0902199D8Z

- **The execution of Section 303 (50 U.S.C. § 4533) authorities requires the President, on a non-delegable basis, to identify a domestic industrial base shortfall as meeting three specific criteria:**
  - The industrial resource, material, or critical technology item is essential to national defense;
  - Without Presidential action under [50 U.S.C. § 4533], United States industry cannot reasonably be expected to provide the capability for the needed industrial resource, material, or critical technology item in a timely manner; and
  - Purchases, purchase commitments, or other action pursuant to [50 U.S.C. § 4533] are the most cost effective, expedient, and practical alternative method for meeting the need
- **Presidential Determinations (PDs) are:**
  - Non-expiring and able to be leveraged for different projects addressing the same shortfalls
  - Varying in breadth and scope depending upon the shortfall/challenge addressed
- **PDs are not:**
  - An appropriation or funding mechanism
  - A mandate to address a specific shortfall or pursue a specific course of action

DPA Title III Statutory Criteria Cont.

- **Under peacetime conditions, the DPA statute imposes constraints on the exercise of Section 303 authorities:**
  - All investments require a PD
  - All actions >$50M require Congressional notification and a 30-day waiting period before action can be taken
  - All actions >$50M require Congressional authorization
- The law currently allows for the **waiver of statutory criteria** in two specific instances:
  - During a period of **national emergency** declared by the Congress or the President
  - Upon a determination by the President, on a nondelegable basis, that action is **necessary to avert an industrial resource or critical technology item shortfall** that would severely impair national defense capability. (50 U.S.C. § 4533).

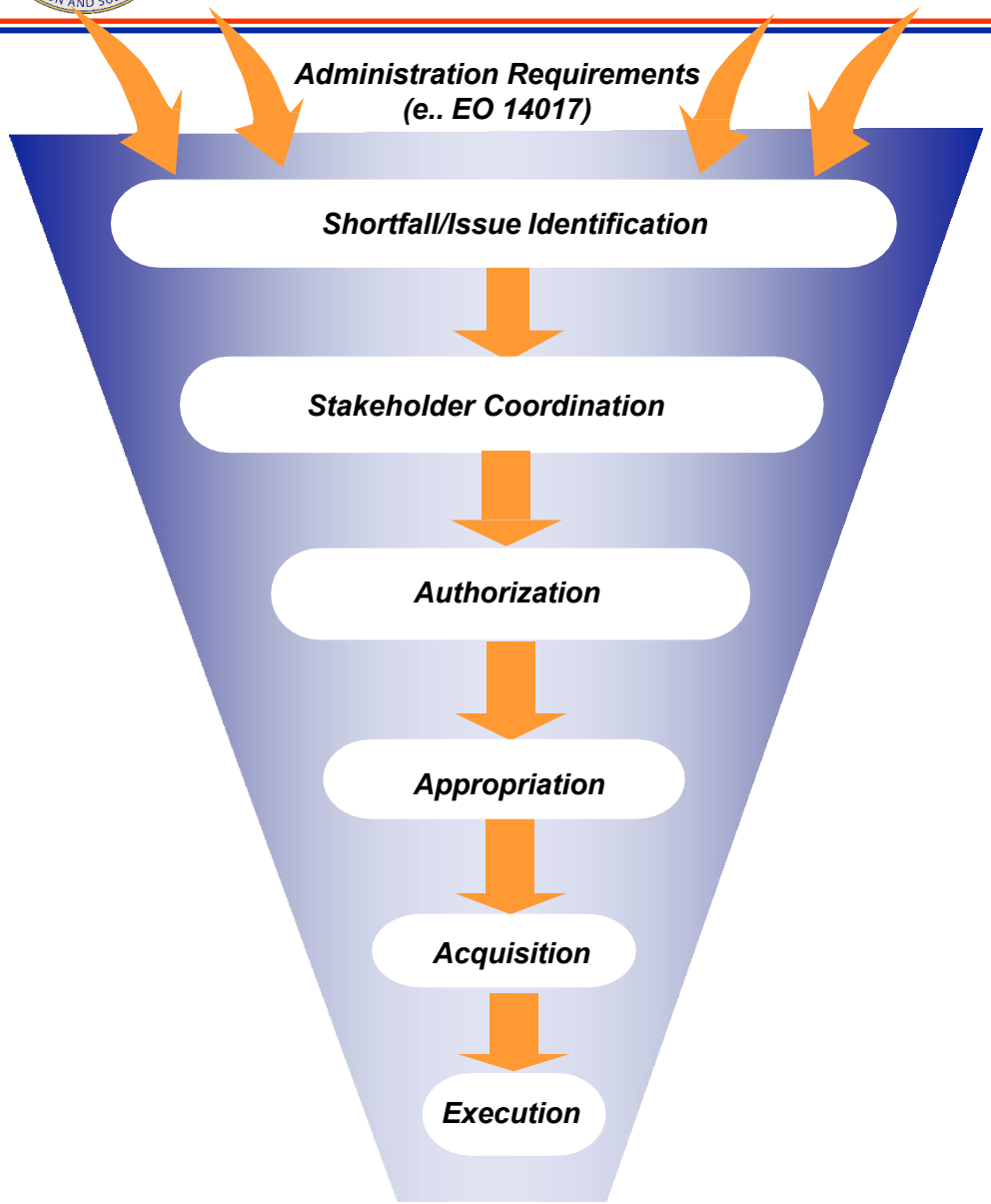
History of Presidential Determinations and Waivers

PE: 0902199D8Z

Presidential Determination/Waiver	Signature Date	Authorization Value
Energetic Materials Production for DoD Munitions	16 January 2019	$50M
Precursors Production for DoD Munitions	16 January 2019	$50M
Inert Materials Production for DoD Munitions	16 January 2019	$50M
Advanced Manufacturing Techniques for DoD Munitions	16 January 2019	$50M
Sonobuoys Production	12 March 2019	$50M
Small Unmanned Aerial Systems	12 June 2019	$50M
Rare Earth Permanent Magnets Production (2x PDs)	22 July 2019	$100M
Rare Earth Separation and Processing Capability (2x PDs)	22 July 2019	$100M
Rare Earth Metal and Alloy Processing Capability	22 July 2019	$50M
Domestic Capacity Expansion for F135 Integrally Bladed Rotors	22 July 2019	$50M
COVID-19 Response (Waiver)	27 March 2020	No Limit
High/Ultra High Temperature Composite for Hypersonics	24 June 2020	$50M
Submarine Industrial Base Production Capacity Essential to the VCS Program (3x PDs)	21 December 2021	No Limit
Radiation-Hardened and Strategic Radiation-Hardened Microelectronics	21 December 2021	No Limit
Critical Materials in Large-Capacity Batteries	31 March 2022	No Limit
Material Critical to Support the Defense Against Adversarial Aggression (Waiver)	3 October 2022	No Limit
Supply Chain Resilience (Waiver)	27 February 2023	No Limit
Airbreathing Engines, Advanced Avionics Position Navigation and Guidance Systems, and Constituent Materials for Hypersonic Systems	1 March 2023	No Limit
Printed Circuit Boards and Advanced Packaging	27 March 2023	No Limit

Requirements Evaluation

PE: 0902199D8Z



- **Issue Identification**
  - Industry- Open Funding Opportunity Announcement
    - https://sam.gov/opp/f373370cfe504a0c9ac0ad41dccee52e/view
  - Industry Mailbox –
    - osd.pentagon.ousd-a-s.mbx.dpa-title-iii-industry-inquiries@mail.mil
- **Authorization and Appropriation**
  - Development of new/increase spending limit on Presidential Determinations
- **Acquisition**
  - Develop DoD requirements
  - Select T3 investment requirements
  - Develop statement of objectives

Why is everyone talking about DPA?

PE: 0902199D8Z

- While the DPA was enacted in 1950, the past few years have seen an **increased interest** in the authorities from the Executive and Legislative Branches, Government agencies, and the public.
- In March 2020, Congress **appropriated $1B** to the DPA Purchases account via the **CARES Act** "to prevent, prepare for, and respond to coronavirus".
  - Greatly **reduced acquisition timelines** resulting in the obligation of $800M in ~10 months
- In FY2022, the DPA was appropriated **$600 million by the Additional Ukraine Supplemental Appropriations Act** to mitigate industrial base constraints for faster **missile production** and expanded domestic capacity for **strategic and critical minerals**.
  - A **further $146 million was addded** into the DPA Fund for increased production of solid rocket motors
- Also in FY2022, the **Inflation Reduction Act appropriated** $500 million for enhanced use of the DPA.
  - The funds were split equally between Department of Energy and the DoD
  - The **$250 million** provided to the DoD will be applied to expanding capabilities for **domestic mining**, **mineral processing**, and related industrial sectors for **large-capacity batteries**.
- The Executive and Legislative branches are increasingly viewing DPA authorities as valuable tools to be leveraged against urgent, critical issues.

Defense Production Act Title III

PE: 0902199D8Z

- **IS:**
  - **Efficient and effective** way to improve the industrial base
    - Modernize, expand, transform
  - **One method** for creating and sustaining market demand
  - Final stop (sometimes) on the way to production
  - **Cross-cutting investment vehicle** to solve root causes, not symptoms
  - Able to **engage** tactically with industry and strategically with policy and legislation
  - **Planned over a five year period to address challenges and shortfalls in priority order**
- **IS NOT:**
  - Title I
  - **A magic bullet**
  - The **solution to all industrial base problems**
  - Appropriate for **service specific** challenges
    - Single platform/service
    - A solution for service specific challenges

Innovation Capability and Modernization (ICAM)

PE: 06072108DZ

Building the "Next Generation of the Arsenal of Democracy" through execution of the IBAS Program

Mission: Strengthen the competitive posture of the U.S. Defense Industrial Base (DIB) in the era of great powers and global competition

Vision: A modern industrial base that fortifies traditional DIB capabilities and forges emerging sectors to respond at will to national security requirements

Priorities:

- **Prepare the defense industrial workforce** – Promote, elevate, and accelerate industrial talent pipelines
- **Ready the modern DIB** – Advance and sustain traditional defense manufacturing sectors
- **Prepare for the future** – Identify, attract, and cultivate emerging defense sectors
- **Assess and shape the risk** – Mitigate supply chain vulnerabilities within the global DIB
- **Build and strengthen partnerships** – across the global DIB

Statutorily Based

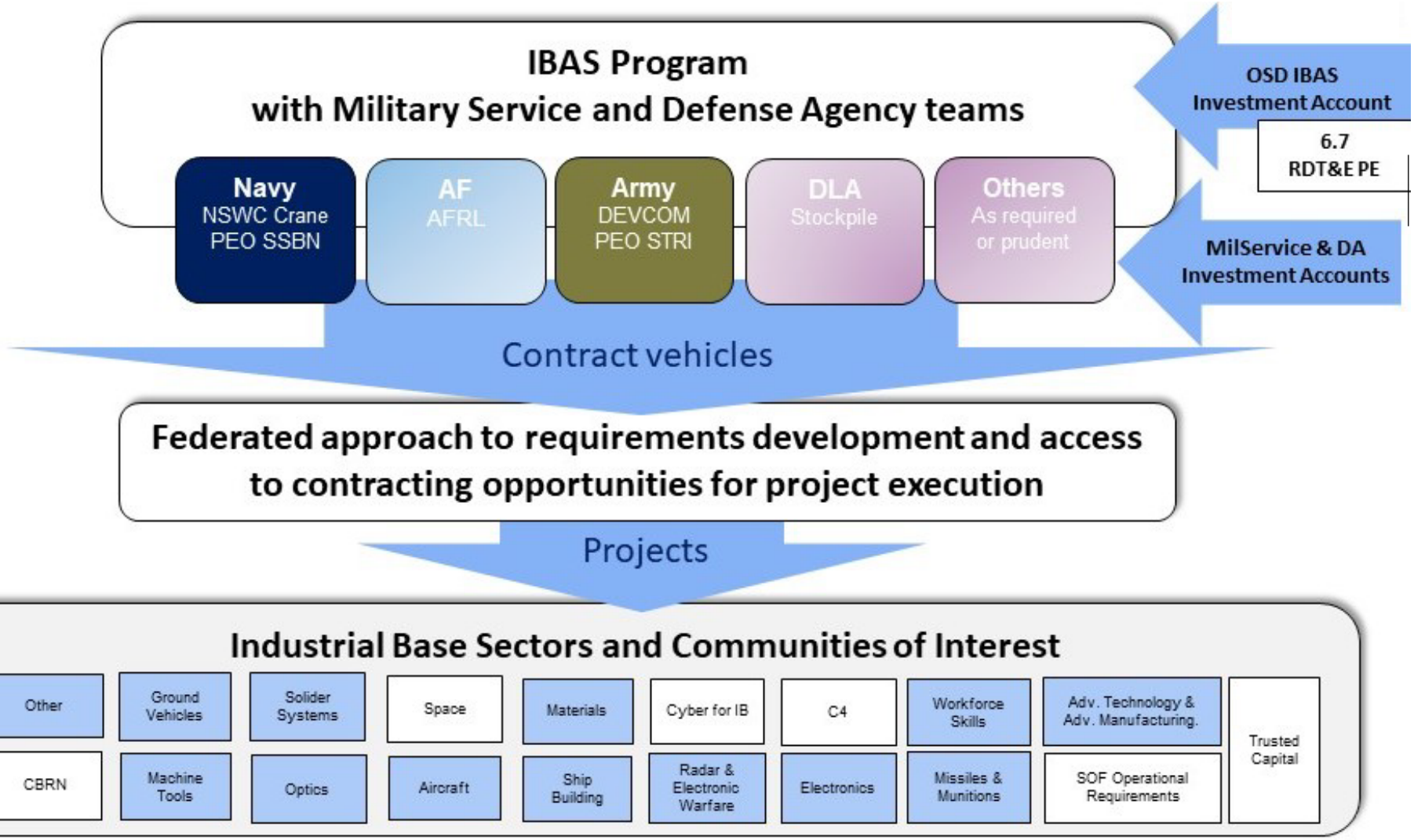
10 U.S. Code § 4817. Industrial Base Fund – IBAS Authorities

1. to support the monitoring and assessment of the industrial base
2. to address critical issues in the industrial base relating to urgent operational needs;
3. to support efforts to expand the industrial base; and
4. to address supply chain vulnerabilities.

These authorities can be used to enhance domestic and allied supply chains.

How We Execute "Federated" Approach

PE: 06072108DZ



**** Blue shaded boxes represent those sectors currently receiving IBAS funding***

America's Cutting Edge (ACE)
Restoring U.S. Machine Tool Prominence

PE: 06072108DZ

Revitalizing American Manufacturing

ACE AMERICA'S CUTTING EDGE

- In 2020, **DoD established a national testbed for ACE** for research, technology advancement, training and workforce development
- Combines scientific expertise of **Oak Ridge National Laboratory**, the research and teaching expertise of **The University of Tennessee**, Knoxville, and the workforce development leadership of **IACMI**

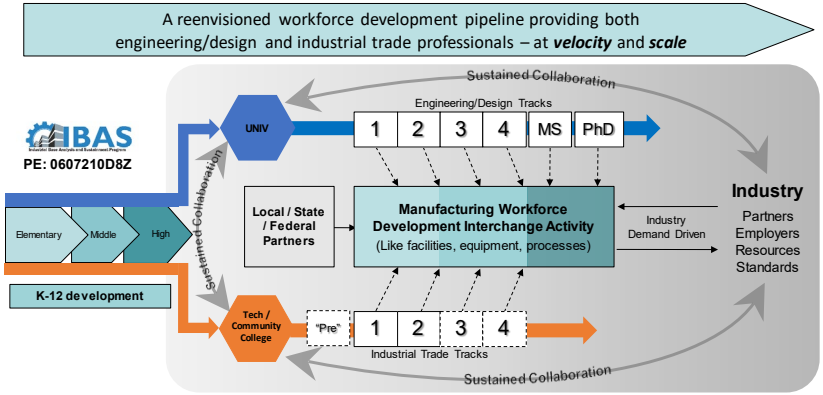
Conducts research to:

- **Increase efficiency** of existing machine tools
- **Develop skills & training** for next generation machine tools for composites and metals
- **Establish tools to rapidly train** the next generation of machine tool designers and operators

National Imperative for Industrial Skills (NIIS)
A Call to Action!

PE: 06072108DZ

- **Multi-year IBAS–Cornerstone acquisition approach launched in March 2020 to manage prototype projects for workforce development**
- **Designed to-scale across Military Departments and organic industrial base activities, agencies, industry, academia**
- **Leverages "WFD ecosystem model"**
  - Common touch point to target multiple WFD segments
  - Two interrelated, post-secondary tracks:
    - University—engineering and design
    - Career and technical—industrial trades



Aspirational Goals

- ***Promote*** the prestige of manufacturing and industrial careers
- ***Accelerate*** training development pipelines
- ***Elevate*** U.S. manufacturing to world-leading status

Objectives

- ***Recruit*** *- Reinvigorated recruiting for CTE*
- ***Train*** *- Responsive training pipelines for manufacturing and industry*
- ***Place*** *- Hire and retain world-class national industrial workforce*

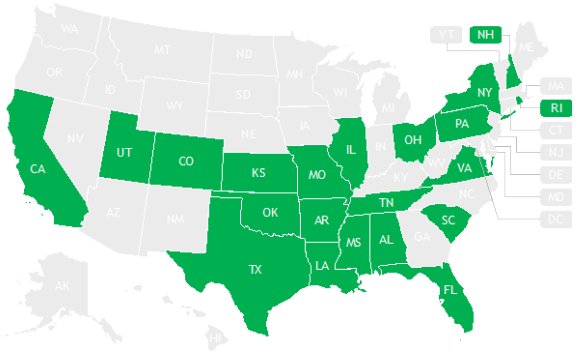
Lines of Effort—Invest and Integrate

- ***Focus and spirally develop*** *a data-driven, program approach*
- ***Expand recruitment*** *to increase diversity, equity, and inclusion*
- ***Establish/Evolve training*** *curricula, processes, and capacity*
- ***Engage*** *local, state, and USG authorities, activities, and resources*
- ***Build partnerships*** *beyond DoD and traditional training community—integrate multiple stakeholders across government, industry, associations, and academia*

Over $150M invested across 18 projects that stress-test different approaches to meeting training requirements, *delivering measurable outcomes in the initiative's third year*

Project MFG
An Enduring Workforce Catalyst Activity

PE: 06072108DZ



To date, over 175 schools / teams representing 29 states and 6 allied nations, featuring students from various community colleges with advanced manufacturing/technical programs, universities, and multiple high school and international technical trade programs, have participated in Project MFG competitions, totaling over 783 individual competitors.

Since its inception, Project MFG has awarded student scholarships and grants totaling almost $596,000 and tools/tooling prize awards totaling an additional $368,000+ for schools and competitors as of its May 2022 National Championship.

Making an immediate impact

- **Changing what and how we teach and train advanced manufacturing**
- **Driving new engagement, partnerships, and investment at multiple levels**
- **Changing mindsets and perceptions through new narratives**

EXHIBIT 135

Goals and Objectives for a Stronger Maritime Nation: A Report to Congress

February 2020

This report was developed by the U.S. Department of Transportation and the Maritime Administration with interagency engagement through the U.S. Committee on the Marine Transportation System.

U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

SUGGESTED CITATION: U.S. Department of Transportation (2020), *Goals and Objectives for a Stronger Maritime Nation: A Report to Congress*, Washington, D.C., 17 p.

Contents

Goals and Objectives for a Stronger Maritime Nation: Report to Congress

Foreword

To develop goals and objectives for this report, the Department of Transportation (DOT), through the Maritime Administration (MARAD), conducted two symposiums and other outreach activities with industry and the public from October 2013 through December 2019. Many recommendations and suggestions were received from stakeholders about how to achieve greater employment of U.S.-flag vessels, create more jobs for American mariners, improve the ability of ports to handle more cargo and larger ships, sponsor research, and achieve other goals and objectives identified in this report. These recommendations and critical thinking served as the foundation for the development of four Goals that form the basis of this report.

There was a strong belief within DOT that all the feedback had merit, including those suggestions that may be beyond the scope of this report, may require changes to current budgetary resources, or may require changes in law. Therefore, DOT/MARAD established Federal Register dockets for the January and May 2014 symposiums to memorialize the stakeholder feedback and serve as a future resource.[1]

While the Federal role and mission in support of a stronger maritime nation is shared among the more than 25 agencies and directorates, this report provides recommendations as they relate to governmental authorities and directives under the DOT. However, it recognizes the value of interagency collaboration in support of the Marine Transportation System (MTS). This report is not intended to supplant the U.S. Committee on the Marine Transportation System (CMTS) National Strategy for the Marine Transportation System: Channeling the Maritime Advantage (2017), rather it provides appropriate recommendations related to DOT/MARAD authorities. All goals and objectives are subject to the limitations of existing legal authority and the availability of funding. Interagency action across Federal agencies and within the CMTS partnerships is needed to implement many of the non-DOT goals and objectives identified within this report.

The DOT extends its gratitude to the inter-departmental cooperation of its military partners and members of the CMTS, for which the Secretary is Chair, and the extraordinary support from U.S. maritime stakeholders and the public who are committed to the U.S. Merchant Marine and the MTS.

[1] Federal Register notices for the symposiums: https://www.federalregister.gov/documents/2013/10/28/2013-25396/national-maritime-strategy-symposium-cargo-opportunities-and-sealift-capacity and https://www.federalregister.gov/documents/2014/03/24/2014-06307/second-national-maritime-strategy-symposium-domestic-shipping-opportunities. Docket submissions can be found at: https://www.regulations.gov/docket?D=MARAD-2013-0101 and https://www.regulations.gov/docket?D=MARAD-2014-0044

I. Executive Summary

This Report to Congress addresses certain requirements of the Consolidated Appropriations Act, 2014, the Howard Coble Coast Guard and Maritime Transportation Act of 2014 (Coble Act), and the John S. McCain National Defense Authorization Act for Fiscal Year 2019 to provide recommendations for specific issues related to the Marine Transportation System (MTS) and national sealift strategies.

To address these legislative requirements, DOT/MARAD conducted outreach activities with industry and the public from October 2013 through December 2019, which resulted in the development of the following four strategic goals:

- **Goal 1**: Strengthen U.S. Maritime Capabilities Essential to National Security and Economic Prosperity

- **Goal 2**: Ensure the Availability of a U.S. Maritime Workforce that Will Support the Sealift Resource Needs of the National Security Strategy

- **Goal 3**: Support Enhancement of U.S. Port Infrastructure and Performance

- **Goal 4**: Enable Maritime Industry Innovation in Information, Automation, Safety, Environmental Impact and Other Areas

The legislative requirements were also addressed through a DOT/MARAD report to Congress in 2015 that discusses the impact of government-impelled cargo on the U.S. merchant marine.[2]

Thirty-nine objectives under the four goals were also developed to provide direction toward enhancing the MTS and our Nation. Within one year, the DOT, through the Maritime Administration and in coordination with the CMTS and other Federal agencies and entities, as appropriate, will:

- Prioritize the 39 objectives for near, medium and long-term capability;
- Develop an implementation plan for the near-term objectives;
- Consider a timeline for addressing the medium and long-term objectives; and,
- Review and report on regulations that impact the competitiveness of the U.S. flag fleet.

[2] U.S. Department of Transportation Maritime Administration, A Report to Congress: Impacts of Reductions in Government Impelled Cargo on the U.S. Merchant Marine, https://www.agri-pulse.com/ext/resources/pdfs/04-21-2015-Report-to-Congress-on-the-Impact-of-Reduction-in-Government-Impelled-Cargo-on-the-US-Merchant-Marine.pdf, April 21, 2015.

II. Introduction and Guiding Principles

Introduction

The U.S. Marine Transportation System (MTS) is critical to national security and the economic prosperity of the Nation. The military depends on MTS industries, vessels, infrastructure, logistics networks, and personnel during times of war and national emergency. The MTS is an integrated network that consists of 25,000 miles of coastal and inland waters and rivers serving 361 ports.[3] The MTS supports $5.4 trillion of economic activity each year and accounts for the employment of more than 31 million Americans.[4] Privately-owned U.S.-flag ships in the international trades, the U.S. mariners they employ, and the U.S. shipyards and port facilities that support and sustain the ships' operation and maintenance have long been relied upon as primary resources to serve as a naval and military auxiliary in time of war or national emergency. These ships, mariners, and facilities have been integral and essential to the defense of our Nation. The capability of the MTS to support military contingency operations, whenever and wherever needed, is advantageous.

As with many U.S. businesses that compete internationally for markets and labor, U.S.-flag ships have higher operating costs relative to foreign-flag vessels.[5] The U.S. DOT and maritime industry are very interested in methods which will lower operating costs, thereby lowering operating cost differentials. To keep our MTS strong in international trade, U.S. Government programs under DOT serve to partially compensate carriers for the operating cost differential between U.S.-flag and foreign-flag vessels. U.S. regulatory compliance is not a major impediment to the competitiveness of the U.S. flag registry, but future improvements in the regulatory process and policy may reduce costs without decreasing safety risk.[6]

In 2014, Congress passed, and the President signed into law, two pieces of legislation requiring DOT to collaborate with other agencies to address important challenges within the MTS. This Report to Congress addresses these legislative requirements:

- Section 169 of the *Consolidated Appropriations Act, 2014*[7] provided "[t]hat the Secretary of Transportation and the Administrator, in collaboration with the Department of Defense, shall further develop a national sealift strategy that ensures the long-term viability of the U.S. Merchant Marine."

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[3] Committee on Marine Transportation System, http://www.cmts.gov/background/index.aspx; U.S. Department of Homeland Security, online at https://www.dhs.gov/transportation -systems-sector.

[4] American Association of Port Authorities, online at http://www.aapa-ports.org/advocating/content.aspx?ItemNumber=21150.

[5] Comparison of U.S. and Foreign-Flag Operating Costs, U.S. Department of Transportation Maritime Administration, https://www.maritime.dot.gov/sites/marad.dot.gov/files/docs/resources/3651/comparisonofusandforeignflagoperatingcosts.pdf September 2011 (compilation of selected vessel owners' responses); National Academy of Sciences, Engineering and Medicine Transportation Research Board, Letter Report: Impact of United States Coast Guard Regulations on United States Registry, http://onlinepubs.trb.org/onlinepubs/reports/USFlagRegistry.pdf.2016.

[6] National Academy of Sciences, Engineering and Medicine Transportation Research Board, Letter Report: Impact of United States Coast Guard Regulations on United States Registry, http://onlinepubs.trb.org/onlinepubs/reports/USFlagRegistry.pdf, 2016.

[7] Consolidated Appropriations Act, 2014, Pub. L. No. 113-76, 128 Stat. 5, 598 (2014).

- Section 603 of the *Coble Coast Guard and Maritime Transportation Act of 2014*[8] directed the DOT in consultation with the U.S. Coast Guard (USCG) to submit to Congress a national maritime strategy that shall:

    1. Identify –
        A. Federal regulations and policies that reduce the competitiveness of U.S.-flag vessels in international transportation markets[9]; and
        B. The impact of reduced cargo flow due to reductions in the number of members of the United States Armed Forces stationed or deployed outside of the United States; and

    2. Include recommendations to —
        A. Make U.S.-flag vessels more competitive in shipping routes between United States and foreign ports[10];
        B. Increase the use of U.S.-flag vessels to carry cargo imported to and exported from the United States;
        C. Ensure compliance by Federal agencies with chapter 553 of title 46, United States Code (cargo preference laws);
        D. Increase the use of third-party inspection and certification authorities to inspect and certify vessels;
        E. Increase the use of short sea transportation routes, including routes designated under section 55601(c) of title 46, United States Code, to enhance intermodal freight movements; and
        F. Enhance United States shipbuilding capability.

- Section 3513(b) of the *John S. McCain National Defense Authorization Act for Fiscal Year 2019*[11] amended Section 603(a) of the Coble Act to set a deadline of ‘‘[n]ot later than 18 months after the date of the enactment of the John S. McCain National Defense Authorization Act for Fiscal Year 2019.”

To develop recommendations, MARAD conducted outreach activities with industry and the public from October 2013 through December 2019. This outreach included forums with stakeholders held on January 14-16, 2014 and May 6, 2014, and periodic meetings with the Maritime Transportation System National Advisory Committee (MTSNAC) and its Mariner Workforce Working Group (MWWG), the National Defense Transportation Association (NDTA) sealift working group, and the U.S. Transportation Command (USTC) Voluntary Intermodal Sealift Agreement Executive Working Group. Through this process, the maritime industry and other maritime stakeholders provided a wide range of suggestions on how to improve the

[8] Coble Coast Guard and Maritime Transportation Act of 2014, Pub. L. No. 113-281, § 603, 128 Stat. 3022, 3061 (2014).
[9] Section 603(b)(1)(A) of the Coble Act is not addressed in this report. As part of DOT’s broader deregulatory goals, DOT continues to work toward addressing this requirement and will provide a supplemental report at a later date.
[10] Section 603(b)(2)(A) of the Coble Act is not addressed in this report. As part of DOT’s broader deregulatory goals, DOT continues to work toward addressing this requirement and will provide a supplemental report at a later date.
[11] John S. McCain National Defense Authorization Act for Fiscal Year 2019, Pub. L. No. 115-232, § 3513, 132 Stat. 1636, 2312 (2018).

strength, competitiveness, efficiency, and safety of the U.S. Merchant Marine and MTS, which served as the foundation for this report. The DOT, working with the Department of Defense (DOD), the Department of Homeland Security, and the other departments, agencies and offices through the CMTS, organized the recommendations and critical thinking into four Goals. Appendix C provides a crosswalk of the statutory requirements, references, and Goals and Objectives that were developed through this effort.

This Report to Congress is intended to address specific statutory requirements of Section 169 of the 2014 Appropriations Act and Section 603 of the Coble Act. DOT will work to address Sections 603(b)(1)(A) and 603(b)(2)(A) within the next year. The goals and objectives contained within this report pertain to areas of maritime transportation in which DOT has the lead or major role among U.S. Government agencies.[12] While the recommendations and critical thinking from the stakeholders and the public served as a foundation for the four Goals and thirty-nine Objectives, some of the feedback received falls outside the scope of DOT's jurisdiction and this report.

Guiding Principles

DOT is committed to meeting its statutory and policy responsibilities regarding support for the U.S. MTS in accordance with the following guiding principles, which apply to all the Goals and Objectives contained within this report:

1. Maritime readiness supports national security and a more resilient economy: DOT strongly supports DOD and the Department of Homeland Security (DHS) in their missions to protect our citizens and national interests in times of crisis and natural disaster. Similarly, DOT supports DHS policies to protect national security, including the National Strategy for Global Supply Chain Security,[13] the Transportation Systems Sector-Specific Plan,[14] and related or successor DHS plans.

2. Maritime transportation is an important component of the multimodal transportation system: In coordination with other Federal Agencies, DOT is committed to using an integrated, multimodal transportation system approach to optimize the contribution of water transportation to the cost-effective, reliable, safe, secure, and environmentally responsible movement of goods and people.

3. A safe, modern, and efficient transportation system is essential to our economic well-being: Well-planned investments in the MTS benefit the Nation's global and domestic trade, economic competitiveness, jobs, mobility, safety, security, and the environment.

[12] On June 21, 2018, the Administration released the "Delivering Government Solutions in the 21st Century: Reform Plan and Reorganization Recommendations," which includes recommendations to reorganize several maritime transportation functions among Federal agencies (https://www.whitehouse.gov/wp-content/uploads/2018/06/Government-Reform-and-Reorg-Plan.pdf). This document does not address those areas of the maritime sector that have been proposed to come under DOT purview in the future. However, should such a reorganization occur, DOT intends to update the Strategy to reflect any new maritime responsibilities of the Department.

[13] White House, National Strategy for Global Supply Chain Security, January 2012.

[14] DHS, Transportation Systems Sector, https://www.dhs.gov/transportation-systems-sector

4. The MTS must be resilient and flexible: Unauthorized use of technologies, cyber-attacks, major weather events and earthquakes, and manmade disruptions can have major adverse consequences for mobility and security. DOT will support DHS and other Federal and State agencies to identify vulnerabilities and take steps to ensure continuity of operations.
5. Maritime transportation has the capacity to alleviate future traffic congestion: DOT will work to identify marine highway routes that, if strategic investments are made at key points along the route, could have significant capacity to handle more freight.
6. Better data, models, and tools for decision-making are needed: DOT, in coordination with other Federal agencies, will promote the use and development of better data and models to measure shipping costs and logistics, mobility, capacity, productivity, and the condition of infrastructure so that planners can more effectively prioritize investments, optimize traffic, and mitigate congestion.
7. Financing programs must be improved: DOT will work to maximize the effectiveness of existing programs, as well as new programs, provided through the President's Infrastructure Plan, the Fixing America's Surface Transportation (FAST) Act, and other legislation to improve public and private access to Federal grants, stipends, loan guarantees, and financing assistance.
8. Cooperation and collaboration are critical: DOT is committed to engagement and collaboration with public and private interests across all modes of transportation at the Federal, State and local levels, including with shippers, carriers, landside port operators, and the public.
9. Innovation is the core strength of the United States and our competitive advantage: Our Nation has an established record of innovative approaches to the maritime industry, including the development of containerization and modern intermodal concepts. DOT and its government, academic, and industry partners will continue to support research in new technologies and methods and promote the incorporation of proven advanced technologies (such as liquefied natural gas (LNG) fueled ship propulsion) in the building, operation, and maintenance of our maritime transportation assets.
10. MTS participants must be good stewards of the environment: DOT will continue to seek out every available opportunity to innovate and cooperate with other agencies in the implementation of environmentally clean, cost-effective, and community-friendly technologies and practices.

Department of Transportation Strategic Plan

The Goals and emphases of this report broadly conform to those of the DOT Strategic Plan for FY 2018-2022. The DOT Strategic Plan goals are as follows:[15]

- Safety: Reduce transportation-related fatalities and serious injuries across the transportation system.
- Infrastructure: Invest in infrastructure to ensure mobility and accessibility and to stimulate economic growth, productivity, and competitiveness for American workers and businesses.
- Innovation: Lead in the development and deployment of innovative practices and technologies that improve the safety and performance of the Nation's transportation system.
- Accountability: Serve the Nation with reduced regulatory burden and greater efficiency, effectiveness and accountability.

U.S. Coast Guard Maritime Commerce Strategic Outlook

The Coast Guard has the responsibility to safeguard the Marine Transportation System and enable the uninterrupted flow of maritime commerce. The U.S. Coast Guard published the Maritime Commerce Strategic Outlook in October 2018, which emphasizes three lines of effort that complement DOT goals:

- Facilitating lawful trade and travel on secure waterways;
- Modernizing aids to navigation and mariner information systems; and
- Transforming workforce capacity and partnerships.

National Security Strategy of the United States of America

The National Security Strategy 2017 establishes four pillars to achieve a strategic vision for protecting the American people. DOT goals support the defense industrial base, including our aviation, surface, and maritime transportation sectors.

- Pillar I - Protect the American people, the homeland, and the American way of life.
- Pillar II - Promote American prosperity.
- Pillar III - Preserve peace through strength.
- Pillar IV - Advance American influence in the world as a positive force.

[15] DOT, U.S. Department of Transportation Strategic Plan for FY 2018-2022, February 2018, https://www.transportation.gov/dot-strategic-plan.

III. State of the U.S. Merchant Fleet, Mariner Workforce, Ports and Shipbuilding

The MTS integrates our economy into the vast global system that moves more than 90 percent of the world's trade by tonnage, including consumer goods, agricultural products, energy, and raw materials. Of the goods that the U.S. imports and exports, approximately 69 percent by weight and 40 percent by value move by water transportation and through our national port system.[16] These industries, vessels, infrastructure, and the personnel that support them also play a critical role in national security, supporting the Nation's ability to provide sealift for the military services during times of war and national emergency:

- **U.S.-Flag Vessels in the International Trades**. As of August 2019, there were 81 large, privately-owned self-propelled U.S.-flag merchant-type vessels of 1,000 gross tons or greater per vessel, and operating exclusively in the U.S. international trades, down from 106 ships as of the end of 2010.[17] These 81 vessels consist of 40 containerships, 21 roll-on/roll-off (Ro-Ro) ships, 11 general cargo/multi-purpose ships, 6 tankers, and 3 dry bulk ships, which are supported by Maritime Security Program stipends (60 vessels) and Preference Cargo from U.S. government agencies. None of the U.S.-flag vessels engaged exclusively in the U.S. international trades, were built in U.S. shipyards. Similarly, the share of our trade carried on such vessels has declined steadily since the end of World War II. Estimates using 2015 U.S. Census foreign trade data indicate that just 1.5 percent of U.S. waterborne imports and exports by tonnage move on oceangoing commercial vessels registered under the flag of the United States. The U.S.-flag fleet carried close to 4 percent of our ocean freight by tonnage from 1977 until 1993 and was 2 percent as of 2003.

- **U.S.-Flag Vessels in the Domestic Trades.** The U.S. domestic water transportation (Jones Act) market is served by approximately 41,000 vessels owned, operated, and built by U.S. citizens.[18] Jones Act vessels are protected by law from foreign competition and operate on U.S. inland and intracoastal waterways, lakes, oceans along the coasts of the United States, and to non-contiguous States and U.S. territories.[19] The great majority of vessels in the domestic trades consist of tugs and barges, work and supply vessels used in the offshore oil industry, and specialty vessels such as pilot boats, dredge vessels, and others. As of August 2019, however, only 99 of the 41,000 vessels operating in the U.S. domestic market are large

[16] DOT/Bureau of Transportation Statistics, Freight Facts and Figures 2017, U.S. International Merchandise Trade Value and Weight by Transportation Mode: 2016, p. 2-15. The United States also has extensive overland trade with Canada and Mexico. http://www.bts.gov/newsroom/freight-facts-and-figures-2017.

[17] DOT/Maritime Administration, U.S.-Flag Privately-Owned Fleet (As of August 19, 2019 and January 1, 2016), https://www.marad.dot.gov/resources/data-statistics/.

[18] U.S. Army Corps of Engineers, WATERBORNE TRANSPORTATION LINES OF THE UNITED STATES, Calendar Year 2016 Volumes 1 through 3 consolidated, p. 55. Published October 2017. This count includes U.S.-flag oceangoing ships, tugs, offshore support vessels, ferries, Great Lakes vessels, and non-self-propelled vessels (liquid and dry cargo barges) operating and/or available for operation as of December 31, 2015, but does not include vessels primarily used as fishing vessels or dredges or derricks, etc., used in construction work.

[19] Section 27 of the Merchant Marine Act of 1920, as amended, popularly known as the Jones Act, requires vessels that serve the U.S. domestic trades be: owned by a U.S. citizen or by companies controlled by individuals that are U.S. citizens with at least 75 percent of ownership; operated with crews that are all U.S. citizens in licensed positions and at least 75 percent U.S. citizens in unlicensed positions; built (or rebuilt, or seized) in the United States; and registered under the U.S. flag with a coastwise endorsement from the U.S. Coast Guard.

cargo-carrying merchant-type vessels capable of self-propelled operation in the deep oceans (comparable to vessels operating in international trades). These 99 large vessels consist of 57 tankers, 24 containerships, 9 general cargo/multi-purpose ships, 7 Ro-Ros, and 2 dry bulk ships. These large ocean-going vessels and their crews engaged in domestic trade, are primarily sustained by the Jones Act. Approximately 873 million short tons of domestic freight moved by water in 2017—equivalent to 5.5 percent of the estimated U.S. domestic freight tonnage carried by all transportation modes.[20] The majority of this tonnage moved on non-self-propelled barges.

- **Military Sealift.** By statute, the Department of Defense is required to rely on U.S. mariners and the U.S.-flag commercial fleet for military sealift and support, to avoid reliance on foreign countries in a crisis.[21] In an activation, the vessels and crews are integrated into the surge sealift fleet, along with 63 merchant-type, government-owned surge sealift vessels that are crewed by mariners drawn from the commercial fleet. The Jones Act, Maritime Security Program, and Preference Cargo from federal agencies are the three pillars that support U.S.-flag commercial sealift. The U.S.-flag commercial fleet played a critical strategic role during World War II and the size of the fleet peaked in 1951. For various reasons, the size of the U.S.-flag commercial fleet has fallen over time as the maritime industry modernized. Further, the size of the fleet decreased from 282 vessels in 2000 to 180 in August 2019, largely due to a decline in the number of tankers and bulk carriers. The U.S.-flag fleet has been roughly steady since 2014. These ocean-going, self-propelled U.S.-flag vessels operate in a global shipping market that includes over 40,000 large self-propelled merchant ships. [22] Within that global market, the Department of Defense already relies on foreign-flag tankers, due to lack of U.S.-flag capabilities.

- **Maritime Workforce.** The United States maintains a workforce of highly qualified maritime professionals, reflecting a strong tradition of maritime education and training. As large U.S.-flag commercial vessels have left the fleet and international credentialing and certification requirements have become more stringent and costly, it is possible that the size of the mariner workforce will decline.[23] Any further decline of the mariner workforce increases the risk of not having a sufficient number of mariners with appropriate experience and credentials to support sustained operations of more than six months by the full U.S. Government surge sealift fleet, U.S. Government non-surge fleet, and U.S.-flag commercial fleet during a wartime emergency.

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[20] U.S. Army Corps of Engineers, WATERBORNE COMMERCE OF THE UNITED STATES Calendar Year 2016, Part 5-National Summaries, p. 1-3 and U.S. Department of Transportation, Freight Facts and Figures 2017 (Table 2-1). Note that the Corps' estimate of domestic waterborne freight includes waterborne movements of petroleum that are not included in the Commodity Flow Survey published in Table 2-1 of Freight Facts and Figures 2017. MARAD added the petroleum movements to the domestic freight numbers in Table 2-1 to calculate the 5.5 percent waterborne share of domestic freight.

[21] Statutes include: 46 U.S.C. § 50101(a)(2); 10 U.S.C. § 2631; 46 U.S.C. § 51104; 46 U.S.C. § 53102; 46 U.S.C. § 53107; 46 U.S.C. § 55302; 50 U.S.C. § 4558, and by National Security Directive 28.

[22] Maritime Administration, U.S. Department of Transportation, U.S.-Flag Privately-Owned Fleet, 1946 – 2016, https://www.maritime.dot.gov/sites/marad.dot.gov/files/docs/outreach/data-statistics/7066/us-fleet-summary-table-1946-2016.xlsx

[23] Maritime Workforce Working Group Report, Maritime Administration, September 29, 2017 https://www.maritime.dot.gov/sites/marad.dot.gov/files/docs/mariners/1026/mwwg-report-congress-finalr3.pdf

- **U.S. Port Infrastructure.** U.S. ports are critical domestic and international transportation hubs. Port activity generates almost 31 million jobs, accounting for 25.7% of the U.S. GDP in 2018, and adding $378.1 billion to federal, state and local taxes.[24] The ability of ports to successfully increase capacity and serve larger vessels more efficiently is vital to the health of many domestic industries. The advent of containerization and intermodal freight services have helped increase cargo-handling efficiency over the last 50 years. However, with trade expected to increase to meet the demands of a growing population, augmented with increased ferry transits, cruise ships, rapidly changing technology, and other non-cargo vessel traffic in our waterways and ports[25], as well as more stringent security-related requirements, greater attention must be made to the physical and informational infrastructure required to keep our ports, safe, secure and efficient.

- **U.S. Ship Construction and Repair Facilities.** In 2015, U.S. shipyards, of which there were 124, built 1,281 vessels of all sizes. The great majority of these vessels consisted of tugs, barges, and offshore supply vessels that operate in the U.S. domestic maritime trades.[26] Over the last several decades, however, large U.S. shipyards and their skilled labor forces for building large commercial vessels have atrophied due to low-cost, highly-subsidized international shipbuilding competition, and other factors resulting in shipyard closures and reductions in the U.S. vendor base. Only two large self-propelled merchant-type vessels intended to operate exclusively in the commercial international trade (as opposed to the U.S. domestic trade) have been built in U.S. shipyards since 1990, and these were built in 1998.[27] The largest U.S. commercial shipyards construct limited numbers of large self-propelled merchant-type vessels for domestic use, averaging 5 large self-propelled vessels per year over the last 5 years, with a peak of 10 such vessels in 2016.[28] This production is small, however, relative to the worldwide production of 1,408 such ships in 2016. New orders for smaller vessels have also fallen since 2015. The ability to sustain commercial building of large vessels is important to the Nation's ability to readily expand the fleet and repair vessels during national emergencies.

[24] Martin & Associates, 2018 National Economic Impact of the U.S. Coastal Port System, Executive Summary, March 2019 for the American Association of Port Authorities.
[25] Bureau of Transportation Statistics, U.S. Department of Transportation, National Transit Database and North American Cruise Statistical Snapshot, May 2012.
[26] U.S. Army Corps of Engineers, WATERBORNE TRANSPORTATION LINES OF THE UNITED STATES, Calendar Year 2016 Volumes 1 through 3 consolidated, p. 57. Published October 2017. The data include U.S.-flag vessels operating and/or available for operation December 31, 2016. Vessels primarily used as fishing vessels or dredges or derricks, etc., used in construction work are excluded.
[27] IHS Sea-Web Maritime Database Query, March 9, 2018. U.S. shipyards export some smaller non-merchant-type vessels, such as workboats and dredges, as well as recreational boats.
[28] IHS Sea-Web Maritime Database Query, March 9, 2018.

IV. Goals and Objectives to Support a Stronger Maritime Nation

Goal 1: Strengthen U.S. Maritime Capabilities Essential to National Security and Economic Prosperity

Objectives for Goal 1:

1.1 Leverage U.S. maritime policies to advance U.S. commercial interests in the global economy.

1.2 Increase the use of U.S. flagged vessels in domestic energy transportation and international energy markets.

1.3 Develop and expand marine highway service options and facilitate their further integration into the current U.S. surface transportation system through the America's Marine Highway Program, especially where water-based transport is the most efficient, effective and sustainable option.

1.4 Adapt organizational structures and related authorities, roles, and responsibilities to ensure the sustained ability to monitor the global performance of the U.S. flagged fleet and the third-party organizations that perform delegated inspection and certification functions on the U.S. Government's behalf.

1.5 Ensure effective use of third parties for inspection and certification by strengthening third-party oversight, auditing, and integrated risk management.

1.6 Address the challenges of the Arctic's rapidly-changing environment to ensure the safety and security of the U.S. marine transportation system.

1.7 Recapitalize the Ready Reserve Force (RRF) with modern vessels as ships reach the end of their usable lives.

1.8 Improve the capability of U.S.-flag international trading vessels to better align with DOD and DOT sealift requirements through a combination of MSP funding, MSC chartering, enforcement of preference cargo requirements, regulatory reform and policy, and incentives to reduce vessel operating costs.

1.9 Examine new ways to support shipbuilding and repair facilities, and increase U.S. coastwise trade for eligible U.S.-flag vessels.

1.10 Enhance the U.S. shipyard base by fostering support for shipyard modernization and innovation, and promoting use of the Capital Construction Fund (CCF) and Construction Reserve Fund (CRF) programs.

Goal 2: Ensure the Availability of a U.S. Maritime Workforce that Will Support the Sealift Resource Needs of the National Security Strategy

Objectives for Goal 2:

2.1 Attract and equip mariners and other maritime workers with skills needed to support the Nation's sealift and economic needs.

2.2 Develop an accurate roster of sealift-qualified mariner volunteers.

2.3 Foster innovation in maritime education and training.
2.4 Designate the US Merchant Marine Academy (USMMA) as the National Center for Maritime Excellence.
2.5 Update USMMA education curricula to address future innovation and emerging technologies.
2.6 Increase the percentage of seagoing employment at appropriate levels of qualification for maritime academy graduates.
2.7 Coordinate with the maritime industry and labor to emphasize "best practices" training standards against sexual harassment, assault and discrimination, and increase diversity in the maritime workforce.
2.8 Recapitalize three State Maritime Academy (SMA) training ships by 2025 to provide safe and modern merchant marine training platforms.
2.9 Support the training and education of unlicensed mariners (ratings) using domestic Centers of Maritime Excellence.
2.10 Incentivize the qualification of steam engineers to assure an adequate pool to support full RFF activation until full RRF recapitalization is achieved.
2.11 Engage with community colleges, K-12 schools, and non-SMA training institutions to promote the development of future mariners and other skilled maritime workers.
2.12 Work with interagency partners to improve credentialing processes for mariners, shipyard workers, port workers, and transitioning veterans.

Goal 3: Support Enhancement of U.S. Port Infrastructure and Performance

Objectives for Goal 3:

3.1 Leverage America's Marine Highways Program to further reduce landside congestion and increase port efficiency.
3.2 Coordinate with port authorities, Metropolitan Planning Organizations (MPOs), State DOTs, and other stakeholders to significantly reduce national port congestion through improved planning and information.
3.3 Incorporate more maritime data from other authoritative sources into DOT's multimodal data inventory.
3.4 Facilitate U.S. port access to funding and financial assistance to modernize and improve port infrastructure and increase intermodal efficiency, including measures to improve infrastructure resiliency to storm surge and other risks.
3.5 Work with DOT interagency partners to enhance the safety of surface transportation intermodal connectors.
3.6 Work with stakeholders to improve and expand landside facilities at U.S. ports and intermodal connectors to ensure adequate accommodation of all sizes of dry bulk, tanker, LNG, and containerships.
3.7 Work with stakeholders and Federal partners to address U.S. ports' capability to accommodate changes in waterway and vessel characteristics, including the recapitalization of aging waterway facilities, aids to navigation and construction tenders,

infrastructure such as locks and dams, and navigation services to maintain a safe and efficient system.

3.8 Compile informed forecasts of long-term demand and technology trends to prepare adequate and resilient future port and landside capacity.

3.9 Increase the effectiveness of the National Port Readiness Network.

3.10 Develop a comprehensive plan for accommodating vessels using LNG as fuel, including LNG bunkering facilities in key domestic ports.

3.11 Work with stakeholders to improve and expand wind energy shore side support.

3.12 Work with stakeholders to leverage emerging future technologies to improve port efficiency.

Goal 4: Drive Maritime Innovation in Information, Automation, Safety, Environmental Impact, and Other Areas

Objectives for Goal 4:

4.1 Work with government and industry stakeholders to facilitate innovations that improve the safety, security, and resilience of the MTS.

4.2 Leverage existing Intelligent Transportation System (ITS) technologies, conduct research on innovative solutions, and work with industry and academia to develop new ITS applications to benefit the safety and efficiency of the maritime transportation/intermodal transportation environment.

4.3 Work with government, industry, and labor partners to accelerate the adoption of productivity and safety-enhancing automation for vessel and port functions, while also meeting national needs for conventional technologies and preserving the existing maritime workforce.

4.4 Promote research to reduce environmental impacts of maritime activities, including assistance to ports and vessel operators to comply with Federal regulations regarding invasive species, vessel emissions (including by using alternative fuels), and other marine impacts.

4.5 Support the implementation of inshore and offshore fairways to prevent construction of obstacles and ensure free flow of commerce, in coordination with resource development proposals and other ocean management plans.

The Way Forward

This report provides thirty-nine objectives under four goals:

1. Strengthen U.S. Maritime Capabilities Essential to National Security and the Economic Prosperity;
2. Ensure the Availability of a U.S. Maritime Workforce that Will Support the Sealift Resource Needs of the National Security Strategy;
3. Support Enhancement of U.S. Port Infrastructure and Performance; and,
4. Drive Maritime Innovation in Information, Automation, Safety, Environmental Impact, and Other Areas.

Within one year, the DOT, through the Maritime Administration and in coordination with the CMTS and other Federal agencies, as appropriate, will:

- Prioritize the 39 objectives for near, medium and long-term capability;
- Develop an implementation plan for the near-term objectives;
- Consider a timeline for addressing the medium and long-term objectives; and,
- Review and report on regulations that impact the competitiveness of the U.S. flag fleet.

Appendix A: U.S. Law, Policy and Plans Related to this Report

National Security Strategy of 2017
Passenger Services Act of 1886
Military Cargo Preference Act of 1904
Shipping Act of 1916
Merchant Marine Act of 1920 (Jones Act)
Merchant Marine Act of 1928
Intercoastal Shipping Act of 1933
Public Resolution 17 of 1934
Merchant Marine Act of 1936
Merchant Ship Sales Act of 1946
Cargo Preference Act of 1954
Clean Air Act of 1963
Merchant Marine Act of 1970
Clean Water Act of 1972
Marine Protection, Research, and Sanctuaries Act of 1972
Deepwater Port Act of 1974
Shipping Act of 1984
Food Security Act of 1985 and Bipartisan Budget Act of 2013
National Security Directive 28 (NSD 28), October 28, 1989
Maritime Security Act of 1996
Ocean Shipping Reform Act of 1998
Maritime Security Act of 2003
Coast Guard and Maritime Transportation Act of 2006
Energy Independence and Security Act of 2007
National Defense Authorization Act for Fiscal Year 2009
Moving Ahead for Progress in the 21st Century Act of 2012
Coast Guard and Maritime Transportation Act of 2012
Water Resources Reform and Development Act of 2014 (WRRDA)
Howard Coble Coast Guard Act of 2014
Fixing America's Surface Transportation Act of 2015 (FAST Act)
Consolidated Appropriations Act of 2016
National Defense Authorization Act for Fiscal Year 2018
National Defense Authorization Act for Fiscal Year 2019
Consolidated Appropriations Act of 2014
Consolidated Appropriations Act of 2018

Appendix B: Statutory Authority and Policies

Merchant Marine Act of 1936: For the last 82 years, the principal authority for the U.S. Government's support of the merchant marine has been provided by the Merchant Marine Act of 1936 (1936 Act), as amended.

National Security Directive 28: The role of the U.S. Merchant Marine as a naval and military auxiliary, established under the 1936 Act, is reflected in National Security Directive 28 (NSD 28), implemented on October 28, 1989.

Howard Coble Coast Guard and Maritime Transportation Act of 2014: Section 603 of the Public Law 113-281, the *Howard Coble Coast Guard and Maritime Transportation Act of* 2014 (Coble Act), directs DOT in consultation with USCG to produce a strategy that identifies:

- Federal regulations and policies that reduce:
  - the competitiveness of U.S.-flag vessels in international transportation markets[29]; and
  - the impact of reduced cargo flow due to reductions in the number of members of the U.S. Armed Forces stationed or deployed outside of the United States; and
- includes recommendations to:
  - make U.S.-flag vessels more competitive in shipping routes between United States and foreign ports[30];
  - increase the use of U.S.-flag vessels to carry cargo imported to and exported from the United States;
  - ensure compliance by Federal agencies with chapter 553 of title 46, U.S. Code (cargo preference laws);
  - increase the use of third-party inspection and certification authorities to inspect and certify vessels;
  - increase the use of short sea transportation routes, including routes designated under section 55601(c) of title 46, U.S. Code, to enhance intermodal freight movements; and
  - enhances U.S.-shipbuilding capability.

National Freight Transportation Policy: U.S. ports and waterways are not directly addressed in the 1936 Act or the Coble Act. DOT notes, however, the inclusion of ports and waterways in the Report to Congress conforms to a broader, more inclusive approach to transportation policy reflected in the *Fixing America's Surface Transportation Act of 2015* (FAST Act) and the National Freight Strategic Plan (NFSP) (issued in draft by DOT in October 2015). Both these documents explicitly recognize ports and waterways as components of the National Freight System, including through the National Multimodal Freight Network (Section 8001 of the FAST Act), the Port Performance Freight Statistics Program (Section 6018 of the FAST Act), and the predecessor freight network defined in the October 2015 draft NFSP.

[29] Section 603(b)(1)(A) is not addressed in this report. As part of DOT's broader deregulatory goals, DOT continues to work toward addressing this requirement and will provide a supplemental report at a later date.
[30] Section 603(b)(2)(A) is not addressed in this report. As part of DOT's broader deregulatory goals, DOT continues to work toward addressing this requirement and will provide a supplemental report at a later date.

Appendix C: Matrix of How the Legislative Requirements are Met

Goal 1: Strengthen U.S. Maritime Capabilities Essential to National Security and the Economic Prosperity
Goal 2: Ensure the Availability of a U.S. Maritime Workforce that Will Support the Sealift Resource Needs of the National Security Strategy
Goal 3: Support Enhancement of U.S. Port Infrastructure and Performance
Goal 4: Drive Maritime Innovation in Information, Automation, Safety, Environmental Impact and Other Areas

Requirement	Goal 1	Goal 2	Goal 3	Goal 4	Additional Resources
2014 Appropriations Act § 169: Develop a national sealift strategy that ensures the long-term viability of the U.S. Merchant Marine	X	X		X	
Coble Act § 603(b)(1)(A): Identify Federal regulations and policies that reduce the competitiveness of U.S.-flag vessels in international transportation markets	*				*As part of DOT's broader deregulatory goals, DOT and DHS continue to work toward addressing this requirement. DOT will provide a supplemental report within one year.
Coble Act § 603(b)(1)(B): Identify the impact of reduced cargo flow due to reductions in the number of members of the U.S. Armed Forces stationed or deployed outside of the United States	X	X			2015 Report to Congress discusses the impact of government-impelled cargo on the U.S. merchant marine
Coble Act § 603(b)(2)(A): Include recommendations to make U.S.-flag vessels more competitive in shipping routes between U.S. and foreign ports		*	*		*As part of DOT's broader deregulatory goals, DOT and DHS continue to work toward addressing this requirement. DOT will provide a supplemental report within one year.
Coble Act § 603(b)(2)(B): Include recommendations to increase the use of U.S.-flag vessels to carry cargo imported to and exported from the U.S.	X				
Coble Act § 603(b)(2)(C): Include recommendations to ensure compliance by Federal agencies with chapter 553 of title 46, US Code (cargo preference laws)	X				
Coble Act § 603(b)(2)(D): Include recommendations to increase the use of third-party inspection and certification authorities to inspect and certify vessels	X				
Coble Act § 603(b)(2)(E): Include recommendations to increase the use of short sea transportation routes, including routes designated under section 55601(c) of title 46, US Code, to enhance intermodal freight movements	X		X		
Coble Act § 603(b)(2)(F): Include recommendations to enhance U.S. shipbuilding capability	X			X	

EXHIBIT 136

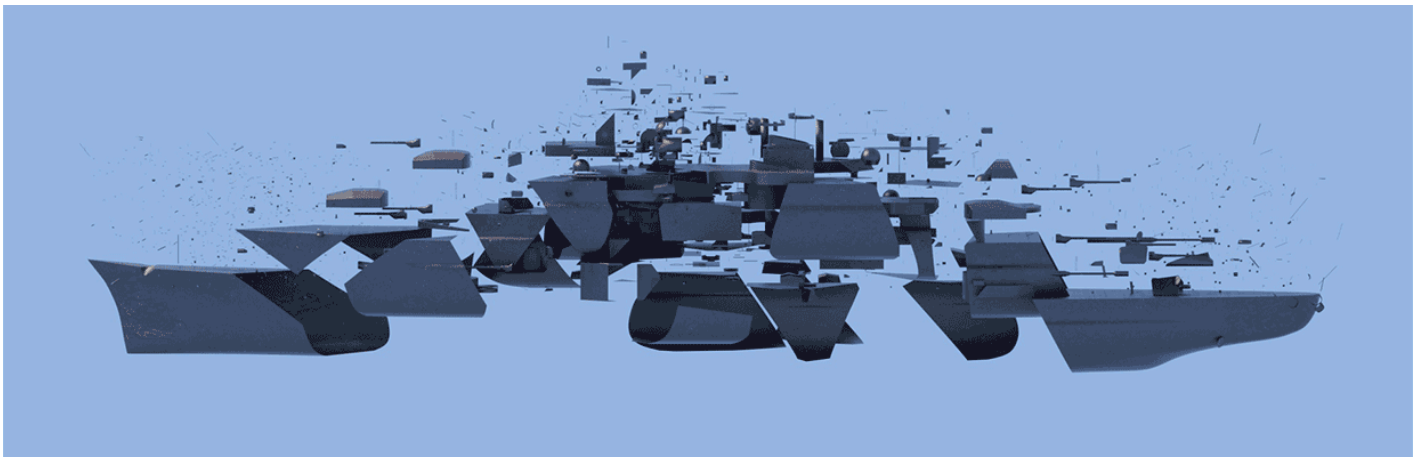
ESSAY

Float, Move, and Fight

How the U.S. Navy lost the shipbuilding race.

OCTOBER 10, 2021, 1:44 AM

By **Alexander Wooley**, a journalist and former officer in the British Royal Navy.



TIMO LENZEN FOR FOREIGN POLICY

The 21st century has not been kind to the U.S. Navy's vast surface fleet. In an effort to leap ahead of other navies through revolutionary designs and technologies, the Navy has instead fallen significantly behind, accepting into service ships that struggle to even "float, move, and fight"—the basic functions of the most rudimentary warship. Ship classes have been cut, and many vessels have been retired early, while others wait years for repairs. These include supposedly cutting-edge vessels that were meant to be the backbone of the current and near-future fleet.

vessel, with mission packages swapped in and out as needed. Yet the LCS manages to combine a lack of firepower with serious defensive vulnerabilities and routine mechanical breakdowns. Two key systems—to counter mines and submarines—have never become operational. LCS costs doubled during construction, the original class size of 52 was cut to 35, and the Navy is retiring the lead ships after just a dozen years of service.

Or consider the massive, futuristic *Zumwalt*-class stealth destroyer. Only three of an originally planned 32 ships are going to be built. Some estimates have the all-in costs for the *Zumwalt* at $7 billion per ship—more expensive than the *Nimitz*-class aircraft carriers they might be expected to escort. The ship's main armament, a new technology called a railgun, doesn't work and would not have been of much use in a maritime conflict with China anyway. In mid-2021, the railgun was effectively canceled.

Then there's the *Ford*. Though a varsity athlete at the University of Michigan, U.S. President Gerald Ford was known for physical stumbles, and his namesake nuclear-powered vessel, a long-awaited replacement for the workhorse *Nimitz*-class carrier, has unfortunately followed in his missteps. The overly ambitious design includes new propulsion, a buggy magnetic catapult, a new aircraft arresting system, a new primary radar, and advanced weapons elevators. Each new technology has had extensive problems, cost overruns, and delays. The Navy issues a news release every time it gets one of the ammunition elevators to work.

Over the past 20 years, the U.S. Government Accountability Office (GAO) has issued roughly 40 reports or testimonies on problematic ship types. Less attention has been paid to the totality of the problem as well as its origins and common symptoms. Together, the many failures constitute a lost generation of shipbuilding, leaving the Navy unready at a time when China has already built the world's biggest fleet, with more hulls splashing off its slipways every year. Given that tensions with China may only worsen—potentially spilling over into outright conflict—the United States needs to take better stock of how it got into this mess.

China's first aircraft carrier, the *Liaoning* (right), arrives in the waters off Hong Kong on July 7, 2017. ANTHONY WALLACE/AFP VIA GETTY IMAGES

The failures in new platforms and technologies were self-induced, unforced errors. They didn't occur as the United States was trying to match a rival or play catch-up to another power. They came, in part, as a result of hubris—an unrivaled belief in the country's power of rapid innovation.

One key turning point came in 1991 during Operation Desert Storm. That lightning victory was perceived not only as a success for coalition forces but for U.S. industry and technology—a star-studded debut of new weapons systems that had been decades in the making. Naval planners were dazzled by the new technology; they figured that by incorporating more revolutionary capabilities into their shipbuilding, they could build fewer hulls with smaller crews. This was particularly enticing at the time, as the

A decade later, in 2001, Donald Rumsfeld was sworn in as U.S. defense secretary, obsessed with technological revolution. He pushed for radical change. Early on in the development of the *Ford*, he overruled the Navy's preference for taking a slow, evolutionary approach to developing the *Nimitz*'s successor, deciding the plans were not sufficiently transformational. Instead, he forced through a program that tried to pull together various revolutionary (and untested) technologies. The result: Some 20 years later, the ship has still not deployed. "The Navy embraced technology for technology's sake," said Rep. Elaine Luria, the vice chair of the House Armed Services Committee and a veteran surface warfare officer whose congressional district includes the massive Norfolk Naval Shipyard and Naval Station Norfolk.

Together, the many failures constitute a lost generation of shipbuilding.

One challenge was trying to design and deploy new shipboard technologies while at the same time building a new ship. Earlier cutting-edge technologies like vertically launched missiles and the AN/SPY-1 radar—core to the *Ticonderoga*– and *Arleigh Burke*-class surface ships—received extensive testing and development both onshore and at sea before they were ever installed in operational warships. This previous practice of "de-risking" meant that if a single technology failed, it failed alone. When, on the other hand, a technology fails aboard a warship that has been handed over to the Navy, the interdependence of systems means the entire ship is rendered nonoperational.

"Whole programs were premised on the introduction of new technologies that will need to work while designing the program not knowing if those technologies will actually work," said Shelby Oakley, a director for contracting and national security acquisitions at GAO, describing flaws in the LCS and *Zumwalt*.

that would serve as research and development vessels—and the Navy would select one. Instead, the Navy kept both test designs, and they went into production as is, deemed good enough.

The decades of U.S. shipbuilding failures were long masked by the absence of any near-peer fleet. But today, the Office of Naval Intelligence (ONI) has concluded that China has the largest navy in the world—by the end of 2020, it had an estimated 360 battle force ships, compared with 297 for the United States. ONI projects that China will have 400 battle force ships by 2025 and 425 by 2030. More worrisome for U.S. planners: Chinese warships are increasingly capable, reducing the quality gap that is the traditional wellspring of U.S. confidence as it contemplates emerging adversaries.

The U.S. Navy now faces contradictory demands. On the one hand, Congress and others are telling it to heed the lessons of recent catastrophes and take a more incremental approach to ship and technology design, procurement, and testing. Yet it also faces congressional pressure to get a significantly larger battle force—in a hurry. That may explain the cognitive dissonance that continues to define naval planning.

For five years, the Navy has lived with the order, codified into law, to increase its fleet to 355 ships. In mid-2021, the Biden administration announced a fuzzy successor to this number, calling for 321 to 372 manned ships. At the same time, the administration and the Defense Department have sounded the alarm on the growing threat posed by China in virtually every domain, with outgoing and incoming Indo-Pacific commanders saying that China may take military action against Taiwan within the next six years. Yet the Navy's latest budget doesn't come close to enabling a shipbuilding program that would meet even the lower range of government targets.

The result is a Navy that continues to decommission ships faster than it builds them. It scraps multibillion-dollar hulls for a lack of repair capacity and falls further behind not just China but relative minnows like Italy and Finland, which have successfully introduced new, robust ship types that the United States has spent decades vainly trying to build. "While the Navy has expended lots of calories on attempts at LCS improvements with little to show for its efforts, other nations have continued to move

U.S. problems stem in part from the way the Navy designs ships. Post-Cold War cuts led to a slowdown in new shipbuilding across the board, and as a result, ailing private industry lobbied the Clinton administration to take on more engineering and design work, a function historically performed in-house by the Navy. Naval Sea Systems Command (NAVSEA) and its associated labs had earlier designed successful ships like the *Ticonderoga*-class cruisers and the *Wasp*-class amphibious assault ships. Then, seeking cost savings in the late 1990s, the Navy reduced this in-house naval architecture and engineering staff by 75 percent, from roughly 1,200 to 300.

The U.S. Navy continues to decommission ships faster than it builds them. It scraps multibillion-dollar hulls and falls further behind.

But perhaps the biggest contrast with China right now is shipbuilding capacity. While China has dozens of big shipyards that can build both warships and big commercial vessels, there are only seven yards in the United States that can build major warships. That dearth of capacity has several effects. With newer classes constantly in the shop for repairs, some ships sit at pier for years before being seen to. Late in 2020, the Navy decided to scrap the $4 billion *Bonhomme Richard*, a big-deck amphibious assault ship that had suffered an internal fire while docked in San Diego, in large part because the industrial base was stretched too thin to be able to handle the reconstruction needed.

For decades, the number of public and private yards has been shrinking, resulting in little competition and reduced capacity. Yards won't invest in infrastructure without orders on the books, and without a steady flow of orders, builders lose skilled workers, know-how, and subcontractors. Unlike in China, there's little commercial shipping to fall back on to keep the U.S. shipbuilding base afloat; around 90 percent of all commercial ships today are built in South Korea, Japan, and China.

And there aren't enough drydocks, especially if the Navy gets serious about expanding the fleet. The infrastructure is old and in poor shape: Norfolk Naval Shipyard's Drydock Number One has been in use since 1833—it refitted the Civil War-era ironclad USS *Merrimack*. The newest drydock at the four Navy-run shipyards was completed in

What can be done? Some think Washington should throw more money at the problem by, for example, increasing the Navy's budget—moving away from the traditional "rule of thirds" division of budget resources among the Army, Air Force, and Navy. Another fix would be to rebuild NAVSEA's in-house engineering and design capabilities. At the very least, critical subsystems need to be successfully prototyped before being integrated into a ship's design. And there should be more discipline before formally launching a new shipbuilding program, ensuring that every new technology has been rigorously assessed.

But just as a slow-moving aircraft carrier generates tremendous forward momentum, the U.S. planning and budgetary process becomes hard to steer or stop once it gets going, especially when funds are already flowing to a new ship class. Add the fact that profit-pursuing private shipyards have an outsized say in the design and building of new vessels, and you have a recipe for disaster.

A straightforward fix—though difficult with annual budget assessments—would be to ensure accurate, long-term shipbuilding plans. Such plans would allow industry to make investments, hire and train workers, and build capacity. The Navy also needs to direct and work more closely with industry to help it better understand the mission the Navy wants to meet. That would ultimately lead to cost savings and efficiencies, as more ships of a given class roll off the slipways, and would keep the industrial base humming.

A straightforward fix would be to ensure accurate, long-term shipbuilding plans.

Potential solutions to the Navy's shipbuilding woes should have appeal to both foreign and domestic policy agendas. The Biden administration believes that the United States must blunt China's ambitions—across the political, economic, and cultural spectrum—by building its strength at home and working with allies abroad. And if the U.S. government wants to counter China's industrial investment and manufacturing capacity, pursue better R&D, and employ more skilled workers, where better to start than the nation's shipyards?

when the Navy selected the winning bid for the new FFG(X) guided missile frigate, it was based on an Italian design and was less technologically ambitious than the recent failed classes. It has also modernized the venerable *Arleigh Burke* to remain the staple of the surface fleet until a new guided missile destroyer program, launched this summer, pays dividends with a brand-new surface combatant.

But none of the short-term fixes can patch decades of failure to keep the Navy in trim. Promised warships decades ahead of their time, American sailors instead are left to go into harm's way with ships from decades past. U.S. policymakers need to own up to that—and fix it.

This story appears in the Fall 2021 print issue.

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EXHIBIT 137

Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2023

Prepared by:

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Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year (FY) 2023

I. Reporting Requirement

This report is submitted per Section 231 of Title 10, United States Code. Appendices 1 - 7 provide supporting details. Appendix 6 is controlled under limited distribution. Appendix 7 is classified and forwarded separately.

II. Submission of the Report

This report is the Department of the Navy's (DoN) 30-year shipbuilding plan for FY2023 through FY2052. The FY2023 President's Budget (PB2023) provides planned funding to procure the ships included in the FY2023-FY2027 Future Years Defense Program (FYDP). Per the FY2022 National Defense Authorization Act (NDAA), the certified expected service life of each vessel, disaggregated by ship class, is included in Appendix 4. Unless otherwise noted, funding levels are constant year (CY) FY2022 dollars.

III. Analytic Efforts Supporting Force Structure Requirements

This plan highlights the Navy's work in coordination with the Office of the Secretary of Defense (OSD) to build a modernized naval force that makes needed contributions to advance the Joint Force's ability to campaign effectively, deter aggression, and, if required, win decisively in combat. As detailed in the June 2021 Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels, the Department previously completed significant analytic work with the Integrated Naval Force Structure Assessment (INFSA) and the Future Naval Force Study (FNFS) in support of the 2018 NDS. For the ranges in the FY22 shipbuilding plan, the FNFS Future Fleet Architectures (FFAs) were adjusted for final analytic insights based on combat effectiveness, industrial base production feasibility, and no real budget growth. These previous analytic works are summarized in Table 1. The Department of the Navy, in coordination with the Department of Defense, will provide the Battle Force Ship Assessment and Requirement Report aligned to the FY2022 NDS, which will inform the FY2024 shipbuilding plan, in accordance with Section 8695 of Title 10, United States Code.

The Department continues to evaluate industrial base health and support to Fleet readiness, capacity, and capability. Timely industrial base delivery of systems and platforms within cost estimates is a key consideration as it quickly enhances warfighting performance. Improvements in today's production enable greater capability and capacity for developing future platforms, such as the future large surface combatant (DDG(X)) and the next generation attack submarine (SSN(X)). The DoN, working with industry partners, will deliberately reduce execution risk through improved cost estimation, prototyping, and land-based testing systems to de-risk critical technologies and ensure that new programs deliver on expected capabilities.

Table 1. Previous Analytic Efforts Completed

Platforms	2016 FSA	2020 INFSA	FNFS FFA Ranges	PB22 Jun 2021 Ranges
Time Frame	Post 2030	Post 2030	2045	2045
Aircraft Carrier	12	12	8-11[1]	9-11
CVL	0	0	0-6[2]	0
LHA/LHD	12	10	6-10	8-9
Amphibious Warfare Ships (less LHA/LHD)	26	41[3]	30-43[3]	40-54[3]
Large Surface Combatant	104	96	72-80	63-65
Small Surface Combatant	52	56	47-60	40-45
Attack Submarines / Large Payload Submarine	66	66	58-70	66-72
Ballistic Missile Submarines	12	12	12	12
Combat Logistics Force	32	45[4]	51-85[4]	56-75
Support Vessels	39	52	27-51	27-29
Unmanned Surface	0	27	81-153[5]	59-89
Unmanned Subsurface	0	18	18-50[5]	18-51
Battle Force	355	390[8]	337-404[6]	321-372[7]
Battle Force + Unmanned Surface	-	417	382-454[6]	380-461
Battle Force + Unmanned Surface + Unmanned Subsurface	-	435	440-540[6]	398-512

1. Lower range may be enabled by acquisition of cost-effective CVL.
2. Cost-effective CVL capabilities and capacity study would be required.
3. Includes future Light Amphibious Warships (LAW).
4. Includes Next Generation Logistics Ships (NGLS).
5. UxV require follow-on analysis of future objectives.
6. FNFS FFA force mix ranges are not the sum of low and high platform ranges listed above. FNFS ranges were derived from previous campaign analysis, however the ranges represented no real budget growth.
7. The PB22 shipbuilding ranges were the sum of the low and high platform ranges possible in 2045, which were derived from FNFS, and updated with analytic insights.
8. The INFSA reflects the most recent full campaign analysis and force structure assessment completed by the Department of the Navy.

The section below highlights key insights within each mission area or domain. Additional information including capability fielding timelines are provided in classified Appendix 7.

Subsurface

- Maintaining the undersea advantage is a priority for the Navy. As the Navy's most survivable strike platforms, SSNs and SSBNs are key to both deterrence and to win decisively in conflict. To meet the additional demand for submarines, the department increased submarine industrial base capacity investments by $2.4B over the FY2022-2026 program. We continue to evaluate the industrial base capacity required for more consistent delivery of two SSNs per year during *Columbia* serial production and subsequent potential increases to SSN procurement following *Columbia* serial production. Trade studies and technology development efforts have started for SSN(X) with planned lead boat construction in the mid-2030s.

Carrier Aviation

- Nuclear powered carriers (CVNs) and carrier air wings (CVWs), the Joint Force's most survivable and adaptable aviation basing option, provide sea control and power projection in contested battlespace, offering a uniquely valuable combination of

maneuver, operational reach, volume of fires, sustainability, and organic sensors. As the center of maritime crisis response, these platforms provide sustained striking power, flexibility, and adaptability for a range of missions, from humanitarian aid to full-scale combat. With the capability to deploy the broadest range of sea-based aviation coupled with the capacity to arrive ready to execute and remain on station, nuclear-powered aircraft carriers provide combatant commanders with an array of combat capabilities unmatched in the world. As with other surface platforms, maintaining the survivability of CVNs is a priority for the Navy.

Surface

- Large Surface Combatants, most notably DDG 51 Flt III and the planned DDG(X) transition starting around FY2030, directly support Distributed Maritime Operations (DMO) and are key to Sea Denial and Sea Control missions. Increased numbers of smaller multi-mission combatants, such as Constellation Class Frigates (FFG 62), enable more efficient distribution of missions across the surface fleet, freeing up the more capable DDGs for critical high-end missions. The 2019 Future Surface Combatant Force Analysis of Alternatives (AoA) and FNFS indicated that the increased capabilities provided by the DDG 51 Flt III and DDG(X), coupled with a multi-mission FFG and supported by a number of unmanned assets such as Large Unmanned Surface Vessel (LUSV) and Medium Unmanned Surface Vessel (MUSV), yield a more distributed and lethal force.

Amphibious Ships

- Amphibious warfare ships are one of the cornerstones of maritime crisis response. They persist forward and are globally deployable. A three-ship Amphibious Readiness Group (ARG) partnered with a Marine Expeditionary Unit (MEU) provides a geographic combatant commander with an array of missions across the spectrum of conflict and crisis response. Amphibious Warfare Ships, sized for one Amphibious Task Force / Marine Expeditionary Brigade (ATF/MEB) and modernized with Joint Forcible Entry Operations (JFEO) capabilities, also provide the ability for rapid aggregation at sea. The Light Amphibious Warship (LAW) program provides maneuver and mobility for Stand-In forces, active campaigning, and contributions to integrated deterrence. In aggregate, Naval Expeditionary Force (NEF) formations contribute to a partnered maritime defense in depth and facilitate an integrated kill chain in conflict.

Combat Logistics Force (CLF)

- Logistics forces, to include current dry cargo and ammunition ships (T-AKEs), traditional fleet oilers (T-AOs) and the newly planned smaller Next Generation Logistics Ships (NGLS), are key to the sustainability of the fleet and Fleet Marine Force during all phases of operations including combat. To support a larger, more distributed force, increased numbers of T-AOs and NGLS platforms improve resiliency of the logistics force. The final CLF force size and mix will continue to evolve pending the NGLS AoA and additional studies as discussed in Section VI. Sealift, as a logistics enabler for the Joint Force, is covered in additional detail in Appendix 5.

Support Vessels

- Support vessels include enabler ships such as fleet tugs, salvage and rescue ships, submarine tenders, command ships, ocean surveillance ships, and fast transports. New submarine tenders will be constructed to support the Navy's new SSNs and SSBNs. Additionally, a new program is initiated to replace and improve the existing T-AGOS

ocean surveillance ships. Given the flexibility inherent in fast transports, additional missions for the fast transport vessels are being evaluated.

Unmanned Platforms

- Unmanned platforms show significant potential to contribute to naval capabilities. MUSVs can add substantial, distributed, low-cost forward sensors and C2 nodes. LUSVs show promise as a distributed weapons payload capacity at an affordable cost with the potential to integrate future capabilities such as sensors and other larger mission packages. In the near term, LUSVs may operate as adjunct missile magazines teamed with larger manned multi-mission platforms to minimize technical risk and maximize survivability. Additionally, Extra Large Unmanned Undersea Vehicles (XLUUVs) will potentially have the capability to deliver multiple payloads at extended ranges. Finally, multiple smaller USVs are being evaluated for various logistics missions and are also in production to support mine countermeasures missions.
- The Navy remains committed to actively testing concept of operations (CONOPS) and employment of these platforms to iteratively assess and fully develop their capabilities in a practical and realistic manner. USV program development is accomplished through land-based testing and at sea prototyping efforts. Platform development and subsystem technical maturation is following a Systems Engineering Framework approach across six lines of effort: reliable hull, mechanical and electrical (HM&E) systems; automated communications systems; integrated combat system; common control system; sensory perception and autonomy; platform and payload prototyping.

In summary, new production platforms, such as unmanned systems, NGLS, and LAW have great potential but also have developmental risk. The wider objective FNFS range shown in Table 1 for those platforms reflects this risk. As prototyping and experimentation retire technical and CONOPS uncertainty, coupled with higher fidelity cost models, we expect that the objective force ranges will narrow.

IV. Plan Objectives – Priorities, Fiscal Environment and Force Structure Adjustments

In order to deliver a ready and lethal Navy within available resources, the Navy has utilized a consistent process with steady priorities in budget submissions since PB2019. The priorities used are:

- Prioritize recapitalization of the SSBN fleet with the *Columbia* class SSBN
- Prioritize readiness to deliver a combat-credible forward force in the near-term
- Invest in increased lethality/modernization with the greatest potential to deliver non-linear warfighting advantages against China and Russia in mid-to-far-term
- Grow warfighting capacity aligned to the analytic work in Table 1. As stated in Section III, the warfighting requirement will be updated based on, and thus reflective of, the 2022 NDS which will inform the FY2024 shipbuilding plan.

The once in a generation recapitalization of the Nation's most survivable leg of the nuclear triad comes at the same time as the Navy modernizes for future threats, placing strain across the Navy's budget. The Navy will only grow ready, lethal, and survivable warfighting capacity at a rate supported by the fiscal guidance and our ability to sustain that capacity in the

future.

This plan does not resource capacity beyond what can be reasonably sustained – manning, training, maintenance, ordnance, operations, and future modernization. However, some risk was accepted in ship maintenance and readiness accounts. Although relatively small, any shortfall in maintenance will be realized as additional cost in the out years with growth above what is not funded in the current year. Assuming no real budget growth, the two low ranges of the plan do not procure all platforms at the desired rate (e.g., DDGs, SSNs and FFGs at two ships per year), which industry needs to demonstrate the ability to achieve, but do maximize capability within projected resources, industrial factors, and technology constraints to build the most capable force. Overall, this approach accepts risk in capacity in order to field a more capable and ready force.

PB2023 also includes difficult decisions to decommission 11 additional in-service platforms in FY2023 beyond the 13 ship reductions planned in previous budget cycles, for a total of 24 ships in FY2023. This decision frees up additional resources for shipbuilding and other priorities including manpower requirements. These include:

- 5 Guided Missile Cruisers (CG) - The Department of the Navy's assessment is the Department is better supported by investing in warfighting readiness, capabilities or capacity other than those of these legacy platforms. CGs have been the Navy's premier air defense command and control platforms for over three decades and this mission is now transitioning to Flight III DDGs. CGs on average are 35 years old and there would be little return on investment in maintaining these ships given their poor reliability, affordability, and lethality. The ships have a large vertical launch capacity; however, the substantial cost of repairing the poor material condition of these ships due to their age, and ongoing concerns with overall legacy sensor, and HM&E system reliability, outweighs the potential warfighting contributions of these platforms over their limited remaining service life.
- 9 Littoral Combat Ships (LCS) – PB2023 focuses the LCS class on mine countermeasures (MCM) and surface warfare (SUW), eliminating the anti-submarine warfare (ASW) mission for the class. Fifteen Independence Class LCSs are dedicated to MCM, and 6 Freedom Class LCS will be dedicated to SUW. The ASW Mission Package (MP) is no longer being pursued due to technical challenges, and the forthcoming introduction of FFG 62 as a highly capable ASW platform. Consequently, eight Freedom Class ships are planned for decommissioning in FY2023 which correlate with the 8 ASW MPs. LCS 3 is also decommissioned as it remains a non-deploying test ship that is no longer needed given the termination of the ASW MP. Continued retention of this ship imposes significant cost to upgrade it to a common configuration (including HM&E, structural, cooling and other upgrades) and capability with the rest of the Fleet. Decommissioning allows for investments in higher priority capability and capacity.
- 4 Dock Landing Ships (LSD) – The Department of the Navy's assessment is the Department is best supported by investing in warfighting readiness, capabilities, or capacity other than these legacy platforms. These legacy ships are in poor material condition due to their age and require significant resources to continue to maintain and operate. Shifting resources to other capabilities better supports the amphibious fleet, and provides more operational capability to the Navy and Marine Corps.

Appendix 1 summarizes PB2023 FYDP funding for ship construction (Shipbuilding and Conversion, Navy – SCN) and illustrates the acquisition, delivery, retirement, and inventory over the next 30 years under three scenarios, two reflecting a budget with no real growth and one reflecting a budget with additional resources beyond the FYDP. Each scenario assumes industry eliminates excess construction backlog and produces future ships on time and within budget. Evolving operational concepts and rapid technological changes make single-point predictions after approximately 10 years unreliable. Accordingly, Appendix 1 highlights a potential range of options for key fleet platforms beyond 10 years. As the Administration works with Congress to refine future years' plans, the composition and ramp-up of battle force procurement beyond FY2028 will be adjusted accordingly. Consistent with the FY2022 shipbuilding plan approach, combat effectiveness and industrial base production feasibility were taken into account.

Appendix 2 depicts costs for three battle force ship ranges outside the FYDP consistent with Appendix 1. At the low end of the ranges (i.e., no real growth budget), the modest increase in the two battle force options beyond the FYDP is a result of two new programs: LAW and NGLS. These smaller ships are critical enablers of the USMC Force Design and DMO, but do not bring the same level of global, multi-mission responsiveness as their larger and more capable counterparts. The higher range would require additional prioritization in ship procurement funding to better reflect the analytic work depicted in Table 1. As previously stated, the Navy will maintain readiness of the Fleet to avoid the possibility of a hollow force. Predicted sustainment costs for this force are detailed in Appendix 3.

V. PB2023 Shipbuilding Plan FYDP Overview

The PB2023 shipbuilding plan includes procurement of 9 manned ships in FY2023 and 51 manned battle force ships within the FYDP. Based on the corresponding projected funding levels in the FYDP, the battle force inventory will be 280 manned ships by FY2027. Without real budget growth, the two low range options achieve 305-307 manned ships in FY2035, and ultimately 318-322 manned ships in FY2045. The higher range achieves 326 manned ships in the mid-2030s, and ultimately 363 manned ships in FY2045. The above inventory levels are traditional manned battle force ships. In addition, unmanned platforms will achieve 89-149 platforms in FY2045 without real budget growth. Future force levels will be adjusted as the capabilities of unmanned platforms develop and are integrated into the battle force.

Full FYDP details of the FY2023 shipbuilding plan are in Appendix 1.

VI. The Future Navy Fleet to Support Distributed Maritime Operations (DMO)

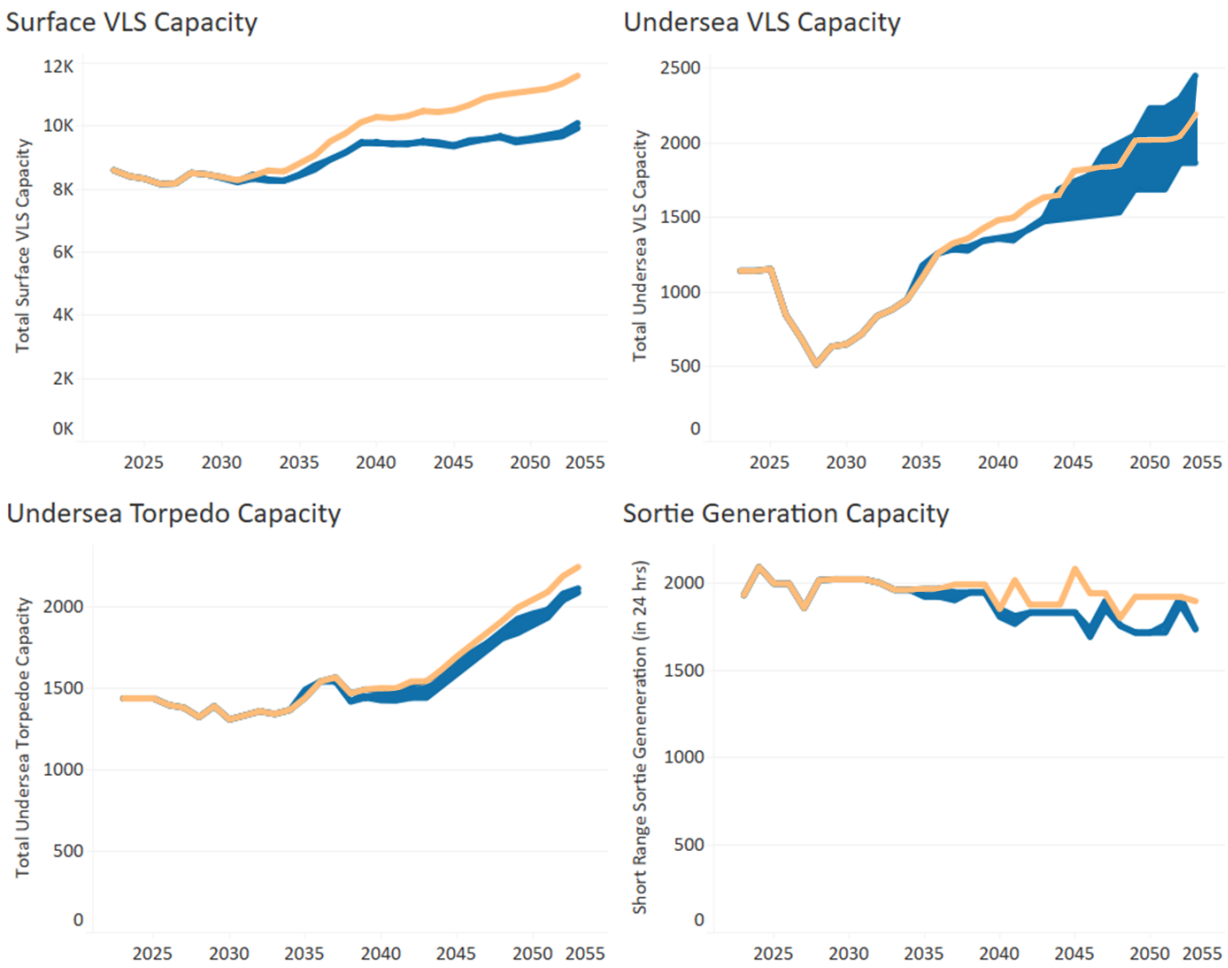
The concepts of DMO and Littoral Operations in a Contested Environment (LOCE) / Expeditionary Advanced Base Operations (EABO) require a balanced and different mix of traditional battle force ships as well as new unmanned, amphibious, and logistic platforms. Previous warfighting analysis validated that a progressive evolution of existing platforms combined with revolutionary introduction of new technologies results in a more survivable and more lethal force than previous force structures. The Department is committed to continually analyzing, testing, and experimenting with novel concepts and capabilities to ensure they will provide an optimal mix of capability to the warfighters of tomorrow.

DMO addresses challenges to sea control and access in contested and "informationalized" environments. This concept describes required capabilities to execute DMO with massed effects. DMO provides the intellectual framework necessary to evolve our fleet to meet the challenges of the future.

To realize these concepts, the Department continues to experiment and analyze a range of solutions to provide lethal capability for sea control and power projection within the framework of DMO. Study areas include, but are not limited to, aircraft carrier force structure, DDG(X), SSN(X), NGLS, amphibious ship mix, and expanded missions for unmanned platforms. This analysis and experimentation, in support of warfighting concepts, is informed by operationally relevant metrics including, but not limited to, capacity, lethality, survivability, operational reach, and affordability. While many of the operationally-informed metrics are classified, Figure 1 shows four unclassified metrics associated with key naval platforms.

The metrics in Figure 1 below highlight the capacity of potential future fleets to generate aircraft sorties, carry Vertical Launch System (VLS) tubes in surface or undersea platforms, and employ undersea torpedoes. The shaded areas within each graph represents the potential trade space in the first two profiles of Table A1-5 within each of the platform types. The gold line on the graph represents the additional warfighting capacity gained by pursuing the third profile in Table A1-5. Procurement pace and volume of platforms will evolve based on technological maturation, operating concepts, threat projections and industrial base capacity.

Figure 1. Key Naval Platform Metrics



Appendix 7 contains additional classified detail on select platforms and metrics, as

well as how those metrics compare with intelligence estimates of our primary strategic competitor.

VII. Unmanned Campaign Framework

The DoN released the Unmanned Campaign Framework and chartered the Unmanned Task Force to innovate and adapt new technology with which to build a more lethal and distributed naval force. To compete and win in an era of strategic competition, the Department is committed to investing in advanced autonomy; highly reliable HM&E systems; networks; and enabling systems to create true integrated human-machine teaming across the fleet. The Navy initiated "Project Overmatch" in support of this effort. As these systems advance in capability, they will become key supporting elements through all phases of warfare and in all warfare domains.

The Navy is accelerating the fielding of a full spectrum of unmanned capabilities. These systems are included in wargames, exercises, fleet battle problems, and limited real-world operations to derive employment plans and concepts of operation. Unmanned systems are funded in the Navy's research and development investments and accounted for in detail in each warfare domain's classified Capability Evolution Plan. Learning from land-based testing and functional prototypes will support continued refinement of platform requirements, technical maturation, capabilities development, and procurement profiles.

VIII. Industrial Base

The Navy's new construction and repair industrial base builds the Future Fleet and sustains today's Fleet. Sustaining and growing this vital shipbuilding base is a national security imperative that both energizes and challenges the Navy and the Nation. Strategic guidance and priorities, particularly as they affect the composition and size of the shipbuilding account, strongly influence the plans across the shipbuilding plan horizon. Nevertheless, over many decades, the foundation of a healthy shipbuilding base remains the Navy's commitment to stable, executable acquisition profiles that promote development and retention of highly-skilled workforces and investment in world-class manufacturing and shipbuilding facilities while maintaining a proper return on investment.

Within the overall industrial base, including both shipyards and suppliers, varying levels of capacity and risk exist. Nuclear powered ship production, a unique capacity with little to no opportunity for commercial or dual use production, is provided by two private shipyards that are currently facilitized and certified to construct nuclear powered ships and will be at capacity for the next 15 years building *Columbia* class SSBNs, *Virginia* class SSNs, next generation SSNs, and *Ford* class CVNs. The PB2023 request included additional industrial base funding to reduce the production risk, stabilize the more than 350 critical suppliers, and help enable recruitment and retention of the skilled production workforce. The non-nuclear shipbuilding industrial base that produces surface combatants, amphibious ships, combat logistics, and support vessels, while recovering from a number of perturbations, has the capacity to meet the force structure ranges of this plan. The Navy is working with these shipbuilders to manage platform transitions and facilitate the use of excess capacity to support the nuclear powered shipbuilding programs. Furthermore, the unmanned surface and undersea vessels described in this plan can be supported by the existing shipbuilding industrial base, providing opportunities for existing shipyards, existing boat and craft builders, and the potential for new entrants.

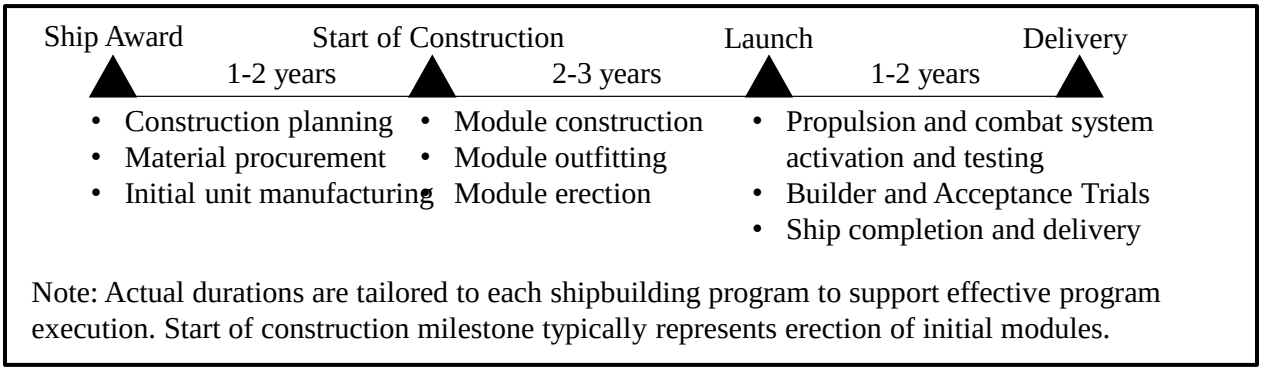
This shipbuilding plan assumes resource levels that are relatively steady or moderately

grow through-out the 30 year plan as shown in Appendix 2. Reduced procurement levels, inefficient profiles, and production gaps that could impact specific portions of the shipbuilding industrial base are sources of potential risk. The Navy is mindful that as fleet composition evolves to meet warfighting requirements, alternative opportunities for the industrial base must be examined. These opportunities include adjusting procurement profiles to mitigate "peaks and valleys" beyond the FYDP, as possible, and ensuring ample competitive opportunities for current and future platforms (i.e., T-AGOS 25, AS(X), LAW, NGLS, and a potential FFG 62 second source for construction when appropriate). These opportunities allow the industrial base to adapt while maintaining the capacity to deliver the capability the nation needs.

To summarize the more complete explanation provided in previous reports, and to keep a clear eye on historical context, the "boom and bust" profiles of the last 60-plus years resulted in sharp peaks followed by significant valleys, and sometimes breaks, in production. The trends provided by recent shipbuilding plans provided insight into why workforce experience and efficiency has become more difficult to reconstitute, and how that fundamentally contributed to longer, more expensive shipbuilding timelines. The buildup in the 1950s and 1980s, followed by "bust" periods of little production, each led to the loss of portions of our shipbuilding industrial capacity. The "boom" periods also led to large-scale block obsolescence as types/classes of ships reached (or will reach) the end of their service lives simultaneously, ultimately driving the need for another "boom" to recover. Given projected funding levels, the ability to recapitalize older ships with new ones is constrained resulting in transient decreases in overall inventory in some platforms. We are at a level of fragility in the supplier base, amplified by COVID impacts, such that without consistent and continuous commitment to steady and executable acquisition profiles the industrial base will continue to struggle and some elements may not recover from another "boom/bust" cycle.

The Navy appreciates that industry requires consistency in work orders under contract, or "backlog", to invest in the facilities, capital equipment, workforce and processes to deliver affordable ships at rate. During the 1-2 years between contract funding and the formal start of the construction milestone, shipbuilders order long lead time material from suppliers, develop and update construction build plans, and start steel cutting and early component fabrication that enable an optimized and efficient production flow once formal construction starts (reflected in Figure 2).

Figure 2. Notional Contract Award to Delivery Timeline



Note: Actual durations are tailored to each shipbuilding program to support effective program execution. Start of construction milestone typically represents erection of initial modules.

Congress has been a great partner in supporting the industrial base and the Navy greatly appreciates this commitment to shipbuilding. Congress has consistently appropriated funding in support of increasing industry capacity and supplier health. The PB2023 budget provides $2.4B

to support a generational increase in demand and includes supplier development, ship builder/supplier infrastructure, workforce development, technology advances, and strategic sourcing of the submarine industrial base. The Navy will continue to collaborate with industry to execute this funding and continue to collaborate with Congress and industry on strategies to positively affect shipbuilding base health.

IX. Summary

The new era of strategic competition requires a larger modernized, capable, globally deployed, forward, and lethal multi-domain Navy. Difficult choices must be made to ensure that the Navy best meets Joint Force operational requirements. These choices include divesting ships that provide less relevant capability to our pacing threat warfighting requirements. It also requires prioritizing promising technologies that need to be fielded quickly and at scale to be operationally relevant in the coming years. Careful prioritization in the near-term, in accordance with the Interim National Security Strategic Guidance and the 2022 NDS, will result in a Navy battle force that is more ready, sustainable, and lethal.

Appendix 1

PB2023 Shipbuilding Plan (FY2023-FY2027)

Table A1-1 includes the President's Budget (PB2023) funding for the Future Years Defense Program (FYDP) portion of the 30-yr shipbuilding plan.

Table A1-1 PB2023 FYDP funding for New Construction Battle Force Ship Building and Conversion Navy (SCN)

	FY2023		FY2024		FY2025		FY2026		FY2027		FYDP	
Ship Type ($M)	**$**	**Qty**	**$**	**Qty**	**$**	**Qty**	**$**	**Qty**	**$**	**Qty**	**$**	**Qty**
CVN 78[1]	2,534		1,894		3,051		3,118		3,846		14,443	
DDG 51	4,995	2	4,259	2	4,221	2	4,264	2	4,292	2	22,031	10
FFG 62	1,160	1	1,976	2	1,047	1	1,896	2	1,041	1	7,120	7
SSN 774	6,560	2	8,335	2	8,747	2	7,778	2	7,516	2	38,936	10
SSBN 826[2]	5,858		5,815	1	7,223		8,477	1	8,955	1	36,328	3
LPD Flt II	1,673	1									1,673	1
LHA(R)[3]	1,085	1	1,535								2,620	1
LSM (Light Amphibious Warship)					247	1	203	1	290	2	740	4
T-AO 205	795	1	1,358	2	733	1	747	1	764	1	4,397	6
T-AOL (Next Gen Logistics Ship)							150	1	156	1	306	2
T-ATS 6	96	1									96	1
T-AGOS 25					434	1	817	2	415	1	1,666	4
AS(X)[4]					1,174	1	1,233	1			2,407	2
Total New Construction[5]	**24,756**	**9**	**25,172**	**9**	**26,877**	**9**	**28,683**	**13**	**27,275**	**11**	**132,763**	**51**

Notes:

1. Funding reflects the two-CVN procurement for CVN 80 and CVN 81 and Advance Procurement (AP) for CVN 82 in FY2026 and FY2027. A decision on CVN 82/83 two-ship buy is NLT FY25.
2. FY2023 includes the last year of incremental full funding for the lead ship and FY2024-25 represents incremental full funding for the 2nd ship and the first year of AP for the 3rd ship. Funding in FY2026 and FY2027 is for the first two serial production ships. Other funding shown is AP and economic order quantity funding for multiple ships.
3. Reflects incremental procurement funding in FY2023 and FY2024 to support LHA 9 construction start in FY2023.
4. New ships planned for future procurement or for replacement of legacy ships are annotated with (X) until their class has been named, such as AS(X).
5. Funding for sustainment (maintenance, personnel, operations, etc.) is in addition to funding for shipbuilding (SCN), and is phased with delivery of battle force ships within the FYDP.

Notable FYDP procurement activity in the PB2023 budget submission includes:

- Continues funding the lead *Columbia* class SSBN appropriated in FY2021, the second in FY2024, and serial production of one SSBN per year beginning in FY2026.
- Continues to meet full funding requirements for CVN 80 and CVN 81 and AP funding for CVN 82 in FY2026 and FY2027.
- Completes funding for *Virginia* class Block V procurement in FY2023 with 2 submarines. Funds 8 *Virginia* class Block VI submarines in the FYDP to support multi-year procurement of ten SSNs from FY2024 to FY2028. The DoN is closely monitoring the submarine construction program while building two Virginia payload

module SSNs and the *Columbia* class SSBN program moving into serial production in FY2026. Additionally, $2.4B is added across the FYDP to increase capacity in the submarine industrial base, as this production rate will require significantly increased and sustained shipbuilding performance. Trade studies and technology development efforts have started for SSN(X) with planned lead boat construction in the mid-2030s.

- Programs funding for 10 DDG 51 class destroyers at a steady rate of two ships per year across the FYDP and seeks authority for multiyear procurement of up to 10 DDGs from FY2023 to FY2027. Delays procurement of DDG(X) to FY2030. Pursuing an FY2030 construction start for DDG(X) sustains DDG 51 Flight III production while reducing execution risk through land-based testing of the integrated power system and new hull form.
- Restructures the FFG 62 procurement profile to 1/2/1/2/1 FY2023-FY2027 due to affordability and design maturation. These changes in small surface combatant procurement manage execution risk in the FFG program for FY2023 as the shipyard works to start construction on the lead ship in FY2022.
- Procures one LPD Flight II in FY2023 and completes procurement of the LPD Flight II line. The preponderance of full funding for LHA 9 is maintained in FY2023 and FY2024. The Navy will begin assessment of a next-generation amphibious ship (i.e., LPD(X)) in FY2023.
- Funds six T-AO 205 class ships across the FYDP including two ships in FY2024.
- Procures one T-ATS 6 towing, salvage, and rescue ship and completes the program in FY2023.
- Begins serial production of T-AGOS 25 ships in FY2025.
- Includes funding for two AS(X) ships in FY2025 and FY2026.

Long-Range Naval Vessel Inventory

Balance across procurement, readiness, and capability must remain in order to field credible naval power. It takes decades of consistent procurement; operations and sustainment; and all the supporting manpower, training, infrastructure, and networks in a disciplined approach to maintain the naval force needed.

Tables A1-2 thru A1-3 depict the procurement and delivery plans, Table A1-4 shows the retirement plan, which drive the battle force inventories shown in Table A1-5. Tables A1-3 and A1-5 assume industry eliminates excess construction backlog and produces future ships on time and within budget. The first two alternatives provide warfighting commanders ready and lethal platforms with no real budget growth. They are based on the FFAs from the FY22 shipbuilding plan, updated for ship cost increases, service life decreases, FY22 appropriations, and PB23 decisions. The third alternative is based on Navy's INFSA analysis. It is constrained by Navy's assessment of industrial base capacity, but requires additional resources beyond the FYDP. It more closely approaches the previous analytic work depicted in Table 1.

The inventory table indicates the projected number of ships in service on the last day of each fiscal year:

- Provides capable capacity for Combatant Commanders.
- The first two profiles add risk outside the FYDP to the submarine and surface combatant

industrial base due to procurement rates less than two per year due to a greater prioritization on other ship classes.

- Continues to include future plans for introducing new or evolved platforms such as the next generation attack (SSN(X)) and large payload-based submarines, small and large surface combatants (DDG(X)), logistics, and support ships.

- The Department continues to review opportunities to accelerate new construction platforms and to assess the ability to extend existing platforms that have a satisfactory Lifecycle Health Assessment to achieve the force necessary to support the Combatant Commanders.

Table A1-2. Long-Range Procurement Profile[1, 2]

Transition *Future Force Design*

FYDP

Fiscal Year	23	24	25	26	27
Aircraft Carrier					
Large Surface Combatant	2	2	2	2	2
Small Surface Combatant	1	2	1	2	1
Attack Submarines	2	2	2	2	2
Ballistic Missile Submarines		1		1	1
Cruise Missile Submarines					
Amphibious Warfare Ships	2		1	1	2
Combat Logistics Force	1	2	1	2	2
Support Vessels	1		2	3	1
Total New Construction	9	9	9	13	11

ALTERNATIVE 1	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	1					1					1					1					1				
Large Surface Combatant	1	2	2	2	1	2	1	2	2	2	2	2	2	2	1	2	2	1	2	1	2	2	2	2	2
Small Surface Combatant	2	1	1	1	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Attack Submarines	2	2	1	1	2	1	2	1	2	2	2	2	2	2	1	2	2	2	2	1	2	2	2	2	2
Ballistic Missile Submarines	1	1	1	1	1	1	1	1																	
Cruise Missile Submarines														1				1			1			1	
Amphibious Warfare Ships	2	2	2	3	2	2	2	3	2	2	1			1		1	1	2	2	2	3	2	3	3	2
Combat Logistics Force	2	2	2	2	2	2	2	1	1					1	1		2	2	3	3	3	1	1	1	1
Support Vessels	1	1																							
Total New Construction	12	11	9	10	9	11	9	10	9	8	8	6	6	8	7	7	9	11	10	10	13	9	10	11	9

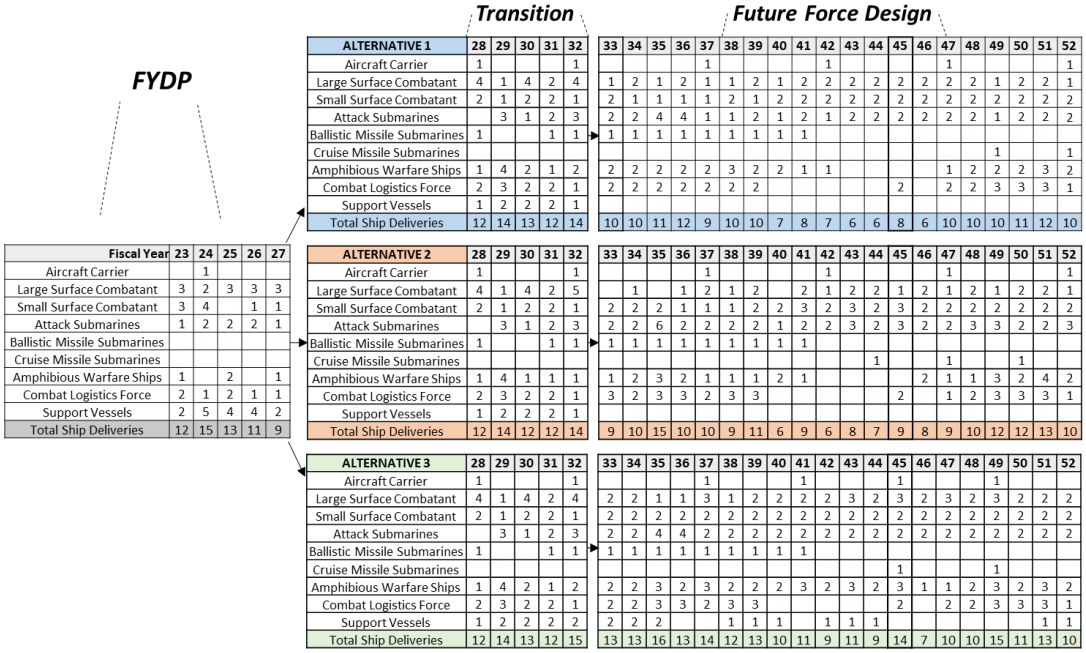
ALTERNATIVE 2	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	1					1					1					1					1				
Large Surface Combatant	1	1	1	1	2	1	1	1	2	1	2	2	2	1	2	1	2	2	1	2	1	2	1	2	2
Small Surface Combatant	2	2	1	1	1	1	1	2	2	3	2	3	2	3	2	2	2	2	2	2	2	2	2	2	2
Attack Submarines	2	2	2	2	2	1	2	2	3	2	3	2	2	3	3	2	2	3	2	2	3	2	2	3	2
Ballistic Missile Submarines	1	1	1	1	1	1	1	1																	
Cruise Missile Submarines										1			1			1			1			1			1
Amphibious Warfare Ships	1	2	1	2	2	2	1	2	1	1	1			2		2	1	1	3	2	3	2	3	3	3
Combat Logistics Force	2	2	3	2	2	3	3	2	2					1	1		1	2	3	3	3	1	1	1	2
Support Vessels	1	1																							
Total New Construction	11	11	9	9	10	10	9	10	10	8	9	7	7	10	8	9	8	10	12	11	13	10	9	11	12

ALTERNATIVE 3	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	1				1				1				1				1				1				1
Large Surface Combatant	2	2	2	2	2	2	2	2	3	2	3	2	3	2	3	2	2	2	2	2	2	2	2	2	2
Small Surface Combatant	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Attack Submarines	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Ballistic Missile Submarines	1	1	1	1	1	1	1	1																	
Cruise Missile Submarines											1			1					1				1		
Amphibious Warfare Ships	3	2	3	2	2	2	3	2	2	3	3	3	3	2	2	1	1	2	2	3	2	3	2	3	2
Combat Logistics Force	2	2	2	2	2	3	3	2	2					1	1		2	2	3	3	3	1	1	1	1
Support Vessels	1	2	2	2	2	1			1	1		1	1	1							1	1	1	1	1
Total New Construction	14	13	14	13	14	13	13	11	13	10	11	10	12	10	11	7	10	10	12	12	13	11	11	11	11

[1] A decision on CVN 82/83 two-ship buy is required no later than FY25 and will be evaluated during upcoming force structure and industrial base studies. The Department is reviewing Large and Small Surface Combatant and Attack Submarine procurement quantities in FY2028-2032.

[2]The ability of the industrial base to support Alternative 3 has not been independently assessed.

Table A1-3. Battle Force Delivery Plan



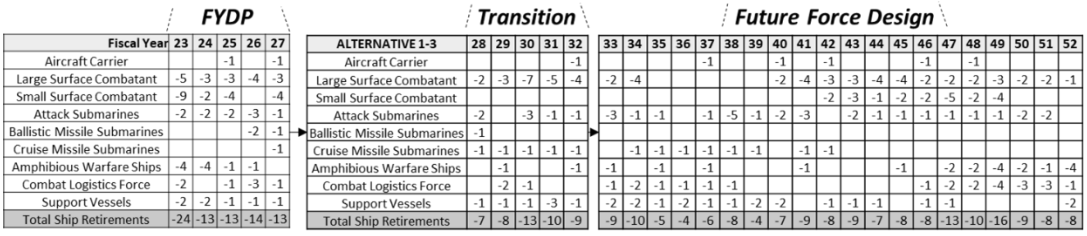
Fiscal Year	23	24	25	26	27
Aircraft Carrier		1			
Large Surface Combatant	3	2	3	3	3
Small Surface Combatant	3	4		1	1
Attack Submarines	1	2	2	2	1
Ballistic Missile Submarines					
Cruise Missile Submarines					
Amphibious Warfare Ships	1		2		1
Combat Logistics Force	2	1	2	1	1
Support Vessels	2	5	4	4	2
Total Ship Deliveries	12	15	13	11	9

ALTERNATIVE 1	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	1				1					1					1					1					1
Large Surface Combatant	4	1	4	2	4	1	2	1	2	1	1	2	1	2	2	2	2	2	2	2	2	1	2	2	1
Small Surface Combatant	2	1	2	2	1	2	1	1	1	1	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2
Attack Submarines		3	1	2	3	2	2	4	4	1	1	2	1	2	1	2	2	2	2	2	2	1	2	2	2
Ballistic Missile Submarines	1			1	1	1	1	1	1	1	1	1	1	1											
Cruise Missile Submarines																						1			1
Amphibious Warfare Ships	1	4	2	1	2	2	2	2	2	2	3	2	2	1	1					1	2	2	2	3	2
Combat Logistics Force	2	3	2	2	1	2	2	2	2	2	2	2						2		2	2	3	3	3	1
Support Vessels	1	2	2	2	1																				
Total Ship Deliveries	12	14	13	12	14	10	10	11	12	9	10	10	7	8	7	6	6	8	6	10	10	10	11	12	10

ALTERNATIVE 2	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	1				1					1					1					1					1
Large Surface Combatant	4	1	4	2	5		1		1	2	1	2		2	1	2	2	1	2	1	2	1	2	2	1
Small Surface Combatant	2	1	2	2	1	2	2	2	1	1	1	2	2	3	2	3	2	3	2	2	2	2	2	2	2
Attack Submarines		3	1	2	3	2	2	6	2	2	2	2	1	2	2	3	2	3	2	2	3	3	2	2	3
Ballistic Missile Submarines	1			1	1	1	1	1	1	1	1	1	1	1											
Cruise Missile Submarines																	1			1			1		
Amphibious Warfare Ships	1	4	1	1	1	1	2	3	2	1	1	1	2	1					2	1	1	3	2	4	2
Combat Logistics Force	2	3	2	2	1	3	2	3	3	2	3	3						2		1	2	3	3	3	1
Support Vessels	1	2	2	2	1																				
Total Ship Deliveries	12	14	12	12	14	9	10	15	10	10	9	11	6	9	6	8	7	9	8	9	10	12	12	13	10

ALTERNATIVE 3	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	1				1					1				1				1				1			
Large Surface Combatant	4	1	4	2	4	2	2	1	1	3	1	2	2	2	2	3	2	3	2	3	2	3	2	2	2
Small Surface Combatant	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Attack Submarines		3	1	2	3	2	2	4	4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Ballistic Missile Submarines	1			1	1	1	1	1	1	1	1	1	1	1											
Cruise Missile Submarines																		1				1			
Amphibious Warfare Ships	1	4	2	1	2	2	2	3	2	3	2	2	2	3	2	3	2	3	1	1	2	3	2	3	2
Combat Logistics Force	2	3	2	2	1	2	2	3	3	2	3	3						2		2	2	3	3	3	1
Support Vessels	1	2	2	2	2	2	2	2		1	1	1		1	1	1								1	1
Total Ship Deliveries	12	14	13	12	15	13	13	16	13	14	12	13	10	11	9	11	9	14	7	10	10	15	11	13	10

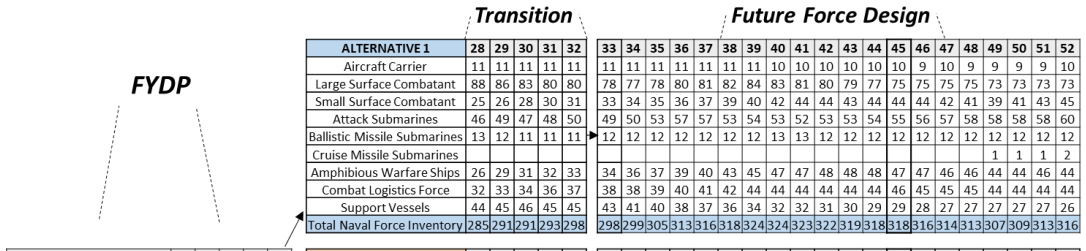
Table A1-4. Battle Force Retirement Plan



Fiscal Year	23	24	25	26	27
Aircraft Carrier			-1		-1
Large Surface Combatant	-5	-3	-3	-4	-3
Small Surface Combatant	-9	-2	-4		-4
Attack Submarines	-2	-2	-2	-3	-1
Ballistic Missile Submarines				-2	-1
Cruise Missile Submarines					-1
Amphibious Warfare Ships	-4	-4	-1	-1	
Combat Logistics Force	-2		-1	-3	-1
Support Vessels	-2	-2	-1	-1	-1
Total Ship Retirements	-24	-13	-13	-14	-13

ALTERNATIVE 1-3	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier					-1					-1			-1		-1				-1		-1				
Large Surface Combatant	-2	-3	-7	-5	-4	-2	-4						-2	-4	-3	-3	-4	-4	-2	-2	-2	-3	-2	-2	-1
Small Surface Combatant															-2	-3	-1	-2	-2	-5	-2	-4			
Attack Submarines	-2		-3	-1	-1	-3	-1	-1		-1	-5	-1	-2	-3		-2	-1	-1	-1	-1	-1	-1	-2	-2	
Ballistic Missile Submarines	-1																								
Cruise Missile Submarines	-1	-1	-1	-1	-1		-1	-1	-1	-1	-1	-1		-1	-1										
Amphibious Warfare Ships	-1		-1		-1	-1				-1				-1				-1		-2	-2	-4	-2	-1	-4
Combat Logistics Force		-2	-1			-1	-2	-1	-1	-1	-1	-1							-1	-2	-2	-4	-3	-3	-1
Support Vessels	-1	-1	-1	-3	-1	-2	-2	-1	-2	-1	-1	-2	-2		-1	-1	-1		-1	-1					-2
Total Ship Retirements	-7	-8	-13	-10	-9	-9	-10	-5	-4	-6	-8	-4	-7	-9	-8	-9	-7	-8	-8	-13	-10	-16	-9	-8	-8

Table A1-5. Battle Force Inventory and Trade Space



Fiscal Year	23	24	25	26	27
Aircraft Carrier	11	12	11	11	10
Large Surface Combatant	88	87	87	86	86
Small Surface Combatant	27	29	25	26	23
Attack Submarines	49	49	49	48	48
Ballistic Missile Submarines	14	14	14	14	13
Cruise Missile Submarines	4	4	4	2	1
Amphibious Warfare Ships	28	24	25	24	25
Combat Logistics Force	30	31	32	30	30
Support Vessels	34	37	40	43	44
Total Naval Force Inventory	285	287	287	284	280

ALTERNATIVE 1	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	11	11	11	11	11	11	11	11	11	11	11	11	10	10	10	10	10	10	9	10	9	9	9	9	10
Large Surface Combatant	88	86	83	80	80	78	77	78	80	81	82	84	83	81	80	79	77	75	75	75	75	73	73	73	73
Small Surface Combatant	25	26	28	30	31	33	34	35	36	37	39	40	42	44	44	43	44	44	44	42	41	39	41	43	45
Attack Submarines	46	49	47	48	50	49	50	53	57	57	53	54	53	52	53	53	54	55	56	57	58	58	58	58	60
Ballistic Missile Submarines	13	12	11	11	11	12	12	12	12	12	12	12	13	13	12	12	12	12	12	12	12	12	12	12	12
Cruise Missile Submarines																						1	1	1	2
Amphibious Warfare Ships	26	29	31	32	33	34	36	37	39	40	43	45	47	47	48	48	48	47	47	46	46	44	44	46	44
Combat Logistics Force	32	33	34	36	37	38	38	39	40	41	42	44	44	44	44	44	44	46	45	45	45	44	44	44	44
Support Vessels	44	45	46	45	45	43	41	40	38	37	36	34	32	32	31	30	29	29	28	27	27	27	27	27	26
Total Naval Force Inventory	285	291	291	293	298	298	299	305	313	316	318	324	324	323	322	319	318	318	316	314	313	307	309	313	316

ALTERNATIVE 2	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	11	11	11	11	11	11	11	11	11	11	11	11	10	10	10	10	10	10	9	10	9	9	9	9	10
Large Surface Combatant	88	86	83	80	81	78	76	76	77	79	80	82	80	78	76	75	73	70	70	69	69	67	67	67	67
Small Surface Combatant	25	26	28	30	31	33	35	37	38	39	40	42	44	47	47	47	48	49	49	47	46	44	46	48	50
Attack Submarines	46	49	47	48	50	49	50	55	57	58	55	56	55	54	56	57	58	60	61	62	64	66	66	66	69
Ballistic Missile Submarines	13	12	11	11	11	12	12	12	12	12	12	12	13	13	12	12	12	12	12	12	12	12	12	12	12
Cruise Missile Submarines																		1	1	1	2	2	2	3	3
Amphibious Warfare Ships	26	29	30	31	31	31	33	35	37	37	38	39	41	41	41	41	41	40	42	41	40	39	40	43	42
Combat Logistics Force	32	33	34	36	37	39	39	41	43	44	46	49	49	49	49	49	49	51	50	49	49	48	48	48	48
Support Vessels	44	45	46	45	45	43	41	40	38	37	36	34	32	32	31	30	29	29	28	27	27	27	27	27	26
Total Naval Force Inventory	285	291	290	292	297	296	297	307	313	317	318	325	324	324	322	321	321	322	322	319	318	314	318	323	327

ALTERNATIVE 3	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Aircraft Carrier	11	11	11	11	11	11	11	11	11	11	11	11	10	11	10	10	10	11	10	10	9	10	10	10	10
Large Surface Combatant	88	86	83	80	80	80	78	79	80	83	84	86	86	84	83	83	81	80	80	81	81	81	81	81	82
Small Surface Combatant	25	26	28	30	31	33	35	37	39	41	43	45	47	49	49	48	49	49	49	46	46	44	46	48	50
Attack Submarines	46	49	47	48	50	49	50	53	57	58	55	56	56	55	57	57	58	59	60	61	62	63	63	63	65
Ballistic Missile Submarines	13	12	11	11	11	12	12	12	12	12	12	12	13	13	12	12	12	12	12	12	12	12	12	12	12
Cruise Missile Submarines																		1	1	1	1	2	2	2	2
Amphibious Warfare Ships	26	29	31	32	33	34	36	38	40	42	44	46	48	50	52	55	57	59	60	59	59	58	58	60	58
Combat Logistics Force	32	33	34	36	37	38	38	40	42	43	45	48	48	48	48	48	48	50	49	49	49	48	48	48	48
Support Vessels	44	45	46	45	46	46	46	47	45	44	44	43	42	42	42	42	42	42	41	40	40	40	40	41	40
Total Naval Force Inventory	285	291	291	293	299	303	306	317	326	334	338	347	350	352	353	355	357	363	362	359	359	358	360	365	367

Appendix 2

Annual Funding for Ship Construction

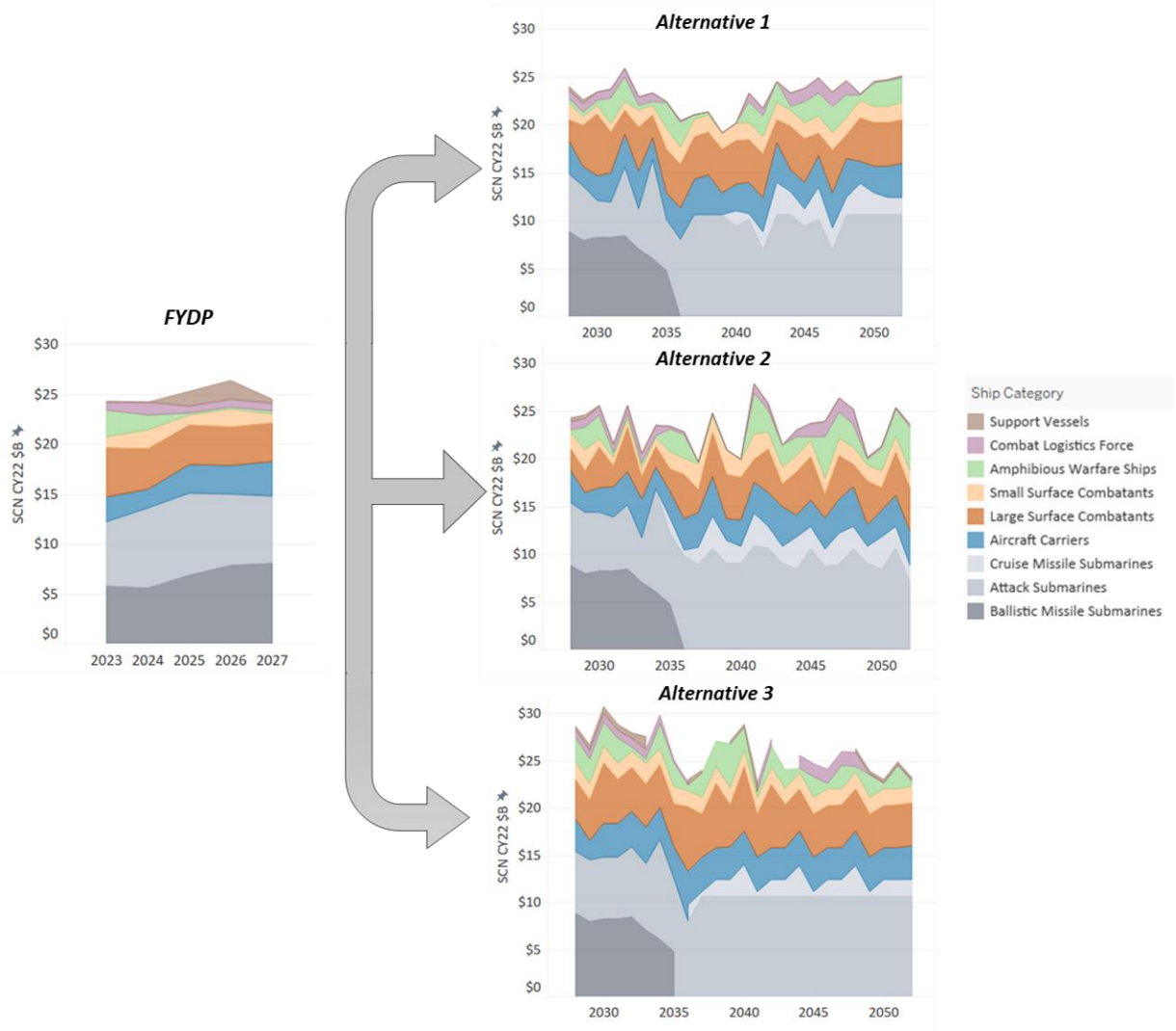
Funding is in FY2022 constant dollars. In Figure A2-1, the first two graphics depict the estimated funding required to achieve the first two profiles of battle force inventories depicted in Appendix 1, Table A1-5, and assume industry produces future ships on time and within budget. The SSBN force was last recapitalized from FY1974 to FY1989. The fiscal impact of the *Columbia* class increased significantly in FY2021 with procurement of the lead SSBN. The impact grows across the FYDP to FY2026 when annual full procurements will be required to support serial production through FY2035. This strategic nuclear investment represents the Navy's most important program and largest fiscal challenge over the next 15 years.

The cost to procure a larger Navy represented by the third profile in Table A1-5, is shown in the third graphic of Figure A2-1, and assumes industry produces future ships on time and within budget. The high range represents an additional $75B real growth beyond the FYDP in FY2022 constant dollars. The increased procurement level, informed by industrial base capacity and on-time and on-budget performance, achieves 326 manned battle force ships in the mid-2030s, and ultimately achieves 363 manned battle force ships in FY2045. The previous analytic work depicted in Table 1 will be updated with follow-on force structure assessment based on, and thus reflective of, the warfighting requirements of the 2022 NDS.

The cost to sustain a larger Navy is in addition to that required for procurement and is phased within the appropriate accounts (i.e., manpower, support, training, infrastructure) to match ship deliveries. Appendix 3 illustrates the projected cost of owning and operating (operations and sustainment) the fleet at the ranges that represent no real budget growth. This appendix does not include the funding associated with Appendix 5, which discusses the growing logistics requirement and sealift recapitalization.

Next generation ships and submarines are in the early stages of requirements definition. Accordingly, cost estimates and their impact on overall force mix will be determined within the ongoing work of the force structure assessment. The baseline acquisition profiles reinforce long-term workforce stability for thoughtful, agile modernization, and a clearer forecast of when to transition between classes of ships.

Figure A2-1. Annual Funding for Ship Construction (FY2023-2052)



Appendix 3

Annual Funding for Sustainment

NDAA FY2019 directed reporting cost considerations of owning and operating a larger force. The priorities stated in the body of this report require that the DoN ensure the operations and sustainment accounts are funded properly to achieve a ready and capable force.

Scaled operations and sustainment funding to support the size of the fleet is essential to maintain and repair the battle force. Appropriately phased sustainment funding must be consistent with the size of the battle force. To be capable, ready, and lethal, the Navy must remain balanced across the elements of readiness, modernization, and force structure. When the life of a ship is extended, the sustainment requirement grows as the age of the ship increases. Moreover, sustainment resources programmed to shift from a retiring ship to a new ship must now stay in place for the duration of the extension. The sustainment requirement grows until equilibrium is reached at the desired higher force inventory, when deliveries match retirements and all resourcing accounts reach steady-state at a higher, enduring cost. Sustainment funding must also be reallocated from other Navy programs during the year of execution for any proposed ship decommissioning that Congress does not approve.

The sustainment costs in Figures A3-1 through A3-3 represent the funding programmed in the FYDP with FY2027 funding levels inflated forward using Office of the Secretary of Defense indices applied to the inventory alternatives shown in Appendix 1, Table A1-5. Included in this sustainment estimate are personnel, planned maintenance, and baseline operations, which represent those costs tied directly to owning and operating a ship. Figures A3-1 through A3-3 do not capture all costs. For example, long-range costs such as modernization and ordnance (threat and technology driven), infrastructure and training (services spread across many ships), and aviation detachments are not included.

The complex model(s) needed to capture indirect costs to own the force are under development. Similar to procurement, estimates become less accurate further into the future.

Figure A3-1. Alternative 1 Annual Funding for Sustainment (FY2023-2052)[1]

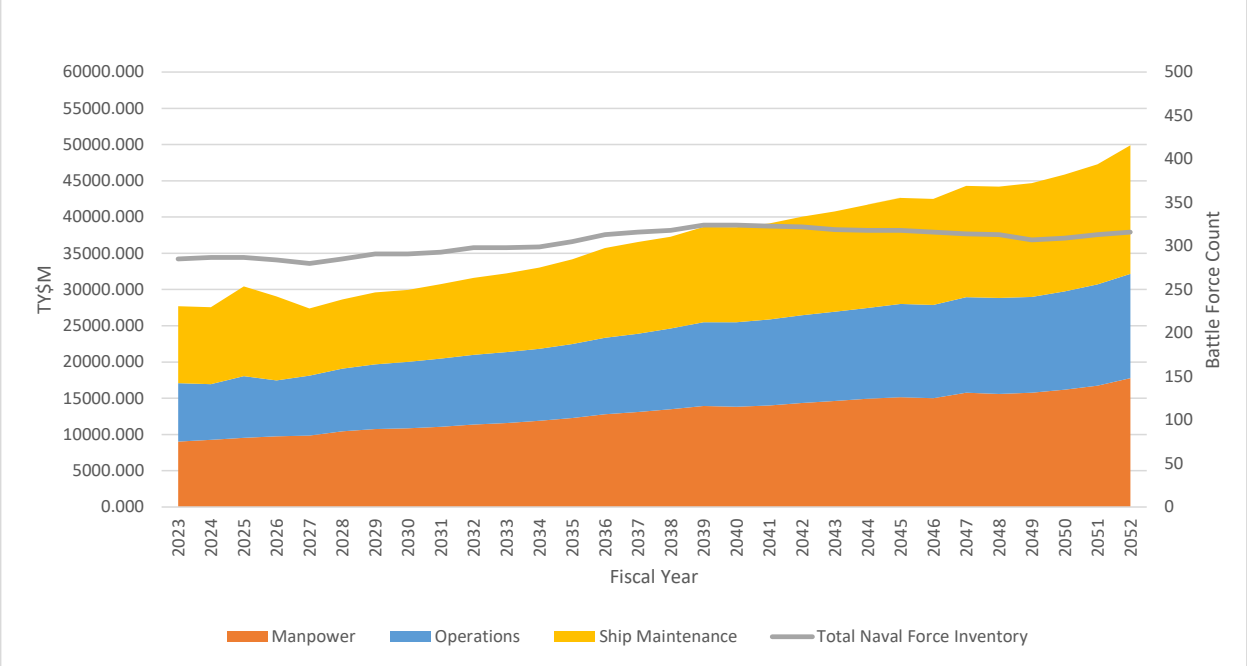


Figure A3-2. Alternative 2 Annual Funding for Sustainment (FY2023-2052)[1]

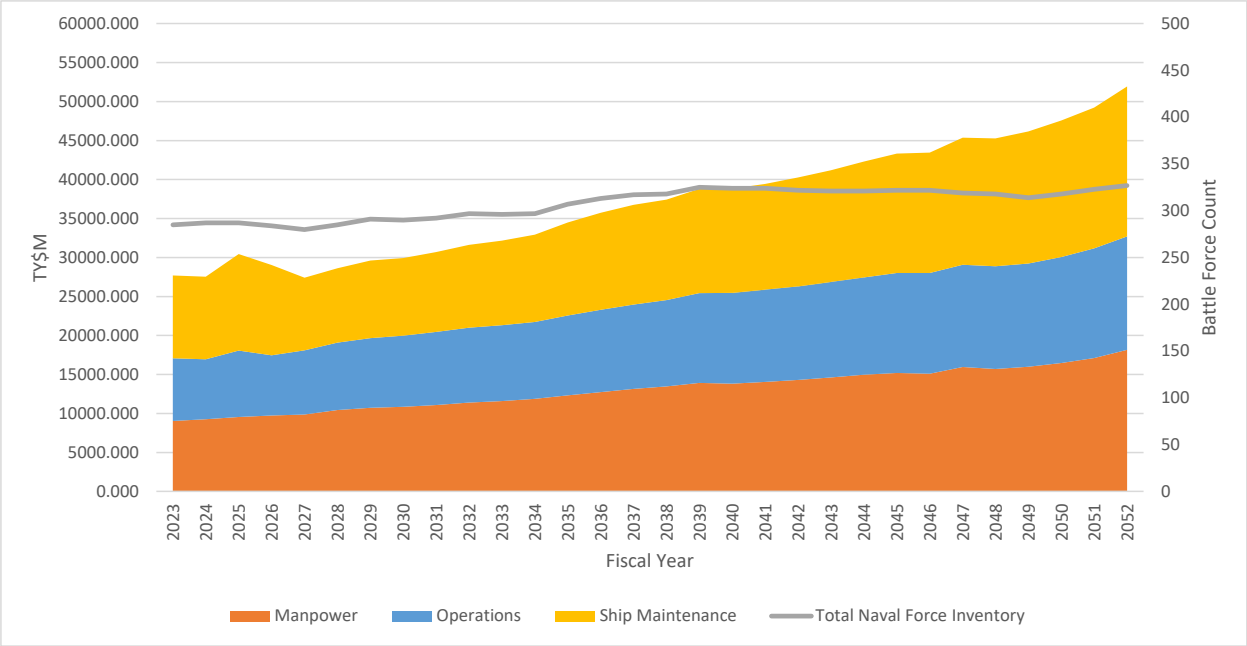
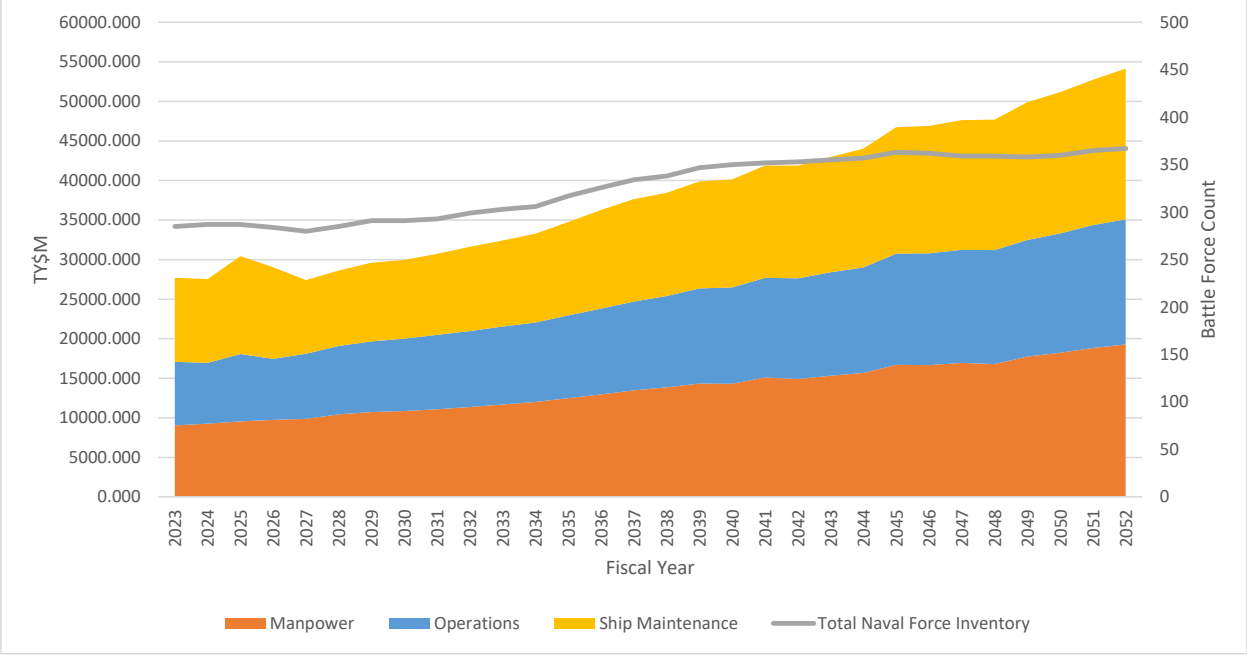


Figure A3-3. Alternative 3 Annual Funding for Sustainment (FY2023-2052)[1]



[1] Shows funding estimated for personnel, maintenance, and operations programmed in the FYDP for the ships in the battle force. Beyond the FYDP, the funding is inflated from FY2027, scaled by projected ship types and quantities in the battle force.

Appendix 4

Planned Decommissioning, Dismantling, and Disposals during FY2023-FY2027 Future-Years Defense Program (FYDP)

This addendum report is in compliance with the Senate Armed Services Committee request for additional information regarding decommissioning and disposal of naval vessels. Table A4-l lists the battle force ships to be inactivated within the FYDP. The table also identifies the planned disposition for each ship and the age of the ship in the year the ship is inactivated. The Expected Service Lives (ESL) for the ship classes have been certified by the Naval Sea Systems Command Senior Technical Authority.

Table A4-1. Ships planned to be inactivated[1] during the FYDP

Inactivation Year (FY) – Total Ships	Ship Name/Designation/Hull Number	Disposition[2]	Age[3]	ESL
2023 – 24 Ships	USS SAN JACINTO (CG 56)	LSA	35	35
	USS LAKE CHAMPLAIN (CG 57)	LSA	35	35
	USS BUNKER HILL (CG 52)	OCIR	37	35
	USS MOBILE BAY (CG 53)	OCIR	36	35
	USS VICKSBURG (CG 69)	OCIR	31	35
	USS FORT WORTH (LCS 3)	OCIR	12	25
	USS MILWAUKEE (LCS 5)	OCIR	7	25
	USS DETROIT (LCS 7)	OCIR	8	25
	USS LITTLE ROCK (LCS 9)	OCIR	7	25
	USS SIOUX CITY (LCS 11)	OCIR	5	25
	USS WICHITA (LCS 13)	OCIR	5	25
	USS BILLINGS (LCS 15)	OCIR	4	25
	USS INDIANAPOLIS (LCS 17)	OCIR	4	25
	USS ST LOUIS (LCS 19)	OCIR	3	25
	USS CHICAGO (SSN 721)	RECYCLE	36	33
	USS KEY WEST (SSN 722)	RECYCLE	36	33
	USS GERMANTOWN (LSD 42)	DISMANTLE	37	40
	USS GUNSTON HALL (LSD 44)	DISMANTLE	34	40
	USS TORTUGA (LSD 46)	DISMANTLE	33	40
	USS ASHLAND (LSD 48)	DISMANTLE	31	40
	USNS JOHN LENTHALL (T-AO 189)	OSIR	36	35
	USNS WALTER S DIEHL (T-AO 193)	DISMANTLE	35	35
	USNS MONFORD POINT (T-ESD 1)	OSIR	10	40
	USNS JOHN GLENN (T-ESD 2)	OSIR	9	40
2024 – 13 Ships	USS ANTIETAM (CG 54)	OCIR	37	35
	USS LEYTE GULF (CG 55)	OCIR	37	35
	USS SHILOH (CG 67)	OCIR	32	35
	USS JACKSON (LCS 6)	OCIR	9	25
	USS MONTGOMERY (LCS 8)	OCIR	8	25
	USS SAN JUAN (SSN 751)	RECYCLE	36	33
	USS TOPEKA (SSN 754)	RECYCLE	35	33
	USS RUSHMORE (LSD 47)	OCIR	33	40
	USS HARPERS FERRY (LSD 49)	OCIR	29	40
	USS CARTER HALL (LSD 50)	OCIR	29	40

	USS PEARL HARBOR (LSD 52)	OCIR	26	40
	USNS CATAWBA (T-ATF 168)	FMS	44	40
	USNS GRASP (T-ARS 51)	DISMANTLE	38	40
2025 – 13 Ships	USS NIMITZ (CVN 68)	RECYCLE	50	50
	USS PHILIPPINE SEA (CG 58)	OCIR	36	35
	USS NORMANDY (CG 60)	OCIR	35	35
	USS LAKE ERIE (CG 70)	OCIR	32	35
	USS HELENA (SSN 725)	RECYCLE	38	33
	USS PASADENA (SSN 752)	RECYCLE	36	33
	USS OAK HILL (LSD 51)	OCIR	29	40
	USNS LEROY GRUMMAN (T-AO 195)	OSIR	36	35
	USS SENTRY (MCM 3)	DISMANTLE	36	30
	USS DEVASTATOR (MCM 6)	DISMANTLE	35	30
	USS GLADIATOR (MCM 11)	DISMANTLE	32	30
	USS DEXTROUS (MCM 13)	DISMANTLE	31	30
	USNS SALVOR (T-ARS 52)	DISMANTLE	39	40
2026 – 14 Ships	USS PRINCETON (CG 59)	OCIR	37	35
	USS CHANCELLORSVILLE (CG 62)	OCIR	37	35
	USS COWPENS (CG 63)	OCIR	35	35
	USS GETTYSBURG (CG 64)	OCIR	35	35
	USS NEWPORT NEWS (SSN 750)	RECYCLE	37	33
	USS SCRANTON (SSN 756)	RECYCLE	35	33
	USS ALEXANDRIA (SSN 757)	RECYCLE	35	33
	USS OHIO (SSGN 726)	RECYCLE	44	42
	USS FLORIDA (SSGN 728)	RECYCLE	43	42
	USS COMSTOCK (LSD 45)	OCIR	36	40
	USNS JOSHUA HUMPHREYS (T-AO 188)	DISMANTLE	39	35
	USNS JOHN ERICSSON (T-AO 194)	LSA	35	35
	USNS PECOS (T-AO 197)	DISMANTLE	36	35
	USS MOUNT WHITNEY (LCC 20)	OCIR	55	68
2027 – 13 Ships	USS DWIGHT D EISENHOWER (CVN 69)	RECYCLE	50	50
	USS CHOSIN (CG 65)	OCIR	36	35
	USS CAPE ST GEORGE (CG 71)	OCIR	34	35
	USS ARLEIGH BURKE (DDG 51)	OCIR	36	40
	USS ANNAPOLIS (SSN 760)	RECYCLE	35	33
	USS MICHIGAN (SSGN 727)	RECYCLE	45	42
	USS HENRY M JACKSON (SSBN 730)	RECYCLE	43	42
	USNS HENRY J KAISER (T-AO 187)	OSIR	40	35
	USS PATRIOT (MCM 7)	DISMANTLE	36	30
	USS PIONEER (MCM 9)	DISMANTLE	35	30
	USS WARRIOR (MCM 10)	DISMANTLE	34	30
	USS CHIEF (MCM 14)	DISMANTLE	33	30
	USNS VICTORIOUS (T-AGOS 19)	OSIR	36	30

Notes:

1. US Navy vessels are commissioned ships that are decommissioned and removed from active status. USNS vessels are non-commissioned vessels that are placed out of service.
2. Out of Commission in Reserve (OCIR) and Out of Service in Reserve (OSIR) ships will be retained on the Naval Vessel Register (NVR) as reactivation candidates. Logistics Support Assets (LSA) are not retained in the NVR.
3. Identifies the age of the vessel at retirement.

Ships planned for dismantling during the FYDP

Prior to final disposition, ships reaching the end of their service lives are evaluated for additional use through intra-agency or inter-agency transfer, foreign military sales (FMS), fleet training, or weapons testing. Ships designated for FMS are retained in a hold status for no more than two years in accordance with Navy policy. The Navy intends to dismantle the ships listed in Table A4-2 within the FYDP. Specific dates will be determined when the ships are contracted for scrapping or recycling.

Table A4-2. Ships Planned for Disposal by Dismantling

Ex-SAFEGUARD (ARS 50)	USNS HENRY J KAISER (T-AO 187)
Ex-GRAPPLE (ARS 53)	USNS JOSHUA HUMPHRIES (T-AO 188)
Ex-NAVAJO (ATF 169)	USNS WALTER S DIEHL (T-AO 193)
Ex-MOHAWK (ATF 170)	USNS PESCOS (T-AO 197)
Ex-SIOUX (ATF 171)	USNS GRASP (T-ARS 51)
Ex-KLAKRING (FFG 42)	USNS SALVOR (T-ARS 52)
Ex-DEWERT (FFG 45)	USS GERMANTOWN (LSD 42)
Ex-SIMPSON (FFG 56)	USS GUNSTON HALL (LSD 44)
Ex-KAUFFMAN (FFG 59)	USS TORTUGA (LSD 46)
Ex-FREEDOM (LCS 1)	USS ASHLAND (LSD 48)
Ex-INDEPENDENCE (LCS 2)	USS SENTRY (MCM 3)
Ex-CHARLESTON (LKA 113)	USS DEVASTATOR (MCM 6)
Ex-MOBILE (LKA 115)	USS PATRIOT (MCM 7)
Ex-EL PASO (LKA 117)	USS PIONEER (MCM 9)
Ex-FORT MCHENRY (LSD 43)	USS WARRIOR (MCM 10)
Ex-ZEPHYR (PC8)	USS GLADIATOR (MCM 11)
Ex-SHAMAL (PC 13)	USS DEXTROUS (MCM 13)
Ex-CANON (PG 90)	USS CHIEF (MCM 14)

Table A4-3 lists the ships that will be used for fleet training in support of Rim of the Pacific (RIMPAC), Pacific Griffon, and Valiant Shield training exercises that will occur during the FYDP. The training will include using selected decommissioned ships as targets for live-fire weapons employment, referred to as a "sinking exercise" (SINKEX). The Chief of Naval Operations (CNO) guidelines authorize SINKEXs when: (1) the event is required to satisfy Title 10 requirements for ship survivability or weapons lethality evaluation; or (2) the event supports major joint or multi-national exercises or evaluation of significant new multi-unit tactics or tactics and weapons combinations.

Table A4-3. Ships Planned for use in Future Fleet Training Exercises

Ex-RAINER (AOE 7)	Ex-CLEVELAND (LPD 7)
Ex-BRIDGE (AOE 10)	Ex-DUBUQUE (LPD 8)
Ex-TARAWA (LHA 1)	Ex-JUNEAU (LPD 10)
Ex-PELELIU (LHA 5)	

Summary

Per the annual Ship Disposition Review conducted on May 18, 2021, Navy will inactivate 77 ships within the FYDP (Table A4-1): 40 will be designated OCIR / OSIR; 16 will

be recycled; 17 will be slated for dismantlement and 4 are assigned a FMS or LSA disposition. This will bring the total number of ships designated for dismantlement to 36 (Table A4-2, 18 previously inactivated ships and 18 ships added during the FYDP). Seven ships are designated for fleet training support (SINKEX) (Table A4-3).

Appendix 5

Auxiliary and Sealift Shipbuilding Plan

Auxiliary and sealift vessels provide support to the joint force, battle force, shore-based facilities, and broader national security missions.

Auxiliary Force Structure

Non-battle force auxiliary ships are operating platforms designed for unique United States military and federal government missions including oceanographic and hydrographic surveys, underwater surveillance, missile tracking and data collection, acoustic research, and submarine support. Tables A5-1 and A5-2 depict current and required inventories.

Table A5-1. Auxiliary vessels owned and operated by DoN

Type	Current Inventory	Required Inventory
Oceanographic survey ships (AGS)	6	8
Navigation test support ship (AGS)	1	1
Submarine escort ships (AGSE)	4	4
Hospital ships (AH)	2	2
Cable repair ships (ARC)	1	2
High speed transport (HST)	1	-
Total	**15**	**17**

Table A5-2. Auxiliary vessels procured by DoN and operated by other services/agencies

Type	Current Inventory	Required Inventory
Missile range instrumentation ship (AGM)	2	2
Oceanographic research ships (AGOR)	6	6
Total	**8**	**8**

Strategic Sealift Force Structure

Strategic sealift is a key enabler of DMO and joint power projection. Sealift ships transport approximately 90 percent of Army and Marine Corps combat equipment and supplies in support of major combat operations. Organic (U.S. government-owned) sealift includes: afloat prepositioning (PREPO) vessels, forward-deployed in full operating status (FOS); surge sealift vessels, maintained in a reduced operating status (ROS) in the continental United States (CONUS); and special capability vessels providing cargo transfer and support functions. With an average vessel age over 40 years, recapitalization of the fleet is necessary to maintain required sealift capabilities. Table A5-3 lists inventory contributing to organic strategic sealift.

Table A5-3. Organic Strategic Sealift Inventory

Type	Current Inventory	Required Inventory
Prepositioning Roll-On/Roll-Off (AK/AKR)	15	19
Surge Roll-On/Roll-Off (RORO)	49	59
Special Capability – Crane ships (ACS)	4	4
Special Capability – Aviation logistics ships (AVB)	2	2
Special Capability – Offshore petroleum distribution (AG)	1	1
Total	**71**	**85**

PREPO vessels operate under Military Sealift Command (MSC) supporting joint warfighting requirements. The FY2023 PREPO sealift fleet consists of 15 Roll-On/Roll-Off (AK/AKR) vessels. This Appendix excludes 4 special capability ships (AKE/ESD) included in the battle force command/support ships category.

Navy resources the procurement, operations, and sustainment of 10 PREPO AK/AKR vessels to meet Marine Corps Maritime Prepositioning Force (MPF) requirements. Army resources operations and sustainment for 5 (AKR) ships meeting service specific requirements. DoN has initiated a new construction acquisition plan to meet future MPF requirements. Current projection is for smaller more capable ships, requiring more ships to meet capacity, with lead ship delivery aligned with current AK vessel retirements beginning in 2030.

Surge sealift vessels operate under MSC and the Department of Transportation's Maritime Administration (MARAD) supporting joint requirements. The FY2023 Surge fleet consists of 49 RORO vessels, and 7 special capability (ACS/AVB/AG) vessels. By the end of FY2023, 7 of the used vessels procured in FY2021-FY2022, will be ready for tasking, 5 RORO vessels will retire from service for future disposal, 8 RORO vessels will transition from MSC's Surge Sealift fleet to MARAD's Ready Reserve Force (RRF), 3 PREPO vessels will transition to surge, and 2 additional used RORO vessels will be procured and enter the RRF.

PB2023 continues Navy's commitment to recapitalize surge sealift requirements through procurement and conversion of used commercial RORO ships; replacing cargo capacity lost as ships retire from service. Required inventory reflects the number of vessels necessary to meet total surge capacity, assuming future procurements meet minimum RORO operational requirements. As the fleet is recapitalized, current inventory will vary depending on the cargo capacity of individual vessels in the fleet.

Procurement Activity

To recapitalize surge sealift fleet, Navy is funding MARAD to acquire used commercial RORO vessels. MARAD has contracted a commercial Vessel Acquisition Manager (VAM) to facilitate vessel procurements. Vessel conversions necessary to meet operational requirements and life-cycle sustainment work will be completed by the U.S. commercial repair industry.

Table A5-4 provides sealift buy-used procurement and conversion funding. Used vessels are commercial RORO ships procured with Shipbuilding and Conversion, Navy funds (SCN), and modified as necessary to meet military cargo carriage requirements with Operation and Maintenance, Navy (OMN). Funding is transferred to MARAD by General Provision. Early fiscal year procurements are converted/modified in the same year, while late procurements are converted/modified the following year.

Table A5-4 PB2023 FYDP funding – SCN, OMN and RDT&E

Long Range Auxiliary and Sealift Plan

	FY23		FY24		FY25		FY26		FY27		FYDP	
Ship Type ($M)	**$**	**Qty**	**$**	**Qty**	**$**	**Qty**	**$**	**Qty**	**$**	**Qty**	**$**	**Qty**
Surge RORO (Used Vessels) SCN Procurement	138	2	142	2	146	2	150	2	155	2	731	10
Surge RORO (Used Vessels) OMN Conversion	104	4	42	2	43	2	45	2	45	2	279	12
PREPO (New Con) RDTEN			15		7		3		2		26	

Table A5-5 depicts new construction shipbuilding procurements for auxiliary and sealift ships with a planned total of 20 ships by FY2028 (includes ships counted in the battle force).

Table A5-5 Auxiliary and Sealift Vessel Procurement Plan – New Construction Vessels

Ship Type / Fiscal Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Oceanographic Survey Ships (AGS)						1	2	1		1	1										1								1	
Navigation Test Support Ship (AGS)						1																								
Submarine Escort Ships (AGSE)																														
Hospital ships (AH)									1	1																				
Cable repair ships (ARC)		1				1																								
High speed transport (HST)																														
Crane Ships (ACS)																														
Offshore Petroleum Distribution (AG)																														
Prepositioning RORO (AK/AKR)						1	1	1	1	1	1	1														2	3	3	1	
Aviation Support Ships (AVB)																														
Surge (RORO)																														
Total Procurement - New	0	1	0	0	0	4	3	2	2	3	2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	2	3	0	0	0

Table A5-6 depicts used vessel procurements for auxiliary and sealift ships. The current profile of 2 used RORO ship procurements per year does not replace cargo capacity at the rate required by planned vessel retirements which will create some risk in mission execution.

Table A5-6 Auxiliary and Sealift Vessel Procurement Plan – Used Vessels

Ship Type / Fiscal Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Oceanographic Survey Ships (AGS)																														
Navigation Test Support Ship (AGS)																														
Submarine Escort Ships (AGSE)																					2	2								
Hospital ships (AH)																														
Cable repair ships (ARC)																														
High speed transport (HST)																														
Crane Ships (ACS)						2	2																							
Offshore Petroleum Distribution (AG)																														
Prepositioning RORO (AK/AKR)																														
Aviation Support Ships (AVB)						1	1																							
Surge (RORO)	2	2	2	2	2	4	4	4	4	3	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	2	2	2	2	2	7	7	4	4	3	2	2	2	1	1	1	2	2	2	2	4	4	2	2	2	2	2	2	2	2

Tables A5-7 and A5-8 depict associated delivery plans for shipbuilding and used vessels, respectively; assuming construction and conversion efforts remain on plan.

Table A5-7 Auxiliary and Sealift Vessel Delivery Plan – New Construction Vessels

Ship Type / Fiscal Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Oceanographic Survey Ships (AGS)										1	2	1		1	1										1					
Navigation Test Support Ship (AGS)										1																				
Submarine Escort Ships (AGSE)																														
Hospital ships (AH)													1	1																
Cable repair ships (ARC)					1			1																						
High speed transport (HST)																														
Crane Ships (ACS)																														
Offshore Petroleum Distribution (AG)																														
Prepositioning RORO (AK/AKR)								1	1	1	1	1	1	1	1													2	3	3
Aviation Support Ships (AVB)																														
Surge (RORO)																														
Total Delivery - New	0	0	0	0	1	0	0	2	1	3	3	2	2	3	2	0	0	0	0	0	0	0	0	0	1	0	0	2	3	3

Table A5-8 Auxiliary and Sealift Vessel Delivery Plan – Used Vessels

Ship Type / Fiscal Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Oceanographic Survey Ships (AGS)																														
Navigation Test Support Ship (AGS)																														
Submarine Escort Ships (AGSE)																						2	2							
Hospital ships (AH)																														
Cable repair ships (ARC)																														
High speed transport (HST)																														
Crane Ships (ACS)						2	2																							
Offshore Petroleum Distribution (AG)																														
Prepositioning RORO (AK/AKR)																														
Aviation Support Ships (AVB)							1	1																						
Surge (RORO)	2	2	2	2	2	4	4	4	4	3	2	2	2	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total Delivery - Used	2	2	2	2	2	6	7	5	4	3	2	2	2	1	1	1	2	2	2	2	2	4	4	2	2	2	2	2	2	2

Table A5-9 shows the retirement plan that, along with the delivery plan, drives the total auxiliary and sealift force inventory in Table A5-10. Executing this plan, for both new construction and procurement of used vessels, will be contingent on the availability of funding.

Table A5-9 Auxiliary Vessel and Sealift Retirement Plan

Ship Type / Fiscal Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Oceanographic Survey Ships (AGS)									-1		-1		-1		-1	-1										-1				
Navigation Test Support Ship (AGS)										-1																				
Submarine Escort Ships (AGSE)																						-2	-2							
Hospital ships (AH)														-1	-1															
Cable repair ships (ARC)					-1																									
High speed transport (HST)						-1																								
Crane Ships (ACS)						-2	-2																							
Offshore Petroleum Distribution (AG)																					-1									
Prepositioning RORO (AK/AKR)											-1	-1	-1															-2	-3	-3
Aviation Support Ships (AVB)										-1	-1																			
Surge (RORO)	-5		-2	-3	-3	-5	-7	-4	-2	-3	-2	-2	-1	-1	-2										-2	-4	-3	-3	-2	-3
Total Retirements	-5	0	-2	-3	-4	-8	-9	-4	-3	-5	-5	-3	-3	-2	-4	-1	0	0	0	0	-1	-2	-2	0	-2	-5	-3	-5	-5	-6

Table A5-10 Auxiliary and Sealift Vessel Inventory

Fiscal Year	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53
Oceanographic Survey Ships (AGS)	7	7	7	7	7	7	6	6	6	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Navigation Test Support Ship (AGS)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Submarine Escort Ships (AGSE)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Hospital ships (AH)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cable repair ships (ARC)	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
High speed transport (HST)	1	1	1	1	1																										
Crane Ships (ACS)	4	4	4	4	4	4	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Offshore Petroleum Distribution (AG)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Prepositioning RORO (AK/AKR)	15	12	12	12	12	12	12	13	14	15	16	16	16	16	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Aviation Support Ships (AVB)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Surge (RORO)	49	54	56	56	55	56	55	52	52	52	51	51	49	49	49	49	51	53	55	57	59	61	63	63	63	63	61	59	59	59	59
Total Auxiliary and Sealift Inventory	87	89	91	91	90	90	90	87	88	91	91	91	89	89	90	90	92	94	96	98	99	101	103	103	103	103	101	99	99	99	99

EXHIBIT 138

MILITARY & DEFENSE

China is the world's biggest shipbuilder, and its ability to rapidly produce new warships would be a 'huge advantage' in a long fight with the US, experts say

Analysis by Ryan Pickrell Sep 8, 2020, 2:03 PM EDT

Photo by Dickson Lee/South China Morning Post via Getty Images

A new Department of Defense report on China's military power said that China "has the largest navy in the world" and is "the top ship-producing nation in the world by tonnage."

s said that "their shipbuilding capacity is a huge advantage for a protracted conflict with the United States," which lacks the bility to quickly build new ships.

e ability to turn out ships faster than any other country, China uild up its force or rapidly replace its naval losses in a conflict.

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China has an edge over the US in shipbuilding, and it could give the country an advantage in a protracted conflict in which both sides see heavy losses at sea, experts told Insider.

"China has already achieved parity with — or even exceeded — the United States in several military modernization areas," the Pentagon reported recently, identifying shipbuilding as one area where China has an advantage.

[The People's Republic of China] has the largest navy in the world, with a battle force of approximately 350 ships and submarines including over 130 major surface combatants," the Pentagon assessed in its latest China Military Power report.

The Pentagon also reported that "China is the top ship-producing nation in the world by tonnage," adding that the country is currently striving to increase "its shipbuilding capacity and capability for all naval classes."

And, as Andrew Erickson, a professor of strategy at the US Naval War College, noted in his analysis of the report, "quality is riding shotgun with quantity" as China builds new, more modern warships.

Among the surface combatants China is building are cruisers, destroyers, and corvettes, which the Department of Defense says "will significantly upgrade the PLAN's air defense, anti-ship, and antisubmarine capabilities."

China is also continuing to build support ships, amphibious warfare ships, and aircraft carriers for expeditionary operations and power projection.

Modern warfare is complicated, with many different factors contributing to a conflict's outcome, but with the ability to produce

ships faster than any other country, China could build up its force or rapidly replace its naval losses in a conflict, much as the US was able to do during World War II.

The US does not have that same shipbuilding capacity today, in part, because the US focuses on building more advanced assets at a handful of specialized shipyards, but also because the US is not that same industrial power.

Although the US Navy — with a battle force of 293 ships — is the most powerful navy in the world, military leaders have expressed concerns about America's decreased ability to rapidly build new ships.

Gen. David Berger, the commandant of the Marine Corps, assessed recently that "replacing ships lost in combat will be problematic, [as] as our industrial base has shrunk, while peer adversaries [have] expanded their shipbuilding capacity."

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[In] an extended conflict, the United States will be on the losing end of a production race—reversing the advantage we had in World War II when

we last fought a peer competitor," Berger wrote in a draft report on operational concepts obtained by Breaking Defense.

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soldiers of the Chinese naval fleet for escort mission line up on the deck at a port , east China's Zhejiang Province, April 28, 2020. Xinhua/Jiang Shan via Getty Images

'A huge advantage'

China's ability to quickly build ships stems from its efforts to build a modern navy. The US, on the other hand, has the advantage of already fielding a modern navy that deploys around the world.

"China can produce ships very fast. There is absolutely no doubt about that," Matthew Funaiole, a senior fellow with the China Power Project at the Center for Strategic and International Studies, told Insider, calling China's shipbuilding capacity"impressive."

But, he explained, "China is in the process of developing its first real, modern navy, so it has a lot of catching up to do, whereas the US already has a modern navy."

While the Chinese People's Liberation Army Navy has more vessels than the US Navy, it has not yet achieved parity. But the less advanced nature of its force and its shipbuilding capacity give it an edge, to a certain extent, in a protracted conflict.

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In a conflict, the US Navy would have better pieces on the board, but it is unlikely to receive many new pieces during the course of the fight. The same is likely not true for China, meaning that a loss is felt potentially more heavily by the US.

"Their shipbuilding capacity is a huge advantage for them in a protracted conflict with the United States," Bryan Clark, a former US Navy officer and defense expert at the Hudson Institute, told Insider.

"They have multiple shipyards building every class of ship, which is not really the case in the US Navy," he said. "It gives them some extra capacity if they need to do a buildup or ramp-up of the navy or rebuild in a conflict where they lose a lot of ships."

question mark when looking at China's naval ambitions is nce capacity, the ability to repair ships damaged in combat.

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"Their maintenance capacity is not as significant as their shipbuilding capacity," Clark said. "Because their fleet is relatively new, they have not had to generate the kind of repair capacity that the US Navy has."

As China continues to expand the world's largest navy, how the country will maintain that expanded force is a problem it will have to address.

"There's so much cost to maintaining vessels," Funaiole said. "Building them is a big cost upfront, but keeping them battle ready, keeping them in good standing order, that costs a lot of money, and it becomes more expensive over time."

Erickson at the Naval War College, explained in his analysis that "China's maintenance capacity has not been tested in volume yet, but seems competent so far."

"Whether China can continue to implement its maintenance plan effectively when midlife ship deadlines trigger massive increases in capacity requirements over the next few years remains to be seen," he noted.

The US has long been a leading naval power, but the US Navy has its fair share of troubling maintenance issues. For example, a recent Government Accountability Office report said that between fiscal years 2015 and 2019, 75 percent of planned maintenance for the service's aircraft carriers and submarines was completed late.

The US and China "are more evenly matched when it comes to ship maintenance capacity," Clark said.

Of course, there is more to war than shipbuilding. When talking about a protracted conflict where both sides are taking losses, many other ome into play that could make the shipbuilding capacity of e less relevant.

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"What kind of prolonged conflict in which the US is sustaining naval losses doesn't escalate into other types of conflict? What is the US response if it lost [an aircraft] carrier or something like that?" Funaiole asked.

"It is an unpleasant thing to think about," he said, "but I think we'd be getting into territory where US shipbuilding capacity is probably not the biggest concern at that point."

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EXHIBIT 139

STATEMENT OF
MARK H. BUZBY
ADMINISTRATOR
MARITIME ADMINISTRATION
U.S. DEPARTMENT OF TRANSPORTATION

BEFORE THE
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE SUBCOMMITTEE ON COAST GUARD AND MARITIME TRANSPORTATION
U.S. HOUSE OF REPRESENTATIVES

THE STATE OF THE U.S. FLAG MARITIME INDUSTRY

January 17, 2018

Good afternoon, Chairman Hunter, Ranking Member Garamendi and members of the Subcommittee. I appreciate the opportunity to discuss the state of the U.S Flag Maritime Industry, and ask that my written statement be entered in the record.

The statutory mission of the Maritime Administration (MARAD) is to foster, promote, and develop the maritime industry of the United States to meet the Nation's economic and security needs. Congress long ago recognized that it is necessary for national defense, and development of domestic and foreign commerce, that we have a U.S. merchant marine capable of serving in times of war or national emergency, and composed of the best-equipped, safest, and most suitable types of vessels, constructed in the U.S., and crewed by trained and efficient citizen mariners.[1]

Unfortunately, over the last few decades, the U.S. Maritime industry has suffered losses as companies, ships, and jobs moved overseas. MARAD will continue to leverage, as appropriate, the current mainstays of the Merchant Marine: the Jones Act, the Maritime Security Program (MSP), and Cargo Preference. Cargo is a main factor determining the number of ships in the U.S. flagged fleet, and the number of ships then influences the number of mariners who are available to run those ships and maintain a strong, resilient, U.S. Merchant Marine. However, as illuminated by the President's National Security Strategy, we live in an increasingly competitive world which requires us to rethink how we address long-term strategic issues facing the industry.

[1] 46 U.S.C. 50101

THE U.S.-FLAG FLEET

MARAD is charged with ensuring that U.S.-flag ships and merchant mariners are available to meet Department of Defense (DOD) sealift requirements. A key to completing that mission is doing what we can within the law to make them better able to compete in international commerce.

The fleet of U.S.-flagged, privately-owned, and commercially operated vessels, along with government-owned vessels, provides critical sealift surge and sustainment capacity to move equipment and materials for the Armed Forces. When needed, these resources can also support other Federal agencies during times of humanitarian crises, and natural disasters such as we witnessed this summer in the wake of Hurricanes Harvey, Irma, and Maria.

The following example draws a distinction between two conflicts. During one of these conflicts, the U.S. military overseas relied on foreign vessels and, during the other, they relied on U.S. flag vessels, including the Reserve Ready Force. During the first Gulf War, the U.S. found it necessary to employ foreign vessels to meet sealift needs; however, 13 of the 177 foreign vessels carrying essential supplies hesitated or refused to enter the area of operations, resulting in a loss of 34 transit days for ships carrying cargo for U.S. troops.[2] During later U.S. military overseas contingency operations in Iraq and Afghanistan from 2002 to 2010, over 95 percent of all military ocean-borne cargoes were moved on U.S.-flag vessels and government-owned sealift vessels activated from reserve status and crewed by U.S. citizen mariners. The U.S. military, the most powerful military in the world, relies on U.S.-flag vessels crewed by U.S. civilian mariners, operating from strategic ports, and using intermodal systems to ensure delivery of vital supplies and equipment to service members and their families stationed overseas.

This transportation partnership between the U.S. military and the U.S.-flag merchant marine has been proven as reliable, enabling, and cost effective to meeting sealift requirements[3]. DOD has long relied on commercial augmentation to meet sealift requirements in peace and war. Access to commercial fleets is formalized through DOD contracts, MARAD Voluntary Intermodal Sealift Agreement (VISA), the Maritime Security Program (MSP), and the Voluntary Tanker Agreement (VTA). Through these programs, DOD gains critical access to U.S. commercial capabilities and the merchant mariners that will crew the government fleet. Since their inception in the mid 1990's, these commercial augmentation programs have provided the federal government assured access to a significant amount of capacity and intermodal capabilities that cannot be replicated by government sources. One alternative to support for a mix of Government and privately-owned vessels contemplated by current authorities, is the development of an expanded, all Government-

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[2] So Many, So Much, So Far, So Fast: United States Transportation Command and Strategic Deployment for Operation Desert Shield/Desert Storm/ James K. Matthews, Cora J. Holt, p. 136.

[3] Global Reach: Revolutionizing the Use of Commercial Vessels and Intermodal Systems for Military Sealift, 1990-2012. A.J. Herberger

vessel fleet the cost of which would be dramatically larger, because we would have more vessels to maintain in standby status

The U.S.-Flag Fleet in Facilitating Coastwise Trade and Supporting National Security

As early as 1817, Congress established legislation restricting foreign flag vessels from trading between US ports. Current U.S. coastwise trade laws[4], commonly referred to as the Jones Act, require the use of qualified U.S.-flag vessels to carry goods in domestic commerce, which includes transportation between and among the U.S. mainland, Puerto Rico, Hawaii and Alaska.[5] This law aims to supplement our national security priorities by supporting the shipyards, repair facilities, and supply chains that produce and repair American built ships, supports a pool of professional Mariners to operate them, and ensures that intermodal equipment, terminals and other domestic infrastructure are available to the U.S. military in times of war or national emergency. Coastwise trade laws promote a strong and vibrant U.S. domestic maritime industry, which helps the United States maintain its expertise in shipbuilding and maritime transportation. The Jones Act also ensures that vessels navigating on a daily basis among and between U.S. coastal ports and vulnerable inland waterways are operating with U.S. documentation and crew rather than under a foreign flag with foreign crew.

More than 40,000 vessels operate in U.S. coastwise and inland trades. While most of this number represents non-self-propelled barge vessels, there are one hundred large privately-owned, self-propelled oceangoing vessels (1,000 gross tons or more) in domestic U.S. trade.[6] While the number of large self-propelled coastwise vessels is down from 221 in 1992, almost 100 ships of that number resulted from the retirement of older single hull, self-propelled tankers, and reduction of Alaska North Slope oil production.

U.S. Shipbuilding Industry

In 2013, American shipbuilders directly employed 110,000 Americans and produced $37.3 billion in gross domestic product.[7] As of January 2018, there are five large oceangoing container vessels (some with roll-on/roll-off capacity) under construction, four on order, and plans for two more. In addition, there are many hundreds of commercial tugs, barges, and

[4] Now codified at chapter 551 of 46 United States Code.

[5] Currently, 91 large U.S.-flag self-propelled ocean-going vessels operate in U.S. domestic commerce. Although this segment of the fleet does not depend on government-impelled cargos, the crews of these vessels are qualified to operate sealift ships in the Government reserve fleet.

[6] Sources: 1992 fleet size from MARAD Historic Fleet Reports and Fleet Lists. December 1, 2017 fleet size from MARAD Merchant Fleet Report. See: https://www.marad.dot.gov/resources/data-statistics/

[7] USDOT/Maritime Administration, The Economic Importance of the U.S. Shipbuilding and Repairing Industry, November 2015, at https://www.marad.dot.gov/wp-content/uploads/pdf/MARAD_Econ_Study_Final_Report_2015.pdf

specialty vessels for the Jones Act market under construction or on order. These civilian shipyards and related industries are part of the Nation's shipbuilding and repair industrial base. Demand for vessels qualified for Jones Act trade plays an important role in ensuring that there is adequate American expertise and capacity to meet national shipbuilding needs and that these shipyards remain available when the military needs them. This is particularly true for the skilled shipbuilding and repair workforce.

The U.S. Flag-Fleet in International Trade

Over the last 25 years, the number of U.S. flagged vessels sailing in the international trade has varied from 183 ships in 1992 to 82 as of December 2017 (Figure 1).[8] There was a rise and decline in the number of U.S. flagged vessels beginning in 2001 triggered by military operations in Iraq and Afghanistan and the subsequent drawdown.

The change in the tonnage capacity since 1992 is significantly less than the change in vessel numbers. In 2014, the total deadweight ton capacity of containerships and roll-on/roll-off vessels was about 95 percent of its 1992 total even though the number of U.S.-flag vessels in 2014 was only 81 vessels.[9] The percentage of U.S. international commercial cargoes by weight carried on U.S. flagged vessels has fallen from 4 percent in 1992 to approximately 1.5 percent today (Figure 2).[10] However, even though the tonnage capacity has not decreased at the rate ships, fewer vessels means fewer jobs available to U.S. mariners, which could impact readiness.

Given the comparatively higher costs of operating a U.S. flag vessel, privately-owned.[11] and -operated ships remain under U.S.-flag only if there is dedicated cargo to move. U.S.-flag vessels have higher operating costs than a foreign flag carriers competing for US commercial imports and exports (i.e., not government-impelled) absent U.S. government direct and indirect subsidies.[12] Moreover, the reductions in government-impelled defense cargoes due to the winding down of wars in Iraq and Afghanistan have been the principal cause of the decline in recent years. Other factors, such as the decline of non-military cargo volumes have also contributed to the decline.

[10] MARAD Calculation using CBP, Census, and commercial data sources
[11] MARAD Calculation using CBP, Census, and commercial data sources
[12] USDOT/MARAD, COMPARISON OF U.S. AND FOREIGN-FLAG OPERATING COSTS, September 2011.

Figure 1: U.S.-Flag Share of Foreign Trade (2005-2015) Based on Cargo Weight. Source: Maritime Administration Analysis based on Census data. Prepared 7/7/2017.

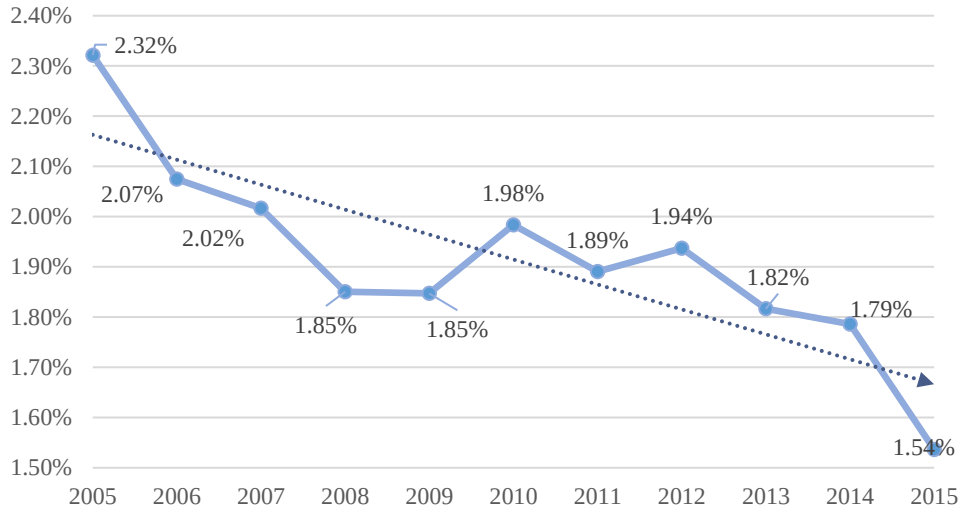
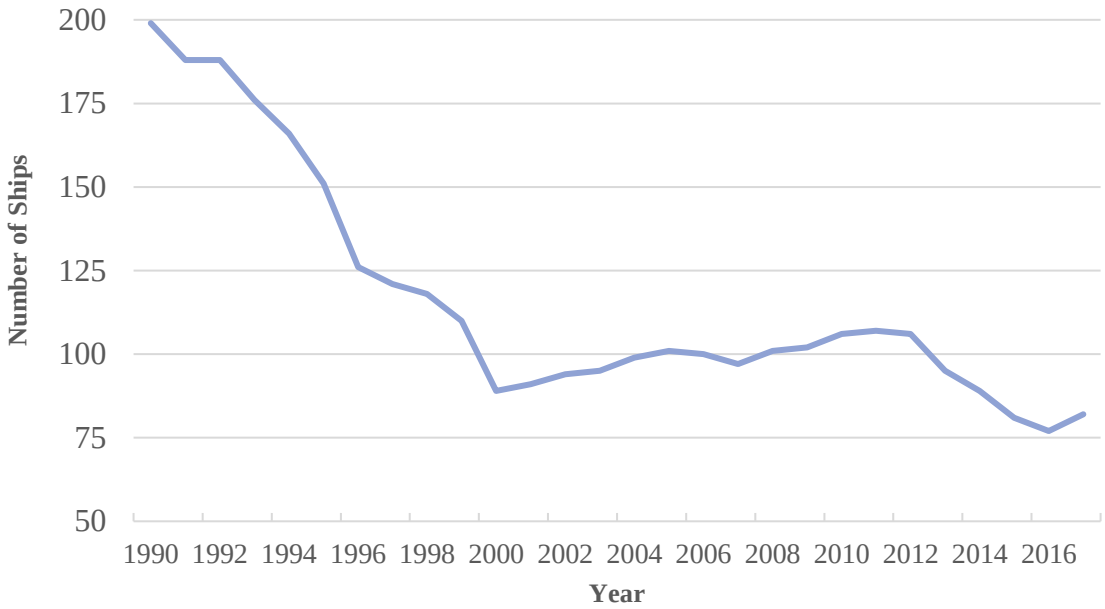


Figure 2: United States Privately-Owned Oceangoing Self-Propelled Vessels 1,000 Gross Tons and Above Operating in International Trades (1990-November 1, 2017). Source: MARAD 2000 – 2016 U.S.-Flag Privately-Owned Fleet Summary and MARAD Calculation using CBP, Census, and commercial data sources.



Cargo Preference Laws

Reacting to a decline in the number of US-flag ships available to move military equipment and to encourage an active, privately-owned and -operated, U.S.-flag fleet, Congress enacted several measures known as "cargo preference" laws between 1904 and 1954. These laws require shippers to use U.S.-flag vessels for ocean-borne transport of significant portion of certain cargoes purchased with Federal funds.

Specifically, 100 percent of military cargo, and at least 50 percent of most non-military government cargo transported by ocean, must be carried on U.S. flag vessels subject to vessel availability and fair and reasonable rates. The cargoes generated because of these programs help ensure the availability of a fleet of privately-owned U.S.-flag ships. The availability of preference cargoes helps to ensure these ships, mariners, and the supply networks they employ are available to transport Government supplies and equipment in the event of an emergency or armed conflict.

Maritime Security Program

The Maritime Security Program (MSP) subsidy program helps offset the costs of operating under the U.S. flag. The Maritime Security Act of 1996 (as amended) authorizes direct annual stipends for up to 60 active, commercially viable, militarily useful, privately-owned U.S.-flag vessels and crews operating in U.S. international trades, in return for the owner/operators' agreement to make the vessels available to the Government in times of war or national emergency. The MSP fleet ensures access to U.S.-flag ships, and estimated employment of up to 2,400 highly qualified U.S. merchant mariners, in ocean-borne foreign commerce – and most critically - with the necessary global intermodal logistics capability to move military equipment and sustainment cargo. Ships operating under the MSP may also carry cargo preference loads, which is an important incentive for vessels to participate in the MSP.

Under this program, participating operators must commit their ships, crews, global network of intermodal facilities and transportation resources upon request by the Secretary of Defense. Of the 82 U.S.-flag vessels that trade internationally, 60 currently participate in the MSP program. Over the past several years, MARAD has strengthened the process for retaining militarily useful ships in the program and has increased the militarily useful capacity of the fleet to meet DOD's requirements. The MSP has supported every U.S. conflict since its inception in 1996, including Operations Enduring Freedom and Iraqi Freedom, and these vessels stand ready to play a vital role in support of U.S. military operations worldwide.

The National Defense Reserve Fleet (NDRF) and Ready Reserve Force (RRF)

MARAD manages and maintains the bulk of our Nation's surge capacity, which is organized in the Ready Reserve Fleet. These 46 ships must be ready for operation within five days for transport of military cargo to critical areas of operation. The RRF functions as a part of the National Defense Reserve Fleet of retention and disposal vessels, and training ships which MARAD provides to state maritime academies, and serve additionally for disaster response in an emergency. RRF and NDRF ships were activated to provide support to other government agencies for recent relief efforts following Hurricanes Harvey, Irma, and Maria, and previously for Hurricanes Katrina, Rita, and Sandy and earthquake relief effort in Haiti. During these deployments these vessels supplied first responders with housing logistical support, and needed relief supplies, including critical Federal Aviation Administration air navigation equipment. MARAD is working with the U.S. Transportation Command (USTRANSCOM) and the US Navy to address the urgent need for recapitalization of the RRF to ensure the readiness of these 46 ships, the average age of which is 43 years.

Availability of Qualified U.S. Mariners

MARAD and DOD rely on the U.S.-flag commercial fleet operating in both the coastwise and international trades to employ enough qualified mariners to crew all the commercial cargo ships that might support military operations, plus the "surge fleet" of 61 Federally-owned cargo ships. As of today, the size and composition of the U.S.-flag commercial fleet is just adequate to meet immediate military contingencies; however, due to the historically low number of ships in both the domestic and international trading U.S.-flag oceangoing fleets over the past several years, MARAD is concerned that there might not be enough qualified mariners with required endorsements to operate unlimited horsepower and unlimited tonnage necessary to sustain a prolonged activation of the entire sealift fleet.

While it appears possible to find enough qualified American mariners for an initial four to six months of sealift surge, sustaining safe operations with qualified crew could be impacted if a sealift surge exceeded six months. Currently, we estimate that there are 11,768 qualified unlimited tonnage/horsepower active mariners available to crew either commercial or Government reserve sealift ships. The initial activation of the 46 MARAD and 15 Military Sealift Command surge vessels would require roughly 3,860 mariners for sustained operation. This is in addition to continued operation of much of the privately-owned commercial fleet.

In particular, there is a shortage of senior-level mariners with unlimited credentials who have sailed within the past 18 months. Contributing factors to this shortage include more stringent international training requirements and medical fitness standards, and the overall declining pool of billets in the U.S.-flag fleet. Given this assessment, I am working closely with the USTRANSCOM, the U.S. Navy's Military Sealift Command, the U.S. Coast Guard and the commercial maritime industry to develop proposals to maintain an adequate number of trained

mariners. Part of our coordinated effort is to further the Military to Mariner program which makes it easier for transitioning servicemen and women to obtain their mariner credentials based on their service experience. Additionally, MARAD is working with the U.S. Coast Guard and the maritime industry to better track licensed mariners who may no longer be sailing, but could serve in a time of crisis. Finally, MARAD is working to develop tools to understand and analyze changes in the numbers of fully qualified mariners in deck and engineering job categories who are trained and available to meet the Nation's commercial and sealift requirements at any given time.

The National Defense Authorization Act for Fiscal Year 2017 (FY 2017 NDAA) established the Maritime Workforce Working Group (MWWG) to examine and assess the size of the pool of qualified U.S.-citizen mariners necessary to support the U.S.-flag fleet in times of national emergency. The MWWG developed a report which is still being reviewed within DOT.

MARITIME TRAINING

MARAD provides funding and support for mariner training programs to produce highly skilled, U.S. Coast Guard (USCG) credentialed, officers for the U.S. Merchant Marine.[13] The U.S. Merchant Marine Academy at Kings Point (USMMA) and State Maritime Academies (SMAs) graduate the majority of entry-level officers with unlimited USCG-credentials. This cadre of well-educated and trained merchant mariners support the U.S. marine transportation infrastructure, and serve our Nation when called upon to support military operations worldwide, national emergency, and humanitarian missions.

The U.S. Merchant Marine Academy

Like the other four other Federal service academies, West Point, the U.S. Naval Academy, the U.S. Air Force Academy, and the U.S. Coast Guard Academy, the USMMA is a premier accredited institution of higher education. Operated by the DOT and managed by MARAD, the USMMA offers a four-year maritime-focused program, centered on rigorous academic and practical 12 month at-sea technical training aboard US Flag ships that leads to a Bachelor of Science degree, a USCG merchant mariner credential with an unlimited tonnage or horsepower officer endorsement, and, upon application and acceptance, a commission as an officer in the Armed Forces or other uniformed services (National Oceanographic and Atmospheric Administration Corps or the U.S. Public Health Service Corps) of the United States. USMMA graduates incur an obligation to serve five years as a merchant marine officer aboard U.S. documented vessels or on active duty with the U.S. Armed Forces or uniformed services. If not on active duty, they must serve as a commissioned officer in a reserve unit of the U.S. Armed

[13] The Secretary of Transportation is specifically authorized to provide education and training to U.S. citizens for the safe and efficient operation of the U.S. Merchant Marine in 46 U.S.C. § 51103(a). See also, 46 U.S.C. Subtitle V Part B. See Chapters 511, 513, 515 and 517.

Services for eight years. The USMMA is the single largest annual contributor to the US Navy's Strategic Sealift Officer community, sponsored by the Commander of the Military Sealift Command. These officers form a critical part of the sealift manning equation because of their service obligation to maintain their license and respond to emergency manning of RRF shipping.

DOT, MARAD, and the USMMA take sexual assault and sexual harassment at the Academy very seriously. The Academy is implementing provisions included in both the Fiscal Year 2017 and Fiscal Year 2018 National Defense Authorization Act aimed at improving the Academy's sexual assault and sexual harassment prevention and response efforts. Actions include enhancing prevention training, increasing campus security, initiating an on-campus culture change program, hiring additional staff for the Sexual Assault Prevention and Response Office, and most recently, testing satellite communication devices that will be made available to midshipmen going on Sea Year and upgrading the 24/7 sexual assault hotline.

State Maritime Academies

In addition to providing oversight of the USMMA, MARAD provides assistance, including training ships, to six state maritime academies (SMAs), which collectively graduate more than two-thirds of the entry-level Merchant Marine officers annually.[14] Approximately 991 Cadets are expected to graduate from the SMAs in 2018.

MARAD provides assistance to fund the enrollment of 75 new cadets each year (across all SMAs) in the Student Incentive Payment (SIP) program for a period of four years. The SIP program provides cadets with funds to be used for uniforms, tuition, books, and subsistence. Upon graduation, SIP students must maintain an unlimited USCG credential for six years, fulfill a three-year service obligation in the maritime industry, and serve in a reserve unit of an Armed Forces or uniformed service for eight years. Assistance provided to the SMAs also includes funding for maintenance and repair costs for training ships on loan from MARAD.

Ensuring the continued availability of SMA training vessels is a critical need and high MARAD priority. Training ship maintenance work is increasingly important and costly as the ships age and approach or exceed their designed service life. Accordingly, MARAD is using funds to address priority maintenance across all the training vessels, with emphasis on the two ships which are more than 50 years old – the EMPIRE STATE (NY) and KENNEDY (MA). These two vessels are now serving beyond their designed service lives. The SMA Cadets receive most of their sea time on these training ships.

[14] The six SMAs are: California Maritime Academy in Vallejo, CA; Great Lakes Maritime Academy in Traverse City, MI; Texas A&M Maritime Academy in Galveston, TX; Maine Maritime Academy in Castine, ME; Massachusetts Maritime Academy in Buzzards Bay, MA; and State University of New York (SUNY) Maritime College in the Bronx, NY. See: 46 U.S.C. Chapter 515.

MARITIME TRANSPORTATION INFRASTRUCTURE

Ports and the U.S. Marine Transportation System are critical to our Nation's economy and to the wellbeing of the U.S. Merchant Marine. As required by 46 U.S.C. § 50302, MARAD established a port infrastructure development program called StrongPorts to better support the development of our port facilities. That program delivers tools and technical assistance to ports and works with state and local partners to integrate ports and maritime transportation into the larger U.S. surface transportation system. MARAD also oversees funding for port infrastructure projects provided through the DOT grant programs.

The America's Marine Highway Program (AMHP) is designed to expand the use of our Nation's navigable waterways to relieve landside congestion, reduce air emissions, provide new transportation options, and generate other public benefits by increasing the efficiency of the surface transportation system. There are currently 24 designated Marine Highway Routes.

The program encourages partnerships with a variety of stakeholders including shippers and manufacturers, truckers, ports and terminals, ocean carriers, and domestic vessel operators to create new supply chain options that use our waterways. America's Marine Highway projects also allow for the optimization of equipment relocation and help to reduce wasteful movement of empty shipping containers.

CONCLUSION

At MARAD, we strive to serve the American people and uphold their right to a government that prioritizes their security, their prosperity, and their interests. MARAD implements programs that promote the economic competitiveness, efficiency, safety and productivity of the U.S. maritime transportation system while ensuring that sealift capability and capacity is available to support the national and economic security needs of the Nation.

I appreciate the Subcommittee's continuing support for maritime programs and I look forward to working with you on advancing the U.S. Maritime Industry in the United States. I will be happy to respond to any questions you and the members of the Subcommittee may have.

EXHIBIT 140

ANALYSES | 2021-12-22

A new phase of China's pressure on Lithuania: weaponisation of European value chains

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In the latest phase of now months-long diplomatic conflict between Beijing and Vilnius, China has developed a new set of economic coercion instruments. In recent weeks, Lithuania was temporarily removed from the PRC customs clearance systems, causing significant difficulties to bilateral trade. Earlier this year, Beijing has halted part of the regular China-Lithuania freight train connections. It also closed credit lines extended for Lithuanian companies, introduced various export restrictions (with products worth 10 million euros halted at the border), and blocked imports of existing orders from China. The PRC is also putting pressure on multinational corporations (including European companies), pushing them to reduce investments in Lithuania and stop sourcing supplies from local companies, threatening with retaliation against their operations on the Chinese market. According to the Federation of German Industries (BDI), German entities face difficulties bringing goods from China to Lithuania and vice versa. Informal trade sanctions also extend to German exports using Lithuanian components. This situation has reportedly affected Siemens, Bosch, Continental, as well as French and American entities, among others. Continental, a global supplier of tires and car parts, is the largest investor in Lithuania's manufacturing sector (with a total investment of around EUR 190 million). Lithuanian textile companies are receiving warnings from partners in France, Germany, and the Netherlands about the possibility of withdrawal from cooperation. The BDI described the Chinese action as a "trade boycott" with EU-wide consequences that are "not to be tolerated". However, it also criticised Lithuania for its policy on Taiwan not being coordinated with EU policy. The German government has so far not commented on the issue.

At Vilnius request, the PRC's economic coercion on Lithuania was addressed in a joint communiqué on December 8th by EC Vice-President Valdis Dombrovskis and EU High Representative Josep Borrell. The EU has made a formal inquiry to the Chinese authorities about the blockades imposed on Lithuanian companies to determine whether the retaliations are of "systemic in nature". EC presented the dispute as a potential field for applying the so-called *anti-coercion instrument* (ACI), allowing counter-sanctions to be imposed on third countries that exert economic pressure on the EU and the Member States. On December 9th, the Chinese customs administration refused to respond to the Commission and the EC announced that it would take the matter to a higher political level. Meanwhile, articles in the Chinese government press denied the allegations and at the same time accused the EU of undermining the 'One China principle. Parallel to the economic retaliation, the PRC intensified political pressure on Lithuania. It took further steps to formally downgrade Lithuania's diplomatic mission in Beijing (to the level of chargé d'affaires representation), demanding that Lithuanian diplomats return their accreditation documents. In response, Lithuania organised the urgent return of the mission's staff with their families on December 15th and announced that the embassy would operate remotely for the time being.

Commentary

- The Lithuanian-Chinese conflict stems from a series of moves by Vilnius that began in the spring of 2021: its withdrawal from the 17+1 initiative, recognition of the persecution of the Uighur minority in China as genocide, and most importantly, the announcement of the establishment of Taiwanese representation in Lithuania and Lithuanian representation in Taiwan. For Vilnius, this policy direction is an important element in a broader push to strengthen its relations with Washington. The United States has offered Lithuania support in resisting China's coercive actions and provided it with a $600 million export credit line. Lithuania’s bilateral contacts with the US visibly intensified in recent months, strengthening Lithuania's sense of security in the face of rising threats from Russia and Belarus. Vilnius has also announced that it will exclude Chinese technology companies from the Lithuanian market for security reasons, especially in critical infrastructure. Lithuania is also trying to turn closer relations with Taipei into deeper economic cooperation

with Taiwan, including in the area of semiconductors. Moreover, it wants to increase its influence on the EU policy towards the PRC, e.g., by repeatedly proclaiming the need to replace the 17+1 format with a common EU policy towards China (27+1).

- Beijing increases economic and diplomatic pressure on Vilnius, trying to make an example out of Lithuania in front of other EU member states. The unprecedented use of the word "Taiwan" in the name of the Taiwanese mission in Vilnius was considered by Beijing as a change in the global status quo regarding diplomatic relations with the island's authorities, undermining China's territorial integrity. In the PRC's view, withdrawal from the 17+1 could encourage other countries to follow suit, undermining the foundations of China's policy towards Central and Eastern Europe. However, the main difficulty for Beijing in recent months has been to exert real economic pressure on the government in Vilnius, given the low level of bilateral business relations. Chinese media thus called for, among other things, the imposition of joint economic sanctions on Lithuania by the PRC, Russia, and Belarus. Beijing eventually decided to internationalise the dispute, shifting it to the EU level by weaponising European value chains. It is also stepping up its propaganda attacks on Lithuania, accusing it of torture and human rights violations against migrants on the border with Belarus, as well as past crimes against the Polish and Jewish minorities.

- Diplomatic conflict's potential impact on Lithuania's position in global supply chains is causing serious concern in Vilnius. The previous informal trade sanctions that focused solely on Lithuanian entities have not been considered severe and have not changed the authorities' position in Vilnius. The threat of losing international contracts due to reports that some companies are considering moving production to plants in other countries is serious. The international brand of Lithuania as a safe destination for investment, which has been built up over the past decades, could suffer significantly. The weaponisation of supply chains built by multinational corporations is a relative novelty for Beijing, which has rarely used such tools, focusing instead on informal trade restrictions. However, sales to China account for only about 1% of Lithuania's total exports. Beijing's new, much more aggressive tactics are also aimed at intimidating other EU countries, mainly from Central Europe, where the economic cooperation model with China is similar to Lithuania's (low direct sales to China with significant indirect exports through the supply chains of Western European companies).

- As the dispute enters a new phase, the Lithuanian authorities' assurances to local constituencies that the Chinese retaliation will not significantly impact the economy are no longer valid. The efforts made by Vilnius to obtain support from the European Commission are to prove that the authorities are active in protecting the interests of Lithuanian business, which is engaged in cooperation with the PRC. Local business circles are putting increasing pressure on the government, arguing that they were encouraged to start co-operating with Chinese partners by the Lithuanian authorities several years ago when the 17+1 was established. The growing discord in Lithuania between the political goals of the ruling right-wing party and the interests of business and consumers is stimulating internal criticism. It is also used in the domestic political struggle – primarily between the government and the president. The head of state has distanced himself from the government's support for Taiwan, describing these actions as ill-considered and uncoordinated.

- The European Commission's reaction is the first example of tangible political support from senior EU officials for Lithuania in its conflict with China. The EC's stance shifted the dispute from bilateral relations to the European level and it will influence the overall dynamics of EU–China relations. Pointing at the China-Lithuania dispute as a case for potential application of the Anti-Coercion Instrument (ACI) brings a promise of further political engagement of the EC in the conflict. However, the EU institutions currently have no immediate legal tools to defend Vilnius' interests. The ACI will be implemented only after the EU Council reviews the EC proposal, and a possible dispute in the WTO could last for years. In such a situation, the burden of supporting Lithuania will fall on the EU capitals. This involves especially Germany, whose multinational companies were targeted by PRC to the most significant degree. Berlin's reaction to the crisis may determine the policy of the new German government towards China. High-profile support of Lithuania and the affected German companies will mean a major shift in relations with Beijing and a departure from Angela Merkel's policy based on dialogue. The lack of proper reaction (or criticism of Vilnius's policy) will send a strong political message to China that pressure on German corporations is an effective tool for influencing the decisions of both Berlin and other European states. The case of Continental is becoming a crucial test – it would take years to move production out of Lithuania, and bowing to Chinese pressure would mean losses for the German company and difficulties related to further disruptions in the automotive supply chains.

- As the economic repercussions of the conflict are increasingly felt by Lithuania, its future dynamics will also depend on the scale of support from the US. Officially, Washington has still not reacted to the latest round of Chinese sanctions, despite the reports about Beijing's pressure on US companies co-operating with Lithuanian partners (e.g., laser manufacturer Thermo Fisher Scientific). US actions and potential counter-measures will have a massive impact on the future use of weaponising global value chains during diplomatic conflicts by the PRC. In turn, US support for Lithuania will be crucial for the future of US-backed rapprochement between other EU and Taiwan that can already be seen in Czech Republic or Slovakia.