

# U.S. Military Power



# An Assessment of U.S. Military Power

America is a global power with global interests. Its military is tasked first and foremost with defending America from attack. Beyond that, it must be capable of protecting Americans abroad, allies, and the freedom to use international sea, air, and space while retaining the ability to engage in more than one major contingency at a time. America must be able not only to defend itself and its interests, but also to deter enemies and opportunists from taking action that would challenge U.S. interests, a capability that includes both preventing the destabilization of a region and guarding against threats to the peace and security of America's friends.

As noted in the five preceding editions of the *Index*, however, the U.S. does not have the necessary force to meet a two-major regional contingency (two-MRC) requirement and is not ready to carry out its duties effectively. Consequently, as we have seen during the past few years, the U.S. risks seeing its interests increasingly challenged and the world order it has led since World War II undone.

## How to Think About Sizing Military Power

Military power begins with the people and equipment used to conduct war: the weapons, tanks, ships, airplanes, and supporting tools such as communications systems that make it possible either for one group to impose its will on another or to prevent such an outcome from happening.

However, simply counting the number of people, tanks, or combat aircraft that the U.S. possesses would be insufficient because it would lack context. For example, the U.S.

Army might have 100 tanks, but to accomplish a specific military task, 1,000 or more might be needed or none at all. It might be that the terrain on which a battle is fought is especially ill-suited to tanks or that the tanks one has are inferior to the enemy's. The enemy could be quite adept at using tanks, or his tank operations might be integrated into a larger employment concept that leverages the supporting fires of infantry and airpower, whereas one's own tanks are poorly maintained, the crews are not well-prepared, or one's doctrine is irrelevant.

Success in war is partly a function of matching the tools of warfare to a specific task and employing those tools effectively in battle. Get these wrong—tools, objective, competence, or context—and you lose.

Another key element is the military's capacity to conduct operations: how many of the right tools—people, tanks, planes, or ships—it has. One might have the right tools and know how to use them effectively but not have enough to win. Given that one cannot know with certainty beforehand just when, where, against whom, and for what reason a battle might be fought, determining how much capability is needed is an exercise of informed but not certain judgment.

Further, two different combatants can use the same set of tools in radically different ways to quite different effects. The concept of employment matters. Concepts are developed to account for numbers, capabilities, material readiness, and all sorts of other factors that enable or constrain one's actions, such as whether one fights alone or alongside

allies, on familiar or strange terrain, or with a large, well-equipped force or a small, poorly equipped force.

All of these factors and a multitude of others affect the outcome of any military contest. Military planners attempt to account for them when devising requirements, developing training and exercise plans, formulating war plans, and providing advice to the President in his role as Commander in Chief of U.S. military forces.

Measuring hard combat power in terms of its capability, capacity, and readiness to defend U.S. vital interests is difficult, especially in such a limited space as this *Index*, but it is not impossible. However difficult determining the adequacy of one's military forces may be, the Secretary of Defense and the military services have to make such decisions every year when the annual defense budget request is submitted to Congress.

The adequacy of hard power is affected most directly by the resources the nation is willing to apply. Although that decision is informed to a significant degree by an appreciation of threats to U.S. interests and the ability of a given defense portfolio to protect U.S. interests against such threats, it is not informed solely by such considerations; hence the importance of clarity and honesty in determining just what is needed in terms of hard power and the status of such power from year to year.

Administrations take various approaches in determining the type and amount of military power needed and, by extension, the amount of money and other resources to commit to it. After defining the national interests to be protected, the Department of Defense (DOD) can use worst-case scenarios to determine the maximum challenges the U.S. military might have to overcome. Another way is to redefine what constitutes a threat. By taking a different view of whether major actors pose a meaningful threat and of the extent to which friends and allies have the ability to assist the U.S. in meeting security objectives, one can arrive at different conclusions about necessary military strength.

For example, one Administration might view China as a rising belligerent power bent

on dominating the Asia-Pacific region. Another Administration might view China as an inherently peaceful rising economic power, with the expansion of its military capabilities a natural occurrence commensurate with its strengthening status. The difference between these views can have a dramatic impact on how one thinks about U.S. defense requirements. So, too, can policymakers amplify or downplay risk to justify defense budget decisions.

There also can be strongly differing views on requirements for operational capacity.

- Does the country need enough for two major combat operations (MCOs) at roughly the same time or just enough for a single major operation and some number of lesser cases?
- To what extent should “presence” tasks—the use of forces for routine engagement with partner countries or simply to be on hand in a region for crisis response—be in addition to or a subset of a military force sized to handle two major regional conflicts?
- How much value should be assigned to advanced technologies as they are incorporated into the force?

## Where to Start

There are two major references that one can use to help sort through the variables and arrive at a starting point for assessing the adequacy of today's military posture: government studies and historical experience. The government occasionally conducts formal reviews that are meant to inform decisions on capabilities and capacities across the Joint Force relative to the threat environment (current and projected) and evolutions in operating conditions, the advancement of technologies, and aspects of U.S. interests that may call for one type of military response over another.

The 1993 Bottom-Up Review (BUR) conducted by then-Secretary of Defense Les Aspin is one such frequently cited example. Secretary



Aspin recognized that “the dramatic changes that [had] occurred in the world as a result of the end of the Cold War and the dissolution of the Soviet Union” had “fundamentally altered America’s security needs” and were driving an imperative “to reassess all of our defense concepts, plans, and programs from the ground up.”<sup>1</sup>

The BUR formally established the requirement that U.S. forces should be able “to achieve decisive victory in two nearly simultaneous major regional conflicts and to conduct combat operations characterized by rapid response and a high probability of success, while minimizing the risk of significant American casualties.”<sup>2</sup> Thus was formalized the two-MRC standard.

Dr. Daniel Gouré, in his 2015 *Index* essay “Building the Right Military for a New Era: The Need for an Enduring Analytic Framework,” noted that various Administrations have redefined force requirements based on their perceptions of what was necessary to protect U.S. interests.<sup>3</sup> In an attempt to formalize the process, and perhaps to have a mechanism by which to influence the executive branch in such matters, Congress mandated that each incoming Administration must conduct a comprehensive strategic review of the global security environment, articulate a relevant strategy suited to protecting and promoting U.S. security interests, and recommend an associated military force posture.<sup>4</sup>

The Quadrennial Defense Reviews (QDRs) have been conducted since 1997, accompanied in 1997, 2010, and 2014 by independent National Defense Panel (NDP) reports that have reviewed and commented on them. Both sets of documents purport to serve as key assessments, but analysts have come to minimize their value, regarding them as justifications for executive branch policy preferences (the QDR reports) or overly broad generalized commentaries (the NDP reports) that lack substantive discussion about threats to U.S. interests, a credible strategy for dealing with them, and the actual ability of the U.S. military to meet national security requirements.

The QDR was replaced by the National Defense Strategy (NDS), released in 2018, and the independent perspectives of the formal DOD review by the National Defense Strategy Commission, which released its view of the NDS in November 2018. Departing from their predecessors, neither document proposed specific force structures or end strength goals for the services.<sup>5</sup>

### **Correlation of Forces as a Factor in Force Sizing**

During the Cold War, the U.S. used the Soviet threat as its primary reference in determining its hard-power needs. At that time, the correlation of forces—a comparison of one force against another to determine strengths and weaknesses—was highly symmetrical. U.S. planners compared tanks, aircraft, and ships against their direct counterparts in the opposing force. These comparative assessments drove the sizing, characteristics, and capabilities of fleets, armies, and air forces.

The evolution of guided, precision munitions and the rapid technological advancements in surveillance and targeting systems, however, made comparing combat power more difficult. What was largely a platform v. platform model has shifted somewhat to a munitions v. target model.

The proliferation of precise weaponry means increasingly that each round, bomb, rocket, missile, and even (in some instances) individual bullet can hit its intended target, thus decreasing the number of munitions needed to prosecute an operation. It also means that the lethality of an operating environment increases significantly for the people and platforms involved. We are now at the point where, instead of focusing primarily on how many ships or airplanes the enemy can bring to bear against one’s own force, one must consider how many “smart munitions” the enemy has when thinking about how many platforms and people are needed to win a combat engagement.<sup>6</sup>

In one sense, increased precision and the technological advances now being

incorporated into U.S. weapons, platforms, and operating concepts make it possible to do far more than ever before with fewer assets.

- Platform signature reduction (stealth) makes it harder for the enemy to find and target them, and the increased precision of weapons makes it possible for fewer platforms to hit many more targets.
- The ability of the U.S. Joint Force to harness computers, modern telecommunications, space-based platforms—such as for surveillance, communications, and positioning-navigation-timing (PNT) support from GPS satellites—and networked operations potentially means that in certain situations, smaller forces can have far greater effect in battle than at any other time in history (although these same advances also enable enemy forces).
- Certain military functions—such as seizing, holding, and occupying territory—may require a certain number of soldiers no matter how state-of-the-art their equipment may be. For example, securing an urban area where line of sight is constrained and precision weapons have limited utility requires the same number of squads of infantry as were needed in World War II.

With smaller forces, each individual element of the force represents a greater percentage of its combat power. Each casualty or equipment loss therefore takes a larger toll on the ability of the force to sustain high-tempo, high-intensity combat operations over time, especially if the force is dispersed across a wide theater or across multiple theaters of operation.

As advanced technology has become more affordable, it has become more accessible for nearly any actor, whether state or non-state. Consequently, it may well be that the outcomes of future wars will depend far more on the skill of the forces and their capacity to sustain

operations over time than they will on some great disparity in technology. If so, readiness and capacity will take on greater importance than absolute advances in capability.

All of this illustrates the difficulties of and need for exercising judgment in assessing the adequacy of America's military power. Yet without such an assessment, all that remains are the defense strategy reviews, which are subject to filtering and manipulation to suit policy interests; annual budget submissions, which typically favor desired military programs at presumed levels of affordability and are therefore necessarily budget-constrained; and leadership posture statements, which often simply align with executive branch policy priorities.

### **The U.S. Joint Force and the Art of War**

This section of the *Index* assesses the adequacy of the United States' defense posture as it pertains to a conventional understanding of "hard power," defined as the ability of American military forces to engage and defeat an enemy's forces in battle at a scale commensurate with the vital national interests of the U.S. While some hard truths in military affairs are appropriately addressed by math and science, others are not. Speed, range, probability of detection, and radar cross-section are examples of quantifiable characteristics that can be measured. Specific future instances in which U.S. military power will be needed, the competence of the enemy, the political will to sustain operations in the face of mounting deaths and destruction, and the absolute amount of strength needed to win are matters of judgment and experience, but they nevertheless affect how large and capable a force one might need.

In conducting the assessment, we accounted for both quantitative and qualitative aspects of military forces, informed by an experience-based understanding of military operations and the expertise of external reviewers. The authors of these military sections bring a combined total of more than a hundred years of uniformed military experience to their analysis.

Military effectiveness is as much an art as it is a science. Specific military capabilities represented in weapons, platforms, and military units can be used individually to some effect. Practitioners of war, however, have learned that combining the tools of war in various ways and orchestrating their tactical employment in series or simultaneously can dramatically amplify the effectiveness of the force that is committed to battle.

Employment concepts are exceedingly hard to measure in any quantitative way, but their value as critical contributors in the conduct of war is undeniable. How they are used is very much an art-of-war matter that is learned through experience over time.

### What Is Not Being Assessed

In assessing the current status of the military forces, this *Index* uses the primary measures used by the military services themselves when they discuss their ability to employ hard combat power.

- The Army's unit of measure is the brigade combat team (BCT);
- The Marine Corps structures itself by battalions;
- For the Navy, it is the number of ships in its combat fleet; and
- The most consistent measure for the Air Force is total number of aircraft, sometimes broken down into the two primary subtypes of fighters and bombers.

Obviously, this is not the totality of service capabilities, and it certainly is not everything needed for war, but these measures can be viewed as surrogates that subsume or represent the vast number of other things that make these "units of measure" possible and effective in battle. For example, combat forces depend on a vast logistics system that supplies everything from food and water to fuel, ammunition, and repair parts. Military operations require

engineer support, and the force needs medical, dental, and administrative capabilities. The military also fields units that transport combat power and its sustainment wherever they may be needed around the world.

The point is that the military spear has a great deal of shaft that makes it possible for the tip to locate, close with, and destroy its target, and there is a rough proportionality between shaft and spear tip. Thus, in assessing the basic units of measure for combat power, one can get a sense of what is probably needed in the combat support, combat service support, and supporting establishment echelons.

The scope of this *Index* does not extend to analysis of everything that makes hard power possible; it focuses on the status of the hard power itself. It also does not assess the services' Reserve and National Guard components, although they account for roughly one-third of the U.S. military force<sup>7</sup> and have been essential to the conduct of operations since September 2001. Consistent assessment of their capability, readiness, and operational role is a challenge because each service determines the balance among its Active, Reserve, and National Guard elements differently (only the Army and Air Force have Guard elements; the Navy and Marine Corps do not). This balance can change from year to year and is based on factors that include cost of the respective elements, availability for operational employment, time needed to respond to an emergent crisis, allocation of roles among the elements, and political considerations.<sup>8</sup>

As with other elements essential to the effective employment of combat power—logistics, medical support, strategic lift, training, etc.—the U.S. military could not handle a major conflict without the Reserve and Guard forces. Nevertheless, to make the challenge of annually assessing the status of U.S. military strength using consistent metrics over time more manageable, this *Index* looks at something that is usually associated with the Active component of each service: the baseline requirement for a given amount of combat power that is readily available for use in a major combat operation.

There are exceptions, however. For example, in this edition of the *Index*, four Army National Guard BCTs are counted as “available” for use because of the significant amounts of additional resources that have been dedicated specifically to these formations to raise their readiness levels.

## The Defense Budget and Strategic Guidance

When it comes to the defense budget, how much we spend does not automatically determine the posture or capacity of the U.S. military. As a matter of fact, simply looking at how much is allocated to defense does not tell us much about the capacity, modernity, or readiness of the forces. Proper funding is a necessary condition for a capable, modern, and ready force, but it is not sufficient by itself. It is possible that a larger defense budget could be associated with less military capability if the money were allocated inappropriately or spent wastefully. That said, however, the budget does reflect the importance assigned to defending the nation and its interests in prioritizing federal spending.

Absent a significant threat to the country’s survival, the U.S. government will always balance spending on defense against spending in all of the other areas of government activity that are deemed necessary or desirable. Ideally, defense requirements are determined by identifying national interests that might need to be protected with military power; assessing the nature of threats to those interests, what would be needed to defeat those threats, and the costs associated with that capability; and then determining what the country can afford or is willing to spend. *Any difference between assessed requirements and affordable levels of spending on defense would constitute a risk to U.S. security interests.*

This *Index* enthusiastically adopts this approach: interests, threats, requirements, resulting force, and associated budget. Spending less than the amount needed to maintain a two-MRC force results in policy debates about where to accept risk: force modernization, the

capacity to conduct large-scale or multiple simultaneous operations, or force readiness.

The National Defense Strategy released in late January 2018 by the Department of Defense is the DOD’s current effort to establish the connection among interests, threats, requirements, and resources.<sup>9</sup> It serves to orient how the DOD intends to prepare the country’s defense and establishes a public baseline of mission and associated requirements against which the country can measure its defense efforts. When discussing resources, the strategy calls for an increased, sustained, and predictable budget as the necessary precondition for its execution—something that has proved elusive in the current budgetary climate of two-year deals designed to circumvent the Budget Control Act of 2011 (BCA).<sup>10</sup>

The decision to fund national defense commensurate with interests and prevailing threats reflects our national priorities and risk tolerance. This *Index* assesses the ability of the nation’s military forces to protect vital national security interests within the world *as it is* so that the debate about the level of funding for hard power is better informed.

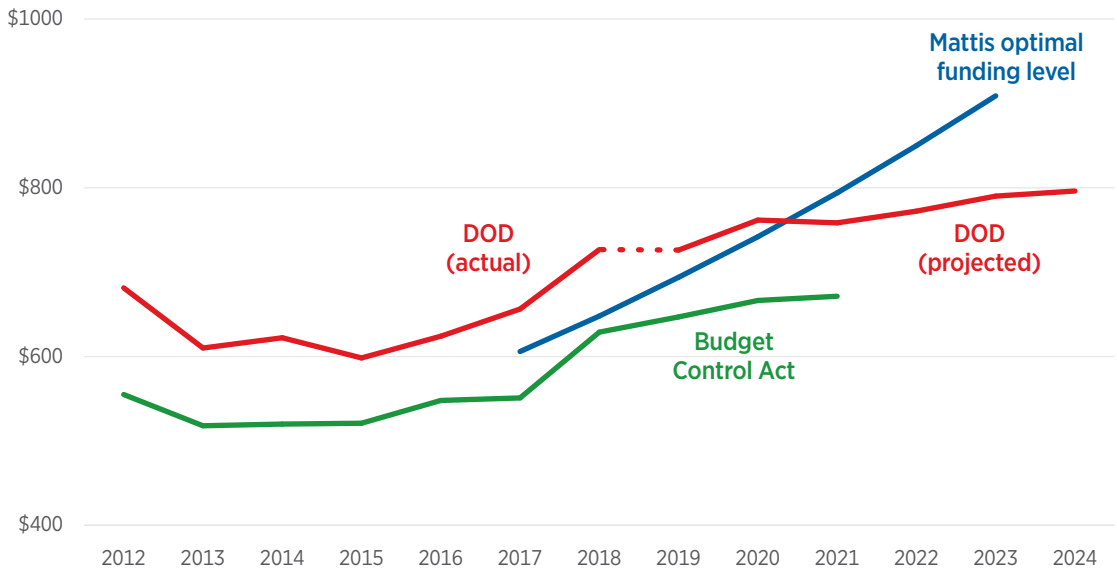
The fiscal year (FY) 2019 base discretionary budget for the Department of Defense was \$616 billion.<sup>11</sup> This represents the resources allocated to pay for the forces (manpower, equipment, training); enabling capabilities (things like transportation, satellites, defense intelligence, and research and development); and institutional support (bases and stations, facilities, recruiting, and the like). The base budget does not pay for the cost of major ongoing overseas operations, which is captured in supplemental funding known as OCO (overseas contingency operations).

The debate about how much funding should be allocated to defense has been framed by the current Administration’s campaign promise to rebuild the military, an objective that is generally supported by Congress. Despite repeated emphasis on the importance of investing more to fix obvious readiness, capacity, and modernization problems, the debate has been determined by larger political dynamics that

## Defense Spending Improves but Falls Short of Optimal Levels

Despite expected increases, defense spending is projected to fall short of former Defense Secretary Gen. Mattis's optimal funding levels.

IN BILLIONS OF DOLLARS



**NOTES:** DOD spending includes mandatory spending (about \$9 billion per year) and OCO spending, which is exempt from the BCA.

**SOURCES:**

- Department of Defense: Office of Management and Budget, *Historical Tables*, "Table 5.1—Budget Authority by Function and Subfunction: 1976–2024," <https://www.whitehouse.gov/omb/historical-tables/> (accessed June 20, 2019).
- Budget Control Act: Brendan W. McGarry, "The Defense Budget and the Budget Control Act: Frequently Asked Questions," Congressional Research Service *Report R44039*, July 13, 2018, <https://fas.org/sgp/crs/natsec/R44039.pdf> (accessed June 20, 2019), and Congress.gov, "H.R. 3877-Bipartisan Budget Act of 2019," August 2, 2019, <https://www.congress.gov/bill/116th-congress/house-bill/3877> (accessed September 12, 2019).
- Mattis optimal funding levels: Frederico Bartels, "Current Planned Defense Budget Falls Short," Heritage Foundation *Background* 3352, September 21, 2018, <https://www.heritage.org/defense/report/current-planned-defense-budget-falls-short>.

 heritage.org

pitted those who want to see an overall reduction in federal spending against those who advocate higher levels of defense spending and those who want to see any increase in defense spending matched by commensurate increases in domestic spending.

Passage of the Bipartisan Budget Act of 2018 (BBA)<sup>12</sup> in early February 2018 raised the BCA caps for FY 2018 and FY 2019. The legislation raised the cap by \$71 billion to \$629 billion in

FY 2018 and by \$69 billion to \$647 billion in FY 2019. This provided substantial budgetary relief for the DOD and, given its two-year coverage, a modicum of stability. This stability was translated into on-time passage of the National Defense Authorization Act and the Defense Appropriations bill, a first since 2008.<sup>13</sup> Passage of a budget before the end of the fiscal year allowed the Pentagon to execute the budget properly and use all the months of the



fiscal year, in contrast with previous years that have been marked by continuing resolutions.<sup>14</sup>

The Department of Defense attributes many of the recent gains in readiness to the stability and predictability provided by the BBA:

The Bipartisan Budget Act of 2018 enabled the Department of Defense (DoD) to continue rebuilding the U.S. military after years of destructive budget cuts. In a time of competing priorities, Congress demonstrated political courage to ensure [that] America's sentinels remain the combat-credible military force we need to deter war and guarantee [that] the President and our diplomats always negotiate from a position of strength.<sup>15</sup>

Following the Bipartisan Budget Act of 2018, Congress and the President come to an agreement on altering the last two years of the BCA caps, and the Bipartisan Budget Act of 2019 became law on August 2, 2019.<sup>16</sup> The act raises the cap for FY 2020 from \$576 billion to \$666.5 billion and for FY 2021 from \$590 billion to \$671.5 billion. The law could yield a more predictable defense budget in the next two years, because the lawmakers will be able to begin their debates based on a defense budget level that is more acceptable to both sides of the aisle.

However, the growth in the defense budget as outlined by the Bipartisan Budget Act of 2019 falls short of what is assessed as needed.

In testimony before the House Armed Services Committee, for example, former Secretary of Defense James Mattis and Chairman of the Joint Chiefs of Staff General Joseph Dunford emphasized the need for sustained budget growth so that U.S. forces can maintain a competitive advantage over likely adversaries.<sup>17</sup> “We know now,” General Dunford testified, “that continued growth in the base budget of at least 3 percent *above inflation* is the floor necessary to preserve just the competitive advantage we have today, and we can’t assume our adversaries will remain still.”<sup>18</sup> Further, the bipartisan commission that assessed the

National Defense Strategy also assessed the need to have budgetary growth of between 3 percent and 5 percent above inflation.<sup>19</sup> The BCA limits the increases to little over inflation, and the current budget request projects increases that are slightly below the inflationary rate.

### **Purpose as a Driver in Force Sizing**

The Joint Force is used for a wide range of purposes, only one of which is major combat operations. Fortunately, such events have been rare (but consistent), averaging roughly 15 years between occurrences.<sup>20</sup> In between (and even during) such occurrences, the military is used to support regional engagement, crisis response, strategic deterrence, and humanitarian assistance, as well as to support civil authorities and U.S. diplomacy.

All of the U.S. Unified Geographic Combatant Commands, or COCOMS—Northern Command (NORTHCOM); European Command (EUCOM); Central Command (CENTCOM); Indo-Pacific Command (INDOPACOM); Southern Command (SOUTHCOM); and Africa Command (AFRICOM)—have annual and long-term plans through which they engage with countries in their assigned regions. These engagements range from very small unit training events with the forces of a single partner country to larger bilateral and sometimes multilateral military exercises. Such events help to foster working relationships with other countries, acquire a more detailed understanding of regional political–military dynamics and on-the-ground conditions in areas of interest, and signal U.S. security interests to friends and competitors.

To support such COCOM efforts, the services provide forces that are based permanently in respective regions or that operate in them temporarily on a rotational basis. To make these regional rotations possible, the services must maintain base forces that are large enough to train, deploy, support, receive back, and again make ready a stream of units that ideally is enough to meet validated COCOM demand.

The ratio between time spent at home and time spent away on deployment for any given unit is known as OPTEMPO (operational tempo), and each service attempts to maintain a ratio that both gives units enough time to educate, train, and prepare their forces and allows the individuals in a unit to maintain some semblance of healthy home and family lives. This ensures that units are fully prepared for the next deployment cycle and that service-members do not become “burned out” or suffer adverse consequences in their personal lives because of excessive deployment time.

Experience has shown that a ratio of at least 3:1 (three periods of time at home for every period deployed) is sustainable. If a unit is to be out for six months, for example, it will be home for 18 months before deploying again. Obviously, a service needs enough people, units, ships, and planes to support such a ratio. If peacetime engagement were the primary focus for the Joint Force, the services could size their forces to support these forward-based and forward-deployed demands.

Thus, the size of the total force must necessarily be much larger than any sampling of its use at any point in time.

In contrast, sizing a force for major combat operations is an exercise informed by history—how much force was needed in previous wars—and then shaped and refined by analysis of current threats, a range of plausible scenarios, and expectations about what the U.S. can do given training, equipment, employment concept, and other factors. The defense establishment must then balance “force sizing” between COCOM requirements for presence and engagement and the amount of military power (typically measured in terms of combat units and major combat platforms, which inform total end strength) that is thought necessary to win in likely war scenarios.

Inevitably, compromises are made that account for how much military the country is willing to buy. Generally speaking:

- **The Army** sizes to major warfighting requirements;
- **The Marine Corps** focuses on crisis response demands and the ability to contribute to one major war;
- **The Air Force** attempts to strike a balance that accounts for historically based demand across the spectrum because air assets are shifted fairly easily from one theater of operations to another (“easily” being a relative term when compared to the challenge of shifting large land forces), and any peacetime engagement typically requires some level of air support; and
- **The Navy** is driven by global presence requirements. To meet COCOM requirements for a continuous fleet presence at sea, the Navy must have three to four ships in order to have one on station. A commander who wants one U.S. warship stationed off the coast of a hostile country, for example, needs the use of four ships from the fleet: one on station, one that left station and is traveling home, one that just left home and is traveling to station, and one that is otherwise unavailable because of major maintenance or modernization work.

This *Index* focuses on the forces required to win two major wars as the baseline force-sizing metric. The military’s effectiveness, both as a deterrent against opportunistic competitor states and as a valued training partner in the eyes of other countries, derives from its effectiveness (proven or presumed) in winning wars.

## Our Approach

With this in mind, we assessed the state of America’s military U.S. forces as it pertains to their ability to deliver hard power against an enemy in three areas:

- Capability,
- Capacity, and
- Readiness.

**Capability.** Examining the capability of a military force requires consideration of:

- The proper tools (material and conceptual) of sufficient design, performance characteristics, technological advancement, and suitability needed for the force to perform its function against an enemy force successfully;
- The sufficiency of armored vehicles, ships, airplanes, and other equipment and weapons to win against the enemy;
- The appropriate variety of options to preclude strategic vulnerabilities in the force and give flexibilities to battlefield commanders; and
- The degree to which elements of the force reinforce each other in covering potential vulnerabilities, maximizing strengths, and gaining greater effectiveness through synergies that are not possible in narrowly stovepiped, linear approaches to war.

The capability of the U.S. Joint Force was on ample display in its decisive conventional war victory over Iraq, in liberating Kuwait in 1991, and later in the conventional military operation in Iraq to depose Saddam Hussein in 2003. Aspects of its capability have also been seen in numerous other operations undertaken since the end of the Cold War. While the conventional combat aspect of power projection has been more moderate in places like Yugoslavia, Somalia, Bosnia and Serbia, and Kosovo, and even against the Taliban in Afghanistan in 2001, the fact that the U.S. military was able to conduct highly complex operations thousands of miles away in austere, hostile environments and sustain those operations as long as required is testament to the ability of U.S. forces to do things that the armed forces of few if any other countries can do.

A modern “major combat operation”<sup>21</sup> along the lines of those upon which Pentagon planners base their requirements would

feature a major opponent possessing modern integrated air defenses; naval power (surface and undersea); advanced combat aircraft (to include bombers); a substantial inventory of short-range, medium-range, and long-range missiles; current-generation ground forces (tanks, armored vehicles, artillery, rockets, and anti-armor weaponry); cruise missiles; and (in some cases) nuclear weapons. Such a situation involving an actor capable of threatening vital national interests would present a challenge that is comprehensively different from the challenges that the U.S. Joint Force has faced in past decades.

Throughout 2018 and 2019, the military community reenergized its debate about the extent to which the U.S. military is ready for major conventional warfare, given its focus on counterinsurgency, stability, and advise-and-assist operations since 2004 and Secretary Mattis’s directive to prepare for conflict in an era of great-power competition.<sup>22</sup> The Army in particular has noted the need to reengage in training and exercises that feature larger-scale combined arms maneuver operations, especially to ensure that its higher headquarters elements are up to the task.

This *Index* ascertains the relevance and health of military service capabilities by looking at such factors as average age of equipment, generation of equipment relative to the current state of competitor efforts as reported by the services, and the status of replacement programs that are meant to introduce more updated systems as older equipment reaches the end of its programmed service life. While some of the information is quite quantitative, other factors could be considered judgment calls made by acknowledged experts in the relevant areas of interest or as addressed by senior service officials when providing testimony to Congress or examining specific areas in other official statements.

It must be determined whether the services possess capabilities that are relevant to the modern combat environment.

**Capacity.** The U.S. military must have a sufficient quantity of the right capability or



capabilities. When speaking of platforms such as planes and ships, there is a troubling and fairly consistent trend that characterizes the path from requirement to fielded capability within U.S. military acquisition. Along the way to acquiring the capability, several linked things happen that result in far less of a presumed “critical capability” than supposedly was required.

- The manufacturing sector attempts to satisfy the requirements articulated by the military.
- “Unexpected” technological hurdles arise that take longer and much more money to solve than anyone envisioned.
- Programs are lengthened, and cost overruns are addressed, usually with more money.
- Then the realization sets in that the country either cannot afford or is unwilling to pay the cost of acquiring the total number of platforms originally advocated. The acquisition goal is adjusted downward, if not canceled altogether, and the military finally fields fewer platforms at a higher cost per unit than it originally said it needed to be successful in combat.

As deliberations proceed toward a decision on whether to reduce planned procurement, they rarely focus on and quantify the increase in risk that accompanies the decrease in procurement.

Something similar happens with force structure size: the number of units and total number of personnel the services say they need to meet the objectives established by the Commander in Chief and the Secretary of Defense in their strategic guidance. The Marine Corps has stated that it needs 27 infantry battalions to fully satisfy the validated requirements of the regional Combatant Commanders, yet it currently fields only 24. In 2012, the Army was building toward 48 brigade combat teams, but incremental budget cuts reduced that number

over time to 31—less than two-thirds the number that the Army originally thought was necessary. The Navy has produced various assessments of fleet size since the end of the Cold War, from 313 ships to 355 ships, and in 2019 conducted yet another force structure review.

Older equipment can be updated with new components to keep it relevant, and commanders can employ fewer units more expertly for longer periods of time in an operational theater to accomplish an objective. At some point, however, sheer numbers of updated, modern equipment and trained, fully manned units are going to be needed to win in battle against a credible opponent when the crisis is profound enough to threaten a vital interest.

Capacity (numbers) can be viewed in at least three ways: compared to a stated objective for each category by each service, compared to amounts required to complete various types of operations across a wide range of potential missions as measured against a potential adversary, and as measured against a set benchmark for total national capability. This *Index* employs the two-MRC metric as a benchmark.

The two-MRC benchmark for force sizing is the *minimum* standard for U.S. hard-power capacity because one will never be able to employ 100 percent of the force at the same time. Some percentage of the force will always be unavailable because of long-term maintenance overhaul, especially for Navy ships; unit training cycles; employment in myriad engagement and small-crisis response tasks that continue even during major conflicts; and the need to keep some portion of the force uncommitted to serve as a strategic reserve.

The historical record shows that, on average, the U.S. Army commits 21 BCTs to a major conflict; thus, a two-MRC standard would require 42 BCTs available for actual use. But an Army built to field only 42 BCTs would also be an Army that could find itself entirely committed to war, leaving nothing back as a strategic reserve, to replace combat losses, or to handle other U.S. security interests. Although new technologies and additional capabilities have made current

TABLE 1

Historical U.S. Force Allocation

Troop figures are in thousands.

	Korean War	Vietnam War	Persian Gulf War	Operation Iraqi Freedom
ARMY				
Total Troop Deployment During Engagement	206.3	219.3	267.0	99.7
Divisions*	6	7	4	1
Reserve Component Divisions Total for Strategic Documents	n/a	n/a	n/a	n/a
Total Army End Strength During Engagement, During Year of Strategy Document Active	1,313.8	1,113.3	738.0	499.0
Total Active End Strength Recommendations	n/a	n/a	n/a	n/a
NAVY				
Total Fleet During Engagement	904	770	529	297
Aircraft Carriers	6	5	6	5
Carrier Air Wings	6	5	6	5
Large Surface Combatants	37	14	30	23
Small Surface Combatants	16	47	16	9
Attack Submarines	4	0	12	12
Amphibious Vessels	34	26	21	7
Combat Logistics and Support Ships	28	29	45	42
Fighter/Attack Squadrons	21	43	22	24
MARINE CORPS				
Total Troop Deployment During Engagement	33.5	44.7	90.0	66.2
Active Divisions*	1	2	2	1
Reserve Divisions	n/a	n/a	n/a	n/a
Marine Expeditionary Force	1	1	1	2
Air Wings Active/Reserve	1	1	1	1
Total Marine Corps End Strength During Engagement by Year of Strategy Document	187.0	289.0	196.3	178.0
Total Recommended End Strength	n/a	n/a	n/a	n/a
AIR FORCE				
Bombers or Bomber Squadrons**	21	23	3	4
Fighter Squadrons	26		30	30
Active Fighter Wings	7	8	10	10
Reserve Fighter Wings				
Airlift/Tankers	239	167	388	293

\* Figures for engagements are numbers deployed; figures for documents are totals.

\*\* Figures for Air Force bombers for Korean War, Vietnam War, Persian Gulf War, and Iraq are bomber squadrons. All other figures are bombers.

\*\*\* 2014 QDR prescribed nine heavy bomber squadrons, equaling 96 aircraft.

	1993 BUR	1997 QDR	2001 QDR	2006 QDR	2010 QDR	2010 Indep. Panel	2-MRC Paper	2014 QDR	2014 NDP
<b>ARMY</b>									
Total Troop Deployment During Engagement	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Divisions*	10	10	10	11	18	11	10	10	n/a
Reserve Component Divisions Total for Strategic Documents	n/a	5	8	8		7	8	8	n/a
Total Army End Strength During Engagement, During Year of Strategy Document Active	572.0	492.0	481.0	505.0	566.0	566.0	550.0	490.0	490.0
Total Active End Strength Recommendations	n/a	n/a	n/a	482.4	n/a	1,106.0	600.0	450.0	490.0

<b>NAVY</b>									
Total Fleet During Engagement	346	310	n/a	n/a	n/a	346	350	n/a	346
Aircraft Carriers	12	12	12	11	11	11	11	11	n/a
Carrier Air Wings	12	11	11	n/a	10	10	10	10	n/a
Large Surface Combatants	124	116	116	n/a	84–88	n/a	120	92	n/a
Small Surface Combatants				n/a	14–28	n/a	n/a	43	n/a
Attack Submarines	55	50	55	n/a	53–55	55	50	51	n/a
Amphibious Vessels	41	36	36	n/a	29–31	n/a	38	33	n/a
Combat Logistics and Support Ships	65	n/a	n/a	n/a	58	n/a	75	n/a	n/a
Fighter/Attack Squadrons	33	30	30	n/a	30	30	30	30	n/a

<b>MARINE CORPS</b>									
Total Troop Deployment During Engagement	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Active Divisions*	4	3	3	n/a	3	n/a	n/a	3	n/a
Reserve Divisions	1	1	1	n/a	1	n/a	n/a	1	n/a
Marine Expeditionary Force	3	3	3	n/a	3	3	3	2	n/a
Air Wings Active/Reserve	n/a	4	4	n/a	4	n/a	n/a	4	n/a
Total Marine Corps End Strength During Engagement by Year of Strategy Document	174.0	174.0	173.0	180.0	202.0	202.0	196.0	182.0	182.0
Total Recommended End Strength	n/a	n/a	n/a	175.0	n/a	243.0	202.0	182.0	182.0

<b>AIR FORCE</b>									
Bombers or Bomber Squadrons**	200	187	112	n/a	96	180	200	96***	n/a
Fighter Squadrons	54	54	46	n/a	42	66	54	48	n/a
Active Fighter Wings	13	12+	15	n/a	n/a	20	20	9	n/a
Reserve Fighter Wings	7	8	12	n/a	n/a	n/a		7	n/a
Airlift/Tankers	n/a	n/a	n/a	n/a	1023	1023	1,000	954	n/a

BCTs more capable than those they replaced, one thing remains the same: Today's BCT, like its predecessors, can only be committed to one place at a time and must be able to account for combat losses, especially if it engages a similarly modernized enemy force. Thus, numbers still matter regardless of modernity.

Again, this *Index* assesses only the Active component of the service, though with full awareness that the Army also has Reserve and National Guard components that together account for half of the total Army. The additional capacity needed to meet these "above two-MRC requirements" could be handled by these other components or mobilized to supplement Active-component commitments. In fact, this is how the Army thinks about meeting operational demands and is at the heart of the long-running debate within the total Army about the roles and contributions of the various Army components. A similar situation exists with the Air Force and Marine Corps.

The balance among Active, Reserve, and Guard elements is beyond the scope of this study. Our focus here is on establishing a minimum benchmark for the capacity needed to handle a two-MRC requirement.

We conducted a review of the major defense studies (1993 BUR, QDR reports, and independent panel critiques) that are publicly available,<sup>23</sup> as well as modern historical instances of major wars (Korea, Vietnam, Gulf War, Operation Iraqi Freedom), to see whether there was any consistent trend in U.S. force allocation. The results of our review are presented in Table 1. To this we added 20 percent, both to account for forces and platforms that are likely to be unavailable and to provide a strategic reserve to guard against unforeseen demands.

Summarizing the totals, this *Index* concluded that a Joint Force capable of dealing with two MRCs simultaneously or nearly simultaneously would consist of:

- **Army:** 50 BCTs.
- **Navy:** at least 400 ships and 624 strike aircraft.

- **Air Force:** 1,200 fighter/attack aircraft.
- **Marine Corps:** 36 battalions.

America's security interests require that the services have the capacity to handle two major regional conflicts successfully.

**Readiness.** The consequences of the sharp reductions in funding mandated by sequestration have caused military service officials, senior DOD officials, and even Members of Congress to warn of the dangers of recreating the "hollow force" of the 1970s when units existed on paper but were staffed at reduced levels, minimally trained, and woefully ill-equipped.<sup>24</sup> To avoid this, the services have traded quantity/capacity and modernization to ensure that what they do have is "ready" for employment.

Supplemental funding in FY 2017, a higher topline in FY 2018, and sustained increases in funding through FY 2019 have helped to stop the bleeding and have enabled the services to plan and implement readiness recovery efforts. Although the return of further cuts under the BCA (to continue in force by law until 2021 unless modified by Congress) could threaten to undo these gains, readiness reporting has been largely optimistic compared to recent years.

It is one thing to have the right capabilities to defeat the enemy in battle. It is another thing to have enough of those capabilities to sustain operations and many battles against an enemy over time, especially when attrition or dispersed operations are significant factors. But sufficient numbers of the right capabilities are rather meaningless if the force is not ready to engage in the task.

**Scoring.** In our final assessments, we tried very hard not to convey a higher level of precision than we think is achievable using unclassified, open-source, publicly available documents; not to reach conclusions that could be viewed as based solely on assertions or opinion; and not to rely solely on data and information that can be highly quantified. Simple numbers, while important, do not tell the whole story.

## U.S. Military Power: Five-Grade Scale

VERY WEAK

WEAK

MARGINAL

STRONG

VERY STRONG

We believe that the logic underlying our methodology is sound. This *Index* drew from a wealth of public testimony from senior government officials, from the work of recognized experts in the defense and national security analytic community, and from historical instances of conflict that seemed most appropriate to this project. It then considered several questions, including:

- How does one place a value on the combat effectiveness of such concepts as Air-Sea Battle, Multi-Domain Operations, Littoral Operations in a Contested Environment, Distributed Maritime Operations, Network-centric Operations, or Joint Operational Access?
- Is it entirely possible to assess accurately (1) how well a small number of newest-generation ships or aircraft will fare against a much larger number of currently modern counterparts when (2) U.S. forces are operating thousands of miles from home, (3) orchestrated with a particular operational concept, and (4) the enemy is leveraging a “home field advantage” that includes strategic depth and much shorter and perhaps better protected lines of communication and (5) might be pursuing much dearer national objectives than the U.S. so that the political will to conduct sustained operations in the face of mounting losses might differ dramatically?

- How does one neatly quantify the element of combat experience, the erosion of experience as combat operation events recede in time and those who participated in them leave the force, the health of a supporting workforce, the value of “presence and engagement operations,” and the related force structures and patterns of deployment and employment that presumably deter war or mitigate its effects if it does occur?

This *Index* focused on the primary purpose of military power—to defeat an enemy in combat—and the historical record of major U.S. engagements for evidence of what the U.S. defense establishment has thought was necessary to execute a major conventional war successfully. To this we added the two-MRC benchmark; on-the-record assessments of what the services themselves are saying about their status relative to validated requirements; and the analysis and opinions of various experts, both in and out of government, who have covered these issues for many years.

Taking it all together, we rejected scales that would imply extraordinary precision and settled on a scale that conveys broader characterizations of status that range from very weak to very strong. Ultimately, any such assessment is a judgment call informed by quantifiable data, qualitative assessments, thoughtful deliberation, and experience. We trust that our approach makes sense, is defensible, and is repeatable.

## Endnotes

1. Les Aspin, Secretary of Defense, *Report on the Bottom-Up Review*, U.S. Department of Defense, October 1993, p. iii, [http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=OCCUQFjAB-ahUKewjj4dWf6N3HAhVEmh4KHdG1CdG&url=ht tp%3A%2F%2Fwww.dtic.mil%2Fcgi-bin%2FGetTRDoc%3FAD%3DADA359953&usg=AFQjCNFvzw730XRz7YRxc5BNr5\\_UdfMiQ \(accessed May 17, 2019\).](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=OCCUQFjAB-ahUKewjj4dWf6N3HAhVEmh4KHdG1CdG&url=ht tp%3A%2F%2Fwww.dtic.mil%2Fcgi-bin%2FGetTRDoc%3FAD%3DADA359953&usg=AFQjCNFvzw730XRz7YRxc5BNr5_UdfMiQ (accessed May 17, 2019).)
2. *Ibid.*, p. 8.
3. Daniel Gouré, “Building the Right Military for a New Era: The Need for an Enduring Analytic Framework,” in *2015 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2015), pp. 27–36, <http://index.heritage.org/militarystrength/important-essays-analysis/building-right-military-new-era/>.
4. John Y. Schrader, Leslie Lewis, and Roger Allen Brown, *Quadrennial Defense Review 2001: Lessons on Managing Change in the Department of Defense* (Santa Monica, CA: RAND Corporation, National Defense Research Institute, 2003), [http://www.rand.org/content/dam/rand/pubs/documented\\_briefings/2005/DB379.pdf](http://www.rand.org/content/dam/rand/pubs/documented_briefings/2005/DB379.pdf) (accessed May 17, 2019).
5. Commission on the National Defense Strategy, *Providing for the Common Defense: The Assessment and Recommendations of the National Defense Strategy Commission*, <https://www.usip.org/sites/default/files/2018-11/providing-for-the-common-defense.pdf> (accessed May 17, 2019), and press release, “National Defense Strategy Commission Releases Its Review of 2018 National Defense Strategy,” United States Institute of Peace, November 13, 2018, <https://www.usip.org/press/2018/11/national-defense-strategy-commission-releases-its-review-2018-national-defense> (accessed May 17, 2019).
6. The United States has not had to contend in combat with any credible air force since the Vietnam War, but U.S. Air Force planners are increasingly concerned about an enemy’s ground-based, anti-air missile capability. For naval planners, ship-based, air-based, and shore-based anti-ship cruise missiles are of much greater concern than is the number of conventional surface combatants armed with large-caliber guns that an enemy navy has. Likewise, ground force planners have to consider the numbers and types of guided anti-armor weapons that an enemy possesses and whether an opposing force has guided artillery, mortar, or rocket capabilities. Guided/precision weapons are typically less expensive (by orders of magnitude) than the platforms they target, which means that countries can produce far more guided munitions than primary weapons platforms. Some examples: Harpoon ASCM (\$2 million)/DDG-51 *Arleigh Burke*-Class destroyer (\$2 billion); AT4 anti-armor weapon (\$1,500)/M1A1 Abrams main battle tank (\$9 million); 120mm guided mortar round (\$10,000) or 155mm guided artillery round (\$100,000)/M198 155mm howitzer (\$500,000); S-300 anti-air missile (\$1 million)/F/A-18 Hornet (\$60 million) or F-35A Lightning II (\$180 million).
7. For a detailed discussion of this force, see Richard J. Dunn III, “America’s Reserve and National Guard Components: Key Contributors to U.S. Military Strength,” in *2016 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2015), pp. 61–73, [https://s3.amazonaws.com/ims-2016/PDF/2016\\_Index\\_of\\_US\\_Military\\_Strength\\_FULL.pdf](https://s3.amazonaws.com/ims-2016/PDF/2016_Index_of_US_Military_Strength_FULL.pdf). For the percentage of U.S. military capability that resides in the Guard/Reserve, see *ibid.*, p. 63.
8. One example of balancing the forces was the Army’s Aviation Restructuring Initiative, in which the active-duty force sought to redistribute certain rotorcraft platforms among the active-duty Army and the National Guard. The Guard has contended that this plan would reduce the capabilities it has gained during recent combat engagements, such as its pilots’ proficiency in flying Apache helicopters. For more on this issue, see U.S. Government Accountability Office, *Force Structure: Army’s Analyses of Aviation Alternatives*, GAO-15-430R, updated April 27, 2015, <http://www.gao.gov/assets/670/669857.pdf> (accessed May 17, 2019).
9. James Mattis, U.S. Secretary of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military’s Competitive Edge*, U.S. Department of Defense, <https://www.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf> (accessed May 17, 2019).
10. Budget Control Act of 2011, Public Law 112-25, 112th Cong., August 2, 2011, <https://www.congress.gov/112/plaws/publ25/PLAW-112publ25.pdf> (accessed April 30, 2019).
11. Table A-7, “DoD Base Budget by Appropriation Title,” and Table A-8, “DoD Base Budget by Military Department,” in U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *United States Department of Defense Fiscal Year 2020 Budget Request: Defense Budget Overview*, March 2019, pp. A-4 and A-5, [https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/fy2020\\_Budget\\_Request\\_Overview\\_Book.pdf](https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/fy2020_Budget_Request_Overview_Book.pdf) (accessed May 19, 2019).
12. Bipartisan Budget Act of 2018, Public Law 115-123, 115th Cong., February 9, 2018, <https://www.congress.gov/bill/115th-congress/house-bill/1892/text/eas2?q=%7B%22search%22%3A%5B%22bipartisan+budget+act+of+2018%22%5D%7D&r=1> (accessed May 20, 2019).
13. Joe Gould, “Pentagon Set to Win First On-Time Budget Since 2008,” *Defense News*, September 13, 2018, <https://www.defensenews.com/congress/2018/09/13/pentagon-set-to-win-first-on-time-budget-since-2008/> (accessed April 30, 2019).
14. Frederico Bartels, “Continuing Resolutions Invariably Harm National Defense,” Heritage Foundation *Issue Brief* No. 4819, February 21, 2018, <https://www.heritage.org/defense/report/continuing-resolutions-invariably-harm-national-defense>.



15. James N. Mattis, Secretary of Defense, introduction to U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *Providing for the Common Defense: A Promise Kept to the American Taxpayer*, September 2018, n.p., <https://media.defense.gov/2018/Oct/03/2002047941/-1/-1/1/PROVIDING-FOR-THE-COMMON-DEFENSE-SEPT-2018.pdf> (accessed May 19, 2019).
16. Bipartisan Budget Act of 2019, Public Law No 116-37, 116th Cong., August 2, 2019, <https://www.congress.gov/bill/116th-congress/house-bill/3877/text> (accessed September 11, 2019).
17. James Mattis, U.S. Secretary of Defense, statement on President's budget request for FY 2018 before the Committee on Armed Services, U.S. House of Representatives, June 12, 2017, <https://docs.house.gov/meetings/AS/AS00/20170612/106090/HHRG-115-AS00-Bio-MattisJ-20170612.pdf> (accessed May 19, 2019).
18. Aaron Mehta, "DoD Needs 3–5 Percent Annual Growth 2023, Top Officials Say," *Defense News*, June 13, 2017, <http://www.defensenews.com/pentagon/2017/06/13/dod-needs-3-5-percent-annual-growth-through-2023-top-officials-say/> (accessed May 17, 2019). Emphasis added.
19. Commission on the National Defense Strategy, *Providing for the Common Defense: The Assessment and Recommendations of the National Defense Strategy Commission*, p. 22.
20. Since World War II, the U.S. has fought four major wars: the Korean War (1950–1953); the Vietnam War (1965–1973); the Gulf War/Operation Desert Shield/Desert Storm (1990–1991); and the Iraq War/Operation Iraqi Freedom (2003–2011).
21. Defense references to war have varied over the past few decades from "major combat operation" (MCO) and "major theater war" (MTW) to the current "major regional contingency" (MRC). Arguably, there is a supporting rationale for such shifts as planners attempt to find the best words to describe the scope and scale of significant military efforts, but the terms are basically interchangeable.
22. Mattis, *Summary of the 2018 National Defense Strategy of the United States of America*, p. 4.
23. The Department of Defense, through the Joint Staff and Geographic Combatant Commanders, manages a relatively small set of real-world operational plans (OPLANS) focused on specific situations where the U.S. feels it is most likely to go to war. These plans are reviewed and updated regularly to account for changes in the Joint Force or with the presumed enemy. They are highly detailed and account not only for the amount of force the U.S. expects that it will need to defeat the enemy, but also for which specific units would deploy; how the force would actually flow into the theater (the sequencing of units); what ports and airfields it would use; how much ammunition, fuel, and other supplies it would need at the start; how much transportation or "lift" would be needed to get the force there (by air, sea, trucks, or rail); and the basic plan of attack. The Pentagon also routinely develops, explores, and refines various notional planning scenarios in order to better understand the implications of different sorts of contingencies, which approaches might be more effective, how much of what type of force might be needed, and the regional issue or issues for which there would have to be an accounting. These types of planning events inform service efforts to develop, equip, train, and field military forces that are up to the task of defending national security interests. All of these efforts and their products are classified national security information and therefore not available to the public.
24. For more on the potential for a hollow force, see Association of the United States Army, "Preventing a Hollow Force Is Army's Top Priority," May 25, 2017, <https://www.ausa.org/news/preventing-hollow-force-army%E2%80%99s-top-priority> (accessed May 19, 2019), and J. V. Venable, "America's Air Force Is in Bad Shape," *National Review*, June 13, 2017, <http://www.nationalreview.com/article/448556/us-air-force-weakened-funding-cuts-shrinking-workforce-aging-fleet-hurt-preparedness> (accessed May 19, 2019).





# U.S. Army

The U.S. Army is America's primary land warfare component. Although it addresses all types of operations across the range of ground force employment, its chief value to the nation is its ability to defeat and destroy enemy land forces in battle.

The Army, more than any other service, has been affected by years of counterinsurgency (COIN) operations in Iraq and Afghanistan. "For the past 17 years," according to former Secretary of the Army Mark Esper, "the Army bore the brunt of the wars in Iraq and Afghanistan. For over a decade, we postponed modernization to procure equipment tailored to counter insurgency operations." Former Army Chief of Staff General Mark Milley has warned similarly that "[i]n the last 17 years, our strategic competitors have eroded our military advantages."<sup>1</sup>

- Modernization programs, such as air defense systems, that were not viewed as complementary to COIN operations were terminated;
- In addition to modernization, Army organizational structure, doctrine, and training were significantly modified to enable increased success in COIN operations;
- Brigade and division capabilities were reduced and realigned to facilitate COIN warfare;
- Combat Training Center rotations focused almost exclusively on COIN scenarios; and

- Leaders and soldiers often went for years without practicing their combat core tasks such as counterbattery fire or tank table gunnery.

When the Army sets its mind to doing something, it generally does it completely and without reservation. Such was the Army's adaptation to COIN operations.

Today, the Army is shifting in accordance with national direction to focus on great-power competition. Characteristically, it is "all in." Combat Training Center scenarios now focus nearly exclusively on high-end decisive action, new matériel programs like longer-range artillery with utility in near-peer competitor situations are being initiated, and organizational structures are being reexamined. Warfighting concepts and doctrine are also shifting to this new construct.

All of this is appropriate, but unlike its approach in the aftermath of the Vietnam War, when the 1976 version of its primary doctrinal manual contained absolutely no mention of COIN operations, the Army thus far has seen fit to preserve some capabilities like Security Force Assistance Brigades, counter-drone equipment, and robust Special Operations capabilities. As it moves into the future, the Army must both guard against allowing the pendulum to swing too far in the new direction of great-power competition and maintain critical capabilities for COIN and stability operations, including their supporting intellectual underpinnings.

Despite the clarity of guidance that was achieved in the 2018 National Defense Strategy (NDS), as well as welcome increases in the

defense budget obtained from fiscal year (FY) 2017 to FY 2019, the need to make up for years of underfunding and different priorities has put the Army behind in the key areas of size and modernization. There is, however, room for cautious optimism. General Milley has testified that with Congress's recent help, "we began to restore our competitive advantage" and that "our recent budgets have helped improve readiness and laid the ground work [*sic*] for future modernization."<sup>2</sup>

The Army is rebounding from direction to cut its strength that was promulgated in the latter half of the Obama Administration. In FY 2019, the Army's authorized Regular Army end strength was 478,000,<sup>3</sup> down from 566,000 as recently as FY 2011.<sup>4</sup> The Obama Administration had planned to cut Regular Army end strength still further to 450,000 by 2018 and as low as 420,000 in future years,<sup>5</sup> but the election of President Donald Trump forestalled those cuts.

According to then-Army Vice Chief of Staff General James C. McConville, if BCA-mandated budget caps returned in FY 2020, "[a]ll the readiness gains we made would be lost. We would not be able to modernize the Army. We'd have to reduce the end strength and we would hurt the quality of life for all our soldiers."<sup>6</sup>

Operationally, the Army "provid[es] Combatant Commanders over 179,000 Soldiers in more than 140 countries, including 110,000 Soldiers deployed on a rotational basis."<sup>7</sup>

## Capacity

The Army refers to its warfighting capacity in terms of brigade combat teams. BCTs are the basic building blocks for employment of Army combat forces. They are usually employed within a larger framework of U.S. land operations but are equipped and organized so that they can conduct independent operations as circumstances demand.<sup>8</sup> A BCT averages 4,500 soldiers depending on its variant: Stryker, Armored, or Infantry. A Stryker BCT is a mechanized infantry force organized around the Stryker combat vehicle. Armored BCTs are the Army's primary armored units and employ

the M1 Abrams Main Battle Tank and the M2 Bradley Fighting Vehicle. An Infantry BCT is a highly maneuverable dismounted unit. Variants of the Infantry BCT are the Airmobile BCT, optimized for helicopter assault, and the Airborne BCT, optimized for parachute forcible entry operations.

While end strength is a valuable metric in understanding Army capacity, the number of BCTs is a more telling measure of actual hard power. The reductions in Army end strength since 2011 have had a disproportionate effect on BCTs. The Regular Army decreased its 45 BCTs (552,100 soldiers) in FY 2013 to 31 BCTs (480,000 soldiers) in FY 2020.<sup>9</sup> Put another way, a 14 percent reduction in end strength led to a 31 percent reduction in BCTs.

When Congress reversed the drawdown in end strength and authorized growth starting in 2017, instead of "re-growing" BCTs, the Army chose primarily to "thicken" the force and raise the manning levels within the individual BCTs to increase unit readiness. The Army's goal is to fill operational units to 105 percent of their authorized manning by the end of 2020, and it is on track to meet this goal.<sup>10</sup>

The FY 2015 National Defense Authorization Act (NDAA) established a National Commission on the Future of the Army to conduct a comprehensive study of Army structure.<sup>11</sup> To meet the threat posed by a resurgent Russia and others, the commission recommended that the Army increase its numbers of Armored BCTs.<sup>12</sup> The Army converted two BCTs to Armored BCTs in 2018 and 2019, bringing the number of Armored BCTs to 16 and helping to "ensur[e] a more balanced distribution between its light and heavy fighting forces."<sup>13</sup>

The Army also has a separate air component organized into combat aviation brigades (CABs), which can operate independently.<sup>14</sup> CABs are made up of Army rotorcraft, such as the AH-64 Apache, and perform various roles including attack, reconnaissance, and lift. The number of Army aviation units also experienced a drawdown. In May 2015, the Army deactivated one of its 12 CABs, leaving only 11 in the Regular Army.

CABs and Stryker, Infantry, and Armored BCTs make up the Army's main combat forces, but not the entirety of the Army. About 90,000 troops form the Institutional Army and provide such forms of support as preparing and training troops for deployments, carrying out key logistics tasks, and overseeing military schools and Army educational institutions. The troops constituting the Institutional Army cannot be reduced at the same ratio as BCTs or CABs, and the Army endeavors to insulate these soldiers from drawdown and restructuring proposals in order to "retain a slightly more senior force in the Active Army to allow growth if needed."<sup>15</sup> In addition to the Institutional Army, a great number of functional or multifunctional support brigades, amounting to approximately 13 percent of the active component force based on historical averages,<sup>16</sup> provide air defense; engineering; explosive ordnance disposal (EOD); chemical/biological/radiological and nuclear protection; military police; military intelligence; and medical support among other types of battlefield support for BCTs.

In 2017, in a major initiative shepherded by General Milley, the Army established the first of six planned Security Force Assistance Brigades (SFABs). These units, composed of about 530 personnel each, are designed specifically to train, advise, and mentor other partner-nation military units. The Army had been using regular BCTs for this mission, but because train-and-assist missions typically require senior officers and noncommissioned officers, a BCT comprised predominantly of junior soldiers is a poor fit. The Army envisions that these SFABs will be able to reduce the stress on the service.<sup>17</sup> The Army's second SFAB was activated in January 2018 at Fort Bragg, North Carolina, and "is now deployed to Afghanistan."<sup>18</sup> Of the six envisioned SFABs, one will be in the National Guard, and the other five will be in the Regular Army.

In 2019, the Army was authorized a total end strength of 1,002,750 soldiers: 478,000 in the Regular Army, 189,250 in the Army Reserve, and 335,500 in the Army National Guard.<sup>19</sup>

Two years ago, in 2017, General Milley testified that in his judgment, the Regular Army should be in the range of 540,000–550,000; the National Guard, 350,000–355,000; and the Army Reserve, 205,000–209,000.<sup>20</sup> Since that time, with the publishing of the 2018 NDS and its emphasis on great-power competition, the missions and challenges that the Army is expected to handle have increased.

Today, the Regular Army is much smaller than General Milley recommended. During the week of March 20, 2019, the Regular Army stood at 476,477 soldiers—63,523 less than the minimum General Milley estimated was necessary even before the NDS directed a return to great-power competition.<sup>21</sup> Since 2017, General Milley and other senior Army leaders have been more circumspect in their assessments. Secretary Esper, for example, stated in April 2019 that "I can't tell you what the Army end strength will be. I know it has to be above 500,000."<sup>22</sup> This modification in messaging suggests either that the Army enjoys less freedom to discuss its necessary size openly or that fiscal realities preclude discussions of numbers higher than 500,000 for the Regular Army.

Most experts agree that the Army is too small. In the FY 2017 NDAA, Congress established the National Defense Strategy Commission to provide an "independent, non-partisan review of the 2018 NDS."<sup>23</sup> Among its findings, the Commission noted that:

[T]he United States now faces five credible challengers, including two major-power competitors, and three distinctly different geographic and operational environments. This being the case, a two-war force sizing construct makes more strategic sense today than at any previous point in the post-Cold War era. Instead, the NDS adopts what is functionally a one-war force sizing construct and recommends only modest increases in force capacity, an approach that is likely to create severe strategic and operational vulnerabilities for the

United States. Even if new technologies such as hypersonic weapons, AI, cyber, and autonomous systems eventually do change the face of warfare, in the near- and medium-term conventional capacity will still matter greatly in fighting and deterring conflict. Consequently, although further capability and posture enhancements are necessary, they are likely to be insufficient to meet America's strategic challenges.... *Simply put, the United States needs a larger force than it has today if it is to meet the objectives of the strategy.*<sup>24</sup>

Moreover, the Army has moved from a force that during the Cold War typically had a third of its personnel stationed overseas to a Continental United States-based force. In 1985, 31 percent of the Army was stationed abroad; in 2015, that figure had fallen to 9 percent.<sup>25</sup> The desire to find a so-called peace dividend following the dissolution of the Soviet Union, combined with the reluctance to close bases in the United States, led to large-scale base closure overseas.

In addition to the increased strategic risk of not being able to execute the NDS within the desired time frame, the result of an insufficient number of BCTs and a diminished Army end strength has been to maintain a higher than desired level of operational tempo (OPTEMPO). Despite a reduction in large unit deployments, particularly to Iraq and Afghanistan, Army units continue to experience sustained demand. In May 2018, the Army was experiencing “a deployment to dwell time ratio of about 1 to 1.2—even though the goal for years has been to level it off at 1-to-2.”<sup>26</sup>

Included in these deployments are the rotations of Armored BCTs to and from Europe and Korea. Rather than relying on forward-stationed BCTs, the Army now rotates Armored BCTs to Europe and Korea on a “heel-to-toe” basis. There is an ongoing debate about whether the rotational BCT or the forward-stationed BCT represents the best option. Proponents of rotational BCTs argue

that they arrive fully trained and remain at a high state of readiness throughout a typical nine-month overseas rotation; those who favor forward-stationed forces point to a lower cost, forces that typically are more familiar with the operating environment, and a more reassuring presence for our allies.<sup>27</sup>

Additionally, the Army is resourcing select Army National Guard (ARNG) BCTs and other units with additional numbers of training days, moving from the standard number of 39 training days to as many as 63 per year to increase readiness levels. Under a concept called “Army National Guard 4.0,” the National Guard has implemented a multiyear training cycle to build readiness over time. As part of this concept, the Army increased the number of National Guard BCTs participating in a Combat Training Center (CTC) rotation from two to four starting in FY 2019.<sup>28</sup> This continues in the fiscal year 2020 budget.<sup>29</sup>

Because of this change in strategy and the increased investment in the National Guard, the 2020 *Index of U.S. Military Strength* counts four ARNG BCTs in the overall Army BCT capacity count. This reflects both their ability to be employed on a dramatically shortened timeline as a result of their training at a Combat Training Center and the increased number of training days.

## Capability

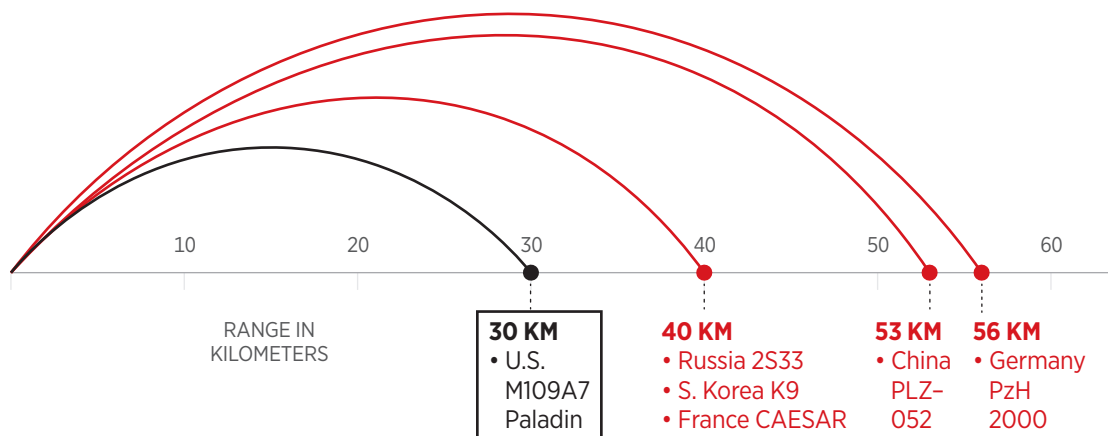
The Army is using equipment designed primarily in the 1970s, fielded in the 1980s, and incrementally upgraded since then. This modernization gap was caused by several factors: preoccupation with the wars in Iraq and Afghanistan, budget cuts including those associated with the Budget Control Act, and failures of major modernization programs like the Future Combat System. Army leaders clearly see this as a challenge and are now striving to modernize the service. In 2020, however, most of their proposed programs are still aspirational and are sensitive to changes in funding or priorities.

The challenge with self-propelled artillery systems illustrates the issue with Army

FIGURE 2

## U.S. Artillery Falls Short—Literally—Compared to Rivals

The U.S. M109A7 Paladin artillery system, in the U.S. Army's arsenal since 2015, has a maximum range of only 30 kilometers—10 kilometers less than the range of Russia's 2S33 system and 23 kilometers short of China's PLZ-052.



### SOURCES:

- **U.S.:** U.S. Army Acquisition Support Center, "Paladin Family Of Vehicles (FOV)—M109a6 Paladin/m992a2 Faasv/m109a7 Sph/m992a3 Cat and Extended Range Cannon Artillery (ERCA)," <https://asc.army.mil/web/portfolio-item/m109-family-of-vehicles-paladinfaasv-and-m109a7-sph-m992a3-cat/> (accessed July 1, 2019).
- **Russia:** Kris Osborn, "Introducing the Army's Secret Weapon to Fight Russia: Super 'Cannons,'" *National Interest*, June 14, 2018, <https://nationalinterest.org/blog/the-buzz/introducing-the-armys-secret-weapon-fight-russia-super-26255> (accessed July 1, 2019).
- **South Korea:** Christopher F. Foss, "South Korea's K9 Self-propelled Artillery Production to Roll into 2021," *Janes*, October 15, 2018, <https://www.janes.com/article/83805/south-korea-s-k9-self-propelled-artillery-production-to-roll-into-2021> (accessed July 1, 2019).
- **France:** Christopher F. Foss, "Denmark Introduces CAESAR 155 mm, Piranha 120 mm Indirect Fire Systems," *Janes*, April 18, 2019, <https://www.janes.com/article/87988/denmark-introduces-caesar-155-mm-piranha-120-mm-indirect-fire-systems> (accessed July 1, 2019).
- **China:** Military Today, "PLZ-05," <http://www.military-today.com/artillery/plz05.htm> (accessed July 1, 2019).
- **Germany:** Krauss-Maffei Wegmann, "PZH-2000: Spezifikation," <https://www.kmweg.com/home/artillery/self-prop-howitzer/pzh-2000/product-specifikation.html> (accessed July 1, 2019).

heritage.org

modernization. The M109 series howitzer was introduced in the early 1960s and has been upgraded multiple times since then. An important part of an artillery system is its range, and most modern countries have artillery systems that can outrange the Paladin 109A7, the Army's current self-propelled howitzer. The Paladin can fire an artillery shell about 22 km–30 km. The Russian 2S33 Msta-SM2 reportedly can hit targets at 40 km.<sup>30</sup> Similarly, the German Army's PzH 2000, the Chinese PLZ-05,

the South Korean K9, and the French CAESAR systems all outrange the Paladin.<sup>31</sup>

The Army's main combat platforms are ground vehicles and rotorcraft.

- The Abrams Main Battle Tank (latest version: M1A2 SEPv3, service entry date 2017) and Bradley Fighting Vehicle (latest version: M2A4, service entry date 2012) are found primarily in Armored BCTs.<sup>32</sup> Also in Armored BCTs, the venerable



M113 personnel carrier is scheduled to be replaced by the new Armored Multi-Purpose Vehicle (AMPV), which in 2018 entered its late testing phase.<sup>33</sup>

- Stryker BCTs are equipped with Stryker vehicles. In response to an Operational Needs Statement, the Stryker BCT (SBCT) in Europe received Strykers fitted with a 30 mm cannon to provide an improved anti-armor capability.<sup>34</sup> The Army recently decided to outfit three of its SBCTs, the ones equipped with the “double V hull,” with the 30 mm autocannon.<sup>35</sup>
- Infantry BCTs have fewer vehicles and rely on lighter platforms such as trucks and High Mobility Multipurpose Wheeled Vehicles (HMMWVs) for mobility.
- The Army is developing a Mobile Protected Firepower system to provide Infantry Brigade Combat Teams with the firepower to engage enemy armored vehicles and fortifications. It hopes to produce 24 prototypes for testing during FY 2020.<sup>36</sup>
- Airborne BCTs are scheduled to receive a new platform, the Ground Mobility Vehicle (GMV), starting in 2019 to increase their speed and mobility. It is anticipated that five airborne BCTs will be equipped by the third quarter of FY 2020.<sup>37</sup>
- Finally, CABs are composed of Army helicopters including AH-64 Apaches, UH-60 Black Hawks, and CH-47 Chinooks.

Overall, the Army’s equipment inventory, while increasingly dated, is well maintained. Despite high usage in Afghanistan and Iraq, because the Army deliberately undertook a “reset” plan, most Army vehicles are relatively “young” because recent remanufacture programs for the Abrams and Bradley vehicles have extended their service lives beyond FY 2028.<sup>38</sup> While the current equipment is well maintained and has received several incremental upgrades,

Abrams and Bradley vehicles first entered service in the early 1980s, making them approximately 38 years old.

The Army has also been methodically upgrading the oldest variants of its rotorcraft. Today, the UH-60M, the newest version of the UH-60, accounts for approximately two-thirds of the total UH-60 inventory. Similarly, the CH-47F Chinook, a rebuilt variant of the Army’s CH-47D heavy lift helicopter, is expected to “remain the Army’s heavy lift helicopter for the next several decades.”<sup>39</sup> However, because the Army has added to procurement programs other than aviation, its \$3.7 billion FY 2020 budget request for aircraft procurement<sup>40</sup> is \$600 million less than the FY 2019 enacted amount.

In addition to the viability of today’s equipment, the military must ensure the health of future programs. Although future modernizing programs are not current hard-power capabilities that can be applied against an enemy force today, they are a significant indicator of a service’s overall fitness for future sustained combat operations. The service may be able to engage an enemy but be forced to do so with aging equipment and no program in place to maintain viability or endurance in sustained operations.

The U.S. military services are continually assessing how best to stay a step ahead of competitors: whether to modernize the force today with currently available technology or wait to see what investments in research and development produce years down the road. Technologies mature and proliferate, becoming more accessible to a wider array of actors over time.

After years of a singular focus on counterinsurgency because of the wars in Iraq and Afghanistan, followed by a concentration on the readiness of the force, the Army is now playing catch-up in the area of equipment modernization. Secretary Esper has testified that “[i]f left unchecked, Russia and China will continue to erode the competitive military advantage we have held for years.”<sup>41</sup>

Secretary Esper has established a new four-star headquarters, Army Futures Command,

to manage modernization. It achieved initial operating capability (IOC) in the summer of 2018 and plans to reach “full operating capacity in summer 2019.”<sup>42</sup> Additionally, the Army has established eight cross-functional teams (CFTs) to improve the management of its top modernization priorities.<sup>43</sup> The Under Secretary and Vice Chief of Staff of the Army are devoting an extraordinary amount of time to issues of equipment modernization, but only time will tell whether the new structures, commands, and emphasis will result in long-term improvement in modernization posture.

The Army aspires to develop and procure an entire new generation of equipment based on its six new modernization priorities: long-range precision fires, next-generation combat vehicle, future vertical lift, the network, air and missile defense, and soldier lethality. Thirty-one programs flow from these programs, and the Army has shifted \$33 billion inside of its five-year program to fund them.<sup>44</sup> Two of the programs that lost money in this shift were the Joint Lightweight Tactical Vehicle (JLTV) and the CH-47F cargo helicopter.

The JLTV, ironically, is the only new-design Army Major Defense Acquisition Program (MDAP) currently underway. Intended to combine the protection offered by Mine Resistant Ambush Protected Vehicles (MRAPs) with the mobility of the original unarmored HMMWV, the JLTV features design improvements that will increase its survivability against anti-armor weapons and improvised explosive devices (IEDs). The Army had planned to procure 49,099 vehicles over the life of the program, replacing only a portion of the current HMMWV fleet. The JLTV is “capable of performing multiple mission roles and designed to provide protected, sustained, networked mobility for personnel and payloads across the full range of military operations.”<sup>45</sup> Recent statements by Army leaders call into question the commitment to the program, and Secretary Esper has expressed uncertainty about the program’s future.<sup>46</sup>

Requested FY 2020 Base Procurement of \$996 million supports 2,530 JLTVs of various

configurations to fulfill the requirements of multiple mission roles and minimize ownership costs for the Army’s Light Tactical Vehicle fleet.<sup>47</sup> Among other notable Army procurements requested in the FY 2020 budget are the M1A2 Abrams SEPv3 upgrade (165); M2 Bradley modifications (128); the Missile Segment Enhancement (MSE) interceptor (147); the UH-60M Black Hawk (73); and AH-64E Apache Block IIIA remanufacture (48).<sup>48</sup>

Similar to the rest of its modernization programs, the Army’s rotorcraft modernization programs do not include any new platform designs. Instead, the Army is upgrading current rotorcraft to account for more advanced systems and developing future aircraft systems under a Future Vertical Lift program.

The Army’s main modernization programs are not currently encumbered by any major problems, but there is justifiable concern about past difficulties and current status. Many new research and development programs have been initiated with an extraordinary amount of publicity and oversight. Only time will tell whether they prove to be successful.

## Readiness

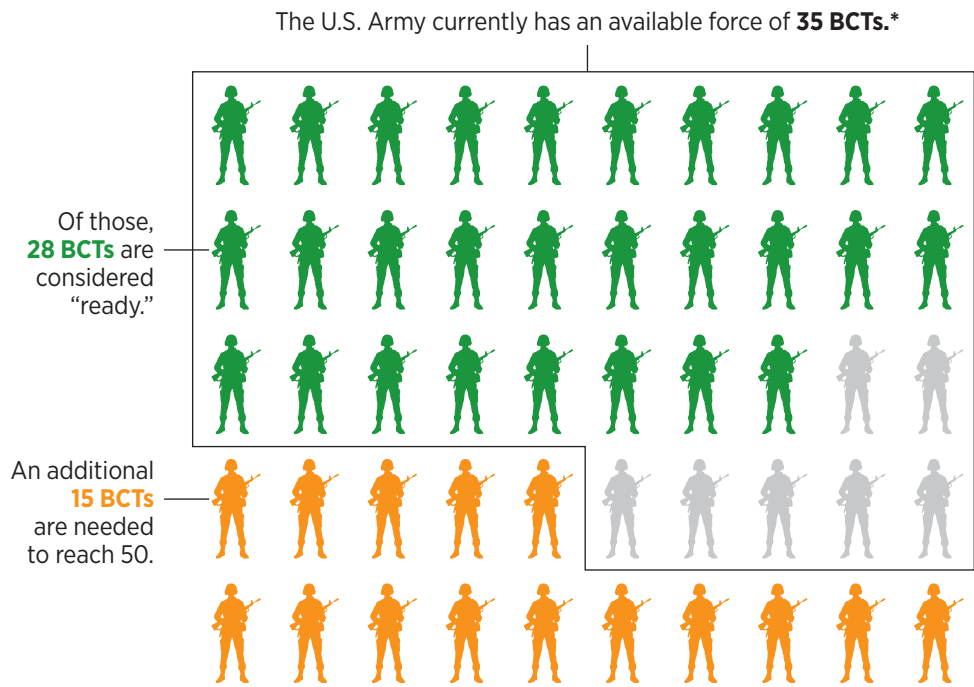
The Army has made progress in increasing the readiness of its forces. The Army’s goal is to have 66 percent of its Regular Army and 33 percent of National Guard Brigade Combat Teams at the highest levels of readiness. In March 2019, General Milley assessed that 28 of the Army’s 58 Total Army BCTs (48 percent) had reached the highest readiness levels, and Secretary Esper testified that “we have increased the number of fully ready brigade combat teams by 55 percent over the past two years.”<sup>49</sup> This would suggest that about 13 BCTs were at the highest levels of readiness two years ago. Further analysis is difficult because General Milley did not provide a breakout of the number of Regular Army versus National Guard Brigades.

As part of the \$716 billion provided for defense in the 2019 defense appropriations bill, Congress provided much-needed relief to the Army by appropriating approximately \$179

FIGURE 3

## Army Readiness: Brigade Combat Teams

Based on historical force requirements, Heritage Foundation experts assess that the Army needs a total of 50 Brigade Combat Teams (BCTs). In addition to active-duty forces, the Army National Guard has four BCTs that operate at a high level of readiness.



SOURCES: *Congressional Quarterly*, “Senate Armed Services Committee Holds Hearing on Fiscal 2020 Budget Request for the Army,” CQ Congressional Transcripts, March 26, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5493831?5> (accessed May 20, 2019), and Heritage Foundation research.

heritage.org

billion. This influx of resources, combined with on-time funding, has had a very positive effect on the rebuilding of readiness.<sup>50</sup>

In the FY 2020 budget request, training activities are relatively well resourced. When measuring training resourcing, the Army uses operating tempo full-spectrum training miles and flying hours, which reflect the number of miles that formations are resourced to drive their primary vehicles on an annual basis and the number of hours that aviators can fly

their helicopters per month.<sup>51</sup> According to the Department of the Army’s budget justification exhibits, “[t]he FY 2020 budget funds 1,549 annual Operating Tempo Full Spectrum Training Miles and 11.6 flying hours per crew, per month for an expected overall training proficiency of BCT-level.”<sup>52</sup> These are far higher than resourced levels of 1,279 miles and 10.8 hours in FY 2019.

The Army reports that readiness increased broadly across all units by 11 percent from



September 2016 to December 2018. Part of this improvement is due to the Army's success in reducing the percentage of soldiers who are non-deployable from 15 in 2015 to six today. Nonetheless, structural readiness problems summarized by too small a force attempting to satisfy too many global presence requirements and Operations Plan (OPLAN) warfighting requirements will continue to challenge the Army. After years of high OPTEMPOs and sustained budget cuts, the Army does not expect to "achieve our readiness objectives" until 2022.<sup>53</sup>

Since March 2016, the Army has been running a program to increase the integration and readiness of select Army National Guard and Reserve formations so that they can be employed more easily when needed. The Army's Associated Units pilot program links select Regular Army and Reserve component units. In June 2018, for example, Vermont's 86th Infantry Brigade was associated with the Regular Army's 10th Mountain Division for an exercise

at Fort Drum, New York.<sup>54</sup> Twenty-seven units across the country are participating in this pilot program, which will be evaluated in 2019 to determine whether it should be made permanent.<sup>55</sup>

As part of its new Sustainable Readiness Model (SRM),<sup>56</sup> the Army uses Combat Training Centers to train its forces to desired levels of proficiency. Specifically, the CTC program's mission is to "provide realistic joint and combined arms training" to approximate actual combat and increase "unit readiness for deployment and warfighting."<sup>57</sup> The Army requested resources for 32 CTC rotations in FY 2020, including four for the Army National Guard.<sup>58</sup> Another change in the Army's training model involves the implementation of a system of Objective T metrics that seeks to remove the subjectivity behind unit commander evaluations of training. Under the Objective T program, the requirements that must be met for a unit to be assessed as fully ready for combat are to be made clear and quantitative.<sup>59</sup>

## Scoring the U.S. Army

### Capacity Score: Weak

Historical evidence shows that, on average, the Army needs 21 brigade combat teams to fight one major regional conflict. Based on a conversion of roughly 3.5 BCTs per division, the Army deployed 21 BCTs in Korea, 25 in Vietnam, 14 in the Persian Gulf War, and around four in Operation Iraqi Freedom—an average of 16 BCTs (or 21 if the much smaller Operation Iraqi Freedom initial invasion operation is excluded). In the 2010 Quadrennial Defense Review, the Obama Administration recommended a force capable of deploying 45 Active BCTs. Previous government force-sizing documents discuss Army force structure in terms of divisions and consistently advocate 10–11 divisions, which equates to roughly 37 Active BCTs.

Considering the varying recommendations of 35–45 BCTs and the actual experience of nearly 21 BCTs deployed per major

engagement, our assessment is that 42 BCTs would be needed to fight two MRCs.<sup>60</sup> Taking into account the need for a strategic reserve, the Army force should also include an additional 20 percent of the 42 BCTs.

Because of the investment the Army has made in National Guard readiness, this *Index* counts four additional ARNG BCTs in the Army's overall BCT count, giving them 35 (31 Regular Army and four ARNG), but 35 is still not enough to meet the two-MRC construct. The service's overall capacity score therefore remains unchanged from 2019.

- **Two-MRC Benchmark:** 50 brigade combat teams.
- **Actual projected 2020 Level:** 35 (31 Regular Army and four ARNG) brigade combat teams.

The Army’s current BCT capacity meets 70 percent of the two-MRC benchmark and is therefore scored as “weak.”

Capability Score: Marginal

The Army’s aggregate capability score remains “marginal.” This aggregate score is a result of “marginal” scores for “Age of Equipment,” “Size of Modernization Programs,” and “Health of Modernization Programs.” (More detail on these programs can be found in the equipment appendix following this section.) The Army scored “weak” for “Capability of Equipment.”

In spite of modest progress with the JLTV and AMPV, and in spite of promising developments in the form of announcements regarding Army Futures Command, CFTs, and the initiation of new Research, Development, Testing and Evaluation (RDTE) funded programs, new Army equipment programs remain in the development phase and in most cases are years from entering procurement phases. Therefore, they are not yet replacing legacy platforms and do not contribute to the Army’s current war-fighting capability. These planned procurements are highly sensitive to any turbulence or reduction in funding.

Readiness Score: Very Strong

The Army has said that it has 28 Total Army BCTs at the highest readiness levels. Four of those BCTs are likely National Guard Brigades, because the Army is focusing personnel, equipment, and training on those units, leaving an estimated 24 Regular Army BCTs out of 31 that are ready (77 percent). The Army’s internal requirement for Active BCT readiness is 66 percent, or 20.5 BCTs ready. Using the assessment methods of this *Index*, this results in a percentage-of-service requirement of 100 percent, or “very strong.”

Overall U.S. Army Score: Marginal

The Army’s overall score is calculated based on an unweighted average of its capacity, capability, and readiness scores. The unweighted average is 3.33; thus, the overall Army score is “marginal.” This was derived from the aggregate score for capacity (“weak”); capability (“marginal”); and readiness (“very strong”). This score is the same as the assessment of the 2019 *Index*, which also rated the Army as “marginal.”

U.S. Military Power: Army

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness					✓
OVERALL			✓		

# ARMY SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Main Battle Tank

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>M1A1/2 Abrams</b> Inventory: <b>775/1611</b> Fleet age: <b>30.5/13.5</b> Date: <b>1985/1992</b> <p>The Abrams is the main battle tank used by the Army in its armored brigade combat teams (BCTs). Its main benefits are lethality, protection, and mobility. The Abrams went through a remanufacture program to extend its life to 2045.</p>	3	4	<b>Decisive Lethality Platform (DLP)</b> <p>The DPL program is intended to replace the Abrams tank. This program is part of the Next Generation Combat Vehicle (NGCV) program, which is number two among the Army's "Big Six" modernization priorities.</p>		

## Infantry Fighting Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>M2 Bradley</b> Inventory: <b>3,700</b> Fleet age: <b>19</b> Date: <b>1981</b> <p>The Bradley is a tracked vehicle meant to transport infantry and provide covering fire. The Bradley complements the Abrams tank in armored BCTs. Originally intended to be replaced by the Ground Combat Vehicle (GCV, now canceled), the Bradley underwent a remanufacture program to extend its life to 2045.</p>	3	3	<b>Optionally Manned Fighting Vehicle (OMFV)</b> <p>In March 2019, the Army issued a request for proposals to competitively build prototypes of the OMFV. The units are expected to be fielded by the end of FY2026. This program is part of the Next Generation Combat Vehicle (NGCV) program, which is number two among the Army's "Big Six" modernization priorities.</p>		

## Armored Fighting Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>Stryker</b> Inventory: <b>4,367</b> Fleet age: <b>9</b> Date: <b>2001</b> <p>The Stryker is a wheeled vehicle that is the main platform in Stryker BCTs. The program was considered an interim vehicle to serve until the arrival of the Future Combat System (FCS), but that program was cancelled due to technology and cost hurdles. The original Stryker is being replaced with a double-v hull configuration (DVH) to increase survivability and a 30mm gun to increase lethality. Its components allow for rapid acquisition and fielding. The Stryker is expected to remain in service for 30 years.</p>	4	4	None		

**NOTE:** See page 338 for details on fleet ages, dates, and procurement spending.

# ARMY SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Armored Personnel Carrier

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>M113 Armored Personnel Carrier</b> Inventory: <b>5,000</b> Fleet age: <b>35</b> Date: <b>1960</b>  The tracked M113 is a supporting role for armored BCTs and in units above brigade level. The APC is being slowly replaced by the Armored Multi Purpose Vehicle (AMPV). Plans are to use the platform until 2045.	2	2	<b>Armored Multi-Purpose Vehicle (AMPV)</b> Timeline: <b>2018-TBD</b>  The AMPV will be adapted from an existing vehicle design which allowed the program to bypass the technology development phase. The fleet will consist of five variants. The first unit is set to be equipped at the end of 2021.	2	4
			<div> <div>PROCUREMENT</div> <div>SPENDING (\$ millions)</div> </div> <div> <div>328</div> <div>2,569</div> <div>\$1,231</div> <div>\$13,377</div> </div>		

## Light Wheeled Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>HMMWV</b> Inventory: <b>100,000</b> Fleet age: <b>17</b> Date: <b>1985</b>  The HMMWV is used to transport troops and for a variety of purposes, for example, as ambulances. The expected life span of the HMMWV is 15 years. Some HMMWVs will be replaced by the Joint Light Tactical Vehicle (JLTV).	2	1	<b>Joint Light Tactical Vehicle (JLTV)</b> Timeline: <b>2015-2036</b>  The JLTV vehicle program is meant to replace some of the Army's HMMWVs and provide improved protection, reliability, and survivability of vehicles. So far the program has experienced a one-year delay due to changes in vehicle requirements. This is a joint program with USMC. In June 2019, the Army approved the JLTV for full rate production.	3	4
			<div> <div>PROCUREMENT</div> <div>SPENDING (\$ millions)</div> </div> <div> <div>8,022</div> <div>40,729</div> <div>\$3,116</div> <div>\$17,588</div> </div>		

**NOTE:** See page 338 for details on fleet ages, dates, and procurement spending.

# ARMY SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Attack Helicopter

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>AH-64 D Apache</b> Inventory: <b>464</b> Fleet age: <b>13.5</b> Date: <b>1997</b>  The Apache is found in Army Combat Aviation Brigades. It can destroy armor, personnel, and material targets. The expected life cycle is about 20 years.	1	3	<b>AH-64E Reman</b>  Timeline: <b>2010–2027</b>  The AH-64E Reman is a program to remanufacture older Apache helicopters into the more advanced AH-64E version. The AH-64E will have more modern and interoperable systems and be able to carry modern munitions, including the JAGM missile.  <div> <div>PROCUREMENT*</div> <div>388</div> </div> <div> <div>SPENDING* (\$ millions)</div> <div>\$4,347</div> </div>	3	5
<b>AH-64E</b> Inventory: <b>250</b> Fleet age: <b>3.5</b> Date: <b>2012</b>  The AH-64E variant is a remanufactured version with substantial upgrades in power plant, avionics, communications, and weapons capabilities. The expected life cycle is about 20 years.	5	5	<b>AH-64E New Build</b>  Timeline: <b>2010–2027</b>  The AH-64E New Build program produces new-build, not re-build, Apaches. The program is meant to modernize and sustain the current Apache inventory. The AH-64E has more modern and interoperable systems and is able to carry modern munitions, including the JAGM missile. FY2019 defense appropriation support increased procurement quantities to address National Guard shortfalls.  <div> <div>PROCUREMENT*</div> <div>74</div> </div> <div> <div>SPENDING* (\$ millions)</div> <div>\$2,417</div> </div>	3	5

## Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>UH-60A Black Hawk</b> Inventory: <b>250</b> Fleet age: <b>35.5</b> Date: <b>1978</b>  The UH-60A is a utility helicopter that provides air assault, aeromedical evacuation, and supports special operations. The expected life span is about 25 years. This variant of the Black Hawk is now being replaced by the newer UH-60M variant.	1	2	<b>UH-60M Black Hawk</b>  Timeline: <b>2004–TBD</b>  The UH-60M, currently in production, is intended to modernize and replace current Black Hawk inventories. The newer M-variant will improve the Black Hawk's range and lift by upgrading the rotor blades, engine, and computers.  <div> <div>PROCUREMENT*</div> <div>1,049</div> </div> <div> <div>SPENDING* (\$ millions)</div> <div>\$18,815</div> </div>	3	5
<b>UH-60M Black Hawk</b> Inventory: <b>1,022</b> Fleet age: <b>7</b> Date: <b>2005</b>  The UH-60M is the follow-on helicopter to the UH-60A. As the UH-60A is retired, the M-variant will be the main medium-lift rotorcraft used by the Army. They are expected to remain in service until at least 2030.	5	4			

\* Additional procurement expected.

**NOTE:** See page 338 for details on fleet ages, dates, and procurement spending.

# ARMY SCORES



Procurement and Spending ■ Through FY 2019  
■ Pending

## Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>CH-47F Chinook</b> Inventory: <b>519</b> Fleet age: <b>8.5</b> Date: <b>2002</b>  The F-variant includes a new digital cockpit and monolithic airframe to reduce vibrations. It transports forces and equipment while providing other functions such as parachute drops and aircraft recovery. The expected life span is 35 years. The Army plans to use the CH-47F until the late 2030s.	5	5	<b>CH-47F</b>  Timeline: <b>2001-TBD</b>  Currently in production, the CH-47F program is intended to keep the fleet of heavy-lift rotorcraft healthy as older variants of the CH-47 are retired. The program includes both remanufactured and new builds of CH-47s. The F-variant has engine and airframe upgrades to lower the maintenance requirements. Total procurement numbers include the MH-47G configuration for U.S. Special Operations Command  <b>PROCUREMENT*</b> <div><div></div></div> 364  <b>SPENDING* (\$ millions)</b> <div><div></div></div> \$10,260	3	5

## Intelligence, Surveillance, and Reconnaissance (ISR)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>MQ-1C Gray Eagle</b> Inventory: <b>164</b> Fleet age: <b>4</b> Date: <b>2011</b>  The Gray Eagle is a medium-altitude long-endurance (MALE) unmanned aerial vehicle (UAV) used to conduct ISR missions. The use of MALE UAVs is a new capability for the Army. The Gray Eagle is currently in production.	4	4	<b>MQ-1C Gray Eagle</b>  Timeline: <b>2010-2022</b>  The MQ-1C UAV provides Army reconnaissance, surveillance, and target acquisition capabilities. The Army is continuing to procure MQ-1Cs to replace combat losses.  <b>PROCUREMENT</b> <div><div></div></div> 221 12  <b>SPENDING (\$ millions)</b> <div><div></div></div> \$3,775 \$108	3	5

\* Additional procurement expected.

**NOTES:** See methodology for descriptions of scores. The Fleet age is the average between the first and last year of delivery. The date is the year of first delivery. The timeline is from the first year of procurement to the last year of delivery/procurement. Spending does not include advanced procurement or research development test and evaluation.

# U.S. Army Modernization Table Citations

## MAIN SOURCES

- Andrew Feickert, “The Army’s M-1 Abrams, M-2/M-3 Bradley, and M-1126 Stryker: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, April 5, 2016, <https://fas.org/sgp/crs/weapons/R44229.pdf> (accessed September 5, 2019).
- International Institute for Strategic Studies, *The Military Balance 2019: The Annual Assessment of Global Military Capabilities and Defence Economics* (London: Routledge, 2019).
- U.S. Department of the Army, *Department of the Army Procurement Programs, Committee Staff Procurement Backup Book, Fiscal Year 2011 Budget Estimate: Aircraft Procurement*, Army, February 2010, <https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2011/base%20budget/justification%20book/aircraft.pdf> (accessed September 6, 2019).
- U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Army, Justification Book of Aircraft Procurement, Army: FY2020 Aircraft Procurement*, Army, March 2019, <https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2020/Base%20Budget/Procurement/01%20Aircraft%20Procurement%20Army.pdf> (accessed September 6, 2019).
- U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Army, Justification Book of Other Procurement, Army: Tactical and Support Vehicles, Budget Activity 1*, March 2019, <https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2020/Base%20Budget/Procurement/05%20Other%20Procurement%20-%20BA1%20-%20Tactical%20&%20Support%20Vehicles.pdf> (accessed September 6, 2019).
- U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Army, Justification Book of Procurement of W&TCV, Army*, March 2019, <https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2020/Base%20Budget/Procurement/03%20Procurement%20of%20Weapons%20and%20Tracked%20Combat%20Vehicles.pdf> (accessed September 6, 2019).

## MISC. SOURCES

### Abrams:

- Andrew Feickert, “The Army’s Optionally Manned Fighting Vehicle (OMFV) Program: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 21, 2019, <https://fas.org/sgp/crs/weapons/R45519.pdf> (accessed September 5, 2019).
- David Axe, “Here’s Your First Look at the Army’s New M1 Abrams Variant,” *Task & Purpose*, February 26, 2019, <https://taskandpurpose.com/m1-abrams-tank-m1a2c> (accessed September 5, 2019).
- U.S. Army Acquisition Support Center, “Abrams Tank Upgrade,” <https://asc.army.mil/web/portfolio-item/gcs-m1-abrams-main-battle-tank/> (accessed September 5, 2019).
- Zachary Keck, “Taiwan Wants American M1 Abrams Tanks. And the Reason Is China,” *The National Interest*, May 5, 2018, <https://nationalinterest.org/blog/the-buzz/taiwan-wants-american-m1-abrams-tanks-the-reason-china-25692> (accessed September 5, 2019).

### Bradley:

- Jen Judson, “Army Drops Request for Proposals to Build Next-Gen Combat Vehicle Prototypes,” *Defense News*, March 29, 2019, <https://www.defensenews.com/land/2019/03/29/armys-request-for-proposals-to-build-next-gen-combat-vehicle-prototypes-drops/> (accessed September 5, 2019).
- David Vergun, “Next Generation Combat Vehicles to Replace Bradley Starting Fiscal Year 2026,” U.S. Army, October 9, 2018, [https://www.army.mil/article/212190/next\\_generation\\_combat\\_vehicles\\_to\\_replace\\_bradley\\_starting\\_fiscal\\_year\\_2026](https://www.army.mil/article/212190/next_generation_combat_vehicles_to_replace_bradley_starting_fiscal_year_2026) (accessed September 5, 2019).

### Stryker:

- U.S. Army Acquisition Support Center, “Stryker Family of Vehicles,” <https://asc.army.mil/web/portfolio-item/gcs-stryker-family-of-vehicles/> (accessed September 5, 2019).

### M113 APC:

- Andrew Feickert, “The Army’s Armored Multi-Purpose Vehicle (AMPV): Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 27, 2019, p. 1, <https://fas.org/sgp/crs/weapons/R43240.pdf> (accessed September 5, 2019).
- U.S. Army Acquisition Support Center, “Armored Multi-Purpose Vehicle (AMPV),” <https://asc.army.mil/web/portfolio-item/gcs-ampv/> (accessed September 5, 2019).



#### **HMMWV:**

- Andrew Feickert, “Joint Light Tactical Vehicle (JLTV): Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 24, 2019, <https://fas.org/sgp/crs/weapons/RS22942.pdf> (accessed September 5, 2019).
- Dan Goure, “7 Ways to Enhance the US Military’s Humvee Fleet [Commentary],” *Defense News*, October 5, 2017, <https://www.defensenews.com/opinion/commentary/2017/10/05/7-ways-to-enhance-the-us-militarys-humvee-fleet-commentary/> (accessed September 5, 2019).
- News release, “AM General Receives Order for 740 New HMMWVs to Support the United States Army’s Modernization Efforts,” AM General, October 23, 2018, <http://www.amgeneral.com/news-events/news/am-general-receives-order-for-740-new-hmmwvs-to-support-the-united-states-armys-modernization-efforts/> (accessed September 5, 2019).
- U.S. Army, Program Executive Office for Combat Support and Combat Service Support, “Army Approves JLTV Full-Rate Production,” June 21, 2019, [https://www.army.mil/article/223482/army\\_approves\\_jltv\\_full\\_rate\\_production](https://www.army.mil/article/223482/army_approves_jltv_full_rate_production) (accessed September 5, 2019).
- U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2015 Budget Estimates, Army, Justification Book: Other Procurement, Army, Tactical and Support Vehicles, Budget Activity 1*, March 2014, p. 22, <https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2015/base%20budget/justification%20book/Other%20Procurement%20Army%201%20-%20Tactical%20and%20Support%20Vehicles.pdf> (accessed September 6, 2019).
- U.S. Army Acquisition Support Center, “Joint Light Tactical Vehicle (JLTV),” <https://asc.army.mil/web/portfolio-item/cs-css-joint-light-tactical-vehicle/> (accessed September 5, 2019).

#### **AH-64D Apache:**

- News release, “Boeing Delivers 100th AH-64D Apache Longbow to U.S. Army,” Boeing, December 9, 1999, <https://boeing.mediaroom.com/1999-12-09-Boeing-Delivers-100th-AH-64D-Apache-Longbow-to-U.S.-Army> (accessed September 5, 2019).
- Defense Contract Management Agency, “AH-64D Program Ended. Last One Delivered,” Helis.com, March 11, 2014, [https://www.helis.com/database/news/ah-64d\\_last/](https://www.helis.com/database/news/ah-64d_last/) (accessed September 5, 2019).
- U.S. Army Acquisition Support Center, “Apache Attack Helicopter AH-64D/E,” [https://asc.army.mil/web/portfolio-item/aviation\\_apache-ah-64e/](https://asc.army.mil/web/portfolio-item/aviation_apache-ah-64e/) (accessed September 5, 2019).

#### **UH-60A Black Hawk:**

- Ray D. Leoni, “Sikorsky Product History: S-70A (UH-60A Black Hawk, YEH-60B SOTAS, EH-60A Quick Fix),” Igor I. Sikorsky Historical Archives, last update May 27, 2015, [https://www.sikorskyarchives.com/S-70A%20\(UH-60A%20Black%20Hawk,%20YEH-60B%20SOTAS,%20EH-60A%20Quick%20Fix\).php](https://www.sikorskyarchives.com/S-70A%20(UH-60A%20Black%20Hawk,%20YEH-60B%20SOTAS,%20EH-60A%20Quick%20Fix).php) (accessed September 5, 2019).
- U.S. Department of the Army, *Department of the Army Procurement Programs, Committee Staff Procurement Backup Book, FY 2006/FY 2007 Budget Request: Aircraft Procurement, Army*, February 2005, p. 22, <https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/20062007/base%20budget/justification%20book/aircraft.pdf> (accessed September 6, 2019).
- U.S. Army Acquisition Support Center, “Black Hawk Utility Helicopter—UH/HH-60,” <https://asc.army.mil/web/portfolio-item/black-hawk-uhhh-60/> (accessed September 5, 2019).

#### **UH-60M Black Hawk:**

- News release, “Sikorsky Delivers 500th ‘M’ Model Black Hawk Helicopter,” Lockheed Martin, July 18, 2012, <https://news.lockheedmartin.com/2012-07-18-Sikorsky-Delivers-500th-M-Model-BLACK-HAWK-Helicopter> (accessed September 5, 2019).

#### **CH-47D/F Chinook:**

- “CH-47D Chinook,” Deagel.com, [http://www.deagel.com/Support-Aircraft/CH-47D-Chinook\\_a000504001.aspx](http://www.deagel.com/Support-Aircraft/CH-47D-Chinook_a000504001.aspx) (accessed September 5, 2019).
- “News: Chinooks Modernized,” *Military Review*, Vol. LXIII, No. 9 (September 1983), p. 78, <http://cgsc.contentdm.oclc.org/cdm/singleitem/collection/p124201coll1/id/298/rec/1> (accessed September 6, 2019).
- News release, “Boeing Delivers First Production F-Model Chinook,” Boeing, July 22, 2004, <https://boeing.mediaroom.com/2004-07-22-Boeing-Delivers-First-Production-F-Model-Chinook> (accessed September 6, 2019).
- U.S. Department of the Army, *Department of the Army Procurement Programs, Committee Staff Procurement Backup Book, FY 2002 Amended Budget Submission: Aircraft Procurement, Army*, June 2001, p. 64, <https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2002/base%20budget/justification%20book/aircraft.pdf> (accessed September 6, 2019).
- U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/ Chief Financial Officer, *United States Department of Defense Fiscal Year 2020 Budget Request: Program Cost by Weapon System*, March 2019, [https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/fy2020\\_Weapons.pdf](https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/fy2020_Weapons.pdf) (accessed September 6, 2019).
- U.S. Army Acquisition Support Center, “CH-47F Chinook,” [https://asc.army.mil/web/portfolio-item/aviation\\_ch47f-chinook/](https://asc.army.mil/web/portfolio-item/aviation_ch47f-chinook/) (accessed September 5, 2019).



***MQ-1C Gray Eagle:***

- U.S. Department of the Army, *Department of the Army Procurement Programs: Committee Staff Procurement Backup Book, Fiscal Year 2010 Budget Estimates: Aircraft Procurement, Army*, May 2009, p. 9, <https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2010/base%20budget/justification%20book/aircraft.pdf> (accessed September 5, 2019).

## Endnotes

1. Congressional Quarterly, "Senate Appropriations Subcommittee on Defense Holds Hearing on the Fiscal 2020 Budget Request for the Army," CQ Congressional Transcripts, March 27, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5495230?10> (accessed June 15, 2019).
2. Ibid.
3. Major General Paul A. Chamberlain, Director, Army Budget, and Davis S. Welch, Deputy Director, Army Budget, *Army FY 2020 Budget Overview*, March 2019, p. 6, <https://www.asafm.army.mil/documents/BudgetMaterial/fy2020/Army%20FY%202020%20Budget%20Overview.pdf> (accessed June 15, 2019).
4. Katherine Blakeley, "Military Personnel: End Strength," Center for Strategic and Budgetary Assessments, August 15, 2017, <https://csbaonline.org/reports/military-personnel> (accessed June 15, 2019).
5. Michelle Tan, "Army Lays out Plan to Cut 40,000 Soldiers," *Army Times*, July 10, 2015, <http://www.armytimes.com/story/military/pentagon/2015/07/09/army-outlines-40000-cuts/29923339/> (accessed June 15, 2018).
6. Congressional Quarterly, "House Armed Services Subcommittee on Readiness Holds Hearing on Fiscal 2020 Budget Request for Military Readiness," CQ Congressional Transcripts, May 9, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5534728?2> (accessed June 15, 2019).
7. The Honorable Mark T. Esper, Secretary of the Army, and General Mark A. Milley, Chief of Staff, United States Army, statement "On the Posture of the United States Army" before the Committee on Armed Services, U.S. House of Representatives, 116th Cong., 1st Sess., April 2, 2019, p. 3, [https://armedservices.house.gov/\\_cache/files/f/5/f5f4cac2-68c1-4105-a896-5dac8c6851f5/9C00D8D946DE1DF1401CD15D792BEEE5.hmtg-116-as00-wstate-esperm-20190402.pdf](https://armedservices.house.gov/_cache/files/f/5/f5f4cac2-68c1-4105-a896-5dac8c6851f5/9C00D8D946DE1DF1401CD15D792BEEE5.hmtg-116-as00-wstate-esperm-20190402.pdf) (accessed June 15, 2019).
8. U.S. Department of the Army, Field Manual 3-96, *Brigade Combat Team*, October 2015, [https://armypubs.army.mil/eprints/DR\\_pubs/DR\\_a/pdf/web/fm3\\_96.pdf](https://armypubs.army.mil/eprints/DR_pubs/DR_a/pdf/web/fm3_96.pdf) (accessed June 15, 2019).
9. Chamberlain and Welch, *Army FY 2020 Budget Overview*, p. 8.
10. Meghann Myers, "Army Chief: Operational Units Will Be Manned to 105 Percent by Next Year," *Army Times*, January 16, 2019, <https://www.armytimes.com/news/your-army/2019/01/16/army-chief-operational-units-will-be-manned-to-105-percent-by-next-year/> (accessed June 15, 2019).
11. H.R. 3979, Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015, Public Law 113-291, 113th Cong., December 19, 2014, Title XVII, <https://www.congress.gov/bill/113th-congress/house-bill/3979/text> (accessed June 17, 2019).
12. National Commission on the Future of the Army, *Report to the President and the Congress of the United States*, January 28, 2016, p. 52, <https://fas.org/man/eprint/ncfa.pdf> (accessed June 15, 2017).
13. U.S. Army Public Affairs, "Army Announces Conversion of Two Brigade Combat Teams," September 20, 2018, [https://www.army.mil/article/211368/army\\_announces\\_conversion\\_of\\_two\\_brigade\\_combat\\_teams](https://www.army.mil/article/211368/army_announces_conversion_of_two_brigade_combat_teams) (accessed June 15, 2019).
14. U.S. Army, Field Manual 3-96, pp. 3-31 and 3-32.
15. Andrew Feickert, "Army Drawdown and Restructuring: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, February 28, 2014, pp. 3 and 18, <https://www.fas.org/sgp/crs/natsec/R42493.pdf> (accessed June 16, 2019).
16. The 13 percent estimate is "based on a review of historical levels" as referenced in U.S. Government Accountability Office, *Army Planning: Comprehensive Risk Assessment Needed for Planned Changes to the Army's Force Structure*, GAO-16-327, April 2016, p. 12, <http://www.gao.gov/assets/680/676516.pdf> (accessed June 16, 2019).
17. C. Todd Lopez, "Security Force Assistance Brigades to Free Brigade Combat Teams from Advise, Assist Mission," U.S. Army, May 18, 2017, [https://www.army.mil/article/188004/security\\_force\\_assistance\\_brigades\\_to\\_free\\_brigade\\_combat\\_teams\\_from\\_advise\\_assist\\_mission](https://www.army.mil/article/188004/security_force_assistance_brigades_to_free_brigade_combat_teams_from_advise_assist_mission) (accessed June 16, 2019).
18. C. Todd Lopez, "Success of First SFAB in Afghanistan Proves 'Army Got It Right,' Commander Says," U.S. Central Command, May 9, 2019, <https://www.centcom.mil/MEDIA/NEWS-ARTICLES/News-Article-View/Article/1842769/success-of-first-sfab-in-afghanistan-proves-army-got-it-right-commander-says/> (accessed June 17, 2019).
19. Chamberlain and Welch, *Army FY 2020 Budget Overview*, p. 6.
20. Congressional Quarterly, "Senate Appropriations Subcommittee on Defense Holds Hearing on the U.S. Army Fiscal 2018 Budget," CQ Congressional Transcripts, June 7, 2017, <https://plus.cq.com/doc/congressionaltranscripts-5117288?3> (accessed June 16, 2019).
21. Congressional Quarterly, "Senate Appropriations Subcommittee on Defense Holds Hearing on the U.S. Army Fiscal 2020 Budget," March 27, 2019.

22. Meghann Myers, "Esper: The Ultimate Size of the Army Is a Moving Target," *Army Times*, April 17, 2019, <https://www.armytimes.com/news/your-army/2019/04/17/esper-the-ultimate-size-of-the-army-is-a-moving-target/> (accessed June 16, 2019).
23. National Defense Strategy Commission, *Providing for the Common Defense: The Assessment and Recommendations of the National Defense Strategy Commission*, released November 14, 2018, p. iii, <https://www.usip.org/sites/default/files/2018-11/providing-for-the-common-defense.pdf> (accessed June 16, 2019). See also S. 2943, National Defense Authorization Act for Fiscal Year 2017, Public Law 114-328, 114th Cong., December 23, 2016, Title IX, Subtitle E, § 942, <https://www.congress.gov/bill/114th-congress/senate-bill/2943/text> (accessed June 17, 2019).
24. National Defense Strategy Commission, *Providing for the Common Defense: The Assessment and Recommendations of the National Defense Strategy Commission*, pp. 35–36. Emphasis in original.
25. Boost Labs, "The U.S. Army: Then & Now," <https://www.boostlabs.com/portfolio/u-s-army-now/> (accessed June 16, 2019).
26. Meghann Myers, "With Retention Up and Recruiting Down, Here's How the Army Plans to Add 7,500 More Soldiers to the Ranks," *Army Times*, May 7, 2018, <https://www.armytimes.com/news/your-army/2018/05/08/with-retention-up-and-recruiting-down-heres-how-the-army-plans-to-add-7500-more-soldiers-to-the-ranks/> (accessed June 16, 2019).
27. See Andrew Gregory, "Maintaining a Deep Bench: Why Armored BCT Rotations in Europe and Korea Are Best for America's Global Security Requirements," Modern War Institute at West Point, July 31, 2017, <https://mwi.usma.edu/maintaining-deep-bench-armored-bct-rotations-europe-korea-best-americas-global-security-requirements/> (accessed June 16, 2019), and Daniel Kochis and Thomas Spoehr, "It's Time to Move US Forces Back to Europe," Heritage Foundation *Commentary*, September 15, 2017, <https://www.heritage.org/defense/commentary/its-time-move-us-forces-back-europe>.
28. Erich B. Smith, "Readiness Enhanced with Army National Guard 4.0 Initiative," U.S. Army, February 26, 2018, [https://www.army.mil/article/201131/readiness\\_enhanced\\_with\\_army\\_national\\_guard\\_40\\_initiative](https://www.army.mil/article/201131/readiness_enhanced_with_army_national_guard_40_initiative) (accessed June 16, 2019).
29. Chamberlain and Welch, *Army FY 2020 Budget Overview*, p. 9.
30. Kris Osborn, "Outranged: New Army Artillery Doubles Ranges—Outguns Russian Equivalent," *The National Interest*, December 12, 2018, <https://nationalinterest.org/blog/buzz/outranged-new-army-artillery-doubles-ranges-outguns-russian-equivalent-38587> (accessed June 16, 2019).
31. John Gordon IV, John Matsumura, Anthony Adler, Scott Boston, Matthew E. Boyer, Natasha Lander, and Todd Nichols, *Comparing U.S. Army Systems with Foreign Counterparts: Identifying Possible Capability Gaps and Insights from Other Armies*, RAND Corporation Research Report, 2015, pp. 19–22, [https://www.rand.org/content/dam/rand/pubs/research\\_reports/RR700/RR716/RAND\\_RR716.pdf](https://www.rand.org/content/dam/rand/pubs/research_reports/RR700/RR716/RAND_RR716.pdf) (accessed June 16, 2019).
32. Andrew Feickert, "The Army's M-1 Abrams, M-2/M-3 Bradley, and M-1126 Stryker: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, April 5, 2016, p. 9, <https://www.fas.org/sgp/crs/weapons/R44229.pdf> (accessed June 16, 2019), and Ashley Givens, "Army Rolls Out Latest Version of Iconic Abrams Main Battle Tank," U.S. Army, October 9, 2017, [https://www.army.mil/article/194952/army\\_rolls\\_out\\_latest\\_version\\_of\\_iconic\\_abrams\\_main\\_battle\\_tank](https://www.army.mil/article/194952/army_rolls_out_latest_version_of_iconic_abrams_main_battle_tank) (accessed June 16, 2019).
33. Allen Cone, "BAE Delivers Armored Multi-Purpose Vehicles to Army for Testing," United Press International, April 4, 2018, <https://www.upi.com/BAE-delivers-Armored-Multi-Purpose-Vehicles-to-Army-for-testing/5181522850392/> (accessed June 16, 2019).
34. Kyle Rempfer, "New Upgunned Stryker Arrives in Europe," *Army Times*, December 19, 2017, <https://www.armytimes.com/news/2017/12/19/new-upgunned-stryker-arrives-in-europe/> (accessed June 16, 2019).
35. Jen Judson, "Army to Outfit Double V-Hull Strykers with 30mm Firepower," *Army Times*, May 1, 2019, <https://www.defensenews.com/land/2019/05/01/army-to-outfit-all-double-v-hull-strykers-with-30mm-firepower/> (accessed June 16, 2019).
36. U.S. Army, Assistant Secretary of the Army (Financial Management and Comptroller), *FY 2020 President's Budget Highlights*, March 2019, p. 29, <https://www.asafm.army.mil/documents/BudgetMaterial/fy2020/Army%20FY%202020%20Budget%20Highlights.pdf> (accessed June 16, 2019).
37. U.S. Army, Acquisition Support Center, "Ground Mobility Vehicle (GMV)," <https://asc.army.mil/web/portfolio-item/cs-css-gmv/> (accessed June 16, 2019).
38. Feickert, "The Army's M-1 Abrams, M-2/M-3 Bradley, and M-1126 Stryker," p. 1.
39. Exhibit P-40, "Budget Line Item Justification: PB 2019 Army," in U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2019 Budget Estimates, Army: Justification Book of Aircraft Procurement*, Army, February 2018, p. 73, <https://www.asafm.army.mil/documents/BudgetMaterial/FY2019/aircraft.pdf> (accessed June 16, 2019).
40. Chamberlain and Welch, *Army FY 2020 Budget Overview*, p. 13.
41. Congressional Quarterly, "Senate Armed Services Committee Holds Hearing on Fiscal 2020 Budget Request for the Army," CQ Congressional Transcripts, March 26, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5493831?5> (accessed June 16, 2019).

42. Andrew Feickert, "Army Futures Command (AFC)," Congressional Research Service *Insight*, updated September 10, 2018, p. [1], <https://fas.org/sgp/crs/natsec/INI10889.pdf> (accessed June 16, 2019).
43. U.S. Army, Training and Doctrine Command, Army Capability Integration Center, "U.S. Army Modernization Strategy," U.S. Army STAND-TO!, June 6, 2018, [https://www.army.mil/standto/archive\\_2018-06-06](https://www.army.mil/standto/archive_2018-06-06) (accessed June 16, 2019).
44. Sebastien Roblin, "The U.S. Army's 'Big Six': How America Plans to Fight Russia or China (and Win)," *The National Interest*, May 18, 2019, <https://nationalinterest.org/blog/buzz/us-armys-big-six-how-america-plans-fight-russia-or-china-and-win-58172> (accessed June 16, 2019).
45. Exhibit P-40, "Budget Line Item Justification: PB 2019 Army," in U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2019 Budget Estimates, Army: Justification Book of Other Procurement, Army: Tactical and Support Vehicles, Budget Activity 1*, February 2018, p. 42, <https://www.asafm.army.mil/documents/BudgetMaterial/FY2019/opa1.pdf> (accessed June 16, 2019).
46. Paul McLeary, "Esper: Chinook & JLTv 'Designed for a Different Conflict,'" *Breaking Defense*, April 16, 2019, <https://breakingdefense.com/2019/04/esper-chinook-jltv-designed-for-a-different-conflict/> (accessed June 16, 2019).
47. Exhibit P-40, "Budget Line Item Justification: PB 2019 Army," in U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Army: Justification Book of Other Procurement, Army: Tactical and Support Vehicles, Budget Activity 1*, p. 46.
48. Chamberlain and Welch, *Army FY 2020 Budget Overview*, p. 14.
49. Congressional Quarterly, "Senate Armed Services Committee Holds Hearing on Fiscal 2020 Budget Request for the Army," March 26, 2019.
50. Chamberlain and Welch, *Army FY 2020 Budget Overview*, p. 3.
51. G3/5/7, "OPTEMPO and Full-Spectrum Operations Training," U.S. Army STAND-TO!, January 26, 2011, [https://www.army.mil/article/50883/optempo\\_and\\_full\\_spectrum\\_operations\\_training](https://www.army.mil/article/50883/optempo_and_full_spectrum_operations_training) (accessed June 16, 2019).
52. U.S. Department of the Army, *Department of the Army Fiscal Year (FY) 2020 Budget Estimates, Volume 1, Operation and Maintenance, Army: Justification of Estimates*, March 2019, pp. 1–2, [https://www.asafm.army.mil/documents/BudgetMaterial/fy2020/oma\\_voll.pdf](https://www.asafm.army.mil/documents/BudgetMaterial/fy2020/oma_voll.pdf) (accessed June 16, 2019).
53. The Honorable Mark T. Esper, Secretary of the Army, and General Mark A. Milley, Chief of Staff, United States Army, statement "On the Posture of the United States Army" before the Committee on Armed Services, U.S. Senate, 116th Cong., 1st Sess., March 26, 2019, p. 3, [https://www.army.mil/e2/downloads/rv7/aps/aps\\_2019.pdf](https://www.army.mil/e2/downloads/rv7/aps/aps_2019.pdf) (accessed June 16, 2019).
54. Charlotte Carulli, "First Combat Training Capability Enhances Associated Units Pilot, Joint Relationships," U.S. Army, July 2, 2018, [https://www.army.mil/article/208021/first\\_combat\\_training\\_capability\\_enhances\\_associated\\_units\\_pilot\\_joint\\_relationships](https://www.army.mil/article/208021/first_combat_training_capability_enhances_associated_units_pilot_joint_relationships) (accessed June 16, 2019).
55. David Vergun, "Associated Units Concept Improving Readiness, Says MG Jarrard," U.S. Army, November 2, 2017, [https://www.army.mil/article/196318/associated\\_units\\_concept\\_improving\\_readiness\\_says\\_mg\\_jarrard](https://www.army.mil/article/196318/associated_units_concept_improving_readiness_says_mg_jarrard) (accessed June 16, 2019).
56. Army G-3/5/7, "Army Readiness Guidance," U.S. Army STAND-TO!, May 19, 2016, <https://www.army.mil/standto/2016-05-19> (accessed June 16, 2019).
57. U.S. Department of the Army, "Combat Training Center Program," Army Regulation 350–50, May 2, 2018, effective June 2, 2018, p. 2, [https://armypubs.army.mil/epubs/DR\\_pubs/DR\\_a/pdf/web/ARN8650\\_AR350\\_50\\_Final.pdf](https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN8650_AR350_50_Final.pdf) (accessed June 16, 2019).
58. Chamberlain and Welch, *Army FY 2020 Budget Overview*, p. 9.
59. Michelle Tan, "'Objective T': The Army's New Mission to Track Training," *Army Times*, October 11, 2016, <https://www.armytimes.com/articles/objective-t-the-armys-new-mission-to-track-training> (accessed June 16, 2019).
60. Note that the first figures derive from an average BCT size of 4,500 and an average division size of 15,000. The second set of numbers derives from the current average of around 3.5 BCTs per division and analysis of the structure of each Army division.

# U.S. Navy

In *A Design for Maintaining Maritime Superiority, Version 2.0*, then-Chief of Naval Operations Admiral John M. Richardson describes the U.S. Navy's mission:

The United States Navy will be ready to conduct prompt and sustained combat incident to operations at sea. Our Navy will protect America from attack and preserve America's strategic influence in key regions of the world. U.S. naval forces and operations—from the sea floor to space, from deep water to the littorals, and in the information domain—will deter aggression and enable peaceful resolution of crises on terms acceptable to the United States and our allies and partners. If deterrence fails, the Navy will conduct decisive combat operations to defeat any enemy.<sup>1</sup>

For much of the post-Cold War period, the Navy, Marine Corps, and Coast Guard (known collectively as the sea services) have enabled the U.S. to project power across the oceans, control activities on the seas when and where needed, provide for the security of coastlines and shipping in maritime areas of interest, and thereby enhance America's deterrent capability without opposition from competitors. However, the ability of competitors to contest U.S. actions has improved, forcing the sea services to revisit their assumptions about gaining access to key regions.

Together, these functional areas—power projection, sea control, maritime security, deterrence, and domain access—constitute the basis for the Navy's strategy. Achieving and sustaining the ability to excel in these functions drives Navy thinking and programmatic efforts.

As the U.S. military's primary maritime arm, the Navy provides the enduring forward

global presence that enables the United States to respond quickly to crises around the world. Unlike ground or air forces, which operate from fixed, large support bases that require the consent of host nations, the U.S. Navy can operate freely at sea across the globe and shift its presence to wherever it is needed without any other nation's permission. As a result, naval forces are often the first U.S. forces to respond to a crisis and, through their persistent forward deployments, continue to preserve U.S. security interests long after conflict formally ends. The Navy's peacetime forward presence supports missions that include securing sea lines of communication for the free flow of goods and services, assuring U.S. allies and friends, deterring adversaries, and providing a timely response to crises short of war.

A few key documents inform the Navy's day-to-day fleet requirements:

- The 2017 National Security Strategy;<sup>2</sup>
- The 2018 National Defense Strategy (NDS);<sup>3</sup>
- The Global Force Management Allocation Plan (GFMAP);<sup>4</sup> and
- The 2018 *Design for Maintaining Maritime Superiority, Version 2.0*.

The 2018 NDS, issued by the Secretary of Defense, describes 11 Department of Defense (DOD) objectives for the Navy and the other branches of the U.S. military including “defending the homeland from attack; sustaining

Joint Force military advantages, both globally and in key regions; deterring adversaries from aggression against our vital interests; and ensuring common domains remain open and free.”<sup>5</sup> The NDS also directs the building of a more lethal, resilient, and agile force to deter and defeat aggression by great-power competitors and adversaries in all warfare domains and across the spectrum of military operations.<sup>6</sup>

The U.S. Navy must also meet forward presence requirements laid out in the GFMAP, which specifies the force presence needed around the world as determined by the combatant commanders (CCDRs) and the Secretary of Defense. To meet the objectives of the NDS and GFMAP, according to the Navy’s fiscal year (FY) 2019 budget request, “the Navy and Marine Corps primary combat force contributors are two Carrier Strike Groups (CSG) and two Amphibious Ready Groups (ARG) forward [deployed] at all times, and keeping three additional CSGs and ARGs in a ready use or surge status (2+3) to deploy within 30 days.”<sup>7</sup>

The Navy did not cite this GFMAP in its FY 2020 budget documents or congressional testimony,<sup>8</sup> but there is no indication that this requirement has been reduced. When questioned during an appearance before a subcommittee of the House Armed Services Committee about the Navy’s ability to maintain two aircraft carriers deployed and an additional three aircraft carriers available to deploy “during potential times of conflict,” Vice Admiral William Merz, Deputy Chief of Naval Operations for Warfare Systems (OPNAV N9), responded that “those numbers are actually sensitive.”<sup>9</sup>

According to the Navy’s March 2019 report to Congress on its long-range plan for construction of naval vessels, “The *Navy Strategy* articulates the maritime implementation of the *National Defense Strategy* and includes three driving elements of readiness, capability and capacity, all of which must remain balanced and scalable in order to field credible naval power.”<sup>10</sup> This *Index* focuses on these elements as the primary means by which to measure U.S. naval strength.

- Capacity must be sufficient both to defeat adversaries in major combat operations and to provide a credible peacetime forward global presence to maintain freedom of the global shipping lanes and deter aggression.
- Naval ships, submarines, and aircraft must possess the most modern warfighting capabilities, including weapons, radar, and command and control systems, to maintain a competitive advantage over potential adversaries.
- Finally, these naval platforms must be properly maintained, and their sailors must be adequately trained to ensure that they are “ready to fight tonight.”

Failure in any one of these critical measures of performance drastically increases the risk that the U.S. Navy will not be able to succeed in its mission and ensure the security of the nation and its global interests. For example, if the fleet is sufficiently large but has out-of-date equipment and weapons, and if its sailors are not proficient at warfighting, the Navy will fail to deter adversaries and will be unable to succeed in battle.

## Capacity

The Navy measures capacity by the number of ships rather than the number of sailors, and it does not count all ships equally. For example, the capabilities and contribution to combat operations of an aircraft carrier and its associated air wing are significantly greater than those of a littoral combat ship (LCS). The Navy focuses mainly on the size of its “battle force,” which is composed of ships that it considers to be directly related to its combat missions.<sup>11</sup>

This *Index* employs a benchmark of 400 ships for the minimum battle force fleet required to handle two simultaneous or nearly simultaneous major regional contingencies (MRCs), with a 20 percent additional margin that serves as a strategic reserve, while also maintaining a peacetime global forward



## Carrier Strike Group

A Carrier Strike Group (CSG) is a principal element of U.S. power projection, conducting missions such as sea control, offensive strike, and air warfare.

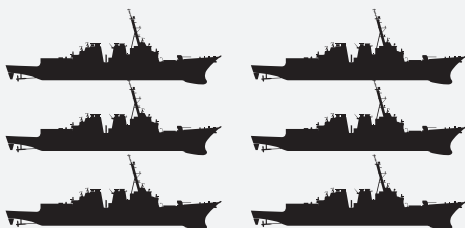


### Aircraft Carrier (CVN)

Capable of supporting combat operations for a carrier air wing of at least 70 aircraft, providing sea-based air combat and power projection capabilities that can be deployed anywhere in international waters.

### Guided Missile Destroyer (DDG)

Surface combatant capable of conducting integrated IAMD, AAW, ASuW, and ASW.



### Guided Missile Cruiser (CG)

Large surface combatant (LSC) capable of conducting integrated air and missile defense (IAMD), anti-air warfare (AAW), anti-surface warfare (ASuW), and anti-submarine warfare (ASW). CGs are the preferred platform for serving as the Air and Missile Defense Commander.



### Guided-Missile Frigate FFG(x)

Multi-mission small surface combatant (SSC) designed to complement the ASuW and ASW capabilities of the CSG as well as serve as a force multiplier for air defense capable DDGs.



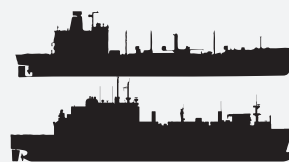
### Attack Submarine (SSN)

Multimission-capable submarines capable of performing ASW and ASuW in defense of the CSG.



### Logistics Ship

Provides fuel, dry stores, and ammunition in support of CSG operations.



SOURCE: Heritage Foundation research.

 heritage.org

FIGURE 5

# Expeditionary Strike Group

An Expeditionary Strike Group (ESG) is the primary element of U.S. amphibious warfare and expeditionary operations.



**Amphibious Assault Ship LHA or LHD**

A landing helicopter assault ship (LHA) or landing helicopter dock (LHD). Capable of supporting short take-off vertical landing (STOVL) operations for embarked Marine strike aircraft squadron as well as tilt-rotor and helicopter squadrons. Some of these ships possess a well deck to launch landing craft to support ship to shore transport of Marines.

**Amphibious Transport Dock (LPD), and Amphibious Dock Landing Ship (LSD)**

Embarked landing craft and amphibious assault vehicles (AAV) augmented by helicopters and tilt-rotor aircraft use LPDs and LSDs to transport and land Marines, and their equipment and supplies.



**Guided Missile Destroyer (DDG)**

LSC capable of conducting integrated IAMD, AAW, ASuW, and ASW.



**Logistics Ship**

Provides fuel, dry stores, and ammunition in support of CSG operations.



**Guided-Missile Frigate FFG(x)**

Multimission small surface combatant (SSC) designed to complement the ASuW and ASW capabilities of the CSG as well as serve as a force multiplier for air defense capable DDGs.



SOURCE: Heritage Foundation research.

presence to deter potential aggressors and assure our allies and maritime partners that the nation remains committed to defending its national security interests and alliances. The analysis that determined this minimum battle force fleet included an independent review of previous force structure assessments, historical naval combat operations, Navy and Marine Corps guidance on naval force composition, current and near-future maritime threats, U.S. naval strategy, and enduring naval missions.

This *Index* assesses that a minimum of 400 U.S. Navy battle force ships is required to provide:

- The 13 carrier strike groups and 15 expeditionary strike groups (ESGs) required to meet the simultaneous two-MRC construct;
- The historical steady-state demand of approximately 100 ships constantly forward deployed in key regions around the world; and
- Sufficient capacity to maintain the Navy's ships properly and ensure that its sailors are adequately trained to "fight tonight."

While this represents a significant increase from the language of the FY 2018 National Defense Authorization Act (NDAA), which specified an official U.S. policy of "not fewer than 355 battle force ships,"<sup>12</sup> and the Navy's own 2016 Force Structure Assessment (FSA),<sup>13</sup> both the Navy's recent fleet readiness issues and the 2018 NDS's focus on the "reemergence of long-term strategic competition"<sup>14</sup> point to the need for a much larger and more capable fleet.

The vast distances of the world's oceans and the relatively slow average transit speeds of naval warships (15 knots) require that the U.S. Navy maintain sufficient numbers of ships constantly forward deployed in key regions around the world to respond quickly to crises and deter potential aggression. This larger fleet includes not only additional small surface combatants (SSCs) to support the strike

groups, but also a significant increase in combat logistics force (CLF) ships to ensure that distributed forces deployed in peacetime and in combat operations can receive timely fuel, food, and ammunition resupply.

On average, four ships in the fleet are required to maintain one ship forward deployed. Most important, the fleet must be large enough to provide the requisite number of CSGs and ESGs when called upon as the primary elements of naval combat power during an MRC operation. Although a 400-ship fleet may be difficult to achieve based on current DOD fiscal constraints and the present capacity of the shipbuilding industrial base, this *Index* benchmark is budget agnostic and based strictly on assessed force-sizing requirements.

As of August 12, 2019, the Navy sailed 290 vessels as part of its battle force fleet,<sup>15</sup> up from 284 in 2018<sup>16</sup> but still well below both the Navy's goal of 355 ships and the 400-ship fleet required to fight and win two MRCs. The FY 2019 NDAA provides \$22.3 billion for the construction of 13 new ships, including (among others listed) three littoral combat ships (LCS); three Flight III *Arleigh Burke* guided missile destroyers (DDG); two fast replenishment oilers (T-AO); expeditionary fast transport (T-EPF); and one towing, salvage, and rescue ship (T-ATS).<sup>17</sup> The Navy has requested the procurement of 12 ships in FY 2020, marking the "largest shipbuilding budget request in over 20 years."<sup>18</sup>

On average, depending on the ship class, a ship is commissioned and joins the fleet three to five years after it is purchased by the Navy. The Navy plans to commission seven additional ships and submarines by the end of 2019 and 10 ships and submarines in FY 2020, including four *Arleigh Burke*-class DDGs, three *Virginia*-class nuclear attack submarines (SSNs), two LCSs, and one T-EPF.<sup>19</sup> The Navy will also retire five battle force ships in FY 2020: two *Los Angeles*-class SSNs and three mine countermeasure ships (MCMs).<sup>20</sup>

The number of ships decommissioned will increase significantly over the next five years as additional *Los Angeles*-class SSNs and MCMs reach the end of their service lives. The recent

Navy decision to retire eight *Ticonderoga*-class guided missile cruisers instead of conducting service life extensions (SLEs) will further slow the pace at which fleet size can grow.<sup>21</sup> The Navy completed a technical evaluation of the “feasibility of extending the service life of selected non-nuclear vessels” in 2018 and could decide to extend the life of ships from several classes from seven to 17 years depending on the funding available and shipyard capacity to achieve and maintain a 355-ship Navy more rapidly by reducing ships lost to decommissioning.<sup>22</sup>

The largest proportional shortfall in the Navy fleet assessed in the *2020 Index* is the same as in the past five editions: small surface combatants.<sup>23</sup> As of August 20, 2019, the Navy’s SSC inventory included 19 LCSs and 11 MCM ships for a total of 30 SSCs,<sup>24</sup> 22 below the objective requirement of 52 established by the Navy<sup>25</sup> and 41 less than the *Index* requirement of 71.<sup>26</sup>

The next-largest shortfall occurs in combat logistics force ships. As of August 20, 2019, the Navy’s CLF inventory was comprised of 12 *Lewis and Clark*-class dry cargo and ammunition ships (T-AKES); 15 *Henry J. Kaiser*-class fleet replenishment oilers (T-AOs); and two *Supply*-class fast combat support ships (T-AOEs), for a total of 29 CLF ships.<sup>27</sup> This is three below the Navy requirement of 32 ships and 25 less than the *Index* requirement of 54.<sup>28</sup>

As of August 20, 2019, the Navy’s attack submarine inventory stood at 50 submarines, comprised of 30 *Los-Angeles*-class (SSN 688); three *Seawolf*-class (SSN 21); and 17 *Virginia*-class (SSN 774) submarines.<sup>29</sup> Although the attack submarine shortfall is not the largest in comparison to the Navy’s requirement of 66 submarines<sup>30</sup> or the Heritage requirement of 65 submarines,<sup>31</sup> several factors make this the most challenging and most important force level issue for the Navy.

- The growing anti-access/area denial (A2/AD) capabilities of great-power competitors like China and the ability of submarines to penetrate these long-range defenses have made attack submarines a

critical component of joint force missions such as power projection and sea control.

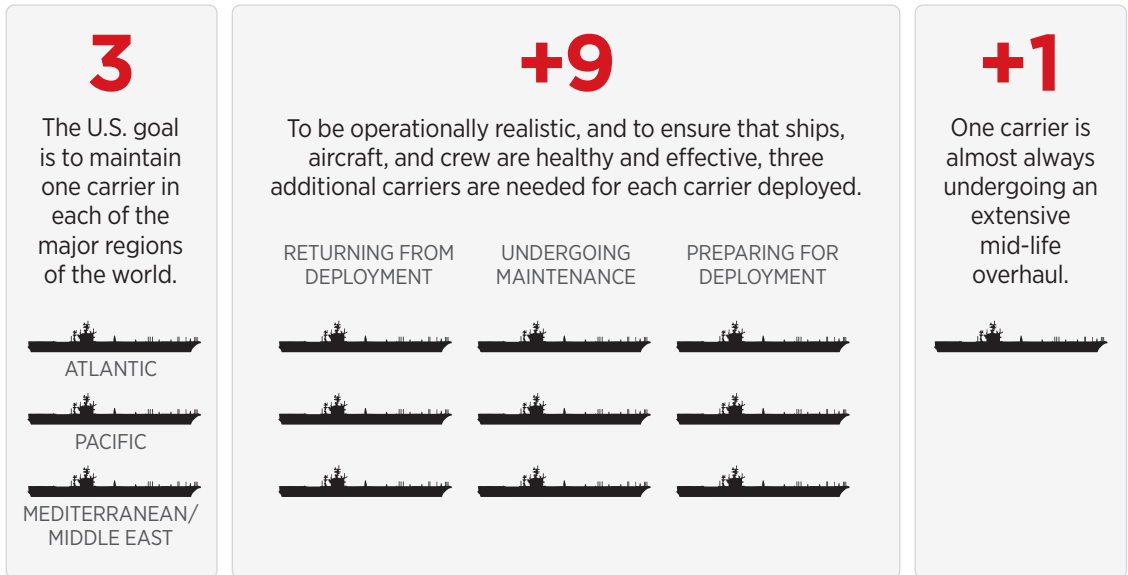
- Geographic combatant commanders have repeatedly expressed concerns that the Navy cannot meet their operational demands for attack submarines. Admiral Philip Davidson, Commander, U.S. Indo-Pacific Command, has stated that his Pacific forces receive only slightly more than 50 percent of their submarine mission requests.<sup>32</sup> The submarine force also gives the U.S. military its greatest competitive advantage against great-power competitors Russia and China.
- The submarine industrial base has very limited excess capacity over the next 30 years to accelerate the production of attack submarines. The Navy’s FY 2020 30-year shipbuilding plan identified opportunities to build only three additional *Virginia*-class submarines over the next six years and an additional nine next-generation SSNs between FY 2037 and FY 2049.<sup>33</sup>

The aircraft carrier force suffers a capacity shortfall of two hulls: As of August 20, 2019, 11 were in the fleet, and the two-MRC construct requires 13.<sup>34</sup> Current U.S. law requires the Navy to maintain a force of “not less than 11 operational aircraft carriers.”<sup>35</sup> The FY 2019 NDAA explicitly specifies “the sense of Congress that the United States should accelerate the production of aircraft carriers to rapidly achieve the Navy’s goal of having 12 operational aircraft carriers.”<sup>36</sup>

The Congressional Research Service (CRS) has assessed that “shifting carrier procurement to 3- or 3.5-year centers could achieve a 12-carrier fleet as soon as the 2030s, unless the service lives of one or more existing carriers were substantially extended.”<sup>37</sup> The Navy’s FY 2029 budget “supports 11 aircraft carriers and 33 large amphibious ships that serve as the foundation upon which our carrier strike groups and amphibious ready groups are based.”<sup>38</sup>

## The Case for 13 Carriers

The U.S. Navy carrier fleet is a critical element of U.S. power projection and supports a constant presence in regions of the world where permanent basing is limited. To handle this large mission properly, Heritage Foundation experts recommend a fleet of 13 carriers.



 [heritage.org](https://heritage.org)

The carrier force fell to 10 between December 2012 and July 2017. The USS *Gerald R. Ford* (CVN-78) was commissioned on July 22, 2017, returning the Navy's carrier force to 11 ships. While the *Ford* is now part of the fleet battle force, however, it will not be ready for routine flight operations until 2020 and will not operationally deploy until 2022.<sup>39</sup> In addition, through 2037, one *Nimitz*-class carrier at a time will be in a four-year refueling and complex overhaul (RCOH) to modernize the ship and refuel the reactor to support its full 50-year service life. The carrier in RCOH will count as a battle force ship but will not be operationally deployable during this four-year period. The combination of these two factors means that only nine aircraft carriers will be operationally available until 2022.

The Navy's FY 2020 budget request is notable for its apparent contradiction regarding the required size of its aircraft carrier fleet. On the one hand, the budget included a two-ship aircraft carrier procurement of CVN 80 and CVN 81 in FY 2020, realizing an estimated \$3.9 billion in savings over buying the ships separately.<sup>40</sup> The Navy simultaneously announced its decision to cancel the previously planned RCOH for USS *Harry S. Truman* (CVN 75), retiring the ship with over 24 years of service life remaining as well as deactivating one carrier air wing. The Navy's FY 2020 30-year shipbuilding plan stated that this decision was "in concert with the Defense Department's pursuit of a more lethal balance of high-end, survivable platforms (e.g. CVNs) and complementary capabilities from emerging technologies."<sup>41</sup>

According to Vice Admiral Merz, the decision to retire USS *Truman* was “not a warfighting decision. It was more of an investment decision.”<sup>42</sup>

Navy officials declared that canceling USS *Truman*’s refueling overhaul would save \$3.4 billion over the FY 2020–FY 2024 period and a total of \$5.6 billion. When factoring in the cost to retire and dismantle the aircraft carrier as well as funds already spent on the replacement reactor cores, the net estimated savings is closer to \$3.5 billion. The Navy’s FY 2020 budget redirected these savings to fund the development and fielding of new lethal technologies such as directed energy weapons, hypersonic missiles, artificial intelligence, and unmanned systems. Navy leadership also cited the more modern *Ford*-class aircraft carrier’s increased lethality and power generation, 33 percent higher sortie rate, a smaller crew with approximately 600 fewer sailors, two and a half times greater electrical power, and over \$4 billion in life-cycle cost savings over the *Nimitz*-class as additional reasons for prioritizing the two-carrier buy over refueling USS *Truman*.<sup>43</sup>

The decision to retire *Truman* engendered significant bipartisan opposition from Congress. The Administration subsequently reversed its decision to decommission *Truman*, and Vice President Mike Pence made an official announcement on April 30, 2019, onboard the carrier.<sup>44</sup> On May 7, 2019, Under Secretary of the Navy Thomas Modly stated “that it is still ‘TBD’ regarding what cuts would be made to pay for the RCOH over the next several years, but he added that the Navy and the Office of the Secretary of Defense are looking across all the services’ budgets for options.”<sup>45</sup>

According to the CRS, “the Navy states that the CVN-75 RCOH can no longer begin in FY2024, as planned prior to the Navy’s FY2020 budget submission, because the Navy spent the months prior to April 30 planning for the ship’s deactivation rather than for giving it an RCOH.”<sup>46</sup> Since *Truman*’s refueling overhaul will now begin in FY 2025, its proposed funding profile will commence in FY 2021. The Navy will only need an additional \$16.9 million

in its FY 2021 budget, but the required funding will increase to \$234.7 million in FY 2022 with an additional \$1.3 billion in FY 2023 and FY 2024.<sup>47</sup> Without increased funding beginning in FY 2021, the Navy will be forced either to make cuts in its shipbuilding plan or to curtail the development of the new lethal technologies for which the planned savings were earmarked.

In December 2016, the U.S. Navy released its latest study of forecasted fleet requirements. The Navy Force Structure Assessment was developed to determine the correct balance of existing forces for “the ever-evolving and increasingly complex maritime security threats the Navy is required to counter in the global maritime commons.”<sup>48</sup> The Navy concluded that a 653-ship force would be necessary to address all of the demands registered in the FY 2017 Global Force Management (GFM) system and that a fleet of 459 ships (200 fewer than the ideal fleet but thought still to be too expensive given current and projected limits on defense spending) would meet warfighting requirements but also accept risk in providing continual presence missions.<sup>49</sup>

The Navy’s final force objective of 355 ships as recommended by the FSA is based on a minimum force structure that “complies with current defense planning guidance,” “meets approved Day 0 and warfighting response timelines,” and “delivers future steady state and warfighting requirements...with an acceptable degree of risk.”<sup>50</sup> This is an increase of 47 in the minimum number of ships from the previous requirement of 308. The most significant increases are:

- Aircraft carriers, from 11 to 12;
- Large surface combatants (guided missile destroyers (DDGs) and cruisers (CGs)) from 88 to 104 “to deliver increased air defense and expeditionary BMD [ballistic missile defense] capacity and provide escorts for the additional Aircraft Carrier”;
- Attack submarines (SSNs), from 48 to 66 to “provide the global presence required



to support national tasking and prompt warfighting response”; and

- Amphibious ships, from 34 to 38.<sup>51</sup>

Section 1025 of the FY 2018 National Defense Authorization Act states in part that “[i]t shall be the policy of the United States to have available, as soon as practicable, not fewer than 355 battle force ships, comprised of the optimal mix of platforms, with funding subject to the availability of appropriations or other funds.”<sup>52</sup> According to the Navy’s long-range plan for construction of naval vessels:

In response to the latest *National Defense Strategy*, *Navy Strategy* and *CNO’s Design for Maintaining Maritime Superiority 2.0*, the Navy is on track to complete the next FSA by the end of 2019. Some of the key elements that will be reviewed include ongoing threat-based fleet architecture review, logistics in support of DMO [distributed maritime operations], surface ship mix with the inclusion of the new frigate, deterrence per the *National Defense Strategy*, and legacy capital investments versus the efficacy of next generation capabilities.<sup>53</sup>

Remarks by Navy leadership during congressional testimony have indicated that the new FSA will likely result in a force-level requirement of 355 ships or more. The mix of ship types is also expected to change to provide an increased number of small surface combatants (frigates) and logistics ships to support more dispersed maritime operations.<sup>54</sup>

The 2019 FSA may discuss unmanned ships and undersea vehicles but almost certainly will not establish an unmanned force size or replace manned ships with unmanned vessels. The FY 2020 30-year shipbuilding plan, however, does address unmanned and optionally manned systems and the battle force:

The physical challenges of extended operations at sea across the spectrum of

competition and conflict, the concepts of operations for these platforms, and the policy challenges associated with employing deadly force from autonomous vehicles must be well understood prior to replacing accountable battle force ships.<sup>55</sup>

The Navy’s FY 2020 30-year shipbuilding plan provides the foundation for building the Navy the nation needs and ultimately achieving the congressionally mandated requirement of 355 battle force ships. Specifically, it states that “[t]he PB2020 30-year shipbuilding plan includes procurement of 55 battle force ships within the FYDP” and that “[o]verall inventory will reach 314 ships by FY2024 and 355 ships in FY2034.”<sup>56</sup> The FY 2019 plan also buys 55 ships over the FY 2020–FY 2024 period but builds only 301 ships over the next 30 years.<sup>57</sup>

Although the FY 2020 plan achieves 355 ships by FY 2034, approximately 20 years earlier than would be the case under the FY 2019 plan, this is done primarily by extending the service lives of all *Arleigh Burke*-class DDGs to 45 years, not by increasing the numbers of new ships.<sup>58</sup> This 355-ship fleet will not possess the desired force mix as defined in the 2016 FSA. It will consist of significantly more large surface combatants than needed (i.e., destroyers and cruisers) but will have fewer aircraft carriers, attack submarines, and amphibious ships than required.<sup>59</sup>

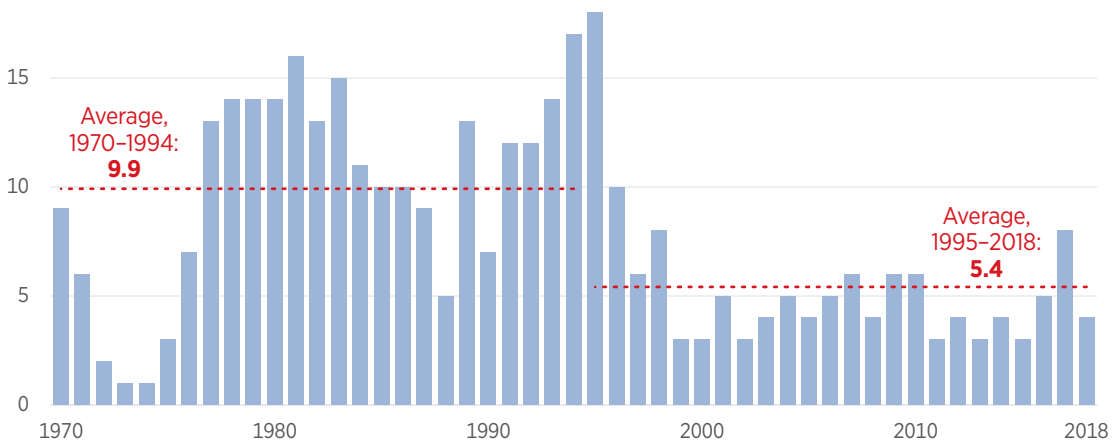
The FY 2020 shipbuilding plan also includes several significant changes in the Navy’s shipbuilding profile over the next five years. It accelerates the acquisition of CVN-81 from FY 2023 to FY 2020 while adding an additional *Virginia*-class submarine and FFG(X) frigate. The plan also decreases the number of LPD-17 Flight II amphibious warships purchased over the next five years from four to two.<sup>60</sup>

The 30-year shipbuilding plan also includes service life extensions for qualified candidate vessels as a key tool with which to increase fleet size more rapidly. The Navy’s FY 2019 budget submission included SLEs for six *Ticonderoga*-class cruisers, four mine countermeasures ships, and “the first of potentially five” *Los*

## Rate of U.S. Navy Ship Commissionings Nearly Cut in Half

The U.S. Navy must commission an average of 14 ships annually to reach a 400-ship Navy by the late-2030s. Its current commissioning rate is about 5 ships annually.

20 ANNUAL COMMISSIONINGS



**SOURCE:** Shipbuilding History, “Large Naval Ships and Submarines,” <http://www.shipbuildinghistory.com/navalships.htm> (accessed August 8, 2018).

heritage.org

*Angeles*-class attack submarines.<sup>61</sup> On April 12, 2018, Vice Admiral Merz informed the House Armed Services Seapower and Force Projection Subcommittee that the Navy will extend the entire *Arleigh Burke* destroyer class to a service life of 45 years.<sup>62</sup>

While the FY 2020 shipbuilding plan includes the DDG-51-class life extension and plans to refuel two *Los Angeles*-class attack submarines over the next five years, it also removes funding for the SLEs for the six oldest *Ticonderoga*-class cruisers “in favor of readiness and other lethality investments.”<sup>63</sup> In April 2019, Admiral Richardson stated that “[w]e’re going to continue to assess the cruisers...and study that to see if it is a good return on the taxpayer’s investment, given the war-fighting punch they bring.”<sup>64</sup> The cost of modernizing the combat systems and key equipment must be weighed against the increased lethality provided by the life extension as well as the fact that *Ticonderoga*-class cruisers have

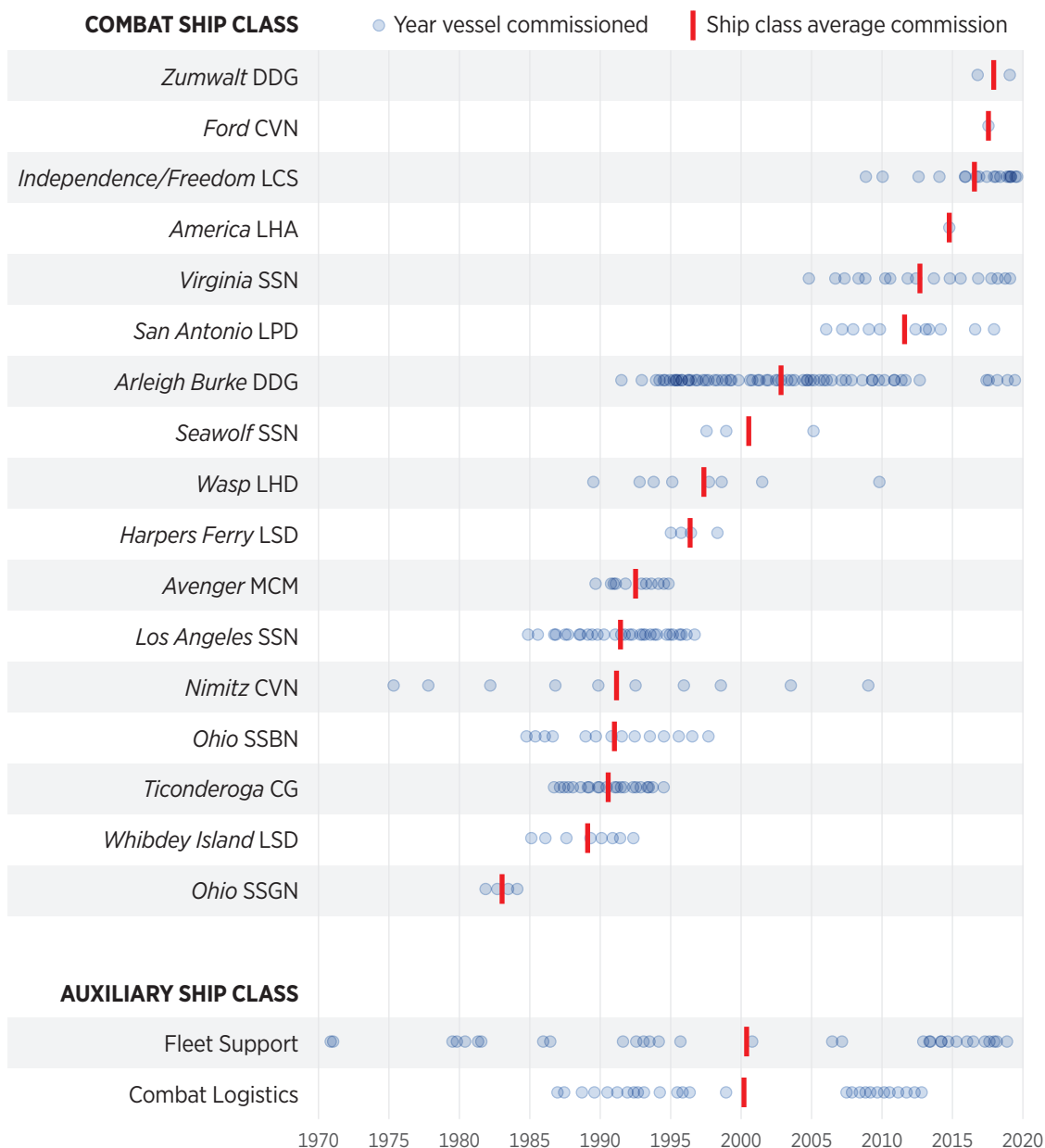
26–32 more vertical launch system (VLS) cells than *Arleigh Burke*-class destroyers have.

The FY 2020 plan also removes the planned life extensions for four MCM ships and accelerates the retirement of all *Avenger*-class MCMs by FY 2023.<sup>65</sup> The Navy states that its transition to “a broad-spectrum, cross-domain, expeditionary approach that includes dedicated LCS-based MCM ships, MCM modules for use aboard Vessels of Opportunity (VOO), small expeditionary MCM teams, and undersea vehicles” supports this accelerated transition from legacy MCM ships.<sup>66</sup>

The mine mission package aviation assets have been certified for operation on *Independence*-variant LCS ships, and certification of *Freedom*-variant ships should occur by the end of FY 2019. Certification of additional undersea MCM assets on *Independence* variants is expected by the end of FY 2019 and on *Freedom* variants by FY 2020. The complete mine mission packages will not reach initial

## Length of Service Since Commissioning

The number and types of ships commissioned by the U.S. Navy has decreased over the past 20 years. The procurement holiday of the 1990s and decreased emphasis on modernization in a time of fiscal constraints have resulted in a fleet of increasing age.



**NOTE:** Data are current as of September 13, 2019.

**SOURCE:** Naval Sea Systems Command, Naval Vessel Register, "Fleet Size,"

<http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML> (accessed September 13, 2019).

heritage.org

operating capability (IOC) until FY 2022 at the earliest.<sup>67</sup> Additional testing and certification delays could cause the Navy to lose a certified and fully operational MCM capability beginning in FY 2023.

Taken alone, total fleet size can be a misleading statistic; related factors must also be taken into account when considering numbers of ships. One such important factor is the number of ships that are forward deployed to meet operational demands. On average, the Navy maintains approximately 90–100 ships (one-third of the total fleet) deployed at any given time. The type or class of ship is also important. Operational commanders must have the proper mix of capabilities deployed to enable a timely and effective response to emergent crises.

Not all ships in the battle force are at sea at the same time. The majority of the fleet is based in the continental United States (CONUS) to undergo routine maintenance and training, as well as to limit deployment time for sailors. However, the CCDRs' requirements for naval power presence in each of their regions provide an impetus to have as many ships forward deployed as possible.

In November 2014, the Navy established an Optimized Fleet Response Plan (OFRP) "to ensure continuous availability of manned, maintained, equipped, and trained Navy forces capable of surging forward on short notice while also maintaining long-term sustainability of the force."<sup>68</sup> The plan incorporates four phases of ship availability/maintenance that result in a basic ratio of 4:1 for CONUS-based force structure required for deployed platforms.

In 2019, the Navy had 104 ships deployed globally, including submarines.<sup>69</sup> This represented 36 percent of the total battle force fleet. As of August 9, 2019, the Navy had 76 "Deployed Battle Force Across the Fleet Including Forward Deployed Submarines."<sup>70</sup> While the Navy remains committed to deploying roughly a third of its fleet at all times, capacity shortages have caused the current fleet to fall below the levels needed to fulfill the Navy's stated forward presence requirements and below

the levels needed for a fleet that is capable of projecting power at the two-MRC level.

The Navy has attempted to increase forward presence by emphasizing non-rotational deployments (having a ship "homeported" overseas or keeping it forward stationed):<sup>71</sup>

- **Homeported:** The ships, crew, and their families are stationed at the port or based abroad.
- **Forward Stationed:** Only the ships are based abroad while crews are rotated out to the ship.<sup>72</sup> This deployment model is currently used for LCS and SSGNs manned with rotating blue and gold crews, effectively doubling the normal forward deployment time.

Both of these non-rotational deployment options require formal agreements and cooperation from friends and allies to permit the Navy's use of their facilities, as well as U.S. investment in additional facilities abroad, but they also allow one ship to provide a greater level of presence than can be provided by four ships based in CONUS and in rotational deployment because they offset the time needed to deploy ships to distant theaters.<sup>73</sup> The Navy's GFM planning assumptions assume a forward deployed presence rate of 19 percent for a CONUS-based ship compared to a 67 percent presence rate for an overseas-homeported ship.<sup>74</sup>

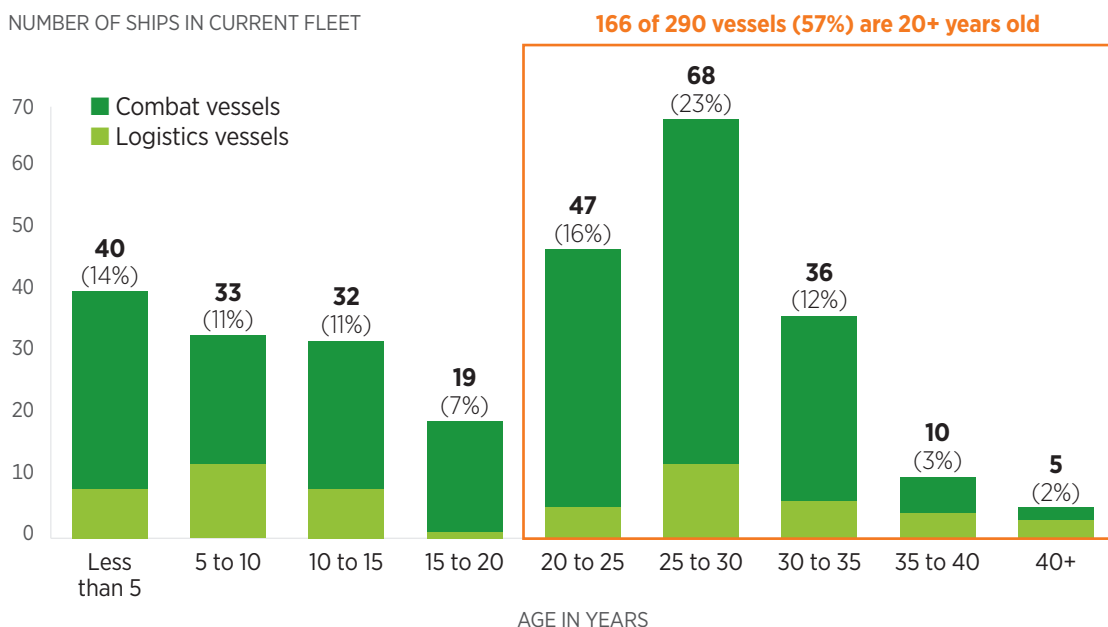
## Capability

Scoring the U.S. Navy's overall ability to protect U.S. interests globally is not simply a matter of counting the fleet. The quality of the battle force is also important in determining naval strength.

A comprehensive measure of platform capability would involve a comparison of each ship and its weapons systems relative to the military capabilities of other nations. For example, a complete measure of naval capabilities would have to assess not only how U.S. platforms would match up against an enemy's

## An Aging U.S. Navy

NUMBER OF SHIPS IN CURRENT FLEET



**NOTE:** Data are current as of September 13, 2019.

**SOURCE:** Naval Sea Systems Command, Naval Vessel Register, "Fleet Size,"

<http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML> (accessed September 13, 2019).

heritage.org

weapons, but also whether formal operational concepts would be effective in a conflict, after which the assessment would be replicated for each potential conflict. This is a necessary exercise and one in which the military currently engages, but it is beyond the scope of this *Index* because such details and analysis are routinely classified.

Capability can be usefully assessed based on the age of ships, modernity of the platform, payloads and weapons systems carried by ships, and the ability of planned modernization programs to maintain the fleet's technological edge. The Navy has several classes of ships that are nearing the end of their life spans, and this will precipitate a consolidation of ship classes in the battle force.

Most of the Navy's battle force fleet consists of legacy platforms. Of the 20 classes of ships in the Navy's inventory, only eight are

currently in production. For example, 61 percent of the Navy's attack submarines are *Los Angeles*-class submarines, an older platform that is being replaced by the more modern and capable *Virginia*-class.<sup>75</sup>

The 30-year shipbuilding plan is not limited to programs of record and assumes procurement programs that have yet to materialize. Some of the Navy's ship designs in recent years, such as the *Gerald R. Ford*-class aircraft carrier, the *San Antonio*-class amphibious ship, and the littoral combat ship, have been substantially more expensive to build than the Navy originally estimated.<sup>76</sup> The first ship of any class is typically more expensive than early estimates project, which is not entirely surprising given the technology assumptions and cost estimates that must be made several years before actual construction begins. In fact, only two of the last 11 lead ships have come in below the

original cost estimate.<sup>77</sup> In addition, the Navy is acting to ensure that critical technologies are fully mature (T-AO 205 *John Lewis*-class fleet replenishment oiler) before incorporation into ship design and requiring greater design completion (83 percent for *Columbia* ballistic missile submarine) before actual production.<sup>78</sup>

The Navy retired its last *Oliver Hazard Perry*-class guided missile frigates in 2015 and since then has been without a multi-mission SSC that can perform anti-submarine warfare (ASW); surface warfare (SUW); and local air defense in support of CSGs and ESGs and as a logistic fleet escort. The littoral combat ship is the only current SSC in the fleet other than the MCM ships.<sup>79</sup>

The Navy recently awarded Raytheon the LCS's over-the-horizon anti-ship (OTH) weapon contract to provide an unspecified number of the Kongsberg-designed naval strike missiles.<sup>80</sup> This encapsulated anti-ship and land attack missile has a range of up to 100 nautical miles and will provide a significant increase in the LCS's offensive capabilities.<sup>81</sup>

Critics of the LCS program have continued to express concerns about “past cost growth, design and construction issues with the first LCSs”; “the survivability of LCSs (i.e., their ability to withstand battle damage)”; “whether LCSs are sufficiently armed and would be able to perform their stated missions effectively”; and “the development and testing of the modular mission packages for LCSs.”<sup>82</sup> The annual report from DOD's Director, Operational Test and Evaluation (DOT&E), has contained numerous comments, many of them extremely critical, regarding LCS operational performance and LCS mission modules.<sup>83</sup>

The LCS concept of operations (CONOPS) has been modified several times since its original design. The Navy's current plan calls for three divisions on each coast of the United States, each with four ships dedicated to a specific mission: ASW, SUW, or MCM.<sup>84</sup> One ship in each division will be dedicated to training, and the other three ships will conduct periodic operational deployments.<sup>85</sup> The non-training ships will be operated by dual crews, similar to

U.S. ballistic missile submarines. This enables the Navy to keep the ships forward deployed longer than the typical seven months without overtaxing their crews. The Navy predicts that by approximately FY 2023, 13 of the 24 ships in the six mission divisions will be maintained forward stationed for 24 months on a rotational basis: three in Singapore, three in Sasebo, Japan, or another Western Pacific location, and seven in Bahrain.<sup>86</sup>

The modular LCS design depends on mission packages (MPs) to provide warfighting capabilities in the SUW, ASW, and MCM mission areas. Until the MPs have reached IOC, LCS will not reach its full warfighting capability. The gun and maritime security mission modules of the SUW MP reached IOC in FY 2014 and FY 2015. The surface-to-surface mission module with the Longbow Hellfire missile reached IOC for the *Freedom*-variant ships in early FY 2019 and is expected to reach IOC for the *Independence* variant by late FY 2019. The ASW MP is scheduled to reach IOC in FY 2020, a delay from FY 2019 caused by Congress's decision to cut all funding for variable-depth sonar procurement in FY 2019.<sup>87</sup>

Originally planned as the first MP to reach IOC, the MCM MP will now be the last to reach IOC with all of its capabilities. The MCM MP aviation assets have been certified for operation on *Independence*-variant LCS ships; the *Freedom*-variant ships should be certified by the end of 2019. Additional undersea MCM assets certification should be complete by the end of 2019 for *Independence* variants and by the end of 2020 for *Freedom* variants. The complete mine mission packages will not reach initial operating capability until 2022 at the earliest.<sup>88</sup> While the LCS mission modules have had numerous technical problems and delays during their development, congressional cuts between FY 2015 and FY 2018 have only compounded the delays in delivering operational mission packages to the fleet.<sup>89</sup>

After not deploying any LCSs in FY 2018, Vice Admiral Richard Brown, Commander of Naval Surface Forces, announced that the Navy would deploy three LCSs in FY 2019.



The Independence-variant USS *Montgomery* (LCS-8) and USS *Gabrielle Giffords* (LCS-10) from the San Diego-based Littoral Combat Ship Squadron-1 (LCSRON-1) will deploy to the Western Pacific. The Navy did not state where the Freedom-variant USS *Detroit* (LCS-7) from Mayport-based LCSRON-2 would deploy. Based on the long-term plan to forward station seven LCSs in Bahrain, as well as the threat posed by Iranian fast attack craft (FAC) and fast inshore attack craft (FIAC), *Detroit* will likely deploy to Bahrain. All three LCSs will deploy with the SUW MP to address lower-threat missions and alleviate some of the operational demand on U.S. destroyers and cruisers. An additional LCSRON-2 LCS is scheduled to deploy early in FY 2020. Vice Admiral Brown also stated that these deployments will commence LCS persistent deployed forward presence as planned under the 2016 LCS operational plan.<sup>90</sup>

The FY 2019 NDAA included funding for three LCSs, two more than the Navy's FY 2019 budget request and three more than the Navy's 2016 FSA requirement of 32 ships. The Navy has not included any LCSs in its FY 2020 budget request because it will be awarding the initial FFG(X) contract in FY 2020. The Navy projects that the LCS battle force will reach 20 LCSs by the end of FY 2019 and 22 by the end of FY 2020.<sup>91</sup> Even when combined with the 11 remaining mine countermeasure vessels in the fleet, this is still well below the fleet size of 71 small surface combatants needed to fulfill the Navy's global responsibilities.

In July 2017, the Navy released a Request for Information (RFI) to the shipbuilding industry with the goal of building a new class of 20 ships, currently referred to as the future guided missile frigate (FFG(X)), beginning in FY 2010.<sup>92</sup> The Navy stated that:

The purpose of this type of ship is to (1) fully support Combatant and Fleet Commanders during conflict by supplementing the fleet's undersea and surface warfare capabilities, allow for independent operations in a contested environment,

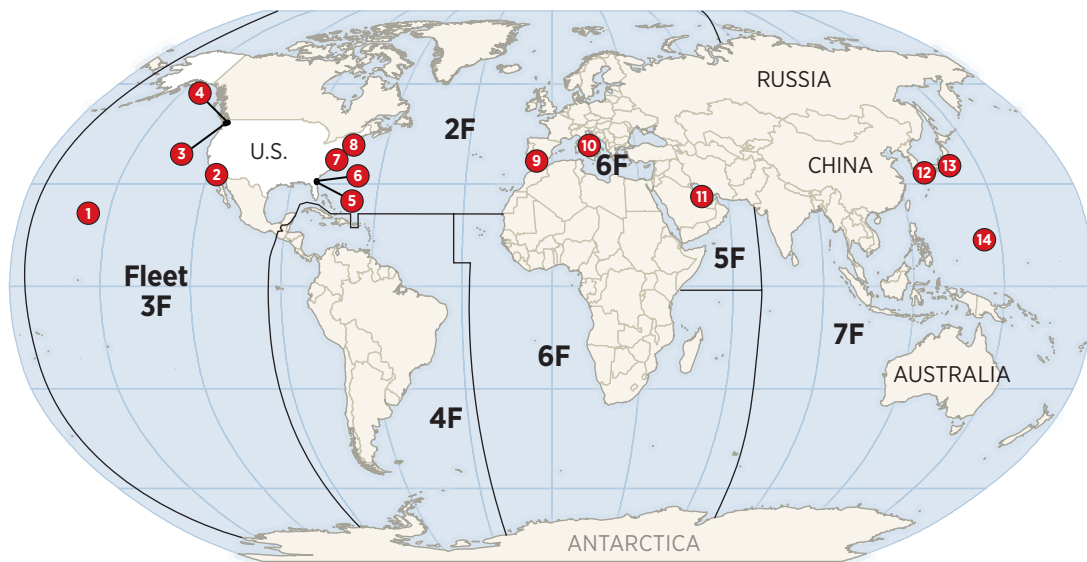
extend the fleet tactical grid, and host and control unmanned systems; and (2) relieve large surface combatants from stressing routine duties during operations other than war.<sup>93</sup>

The RFI further specified that:

- “[T]he FFG(X) will normally aggregate into strike groups and Large Surface Combatant led surface action groups but also possess the ability to robustly defend itself during conduct of independent operations while connected and contributing to the fleet tactical grid”;
- “Complement the surface warfare (SuW) capabilities of a Carrier Strike Group and Expeditionary Strike Group with capacity in aggregated operations (e.g., as a pack) to deter or defeat aggression by adversary warships with over-the-horizon anti-ship missiles”;
- “Perform anti-submarine warfare (ASW) scout and patrol missions that complement the capabilities of Strike Group and theater operations with enhanced active and passive undersea sensing capabilities”; and
- “Support transoceanic logistics movements by serving as a force multiplier to area air defense capable destroyers.”<sup>94</sup>

The Navy's FY 2020 shipbuilding plan would procure the 20 frigates between FY 2020 and FY 2030. The Navy's desire to award the FFG(X) detailed design and construction contract in FY 2020 did not provide sufficient time for a completely new design, instead driving it to build FFG(X) based on an existing SSC ship design that can be modified to meet the FFG(X)'s specific capability requirements.<sup>95</sup> On February 16, 2018, the Navy awarded five FFG(X) conceptual design contracts to Austal USA; Huntington Ingalls Industry/Ingalls Shipbuilding (HII/Ingalls); Lockheed Martin;

## Key U.S. Naval Installations



- 1 Joint Base Pearl Harbor-Hickham, Hawaii**  
U.S. Pacific Fleet headquarters; homeport to CGs, DDGs, and SSNs
- 2 Naval Base San Diego and Naval Base Coronado, Calif.**  
U.S. Third Fleet headquarters; largest West Coast U.S. naval base; homeport to CVNs, CGs, DDGs, LCSs, SSNs, and amphibious ships
- 3 and 4 Naval Base Kitsap and Naval Station Everett, Wash.**  
Homeport to CVNs, SSNs, DDGs, and U.S. Pacific Fleet SSBNs and SSGNs
- 5 Naval Station Mayport, Fla.**  
U.S. Fourth Fleet headquarters; homeport to CGs, DDGs, amphibious ships, and LCSs
- 6 Naval Submarine Base King's Bay, Ga.**  
Homeport to U.S. Fleet Forces Command SSBNs, and SSGNs
- 7 Naval Base Norfolk and Joint Expeditionary Base Little Creek, Va.**  
U.S. Fleet Forces Command and U.S. Second Fleet headquarters; largest naval base in the world; homeport to CVNs, CGs, DDGs, amphibious ships, and SSNs
- 8 Naval Submarine Base Groton, Conn.**  
Homeport to SSNs
- 9 Naval Station Rota, Spain**  
Homeport to ballistic missile defense DDGs
- 10 Naval Support Activity Gaeta, Italy**  
U.S. Sixth Fleet headquarters; homeport to U.S. Sixth Fleet command ship
- 11 Naval Support Activity, Bahrain**  
U.S. Fifth Fleet headquarters; homeport for MCM ships; provides logistics support for ships forward deployed to U.S. Fifth Fleet
- 12 U.S. Fleet Activity Sasebo, Japan**  
Homeport to amphibious ships and MCM ships
- 13 U.S. Fleet Activity Yokosuka, Japan**  
Largest overseas U.S. naval base; U.S. Seventh Fleet headquarters; homeport to CVN, CGs, DDGs, and U.S. Seventh Fleet command ship; provides logistics support for ships forward deployed to U.S. Seventh Fleet
- 14 Naval Base Guam: Navy Expeditionary Force Command Pacific headquarters**  
Homeport to SSNs and submarine tenders; provides logistics support for SSNs forward deployed to U.S. Seventh Fleet

**NOTE:** Fleet boundaries are approximate.

**SOURCE:** Heritage Foundation research.

 heritage.org

Fincantieri/Marinette Marine (F/MM); and General Dynamics/Bath Iron Works (GD/BI-W).<sup>96</sup> The Navy will select one shipbuilder in FY 2020.<sup>97</sup>

As noted earlier, the Navy has been conducting an updated Force Structure Assessment that should be released before the end of 2019. Details are not yet available, but Navy officials have suggested that the proportion of SSCs (frigates) compared to LSCs (destroyers and cruisers) would likely increase as the Navy moves to a more distributed and dispersed CONOPS. A recent OPNAV N96 Surface Warfare directorate brief provides a glimpse into a future distributed surface force architecture with twice as many SSCs as LSCs.<sup>98</sup> If the Navy does pursue a much larger SSC force, it could expand the FFG(X) requirement and increase the build rate above two per year so that it can meet a new force goal more rapidly.

As of August 20, 2019, the Navy possessed 22 *Ticonderoga*-class (CG 47) cruisers.<sup>99</sup> To save operating expenses, it has been pursuing a plan to put half of this fleet into temporary layup status in order to extend this class's fleet service time into the 2030s—even though these ships are younger than their expected service lives (in other words, have been used less than planned). Under the FY 2015 National Defense Authorization Act:

Congress...directed the Navy to implement the so-called “2-4-6” program for modernizing the 11 youngest Aegis cruisers. Under the 2-4-6 program, no more than two of the cruisers are to enter the modernization program each year, none of the cruisers is to remain in reduced status for modernization for more than four years, and no more than six of the cruisers are to be in the program at any given time....<sup>100</sup>

The Navy's FY 2020 budget request removed funding for SLEs for the six oldest cruisers, added in the FY 2019 request, in exchange for increased readiness and lethality investments.<sup>101</sup> The retirement of the two

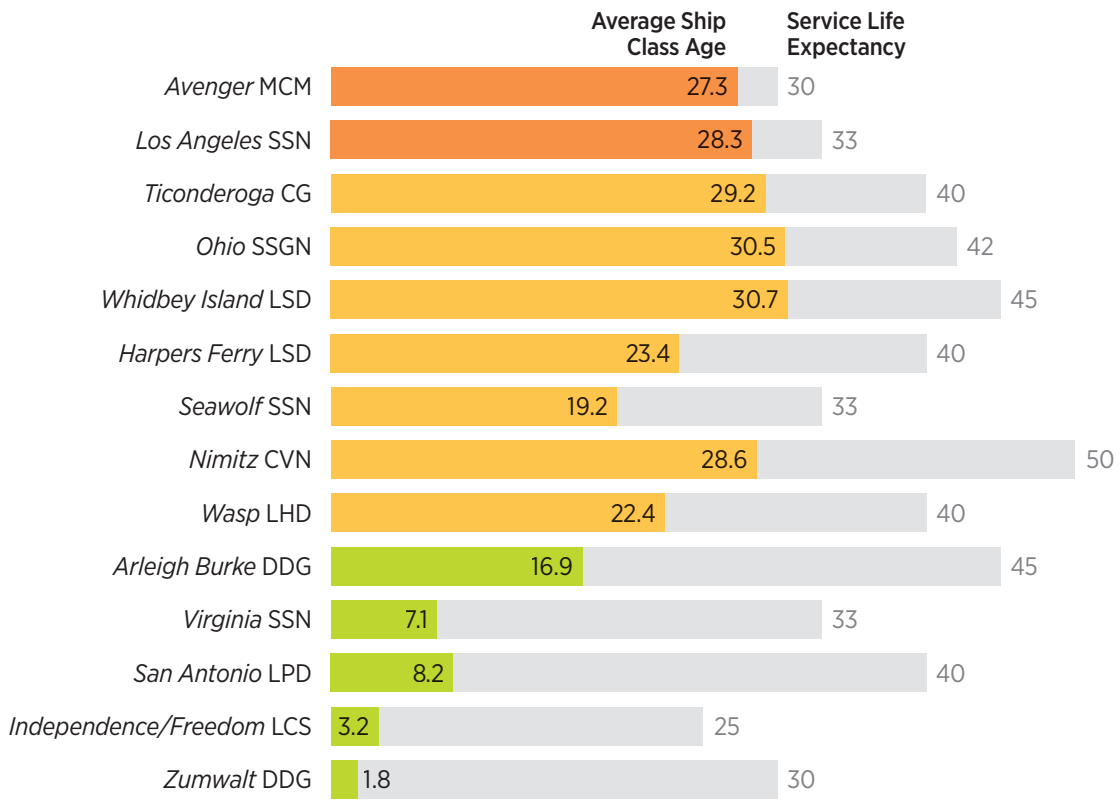
oldest cruisers, scheduled for FY 2020, has been deferred to FY 2021 so that the Navy can assess the cost versus increased lethality from modernizing these ships. The Navy will continue to execute the “2-4-6” plan in FY 2020. This “CG Modernization (Mod) Program...upgrades combat systems; command, control, communications, computers, and intelligence (C4I) systems; and hull, mechanical, and electrical (HM&E) systems to achieve an extended service life and pace the multi-mission threats.”<sup>102</sup> The Navy's FY 2020 budget request supports the continued modernization of the nine newest *Ticonderoga*-class cruisers (CG 65–CG 73).<sup>103</sup>


The Navy's FY 2020 budget request procures three DDG 51 Flight III destroyers as part of a 10-ship multi-year procurement, bringing the class size to 85 ships.<sup>104</sup> The Flight III provides a significant capability upgrade to the Navy's integrated air and missile defense with the incorporation of the air and missile defense radar. In addition, “PB-20 includes \$4 billion across the FYDP to modernize 19 guided missile destroyers. This includes critical upgrades to AEGIS Baseline 9, enabling them to simultaneously perform Integrated Air and Missile Defense (IAMD) and Ballistic Missile Defense (BMD) operations.”<sup>105</sup>

The DDG-1000 *Zumwalt*-class “is a multi-mission destroyer with an originally intended emphasis on naval surface fire support (NSFS) and operations in littoral (i.e., near-shore) waters.”<sup>106</sup> The *Zumwalt*-class has been plagued by cost overruns, schedule delays, and the exorbitant cost of the projectile for its advanced gun system. In July 2008, the Navy announced that it would end procurement of DDG-1000s after the initial three ships because it had “reevaluated the future operating environment and determined that its destroyer program must emphasize three missions: open-ocean antisubmarine warfare (ASW), countering anti-ship cruise missiles (ASCMs), and countering ballistic missiles.”<sup>107</sup> The stealthy DDG-1000 hull design cannot support the required ballistic missile defense capabilities without significant modifications.

# Combat Fleets Pushing Limits of Life Expectancy

AVERAGE SHIP CLASS AGE AS PERCENTAGE OF SERVICE LIFE EXPECTANCY: ■ <50% ■ 50%-75% ■ 75%+



**NOTE:** Average ship class age as of October 2019.  
**SOURCE:** Heritage Foundation research based on data from U.S. Department of the Navy, U.S. Department of Defense, U.S. Government Publishing Office, and other sources. 

A core part of the *Zumwalt*-class’s original NSFS mission was its “two new-design 155mm guns called Advanced Gun Systems (AGS),” which “were to fire a new 155mm, gun-launched, rocket-assisted guided projectile called the Long-Range Land-Attack Projectile (LRLAP, pronounced LUR-lap).” When the DDG-1000 program was cut to three ships, the LRLAP’s cost per round skyrocketed to \$800,000, making the projectile’s cost prohibitive. The Navy has yet to announce a replacement projectile, and the AGSs are currently

non-operational as any replacement munition will require modifications to the AGS and its munition handling equipment.<sup>108</sup>

In December 2017, the Navy announced that because of changes in global security threats and resulting shifts in Navy mission requirements since the original DDG-1000’s missions were established in 1995, it was updating the DDG-1000’s primary mission to reflect the current needs of the Navy and the ship’s stealth and other advanced capabilities. The DDG-1000’s primary mission will shift

from an emphasis on naval gunfire support for Marines on shore to an emphasis on surface strike (the use of missiles to attack surface ships and possibly land targets).<sup>109</sup> This offensive strike conversion will incorporate integration of Raytheon's multi-mission SM-6 anti-air and anti-surface missile, as well as the Maritime Strike variant of the Tomahawk missile.<sup>110</sup> The Government Accountability Office (GAO) reports that "[a]ccording to Navy officials, the planned modifications to support the new mission will cost about \$1 billion...."<sup>111</sup>

With DDG-1000 still undergoing testing and certification, and given the need to determine the final concept of operations and capabilities required for the offensive strike mission, it will be several years before DDG-1000 is truly mission capable. With a class of only three ships, it will be difficult to maintain even one destroyer forward deployed at all times.

As part of his May 2019 announcement of the establishment of Surface Development Squadron One (SURFDEVRON 1), Vice Admiral Brown discussed a primary near-term role for the *Zumwalt* class. Initially, SURFDEVRON will focus on experimenting with the *Zumwalt*'s unique capabilities and new warfighting concepts. After the Navy's new medium unmanned surface vessels (MUSVs) and large unmanned surface vessels (LUSVs) are delivered, the focus of experimentation will shift to integrating these unmanned vessels into the fleet.<sup>112</sup>

In March 2019, Marine Corps Commandant General David Berger, then serving as Deputy Commandant, Combat Development and Integration, and Commanding General, Marine Corps Development Command, reiterated the requirement for 38 amphibious warships: 12 amphibious assault ships (LHA/LHD); 13 amphibious transport dock (LPD-17) Flight I ships; and 13 dock landing (LSD/LPD-17) Flight II ships.<sup>113</sup> As of August 20, 2019, the U.S. Navy amphibious force consisted of 32 ships: nine LHA/LHD, 11 LPD-17 Flight I, and 12 LSD ships.<sup>114</sup> Navy leaders have also stated that "the future amphibious force and composition will be evaluated as part of the larger ongoing force

structure assessment."<sup>115</sup> New Marine Corps operational concepts, such as Littoral Operations in a Contested Environment and Expeditionary Advanced Base Operations (EABO), call for smaller and more dispersed Marine units conducting missions ranging from ISR to coastal defense to forward arming and refueling points (FARPs) for F-35B operations.<sup>116</sup> These dispersed expeditionary operations could require larger numbers of smaller amphibious ships than the current LHA and LPD programs, possibly ranging in size from an expeditionary fast transport ship (T-EPF) to an expeditionary sea base (ESB).<sup>117</sup>

The Navy's 12 landing ships, the *Whidbey Island*-class and *Harpers Ferry*-class amphibious vessels, are currently scheduled to reach the end of their 40-year service lives in 2025. The 13-ship LPD-17 Flight II program, previously known as the LX(R) program, will replace these legacy landing ships. The Flight II was designed to be a less costly and subsequently less capable alternative to the LPD-17 Flight I *San Antonio*-class design.<sup>118</sup> Although the first Flight II ship was planned for FY 2020, Congress directed the Navy to accelerate it to FY 2018.<sup>119</sup> Both Flight I and Flight II LPDs are multi-mission ships designed to embark, transport, and land elements of a Marine landing force by means of helicopters, tilt-rotor aircraft, landing craft, and amphibious vehicles.<sup>120</sup>

As of August 20, 2019, the Navy had nine amphibious assault ships in the fleet: eight *Wasp*-class LHDs and the *USS America* LHA-6.<sup>121</sup> The *America*-class amphibious assault ships (LHAs) are the largest amphibious ships and designed to replace the now-retired *Tarawa*-class LHA and the aging *Wasp*-class LHD; they resemble a small aircraft carrier and can conduct "Vertical/Short Take-Off and Landing (V/STOL), Short Take-Off Vertical Landing (STOVL), Vertical Take-Off and Landing (VTOL) tilt-rotor and Rotary Wing (RW) aircraft operations."<sup>122</sup> LHA Flight 0 (LHA-6 and 7) were built without a well deck to provide more space for Marine Corps aviation maintenance and storage as well as increased JP-5 fuel capacity. LHA Flight 1 (LHA-8 and beyond) will reincorporate a well



deck for increased mission flexibility. All LHA ships can accommodate the Marine Corps F-35 B V/STOL strike fighter, but only USS *Wasp* (LHD-1) and USS *Essex* (LHD-2) have been modified to support F-35B flight operations.<sup>123</sup> USS *America* is deploying to Japan in late FY 2019 to replace USS *Wasp* as the Forward Deployed Naval Force amphibious ship, and USS *Tripoli* (LHA-7) is scheduled to be commissioned and to join the fleet in late FY 2019.<sup>124</sup>

The Navy's 11-ship aircraft carrier force consists of 10 *Nimitz*-class nuclear-powered carriers and one *Ford*-class nuclear-powered carrier. The *Nimitz*-class carriers vary in age from 44 to 10 years and have an average age of 28.4 years. U.S. aircraft carriers have a service life of 50 years, with their most significant modernization occurring during their approximately 44-month midlife RCOH. This major depot maintenance not only refuels the reactor core to operate the remainder of the ship's 50-year service life, but also overhauls, repairs, and modernizes major ship and combat systems. This means that a 30-year-old carrier possesses more modern capabilities than a 20-year old carrier.

The USS *Ford*-class program is further modernizing the carrier force and will replace all of the *Nimitz*-class carriers over the next 40 years. The *Ford*-class incorporates several new technologies that promise to increase aircraft sortie rates, decrease the number of sailors needed to operate the ship, and reduce operating and sustainment costs by approximately \$4 billion over its 50-year life.<sup>125</sup>

Unfortunately, "the development of EMALS [Electromagnetic Aircraft Launch System], AAG [Advanced Arresting gear], AWE [Advanced Weapons Elevator], DBR [Dual Band Radar], and the Integrated Warfare System delayed the ship's first deployment to FY22."<sup>126</sup> Because of continued reliability issues related to system software, the Navy had accepted only two AWEs as of March 2019.<sup>127</sup> AWE testing delays and repairs to *Ford*'s main turbine generators caused completion of post-shakedown availability (PSA) to be delayed until October 2019.<sup>128</sup>

On May 29, 2019, Assistant Secretary of the Navy for Research, Development and Acquisition James Geurts announced that while USS *Ford* will complete its PSA in October 2019, only some of its AWEs will be operational when she goes back to sea.<sup>129</sup> In response to the Navy's statement, Senate Armed Services Committee Chairman Senator James Inhofe told *Breaking Defense* that:

[F]urther delays on the USS Gerald R. Ford advanced weapons elevators are disappointing—and present a dangerous readiness gap. This is a letdown for our fleet and for the taxpayer, and is why the FY20 NDAA includes stronger oversight for the key systems on the Ford, including the elevators and launch system. We need to get it fully operational as soon as possible.<sup>130</sup>

The Navy has not announced any delay in USS *Ford*'s first operational deployment, scheduled for FY 2022.

The sole mission of the Navy's nuclear ballistic missile submarine (SSBN) is strategic nuclear deterrence, for which it carries long-range submarine-launched ballistic missiles. They provide the most survivable leg of America's strategic nuclear deterrent force with 70 percent of the nation's accountable nuclear warheads and its only assured second-strike or retaliatory nuclear strike capability.<sup>131</sup> The Navy's force structure assessment and the DOD's 2018 *Nuclear Posture Review* established a requirement for a minimum of 12 *Columbia*-class nuclear ballistic missile submarines to replace the legacy *Ohio*-class SSBN.<sup>132</sup> The average acquisition cost of these submarines is \$7.1 billion, and their production will consume a significant portion of the Navy's shipbuilding funding if the overall budget is not increased.<sup>133</sup>

The Navy's FY 2013 budget deferred procurement of the lead boat from FY 2019 to FY 2021, with the result that the Navy's SSBN force will drop to "11 or 10 boats for the period FY2030–FY2041."<sup>134</sup> The Navy may have increased difficulty maintaining U.S. Strategic



Command's requirement for a minimum of 10 operational SSBNs as it strives to maintain the legacy *Ohio*-class SSBN fleet to the end of their 42-year service life. With little schedule margin until its first strategic deterrent patrol in FY 2031, it is easy to see why the *Columbia*-class SSBN remains "the Navy's number one acquisition priority."<sup>135</sup>

The *Columbia*-class design incorporates several new technologies to increase its stealth and operational availability. The submarine and its life-of-ship reactor core have been designed for a 42-year service life as opposed to the service life of the *Ohio*-class, which was extended from 30 years to 42 years.<sup>136</sup> The Navy needs 12 *Columbia*-class SSBNs "to meet the requirement for 10 operational boats because the midlife overhauls of *Columbia*-class boats, which will not include a nuclear refueling, will require less time (about two years) than the midlife refueling overhauls of *Ohio*-class boats...."<sup>137</sup> Additionally, the submarine's electric drive propulsion motor and other stealth technologies will ensure that the nation's SSBN force remains undetectable and survivable against evolving threats into the 2080s.

Significant defects in key equipment have eroded some of the *Columbia* program's schedule margin. In 2017, "[a] manufacturing defect that affected the system's first production-representative propulsion motor required extensive repair that consumed 9 months of schedule margin at the land-based test facility."<sup>138</sup> This was followed by the discovery in July 2018 that 12 common missile compartment missile tubes produced by a single vendor had significant welding defects because of inexperienced welders and inspectors.<sup>139</sup> "While the Navy and shipbuilder are still determining the cost and schedule impacts of the weld defects," according to the GAO, "program officials estimated that addressing this issue will consume up to 15 [months] of the 23-month schedule margin for these components."<sup>140</sup>

If additional technical or production issues arise during the construction, *Columbia*'s remaining schedule margin could quickly evaporate. On March 6, 2019, recognizing the critical

importance of the *Columbia* program and its FY 2028 delivery deadline, the U.S. Navy announced "the establishment of Program Executive Office Columbia (PEO CLB)," which "will focus on the design, build, and sustainment of the *Columbia* program and associated efforts that include interface with Strategic Systems Program and the United Kingdom for the Dreadnought Program."<sup>141</sup> Assistant Secretary Geurts stated that:

The evolution from initial funding to construction, development and testing to serial production of 12 SSBNs will be crucial to meeting the National Defense Strategy and building the Navy the nation needs. PEO Columbia will work directly with resource sponsors, stakeholders, foreign partners, shipbuilders and suppliers to meet national priorities and deliver and sustain lethal capacity our warfighters need.<sup>142</sup>

SSNs are multi-mission platforms whose primary peacetime and combat missions include covert intelligence collection, surveillance, ASW, anti-surface warfare (ASuW), special operations forces insertion/extraction, land attack strikes, and offensive mine warfare.<sup>143</sup> The *Virginia*-class SSN will replace the aging *Los Angeles*-class SSNs as the workhorse of the Navy's attack submariner force. The Navy's FY 2020 budget requests three *Virginia*-class SSNs, the first time in over 20 years the Navy has procured three SSNs in one fiscal year.<sup>144</sup> Since the advance procurement for the third *Virginia*-class SSN was not included in the Navy's FY 2019 budget, construction of this third submarine most likely will not commence until FY 2023.<sup>145</sup> Critical parts and equipment for this additional submarine above the planned 10-submarine block buy have not been purchased yet, and the shipyards (Electric Boat and Huntington Ingalls Industries/Newport News Shipbuilding) have not planned for this submarine in their *Virginia*-class construction plan.

The Virginia Payload Module (VPM) is an 84-foot-long, midbody section equipped with

four large-diameter, vertical launch tubes that can carry up to 28 additional Tomahawk missiles or other payloads. VPM is being added to Block V *Virginia*-class submarines to help offset the retirement of the four *Ohio*-class guided missile submarines, each of which can carry 54 Tomahawk cruise missiles, by FY 2028. The Block V submarines also include several acoustic and other technological improvements to maintain the *Virginia* class's undersea superiority over Russian and Chinese submarines.<sup>146</sup>

The Navy's FY 2019 shipbuilding plan called for nine of the 10 Block V *Virginia*-class submarines to include VPM. The Navy's FY 2020 budget and shipbuilding plan now call for eight of the now 11 Block V submarines to include VPM.<sup>147</sup> While the Navy's FY 2020 Block V *Virginia*-class submarine construction plan delivers one additional submarine, these 11 submarines will be able to carry 28 fewer Tomahawks than could be carried by the original 10 submarines.

The FY 2020 budget request includes \$806 million to accelerate the Navy's unmanned surface vessel (USV) and unmanned undersea vehicle (UUV) programs. The Navy had planned to pay for the bulk of these unmanned systems in FY 2020 and across the FYDP by canceling the USS *Truman*'s RCOH. With the reversal of this decision, if Congress does not provide additional funding in FY 2020 and beyond, these unmanned programs will be in jeopardy. The Navy is applying a family-of-systems approach to USVs and UUVs that incorporates unmanned platforms of various sizes to perform different missions.<sup>148</sup>

The Large USV (LUSV) program will purchase two prototype vessels based on the OSD Strategic Capabilities Office *Overlord* program in FY 2020 to provide distributed lethality and increased capacity.<sup>149</sup> The Navy also issued an RFP for a Medium USV (MUSV) in May 2019 that will leverage the ONR *Sea Hunter* program to provide distributed sensing and communications relays for surface forces. The Navy currently has one *Sea Hunter* prototype, and a second is scheduled for delivery by late FY

2020. The MCM USV is part of the LCS MCM MP and will enter low initial rate production (LRIP) in FY 2019.<sup>150</sup>

The Navy is purchasing 37 UUVs in FY 2020, including two *Orca* Extra Large UUVs (XLUUV); 27 Mk-18 *Knifefish* MCM UUVs; and eight *Razorback* medium UUVs. The Navy awarded Boeing a \$43 million contract in February 2019 to build four XLUUVs based on its *Echo Voyager* XLUUV. *Orca* will be pier-launched and long-range (up to 6,500 nm) and will provide a large undersea payload capacity to support a variety of missions.<sup>151</sup> *Knifefish* entered LRIP in FY 2019 and is part of the LCS MCM MP providing buried undersea mine detection.<sup>152</sup> *Razorback* provides a submarine-launched and recovered UUV for battlespace sensing. The dry dock shelter-launched version commenced delivery in FY 2019, and the torpedo tube-launched version is scheduled to begin delivery in FY 2020.<sup>153</sup> The Navy is also developing the *Snakehead* Large Diameter UUV (LDUUV) to provide a submarine or surface ship-launched UUV with increased payload and range. The program will deliver "an operationally relevant prototype in 2021" and issue an RFP for a more capable *Snakehead* UUV in FY 2020.<sup>154</sup>

These USV and UUV programs have the potential to provide greater dispersed maritime sensing and lethality, extending the fleet's reach and ISR capabilities. The Navy still has significant testing and CONOPS development to conduct before they become an integral part of the fleet. Getting these prototype platforms in the hands of Navy sailors will accelerate the learning and technological development of unmanned systems.

The Navy's long-range strike capability derives from its ability to launch various missiles and combat aircraft. As a class, naval aircraft are much more expensive and difficult to modernize than missiles are. Until the 1980s, the Navy operated several models of strike aircraft that included the F-14 Tomcat, A-6 Intruder, A-4 Skyhawk, and F/A-18 Hornet. The last of the A-6, A-4, and F-14 aircraft were retired, respectively, in 1997, 2003, and 2006.

Over the past 20 years, this variety has been winnowed to a single model: the F/A-18. The F/A-18A-D Legacy Hornet has served since 1983; it is out of production and currently flown by 13 Marine Corps squadrons, the Naval Aviation Warfighting Development Center, and the Blue Angels. The last Navy legacy Hornet squadron completed its final operational deployment in April 2018.<sup>155</sup> The last operational legacy Hornet squadron transitioned to more capable and modern F/A-18E/F Super Hornets in February 2019.<sup>156</sup>

The F/A-18E/F Super Hornet has longer range, greater weapons payload, and more survivability than the F/A-18A-D Legacy Hornet and “will be the numerically predominant aircraft in CVWs into the 2030s.”<sup>157</sup> The Navy’s FY 2020 budget request includes 24 F/A-18E/F Super Hornets and an additional 84 Block III Super Hornets over the next five years in an attempt to mitigate shortfalls in its strike aircraft inventory.<sup>158</sup> In April 2019, Rear Admiral Scott Conn, Director of Air Warfare (OPNAV N98), testified that the Navy’s strike fighter shortfall will reach its lowest point, 51 aircraft, in FY 2020 before decreasing to “single digits by FY ’24.”<sup>159</sup>

The EA-18G Growler is the U.S. Navy’s primary electronic attack aircraft and provides tactical jamming and suppression of enemy air defenses. The final EA-18G aircraft was delivered in FY 2018, bringing the total to 160 aircraft and fulfilling “current Navy requirements for Airborne Electronic Attack (AEA) for nine CVWs and five expeditionary squadrons plus one reserve squadron.” The FY 2020 budget continues to fund additional modernization to ensure that the “EA-18G maintains its edge in the electromagnetic spectrum by providing robust sensing and engagement capabilities.”<sup>160</sup>

The Navy has been addressing numerous incidents, or physiological episodes (PEs), of dizziness and blackouts by F/A-18 and T-45 aircrews over the past several years. Navy investigators have identified “multiple interrelated causal factors” and have instituted mitigation efforts that include “software modifications, personnel education, and equipment changes.”

The T-45 training aircraft have undergone a significant reduction in PE rate with only 14 events in over 100,000 hours flown since the aircraft returned to operation. Two events are still under investigation, and seven have been attributed to human factors. In addition to correcting the identified engine flow problem, the Navy is “integrating an Automatic Backup Oxygen System (ABOS) to improve oxygen generating system performance overall.”<sup>161</sup>

Implemented mitigation efforts are also improving F/A-18 PE rates. F/A-18 A-D PE rates have fallen by almost 50 percent, a reduction that is attributed primarily to implementation of AFB (Air Frame Bulletin) 821, which “places life limits on seven ECS high-time components with the purpose of inspecting and replacing components as necessary to improve and baseline system operation.” The F/A-18 Root Cause Corrective Action Team identified “premature component failure as a contributory factor in almost 300 PEs.” All of the identified parts are undergoing redesign, but only two redesigns will be implemented in FY 2019. A final major PE mitigation effort is the Navy’s ongoing development of a new “On Board Oxygen Generating System concentrator designed to replace the existing concentrator currently in the F/A-18 and EA-18 aircraft.”<sup>162</sup>

Even with the Navy’s focus on identifying and correcting the causes of these events, PEs continue to be a significant concern for the naval aviation community and have further reduced the operational availability of the Navy’s strike fighter and electronic attack aircraft.

The F-35C is the Navy’s largest aviation modernization program. This fifth-generation fighter (all F/A-18 variants are considered fourth-generation) has greater stealth capabilities and state-of-the-art electronic systems, allowing it to sense its tactical environment and communicate with multiple other platforms more effectively. The Department of the Navy plans to purchase 273 Navy F-35Cs and 67 Marine Corps F-35Cs.<sup>163</sup> The F-35 can accomplish a wide spectrum of missions including strike, close air support, counter air, escort, and suppression of enemy air defenses.<sup>164</sup> The

Navy's objective is to "attain a '2+2' mix of two F-35C squadrons and two F/A-18E/F Block III squadrons per CVW by the mid-2030s."<sup>165</sup>

The Navy declared initial operational capability (IOC) of the F-35C in February 2019, explaining that:

In order to declare IOC, the first operational squadron must be properly manned, trained and equipped to conduct assigned missions in support of fleet operations. This includes having 10 Block 3F, F-35C aircraft, requisite spare parts, support equipment, tools, technical publications, training programs and a functional Autonomic Logistic Information System (ALIS). Additionally, the ship that supports the first squadron must possess the proper infrastructure, qualifications and certifications.<sup>166</sup>

The F-35C IOC was postponed because of F-35 program development delays and the Navy's unique requirement for Block 3F-equipped F-35C aircraft.<sup>167</sup> The Marine Corps' F-35C reached IOC in 2015, and the Air Force declared the F-35A IOC in 2016.<sup>168</sup> The first operational F-35C deployment is scheduled for FY 2021 as part of Carrier Air Wing 2 onboard USS *Carl Vinson*.<sup>169</sup>

The E-2D Advanced Hawkeye is the Navy's carrier-based Airborne Early Warning and Battle Management Command and Control aircraft. The E-2D forms the hub of the Naval Integrated Control-Counter Air system and provides critical Theater Air Missile and Missile Defense capabilities.<sup>170</sup> The Navy's FY 2020 budget procures four aircraft with an additional 14 aircraft to be procured over the next three years.<sup>171</sup>

The MQ-4C *Triton* is a land-based, high-altitude, long-endurance UAV that fills a "vital role for the Joint Forces Maritime Component Commander by delivering persistent and netted maritime ISR and furthers our plan to retire legacy EP-3E aircraft...."<sup>172</sup> The Navy's FY 2020 budget requests two aircraft on the path to achieving IOC in FY 2021 and eventually

delivering five *Triton* orbits.<sup>173</sup> The Navy requirement is 68 *Triton* aircraft.<sup>174</sup> The planned initial deployment of two *Triton* UAVs to Guam in FY 2018 was delayed following the September 2018 MQ-4C crash-landing as a result of technical issues with the aircraft.<sup>175</sup>

The MQ-25 *Stingray* is a carrier-launched UAV with a primary mission as a carrier-based tanker to extend the range of CVW with a secondary mission to provide ISR for CSGs.<sup>176</sup> The FY 2020 budget requests \$671.3 million to procure three system demonstration test article aircraft and initiate assembly of four engineering development model (EDM) aircraft.<sup>177</sup>

The National Defense Strategy's focus on the return to great-power competition and building a more lethal force is manifested in the Navy's FY 2020 budget prioritization of "developing and fielding new capabilities in the areas of unmanned vehicles, directed energy [weapons], artificial intelligence, hypersonics, and other advanced weapons technology."<sup>178</sup>

The Navy's FY 2020 budget requests 90 Block V Tactical Tomahawk (TACTOM) cruise missiles; 156 Navigation/Communication upgrade kits to improve performance in A2/AD environments; and 20 Maritime Strike Tomahawk (MST) kits. It also purchases 48 Long Range Anti-Ship Missiles (LRASMs) that will provide the "ability to conduct anti-surface warfare (ASuW) operations against near/mid-term high-value surface combatants protected by Integrated Air Defense Systems with long-range Surface-to-Air-Missiles and deny adversaries sanctuary of maneuver."<sup>179</sup> The Navy's FY 2020 Unfunded Priorities List reflects that the LRASM inventory "is below the Total Munitions Requirement" and requests an additional seven LRASM missiles to "achieve industry's maximum production capacity in FY20."<sup>180</sup> The LRASM "is on-track to achieve EOC on the Navy's F/A-18E/F aircraft prior to the schedule objective of the fourth quarter of FY 2019."<sup>181</sup>

The Navy has been developing prototype high energy laser (HEL) weapons systems for several years and deployed the first operational HEL system, the Laser Weapons System



(LaWS), onboard the Afloat Forward Staging Base ship USS *Ponce* in the Persian Gulf from December 2014 to September 2017.<sup>182</sup> The Navy's FY 2020 budget request includes \$101 million for the Navy Laser Family of Systems (NLFoS) "to provide near-term, ship-based laser weapon capabilities."<sup>183</sup> The two primary programs in the NLFoS are:

- Solid State Laser Technology Maturation (SSL-TM), an Office of Naval Research program to "develop an advanced 150kW High Energy Laser (HEL) weapon demonstrator that will support future laser development with installation on an LPD17 class ship for at sea testing in FY 2020."<sup>184</sup>
- Surface Navy Laser Weapon System (SNLWS), Increment 1, also known as the high-energy laser with integrated optical dazzler and surveillance (HELIOS), a rapid development effort to field an advanced integrated 60kW or greater laser weapon system with the ability to dazzle and destroy ISR UAVs, defeat fast inshore attack craft (FIAC) and provide combat identification and battle damage assessment.<sup>185</sup>

In March 2019, Rear Admiral Ron Boxall, Director of Navy Surface Warfare (OPNAV N96), announced that the Navy plans to install a HELIOS weapons system "aboard a West Coast Arleigh Burke-class Flight IIA destroyer" in 2021.<sup>186</sup> The HELIOS system would be a permanent integrated system.<sup>187</sup>

## Readiness

Admiral William Moran, Vice Chief of Naval Operations, testified before the Senate Armed Services Readiness Subcommittee in February 2018 that:

The readiness of Naval Forces is a function of three components; people, material and time. Buying all the people, ships and aircraft will not produce a ready Navy without the time to maintain hardware and time for our people to train and

operate. Too much time operating and not maintaining degrades our material and equipment readiness. Conversely, too much time for maintenance has a negative impact on meeting planned training and operational schedules, and the corresponding negative impact on the readiness of our Sailors to fight. This is a vicious cycle that Continuing Resolutions and insufficient funding create by disrupting the balance we need to maintain readiness, and our ability to grow capability and capacity.<sup>188</sup>

From FY 2009 to FY 2017, the Department of Defense endured eight straight years of Continuing Resolutions (CRs) that averaged 106 days per fiscal year; this was compounded by the 174-day CR in FY 2018. These CRs forced the Navy to operate under reduced spending levels and severely limited its ability to complete required ship and aircraft maintenance and training.<sup>189</sup> FY 2019 marked the first time in over a decade that the DOD and the Navy did not operate under a CR for at least part of the fiscal year. Having a full fiscal year to plan and execute maintenance and operations helped the Navy to continue its path to restoring fleet readiness. Admiral Richardson testified before the Senate Armed Services Committee in April 2018 that it would take until 2021 or 2022 to restore fleet readiness to an "acceptable" level but that the continued lack of "stable and adequate funding" would delay these efforts.<sup>190</sup>

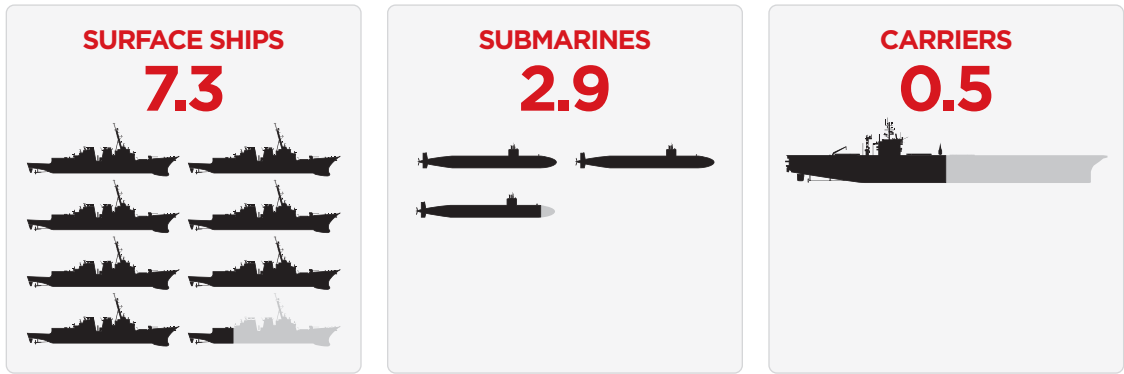
Assessing the readiness of individual naval ships and their sailors can be extremely difficult. First, official readiness data on each Navy ship, submarine, or aircraft squadron are maintained and promulgated via the classified Defense Readiness Reporting Network–Navy. The readiness level of each ship and its crew will also vary significantly over the 36-month OFRP cycle as the ship conducts various maintenance, training, and certifications in preparation for its operational deployment.

Because the demands of material readiness and operational readiness are sometimes in opposition to each other, these two critical

FIGURE 7

## Ship Maintenance Delays Limit U.S. Navy

Maintenance delays have led to thousands of days in which ships were unavailable for training and operations, effectively diminishing the size of the Navy. Figures shown below are the average number of ships lost per year for 2012–2018 due to maintenance delays.



**SOURCE:** Heritage Foundation calculations based on data from U.S. Government Accountability Office, "Navy and Marine Corps: Rebuilding Ship, Submarine, and Aviation Readiness Will Require Time and Sustained Management Attention," December 12, 2018, <https://www.gao.gov/assets/700/695911.pdf> (accessed June 18, 2019). Figures shown are for fiscal years.

 heritage.org

readiness components may not always be in sync. For example, although the operational readiness of a ship's crew just completing a seven-month overseas deployment will be very high, its material readiness could be lower because periodic maintenance and repairs could not be completed during deployment. While determining the readiness of individual ships can be problematic, overall fleet readiness can be assessed based on operational demand and reports on fleet training, maintenance, and fleet manning.

Like the other services, the Navy had to dedicate readiness funding to the immediate needs of various engagements around the globe for several years. As a result, maintenance and training for non-deployed ships and sailors were not prioritized. Deferral of ship and aircraft depot maintenance because funding is inadequate or public shipyards lack sufficient

capacity has had a ripple effect on the whole fleet. When ships and aircraft are finally able to begin depot maintenance, their material condition is worse than normal because of the delay and high operational tempo (OPTEMPO) of the past 15 years. This in turn causes maintenance to take longer than scheduled, which leads to further delays in fleet depot maintenance and increases the demands placed on ships and aircraft that are still operational. Correcting these maintenance backlogs will require a level of stable funding that is sufficient to defray the costs of ship maintenance and modernize the public shipyards.

These maintenance and readiness issues also affect the Navy's capacity by significantly reducing the numbers of operational ships and aircraft available to support the combatant commanders. For example, between 2012 and 2018, ship maintenance delays resulted in the



loss of 1,207 aircraft carrier, 18,581 surface ship, and 7,321 submarine operational days.<sup>191</sup> This is the equivalent of losing 0.5 aircraft carriers, 7.3 surface ships, and 2.9 submarines from fleet operations each year. In FY 2018, even with additional readiness funding, maintenance delay days increased for aircraft carriers, surface ships, and submarines.<sup>192</sup> The almost six-month FY 2018 CR also helped to delay the start of new depot maintenance last year. The domino effect of cascading deferred maintenance has led to a \$763 million shortfall in surface ship and submarine depot maintenance funding in FY 2020.<sup>193</sup>

The USS *Boise* has become the poster child for excessive submarine maintenance backlogs. Her certification for submerged operations expired in 2016 when Norfolk Naval Shipyard was unable to commence *Boise's* scheduled depot maintenance for over three years.<sup>194</sup> No longer able to operate at sea, as of May 25, 2019, USS *Boise* has sat pierside for over 1,088 days (almost three years) awaiting commencement of her depot maintenance.

After awarding a contract to Huntington Ingalls/Newport News Shipbuilding (HII/NNS), USS *Boise* was scheduled to begin maintenance in January 2019.<sup>195</sup> Because of continued delays with overhauls of USS *Helena* and USS *Columbus*, however, USS *Boise* remains without an official start date for her maintenance.<sup>196</sup> During a May 9, 2019, readiness hearing, Admiral Moran informed Congress that the Navy had deferred *Boise's* depot maintenance until FY 2020 because of funding and shipyard capacity issues.<sup>197</sup>

Funding ship maintenance at the maximum executable capacity of both public and private shipyards in FY 2020 can address only 95 percent of the required maintenance, a decrease from a 96 percent execution in FY 2019.<sup>198</sup> Funding FY 2020 aviation maintenance at the maximum executable level of the depots can meet only 95 percent of the requirement, an increase from FY 2019's 92 percent execution rate.<sup>199</sup>

Since the Navy cannot meet its current maintenance demands, the maintenance

backlog will continue to grow until the capacities of the ship and aviation maintenance enterprise exceed the annual maintenance requirements. As the fleet grows to 355 ships over the next 15 years, the mounting maintenance needs will stress not only shipyard repair capacity, but also future Navy budgets. For example, the Navy's fleet sustainment costs (manpower, operations, and maintenance) will rise from approximately \$24 billion in FY 2020 to \$30 billion in FY 2024.<sup>200</sup>

The FY 2019 NDAA funded increasing the public shipyard workforce by 1,414 workers, and the Navy's FY 2020 budget requests an additional 1,223 workers.<sup>201</sup> Even with the hiring of additional shipyard workers over the past three years, the public (government-owned) shipyards can still not keep up with ship and submarine maintenance demands. Newly hired shipyard workers do not immediately translate into increased productivity. Since it can take up to five years to become fully trained and proficient, depending on the specific skill set of the new workers, the true impact of the larger shipyard workforce will not be felt for several years.

Recognizing the importance of the Navy's four public shipyards to fleet readiness and national defense, Naval Sea Systems Command (NAVSEA) completed its Shipyard Optimization and Recapitalization Plan in September 2018. This plan lays out the framework and investment plan to modernize the public shipyards through three primary focus areas: dry dock recapitalization (\$4 billion); facility layout and optimization (\$14 billion); and capital equipment modernization (\$3 billion).<sup>202</sup> The Navy commenced this \$21 billion, 20-year public shipyard optimization plan in FY 2019.

In response to NDS guidance and "requirements for sustaining the Navy the nation needs," the Navy developed its inaugural Naval Sea System Command Long-Range Plan for the Maintenance and Modernization of Naval Vessels for Fiscal Year 2020. The plan complements the Navy's annual 30-year shipbuilding plan and "describes the Navy's continued challenges with high-tempo operations that

[have] resulted in a maintenance backlog and reduced readiness rates for Navy ships.” It also captures key efforts across private and public shipyards, as well as the industrial base, to improve maintenance capacity and capabilities. Finally, it commits the Navy to the development of “long-range maintenance and modernization requirements based on technical analysis and condition assessment of the fleet driven by the number of ships in the FY 2020 Shipbuilding Plan.”<sup>203</sup>

This long-term maintenance and modernization plan will be critical to leveraging both public and private shipyard capacity most efficiently to reduce maintenance backlogs while supporting a growing fleet size. Providing private shipyards with several years to plan depot-level maintenance will enable more thorough maintenance planning and dry dock utilization, ultimately resulting in shorter and more cost-effective maintenance availabilities.

Ship and aircraft operations and training are just as critical to fleet readiness as maintenance is. The Navy’s FY 2020 budget supports the OFRP and forward deployed presence requirements by funding ship operations for deployed and non-deployed forces at a rate of 58 days and 24 days underway per quarter, respectively.<sup>204</sup> In addition, flight hours are funded to achieve a T-rating of 2.0 for nine Navy carrier air wings supporting the “requirements of deployed units, units training in preparation to deploy, and the maximum executable requirements of non-deployed units for sustainment and maintenance readiness levels.”<sup>205</sup> T-rating is measured on a scale of 1.0–4.0 and “describes a unit’s capability to execute its mission essential tasks (METs).” A T-rating of 2.0 means that a squadron or air wing is “able to complete 80 percent of its METs.”<sup>206</sup>

The Navy’s aviation readiness is also suffering because of deferred maintenance, delayed modernization, and high OPTEMPO. An April 2018 *Military Times* report revealed that over the past five years, naval aviation mishaps had increased 82 percent across the entire fleet but 108 percent for F/A-18E/F Super Hornets. Although analysis showed numerous causes

behind individual accidents, this abrupt rise began after 2013, the first year that Budget Control Act (BCA) sequestration limits took effect. The Navy made cuts in aviation maintenance and spare parts to meet budget caps while operational demand was simultaneously increasing. For example, F/A-18E/F Super Hornets “conducted 18,000 more flight hours in 2017 than in 2013.”<sup>207</sup>

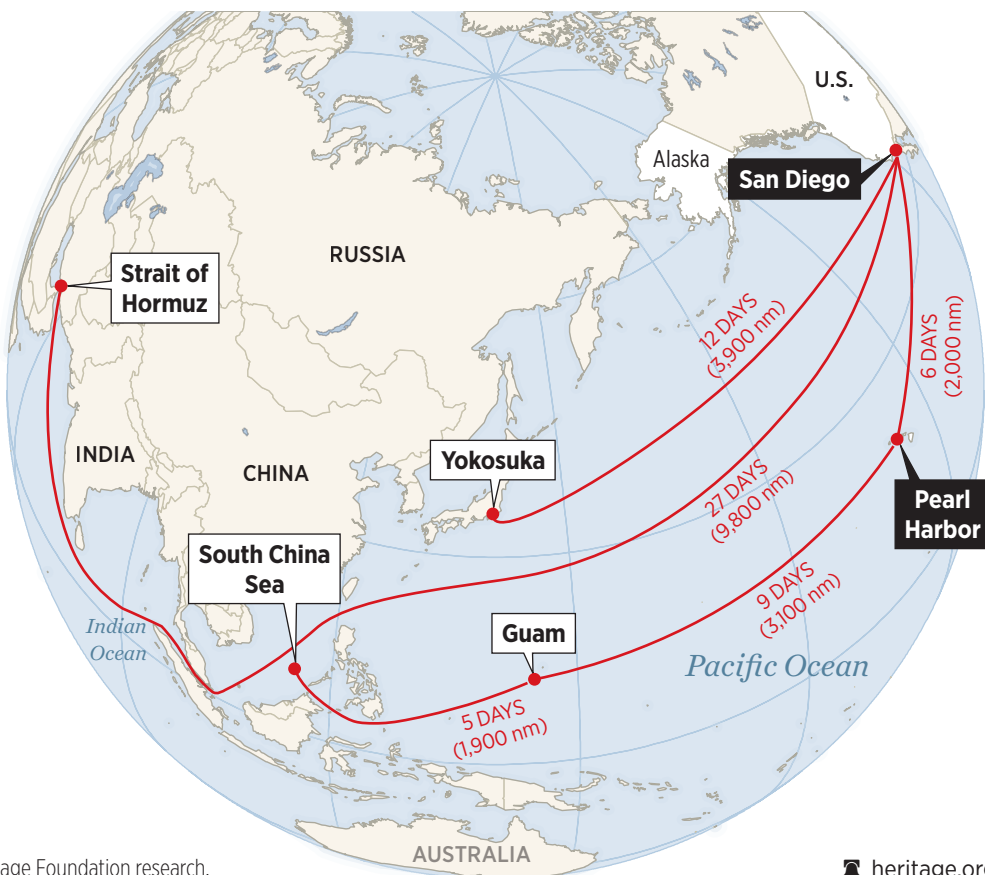
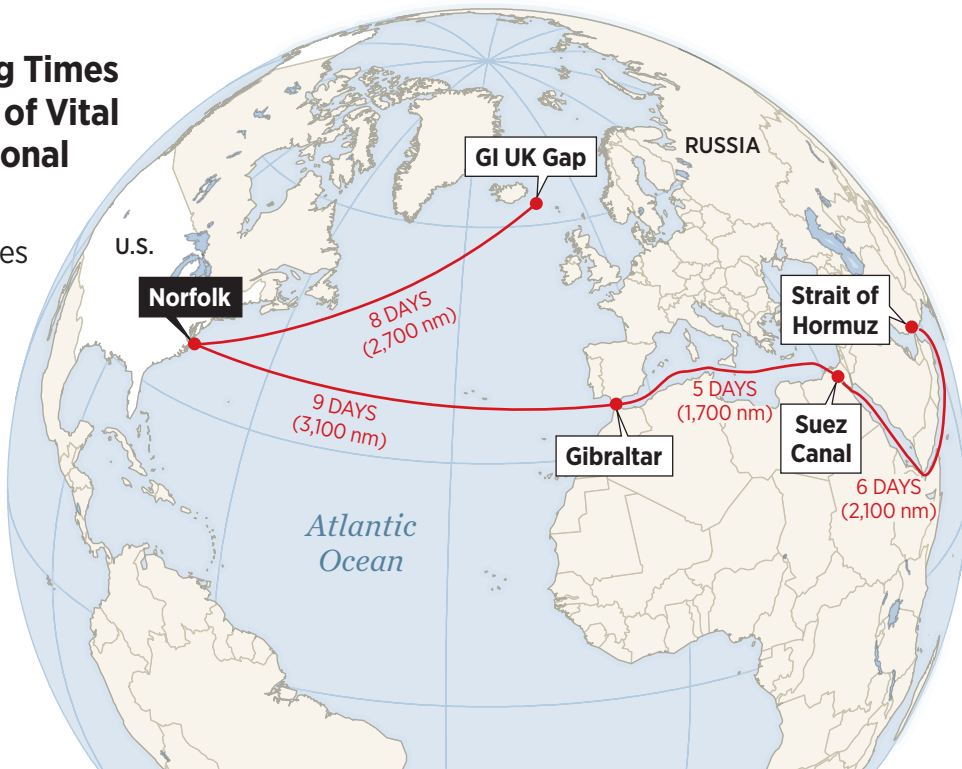
The naval aviation community made extreme efforts to gain every bit of readiness possible with the existing fleet, but even these efforts cannot solve the problems of too little money, too few usable assets, and too much work. Consistent with its policy of “supporting deployed and next to deploy forces,” the Navy was “forced to cannibalize aircraft, parts and people” to ensure that deploying squadrons had sufficient operational aircraft and personnel to operate safely and effectively. Moreover, “to properly man the required Carrier Air Wings either on deployment or on preparing to deploy at mandated levels of 95%, there are not enough Sailors left to fill the two remaining Air Wings in their maintenance phase.”<sup>208</sup>

On September 17, 2018, then-Secretary of Defense James Mattis issued a memorandum tasking the military service secretaries with “achieving a minimum of 80% mission capability rates for our FY 2019 Navy and Air Force F-35, F-22, F-16, and F-18 inventories—assets that form the backbone of our tactical air power—and reducing these platforms’ operating and maintenance costs every year, starting in FY 2019.”<sup>209</sup>

A Naval Air Forces spokesman informed USNI News that before the memo’s release, the “latest combined Super Hornet readiness number was 53.3 percent.”<sup>210</sup> In response to the Mattis memorandum, Navy leadership commenced working with the commercial airline industry to improve the efficiency of F/A-18 aviation maintenance and spare parts logistics.<sup>211</sup> These efforts have led to significant improvements both in the plane’s maintenance efficiency and in its Mission Capable rate. In April 2019, Rear Admiral Conn informed Congress that “we’ve reduced the planned

# Steaming Times to Areas of Vital U.S. National Interest

Steam times are based on an average speed of 15 knots.



SOURCE: Heritage Foundation research.

heritage.org

maintenance interval for Super Hornets from 120 to 60 days” and that the Super Hornet Mission Capable rate has been fluctuating between 63 and 76 percent.<sup>212</sup> Vice Admiral Mathias Winter, Joint Strike Fighter Program Director, testified that as of April 2019, the F-35C’s Mission Capable rate was 84 percent.<sup>213</sup>

During the summer of 2017, the U.S. Navy experienced the worst peacetime surface ship collisions in over 41 years when the USS *John S. McCain* (DDG 56) and USS *Fitzgerald* (DDG 62) collided with commercial vessels, claiming the lives of 17 sailors, during two unrelated routine “independent steaming” operations in the western Pacific Ocean. These tragic incidents, coupled with the USS *Antietam* (CG 54) grounding and the USS *Lake Champlain* (CG 57) collision earlier in 2017, raised significant concerns about the readiness and operational proficiency of the U.S. Navy’s surface fleet. Admiral Richardson responded by ordering a “service wide operational pause” to review practices throughout the fleet.<sup>214</sup> The Department of the Navy conducted two major reviews to examine root causes and recommended corrective actions both for the surface fleet and fleet-wide.

In October 2017, at the direction of the Vice Chief of Naval Operations, Admiral Phil Davidson, then Commander, Fleet Forces Command, completed a *Comprehensive Review of Recent Surface Force Incidents* to determine the improvements or changes needed to make the surface force safer and more effective. Admiral Davidson’s review addressed training and professional development; “operational and mission certification of deployed ships with particular emphasis on ships based in Japan”; “deployed operational employment and risk management”; “material readiness of electronic systems to include navigation equipment, surface search radars, propulsion and steering systems”; and “the practical utility and certification of current navigation and combat systems equipment including sensors, tracking systems, displays and internal communication systems.”<sup>215</sup> His report recommended 58 actions to correct

deficiencies across the “Doctrine, Organization, Training, Material, Leadership and Education, Personnel, and Facilities (DOTMLPF)” spectrum.<sup>216</sup>

The Secretary of the Navy directed a team of senior civilian executives and former senior military officers to conduct a *Strategic Readiness Review* examining issues of governance, accountability, operations, organizational structure, manning, and training over the past three-plus decades to identify trends and contributing factors that have compromised fleet performance and readiness. The report identifies four broad strategic recommendations that the Navy must address to arrest the erosion of readiness and reverse the “normalization-of-deviation” that led to a gradual degradation of standards:

- “The creation of combat ready forces must take equal footing with meeting the immediate demands of Combatant Commanders.”
- “The Navy must establish realistic limits regarding the number of ready ships and sailors and, short of combat, not acquiesce to emergent requirements with assets that are not fully ready.”
- “The Navy must realign and streamline its command and control structures to tightly align responsibility, authority, and accountability.”
- “Navy leadership at all levels must foster a culture of learning and create the structures and processes that fully embrace this commitment.”<sup>217</sup>

After more than a year of repairs, USS *Fitzgerald* finally left the dry dock at Ingalls Shipbuilding on April 16, 2019. *Fitzgerald* has been out of commission since its June 17, 2017, collision. Although the Navy has not released a projected date for the final completion of all repairs and her return to operations, a NAVSEA official did provide the following statement:



Since the ship's arrival in Pascagoula in January 2018, work has focused on restoring the integrity of the hull and topside structures that were damaged during a collision in 2017....

To restore the impacted spaces to full operations and functionality, various Hull, Mechanical and Electrical (HM&E), Combat System (CS) and Command, Control, Communications, Computers and Intelligence (C5I) repairs are being conducted. These repairs range from partial to complete refurbishment of impacted spaces to replacement of equipment such as the radar and electronic warfare suite. The ship is also receiving HM&E, Combat System and C5I modernization upgrades. Due to the extent and complexity of the restoration, both repair and new construction procedures are being used to accomplish the restoration and modernization efforts.<sup>218</sup>

USS *McCain* left the dry dock in Yokosuka in November 2018 after nine months and was still undergoing pierside repairs to return

her to operation as of May 2019. In addition to repairing damage from her collision, “[t]he ongoing availability also includes completing maintenance work that had previously been deferred....”<sup>219</sup> The Navy is taking advantage of these extended repair availabilities to conduct additional maintenance and modernization, but the fact that these two warships have been non-operational for almost two years still highlights how complex and time-consuming major repairs to modern warships can be. It is hoped that the Navy can learn from these repairs and develop plans for expedited repairs to battle force ships damaged in any future conflict.

Despite the fact that the Navy has implemented several maintenance and training reforms to improve fleet and aviation readiness, it will take several years of Navy leadership oversight and stable funding to ensure that the Navy's sailors and platforms are ready to compete and win against great-power competitors if called upon to do so. It is also worth noting again that the Navy's own readiness assessments are based on the ability to execute a strategy that assumes a force-sizing construct that is smaller than the one prescribed by this *Index*.

## Scoring the U.S. Navy

### Capacity Score: Weak

The Navy is unusual relative to the other services in that its capacity requirements must meet two separate objectives. First, during peacetime, the Navy must maintain a global forward presence both to deter potential aggressors from conflict and to assure our allies and maritime partners that the nation remains committed to defending its national security interests and alliances. This enduring peacetime requirement to maintain a sufficient quantity of ships constantly forward deployed around the world is the driving force behind ship force structure requirements: enough ships to ensure that the Navy can provide the necessary global presence.

On the other hand, the Navy also must be able to fight and win wars. In this case, the

expectation is to be able to fight and win two simultaneous or nearly simultaneous MRCs. When thinking about naval combat power in this way, the defining metric is not necessarily a total ship count, but rather the carrier strike groups, amphibious ships, and submarines deemed necessary to win both the naval component of a war and the larger war effort by means of strike missions inland or cutting off the enemy's maritime access to sources of supply. An accurate assessment of Navy capacity takes into account both sets of requirements and scores to the larger requirement.

It should be noted that the scoring in this *Index* includes the Navy's fleet of ballistic missile (SSBN) and fast attack submarines (SSN) to the extent that they contribute to the overall size of the battle fleet and with

TABLE 2

Navy Force Structure Assessment

Ship Type/Class	Current Fleet	2016 Force Structure Assessment	2020 Index Recommendation
Ballistic Missile Submarines	14	12	12
Aircraft Carriers	11	12	13
Large Surface Combatants	89	104	105
Small Surface Combatants	30	52	71
Attack Submarines	50	66	65
Guided Missile Submarines	4	0	0
Amphibious Warships	32	38	45
Combat Logistics Force	29	32	54
Command and Support	31	39	35
<b>Total</b>	<b>290</b>	<b>355</b>	<b>400</b>

SOURCE: U.S. Department of Defense, U.S. Navy, Naval Vessel Register, “Fleet Size,” <http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML> (accessed September 11, 2019).

 heritage.org

general comment on the status of their respective modernization programs. Because of their unique characteristics and the missions they perform, their detailed readiness rates and actual use in peacetime and planned use in war are classified. Nevertheless, the various references consulted are fairly consistent, both with respect to the numbers recommended for the overall fleet and with respect to the Navy’s shipbuilding plan.

An SSBN’s sole mission is strategic nuclear deterrence, for which it carries long-range submarine-launched ballistic missiles. They provide the most survivable leg of America’s strategic nuclear deterrent force. In contrast, as noted, SSNs are multi-mission platforms whose primary peacetime and combat missions include covert intelligence collection, surveillance, ASW, ASuW, special operations forces insertion/extraction, land attack strikes, and offensive mine warfare.<sup>220</sup>

**Two-MRC Requirement.** This *Index* uses the fleet size required for the Navy “to meet a

simultaneous or nearly simultaneous two-war or two–major regional contingency (MRC)” as the benchmark against which to measure service capacity. This benchmark consists of the force necessary to “fight and win two MRCs and a 20 percent margin that serves as a strategic reserve.” A strategic reserve is necessary because deployment of 100 percent of the fleet at any one time is extremely improbable and risky. Enduring requirements like training and maintenance make such deployment of the entire fleet infeasible, and committing 100 percent of the battle force would leave the nation without any resources available to handle emergent crises.

The primary elements of naval combat power during an MRC operation derive from carrier strike groups (which include squadrons of strike and electronic warfare aircraft as well as support ships) and amphibious assault capacity. Since the Navy maintains a constantly deployed global peacetime presence, many of its fleet requirements are beyond the scope of



the two-MRC construct, but it is nevertheless important to observe the historical context of naval deployments during a major theater war.

**Thirteen Carrier Strike Groups.** The goal for the Navy's aircraft carrier fleet is derived from analysis of the Joint Force wartime planning scenarios and meets the GFMAP goal for continuous 2.0 CSG forward presence and 3.0 CSG 30-day surge deployment capacity. The U.S. Navy has deployed an average of six aircraft carriers to support major U.S. military operations since the end of the Cold War; key examples include combat operations in Kuwait in 1991, Afghanistan in 2001, and Iraq in 2003.<sup>221</sup> As summarized by the Congressional Budget Office:

Maintaining a fleet of 11 carriers would usually allow 5 of them to be available within 30 days for a crisis or conflict (the rest would be undergoing scheduled maintenance or taking part in training exercises and would be unready for combat). Within 90 days, the Navy would generally have seven carriers available. A larger carrier force would be able to provide more ships for a conflict, and a smaller force fewer.<sup>222</sup>

This correlates with the recommendations of numerous force-sizing assessments, from the 1993 Bottom-Up Review (BUR)<sup>223</sup> to the Navy's 2016 Force Structure Assessment,<sup>224</sup> each of which recommended at least 11 aircraft carriers.

Assuming that 11 aircraft carriers are required to engage simultaneously in two MRCs, and assuming that the Navy ideally should have a 20 percent strategic reserve in order to avoid having to commit 100 percent of its CSGs and to account for scheduled maintenance, the Navy should maintain 13 CSGs. Several Navy-specific metrics regarding fleet readiness and deployment cycles support a minimum of at least a 20 percent capacity margin above fleet operational requirements.<sup>225</sup>

The November 2017 Chief of Naval Operations Instruction 3501.316C, "Force

Composition of Afloat Navy and Naval Groups," provides the most current guidance on CSG baseline capabilities and force mix:

- Five to seven air and missile defense-capable large surface combatant ships (guided missile cruiser (CG) or guided missile destroyer (DDG)) to conduct anti-ship missile and anti-air warfare defense;
- A naval integrated fire control, counter air-capable cruiser as the preferred ship for the air and missile defense commander;
- No fewer than three cruise missile land attack-capable (such as Tomahawk land attack missile or follow-on weapon) large surface combatant ships;
- No fewer than three surface warfare cruise missile-capable (such as Harpoon or follow-on weapon) large surface combatant ships;
- No fewer than four multi-functional tactical towed array systems; and
- One fast combat support (T-AOE) or equivalent pair of dry cargo and ammunition (T-AKE) and fleet replenishment oiler (T-AO) combat logistics force ships.<sup>226</sup>

Although not mentioned in this instruction, historically, at least one SSN was typically assigned to a CSG during the Cold War.<sup>227</sup>

Based on these requirements and the capabilities of current and planned ship classes, the nominal CSG force composition to possess the capacity needed to support a major regional conflict is:

- One nuclear-powered aircraft carrier;
- One carrier air wing (CVW);
- One guided missile cruiser;
- Four guided missile destroyers;

- Two guided missile frigates;
- Two nuclear-powered attack submarines;
- One fast combat support ship or pair of one dry cargo and ammunition and one fleet replenishment oiler; and
- Until the Navy's new FFG(X) becomes operational, a nominal CSG that consists of six instead of four DDGs.

**Thirteen Carrier Air Wings.** In the above-referenced examples,<sup>228</sup> each carrier deployed for combat operations was equipped with a carrier air wing, making five to six air wings necessary for each of the major contingencies listed. The strategic documents differ slightly in this regard because each document suggests that one less carrier air wing than the number of aircraft carriers is sufficient.

A carrier air wing customarily includes four strike fighter squadrons.<sup>229</sup> Twelve aircraft typically comprise one Navy strike fighter squadron, so at least 48 strike fighter aircraft are required for each carrier air wing. To support 13 carrier air wings, the Navy therefore needs a minimum of 624 strike fighter aircraft.<sup>230</sup>

**Fifteen Expeditionary Strike Groups.** The 1993 BUR recommended a fleet of 41 large amphibious vessels to support the operations of 2.5 Marine Expeditionary Brigades (MEBs).<sup>231</sup> Since then, the Marine Corps has expressed a need to be able to perform two MEB-level operations simultaneously, which would require a fleet of 38 amphibious vessels.<sup>232</sup>

The number of amphibious vessels required in combat operations has declined since the Korean War, which employed 34 amphibious vessels. For example, 26 were deployed in Vietnam; 21 were deployed for the Persian Gulf War; and only seven supported Operation Iraqi Freedom, which did not require as large a sea-based expeditionary force.<sup>233</sup> The Persian Gulf War is the most pertinent example for today because it was a two-MEB operation, the capabilities of this 1991 amphibious force are similar to present-day amphibious ships, and

the modern requirements for an MEB most closely resemble this engagement.<sup>234</sup>

The Marine Corps describes an MEB Amphibious Assault Task Force (AATF) as consisting of five amphibious transport dock ships (LPDs); five dock landing ships (LSDs); and five amphibious assault ships, either landing ship assault (LHA) or landing helicopter dock (LHD).<sup>235</sup> In conjunction with the Navy's Expeditionary Strike Group definition, five ESGs compose one MEB AATF.<sup>236</sup> The Navy also specifies that for an ESG, "other forces assigned" such as "surface combatants and auxiliary support vessels will be similar to those assigned to a CSG dependent on the threat and capabilities of the ships assigned."<sup>237</sup>

Based on these requirements and definitions, the nominal ESG engaged in an MRC would include:

- One landing ship assault or landing helicopter dock,
- One amphibious transport dock,
- One amphibious dock landing ship,
- Two guided missile destroyers,
- Two guided missile frigates, and
- One fast combat support ship or pair consisting of one dry cargo and ammunition and one fleet replenishment oiler.

Two simultaneous MEB-level operations therefore require a minimum of 10 ESGs or 30 operational amphibious warships. The 1996 and 2001 QDRs each recommended 12 amphibious ready groups. While the Marine Corps has consistently advocated a fleet of 38 amphibious vessels to execute its two-MEB strategy,<sup>238</sup> it is more prudent to field a fleet of at least 45 amphibious ships. This incorporates a more conservative assumption that 12 ESGs could be required in a two-MRC scenario against near-peer adversaries in addition to ensuring a strategic reserve of 20 percent.<sup>239</sup>

**Total Ship Requirement.** This *Index* assesses that a minimum of 400 U.S. Navy battle force ships is required to provide:

- The 13 carrier strike groups and 15 expeditionary strike groups required to meet the simultaneous two-MRC construct;
- The historical steady-state demand of approximately 100 ships constantly forward deployed in key regions around the world; and
- Sufficient capacity to maintain the Navy's ships properly and ensure that its sailors are adequately trained to "fight tonight."

The bulk of the Navy's battle force ships are not directly supporting a CSG or ESG during peacetime operations. Many surface vessels and attack submarines deploy independently, which is often why their requirements exceed those of a CSG. The same can be said of the ballistic missile submarine (nuclear missiles) and guided missile submarine (conventional cruise missiles), which operate independently of an aircraft carrier.

This *Index*'s benchmark of 400 battle force ships is informed by previous naval force structure assessments and government reports as well as independent analysis incorporating the simultaneous two-MRC requirement, CSG and ESG composition, and other naval missions and requirements. Because they have not yet matured sufficiently to replace manned ships or submarines in the battle force, unmanned systems are not included in the recommended fleet composition. Ship classes that are not current programs of record also were not included in this assessment because notional ship designs do not have validated requirements, their capabilities are unknown, and they have no assurance of being built.<sup>240</sup>

The most significant differences between this updated total ship requirement and the Navy's 2016 FSA are in SSC and CLF ships. The increase in SSCs from the Navy requirement of 52 to 71 is driven primarily by the

assessed CSG and ESG compositions, which include two FFGs per strike group. The two-MRC ESG and CSG demand alone requires 56 FFGs in addition to the continued requirement for a combination of at least 15 MCM ships and MIW LCSs. Similarly, the CLF requirement of 54 ships is dependent on the logistics demands of the two-MRC requirement of 13 operational CSGs and 12 ESGs. Since the Navy possesses only two T-AOEs that can each support the fuel and ammunition needs of a strike group, a pair of single-purpose T-AOs and T-AKEs is required for each CSG and ESG.

While a 400-ship fleet is significantly larger than the Navy's current 355-ship requirement, it should be noted that the final 2016 FSA requirement of 355 ships was based on the previous Administration's "Defeat/Deny" Defense Planning Guidance and "delivers future steady state and warfighting requirements with an acceptable degree of risk."<sup>241</sup> The Navy's analysis determined that a 459-ship force was "needed to achieve the Navy's mission with reasonable expectations of success without incurring significant losses" but that it was "unreasonable... to assume we would have the resources to aspire to a force of this size with this mix of ships."<sup>242</sup> Finally, this FSA has not been updated to address the 2018 National Defense Strategy, which reestablished "[l]ong-term strategic competitions with China and Russia" as the DOD's "principal priorities."<sup>243</sup>

The numerical values used in the score column refer to the five-grade scale explained earlier in this section, where 1 is "very weak" and 5 is "very strong." Taking the *Index* requirement for Navy ships as the benchmark, the Navy's current battle forces fleet capacity of 289 ships, planned fleet of 296 ships by the end of FY 2019, and revised fleet size (implied by both the 2018 NDS, which highlights great-power competition, and analysis of the Navy's history of employment in major conflicts) result in a score of "weak," which is unchanged from the 2019 *Index*. Depending on the Navy's ability to fund more aggressive growth options and SLEs as identified in the FY 2020 30-year shipbuilding plan; the *Columbia*-class ballistic missile

submarine and *Ford*-class aircraft carrier programs that will consume a significant portion of the current shipbuilding budget per hull; and the growing number of ship and submarine retirements, the Navy's capacity score could fall further in the "weak" category in the near future.

### Capability Score: Marginal

The Navy's overall capability score remained "marginal." This was consistent across all four components of the capability score: "Age of Equipment," "Capability of Equipment," "Size of Modernization Program," and "Health of Modernization Programs." Given the number of programs, ship classes, and types of aircraft involved, the details that informed the capability assessment are presented more accessibly in a tabular format as shown in the Appendix.

### Readiness Score: Marginal

The Navy's readiness score also remained "marginal." This assessment combines two major elements of naval readiness: the ability to provide both the required levels of presence around the globe and surge capacity on a consistent basis. As elaborated below, the Navy's ability to maintain required presence in key regions is "strong," but its ability to surge to meet combat requirements ranges from "weak" to "very weak" depending on how one defines the requirement. In both cases—presence and surge—the Navy has sacrificed long-term readiness to meet current operational demands for many years.

Although the Navy has prioritized restoring readiness through increased maintenance and training since 2017, as Admiral Richardson has stated, it will take at least until 2022 for the Navy to restore its readiness to required levels.<sup>244</sup> To improve personnel readiness:

The FY 2020 Military Personnel, Navy budget request is 5,100 higher than the end strength in FY 2019 and supports Navy manpower, personnel, training, and education. To ensure success, the Navy

has made investments in special and incentive pays, critical to recruiting and retaining the very best people our nation has to offer.

Furthermore, the FY 2020 request increases funding and strength for phased increases in manpower for expeditionary and aviation operational units, re-establishment of U.S. Second Fleet, production recruiters to support increased accession mission capacity, DDG-51 *Arleigh Burke* class destroyer new construction crews and class manpower increases, helicopter maritime strike (MH-60R Seahawk) squadron new construction and manpower requirements, changes to CVN 79 *Gerald R. Ford* class aircraft carrier new construction crew resulting from updated crew phasing, increases to expeditionary mine countermeasures mission, and the necessary capabilities required for increased enlisted and officer accession capacity of 42,000 and 4,500 respectively.<sup>245</sup>

Although the Navy is working proactively to address manning shortfalls and anticipate the demands of a growing fleet, there are some challenges. In February 2019, Admiral Christopher Grady, Commander, United States Fleet Forces Command, informed Congress that the Navy is short about 6,200 sailors to meet at-sea manning requirements.<sup>246</sup> After insufficient crew manning was found to be a contributing factor in the *Fitzgerald* and *McCain* fatal collisions, the Navy reassessed and increased the required number of sailors on all ship classes. The increase in ship crew size from 4 percent to 14 percent across the fleet contributed to this manning shortfall. The average crew size of an *Arleigh Burke*-class destroyer has grown from 240 sailors in 2017 to 272 sailors in 2019 on the path to reaching the new requirement of 318 sailors in FY 2023.<sup>247</sup>

The Navy barely exceeded its FY 2018 recruiting goal of 39,000 new sailors by only 18 recruits.<sup>248</sup> The Navy has assessed that its total manpower will need to grow by approximately

35,000 sailors to support a 355-ship Navy. The Navy faces several challenges in meeting the growing fleet demand for sailors: A strong U.S. economy increases the competition to hire young adults; only approximately 29 percent of young adults qualify to join the military; and only 7 percent of young Americans are interested in enlisting in the Navy.

The Navy is taking proactive approaches to meet these challenges head on by increasing the number of recruiters; focusing 70 percent of its recruiting campaigns on digital platforms; reassessing some outdated recruiting policies; and offering targeted recruitment bonuses for critical Navy occupations such as nuclear power specialties, SEALs, and explosive ordnance disposal technicians.<sup>249</sup> These efforts should have a positive impact on the recruitment and retention of sailors, and Navy leadership must continue to prioritize and fund these initiatives not only to recruit, but also to retain more sailors as the fleet grows.

Though the Navy has been able to maintain approximately a third of its fleet globally deployed, and while the OFRP has improved readiness for individual hulls by restricting deployment increases, demand still exceeds the supply of ready ships needed to meet the operational demand of CCDRs sustainably. Admiral Moran expressed deep concern about the Navy's ability to meet the nation's needs in a time of conflict in this exchange with Senator Joni Ernst (R-IA) in 2016:

Senator Ernst: ...If our Navy had to answer to two or more of the so-called four-plus-one threats today, could we do that?

Admiral Moran: ...[W]e are at a point right now...that our ability to surge beyond our current force that's forward is very limited, which should give you a pretty good indication that it would be challenging to meet the current guidance to defeat and deny in two conflicts.<sup>250</sup>

Three surface ship collisions and one grounding that resulted in the loss of 17 sailors

in the Pacific during 2017 revealed how significant the Navy's and specifically its surface fleet's readiness crisis had become. The Chief of Naval Operations, Admiral Richardson, responded with a directive that "an operational pause be taken in all fleets around the world and that a comprehensive review be launched that examines the training and certification of forward-deployed forces as well as a wide span of factors that may have contributed to the recent costly incidents."<sup>251</sup>

The GAO also conducted its own readiness reviews. One of its most disturbing findings was a lack of formal dedicated training and deployment certification time for the Japan-based ships compared to the CONUS-based ships whose OFRP cycle ensures that all ships are properly trained and mission certified before being forward deployed. Since the Japan-based ships are in a permanently deployed status, and in an effort to meet the ever-increasing demand, these ships were not provided any dedicated training time, and by June 2017, 37 percent of their warfare certifications were expired. Pacific Fleet leadership had increasingly waived these expired certifications to deploy these ships, and the GAO discovered that these waivers increased fivefold between 2015 and 2017.<sup>252</sup>

Another critical finding was the lack of basic seamanship proficiency, not just among the crews of USS *John S. McCain* and USS *Fitzgerald*, but across the surface warfare community. Surface Warfare Officer School seamanship competency checks of 196 first sea tour Officer of the Deck-qualified junior officers during the spring of 2018 revealed that evaluations of almost 84 percent of these officers revealed "some concerns" or "significant concerns."<sup>253</sup>

The readiness reviews recommended several corrective actions to improve the material condition of Navy ships as well as the professional training and operational proficiency of their crews. For example:

- Cancellation of all risk-assessment mitigation plans (RAMPs) and waivers for expired mission certifications.<sup>254</sup>



- A new 24-month force generation plan for all Japan-based ships that includes 18 weeks of dedicated training time and seven months of maintenance time.<sup>255</sup>
- Ready for Sea Assessments on Japan-based “cruisers and destroyers, with the exception of those completing or in maintenance, in order to re-baseline existing afloat certifications.”<sup>256</sup>
- A redesigned Surface Warfare Officer (SWO) career path that increases professional and seamanship training, adds individual proficiency assessments, and increases at-sea time.<sup>257</sup>

In January 2018, Under Secretary of the Navy Thomas Modly established a Readiness Reform and Oversight Council (RROC) to “oversee and ensure the implementation of Strategic Readiness Review (SRR) and Comprehensive Review (CR) recommendations” as well as to “assess the overall health and effectiveness of DON efforts to reform and improve readiness.”<sup>258</sup> Admiral Moran, Vice Chief of Naval Operations, provided an annual update on the progress of the RROC in February 2019. Among the highlighted accomplishments:

- “91 of the remaining [111] recommendations of the Strategic Readiness Review (SRR) and Comprehensive Review (CR) have been implemented.”
- “[O]ur Force Generation strategy, the process by which we certify ships for sea, was completely restructured. Today, any operations outside the guidance established by the Surface Force Commander require[] notification of a Four-Star Fleet Commander to ensure visibility and accountability.”
- “Fleet Commanders conducted Ready-for-Sea Assessments to ensure appropriate manning levels, training certification, and equipment status for every operational

ship at sea. Fifteen of eighteen Forward Deployed Naval Force-Japan (FDFNF-J) ships were assessed as ready for sea. The three remaining ships were immediately sidelined for additional training and maintenance prior to getting underway.”

- “FDFNF manning requirements were formally assigned higher priority than Continental United States (CONUS) requirements for sea and shore billets, respectively.... Currently across FDFNF, at-sea billets are filled at 100% in the aggregate, compared to the Navy-wide average of 95%.”
- “The revised SWO career path will increase time at sea during an officer’s first sea tour (48 total months).... The Mariner Skills Training Program (MSTP) takes a holistic view of the career path, delivering improved Junior Officer of the Deck training (May 2019) [and] Officer of the Deck courses (May 2021).... In July 2018, Surface Warfare Officers School (SWOS) trainees were recertified as U.S. Coast Guard Standards of Training, Certification, & Watchkeeping (SCTW) compliant.... SWOs will have proficiency measured via ten Career Milestone assessments.”<sup>259</sup>

In his FY 2020 Posture Statement, Admiral Richardson stated that:

PB-20 assigns the highest funding priority to CR/SRR-related investments—\$346 million in FY-20 and \$1.1 billion over the FYDP.... Additionally, we remain committed to assessing our ships and crews, understanding the impact of fatigue and other human factors, filling personnel gaps for ships on deployment or in sustainment, and dedicating time to maintain our forward-deployed Fleet.<sup>260</sup>

Admiral Richardson’s statement and the RROC’s accomplishments to date demonstrate that Navy leadership has taken the tragedies



of 2017 to heart and is committed to restoring surface warfare proficiency and readiness. Unfortunately, it will take several years to implement all corrective actions and even longer for these efforts to translate into satisfactory material and training readiness across the entire surface fleet.

The Navy's readiness as it pertains to providing global presence is rated "marginal." The level of CCDR demand for naval presence and the fleet's ability to meet that demand are similar to those found in the *2019 Index* but are still challenged by the range of funding problems noted in this section. The Navy maintains its ability to forward deploy approximately one-third of its fleet and has been able to stave off immediate readiness challenges through the OFRP.

The Navy's readiness corrective actions, coupled with an inadequate fleet size, have reduced its ability to respond to CCDR requirements for sustained presence, crisis support, and surge response in the event of a major conflict. Since CCDR demand signals have become insatiable in recent years, recent actions by the Navy to prioritize maintenance and training over peacetime deployments have created a more realistic and sustainable OP-TEMPO for missions short of major conflict. The Navy's actions to improve training and efficiency for the fleet and specifically for the surface warfare community will help to correct the systemic issues that led to severely degraded operational proficiency, but it will be several years before they can fully change the culture and raise the level of the fleet's overall professional knowledge and experience.

Even with prioritized investments in ship and aircraft maintenance at the maximum executable levels of the Navy's ship and aircraft depots, the Navy still cannot meet the maintenance requirement for FY 2020. Without increased and sustained funding to meet the Navy's fleet recapitalization requirements and improvements in shipyard maintenance capacity, the readiness of the Navy's fleet will remain compromised.

Although the Navy has made strides in arresting its readiness decline since Admiral Moran expressed his concerns about the Navy's ability to handle two major crises more than a year ago, the gains have not been sufficient to justify an assumption that his concerns do not still hold true today. The escalating depot maintenance demands of a growing fleet, coupled with several attack submarine refueling overhauls in the near future, could amplify ship maintenance backlogs before the effects of shipyard modernization and a larger maintenance workforce are felt. The short-term readiness gains made in the Navy's strike fighter inventory must be sustained and applied across the entire naval aviation enterprise.

### **Overall U.S. Navy Score: Marginal**

The Navy's overall score for the *2020 Index* is "marginal," the same as it was in the *2019 Index*. This was derived by aggregating the scores for capacity ("weak"); capability ("marginal"); and readiness ("marginal").

The Navy has prioritized restoring material and warfighting readiness, and this has been matched by increased funding since 2017. However, despite some incremental improvements, the competing effects of growing maintenance demands versus the extended timeline to increase public shipyard capacity and efficiency could mitigate or reverse these gains. Similarly, the Navy's FY 2020 shipbuilding plan and modernization plans forecast a larger and more lethal fleet, but funding limitations will make it extremely difficult for the Navy to increase capacity and field new lethal capabilities in the near term.

Unless Defense Department leadership and Congress can provide a sustained increase in procurement and research and development funding, the plans to build a bigger and better Navy will be curtailed. This could result in future degradation of the Navy's capacity and capability scores.

U.S. Military Power: Navy

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness			✓		
OVERALL			✓		

# NAVY SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Aircraft Carrier

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b><i>Nimitz</i>-Class Aircraft Carrier (CVN-68)</b> Inventory: <b>10</b> Fleet age: <b>28</b> Date: <b>1975</b>  The <i>Nimitz</i> -class is a nuclear powered multipurpose carrier. The aircraft carrier and its embarked carrier air wing can perform a variety of missions including maritime security operations and power projection. Its planned service life is 50 years. The class will start retiring in FY 2025 and will be replaced by the <i>Ford</i> -class carriers.	3	3	<b><i>Ford</i>-Class Aircraft Carrier (CVN-78)</b>  Timeline: <b>2017–2032</b>  Currently in production, the <i>Ford</i> -class will replace the current <i>Nimitz</i> -class aircraft carriers. The <i>Ford</i> -class design uses the basic <i>Nimitz</i> -class hull form but incorporates several improvements: 33 percent higher sortie rate; a smaller crew with approximately 600 fewer sailors; two and a half times greater electrical power, and over \$4 billion in life cycle cost savings over the <i>Nimitz</i> -class.	2	2
<b><i>Ford</i>-Class Aircraft Carrier (CVN-78)</b> Inventory: <b>1</b> Fleet age: <b>2</b> Date: <b>2017</b>  The <i>Ford</i> -class incorporates new technologies that will increase aircraft sortie rates, reduce manning, provide greater electrical power for future weapons systems, and decrease operating costs. Its planned service life is 50 years.	5	4	<div> <div> <b>PROCUREMENT</b> <div> <div></div> <div>37</div> </div> </div> <div> <b>SPENDING (\$ millions)</b> <div> <div></div> <div>\$29,787\$19,410</div> </div> </div> </div>		

**NOTE:** See page 392 for details on fleet ages, dates, and procurement spending.

# NAVY SCORES



Procurement and Spending ■ Through FY 2019  
■ Pending

## Large Surface Combatant

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b><i>Ticonderoga-Class Cruiser (CG-47)</i></b> Inventory: <b>22</b> Fleet age: <b>29</b> Date: <b>1983</b>  The <i>Ticonderoga</i> -Class is a multi-mission battle force ship equipped with the Aegis Weapons System. While it can perform strike, anti-surface warfare and anti-submarine warfare, its primary focus is air and missile defense. Between FY 2021 and 2024, the Navy plans to retire eight of the 22 CGs, given their life expectancy of 40 years.	2	3	<b><i>Zumwalt-Class Destroyer (DDG-1000)</i></b>  Timeline: <b>2016–2022</b>  The DDG-1000 was designed to be a new-generation destroyer capable of handling more advanced weapon systems with modern gun systems and a hull design aimed to reduce radar detectability for its primary mission of naval surface fire support (NSFS). The DDG-1000 program was intended to produce a total of 32 ships, but this number was reduced to 3. The first DDG-1000 was commissioned in October 2016.  <b>PROCUREMENT</b> <div><div></div>3</div> <b>SPENDING (\$ millions)</b> <div><div></div>\$12,987</div> <div><div></div>\$208</div>	1	1
<b><i>Zumwalt-Class Destroyer (DDG-100)</i></b> Inventory: <b>1</b> Fleet age: <b>3</b> Date: <b>2016</b>  The <i>Zumwalt</i> -Class is a multi-mission destroyer that incorporates several technological improvements, such as a stealthy hull design and integrated electric-drive propulsion system. Although it has passed sea trials, it continues to experience problems with its combat systems. The third and final ship of the class is expected to be commissioned in late FY 2019.	5	2			
<b><i>Arleigh Burke-Class Destroyer (DDG-51)</i></b> Inventory: <b>67</b> Fleet age: <b>17</b> Date: <b>1991</b>  The <i>Arleigh Burke</i> -Class is a multi-mission guided missile destroyer featuring the Aegis Weapons System with a primary mission of air defense. The Navy plans to extend the service life of the entire class to 45 years from its original life expectancy of 35–40 years.	4	4	<b><i>Arleigh Burke-Class Destroyer (DDG-51)</i></b>  Timeline: <b>1991–2029</b>  DDG-51 production was restarted in FY 2013 to make up for the reduction in DDG-1000 acquisitions. Beginning in FY 2017, all DDG-51s procured will be the Flight III design, which includes the Advanced Missile Defense Radar (AMDR), a more capable missile defense radar.  <b>PROCUREMENT</b> <div><div></div>82</div> <div><div></div>15</div> <b>SPENDING (\$ millions)</b> <div><div></div>\$89,948</div> <div><div></div>\$28,020</div>	4	4



NOTE: See page 392 for details on fleet ages, dates, and procurement spending.

# NAVY SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Small Surface Combatant

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>Littoral Combat Ship (LCS)</b> Inventory: <b>17</b> Fleet age: <b>3</b> Date: <b>2008</b>  The Littoral Combat Ship includes two classes: the <i>Independence</i> -class and the <i>Freedom</i> -class. The modular LCS design depends on mission packages (MP) to provide warfighting capabilities in the SUW, ASW, and MCM mission areas. The ship has an expected service life of 25 years.	5		<b>Littoral Combat Ship (LCS)</b>  Timeline: <b>2009–2019</b>  The LCS is intended to fulfill the mine countermeasure, antisubmarine warfare, and surface warfare roles for the Navy. It will be the only small surface combatant in the fleet once the Navy's MCM ships retire. A new program called the FFG(X) will fill out the remaining 20-ship small surface combatant requirement.	2	2
<b>Avenger-Class Mine Counter Measure (MCM-1)</b> Inventory: <b>11</b> Fleet age: <b>27</b> Date: <b>1989</b>  <i>Avenger</i> -class ships are designed as mine sweepers/hunter-killers capable of finding, classifying, and destroying moored and bottom mines. The class has an expected 30-year service life. The remaining MCMs are expected to be decommissioned throughout the 2020s. While there is no direct replacement single mission MCM ship in production, the Navy plans to fill its mine countermeasure role with the LCS and its MCM MP.	1	2	<b>PROCUREMENT</b>  33	<b>SPENDING (\$ millions)</b>  \$16,719 \$80	

## SSGN Cruise Missile Submarine

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
<b>Ohio-Class (SSGN-726)</b> Inventory: <b>4</b> Fleet age: <b>36.5</b> Date: <b>1981</b>  The SSGNs provide the Navy with a large stealthy strike and special operations mission capabilities. From 2002–2007, the four oldest <i>Ohio</i> -class ballistic missile submarines were converted to guided missile submarines. Each SSGN is capable of carrying up to 154 Tomahawk land-attack cruise missiles and up to 66 special operations forces for clandestine insertion and retrieval. All four SSGNs will retire between FY 2026–2028. The Navy has tentative plans to replace the SSGNs with a new Large Payload Submarine beginning in FY 2036.	2	4	None		

**NOTE:** See page 392 for details on fleet ages, dates, and procurement spending.

# NAVY SCORES



Procurement and Spending ■ Through FY 2019  
■ Pending

## Attack Submarines

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>Seawolf-Class (SSN-21)</b> Inventory: <b>3</b> Fleet age: <b>19</b> Date: <b>1997</b>  The <i>Seawolf</i> -class is exceptionally quiet, fast, well-armed, and equipped with advanced sensors. Though lacking a vertical launch system, the <i>Seawolf</i> -class has eight torpedo tubes and can hold up to 50 weapons in its torpedo room. Although the Navy planned to build 29 submarines, the program was cut to three submarines. The <i>Seawolf</i> -class has a 33-year expected service life. They have been succeeded by the <i>Virginia</i> -class attack submarine.	3	4	<b>Virginia-Class (SSN-774)</b>  Timeline: <b>2004–2019</b>  The Virginia Payload Module (VPM) will be incorporated into eight of the 11 planned Block V submarines beginning in FY 2019. VPM includes four large-diameter, vertical launch tubes that can carry up to 28 additional Tomahawk missiles or other payloads.  <b>PROCUREMENT</b> <div><div></div><div></div></div> <div>3028</div> <b>SPENDING (\$ millions)</b> <div><div></div><div></div></div> <div>\$79,794\$68,285</div>	2	3
<b>Los Angeles-Class (SSN-688)</b> Inventory: <b>31</b> Fleet age: <b>28</b> Date: <b>1976</b>  The <i>Los Angeles</i> -class comprises the largest portion of the Navy's attack submarine fleet. They are multi-mission submarines that can perform covert intelligence collection, surveillance, ASW, ASuW, and land attack strike. The <i>Los Angeles</i> -class has a 33-year expected service life. The last <i>Los Angeles</i> -class submarine is expected to retire in the late 2020s and is being replaced by the <i>Virginia</i> -class.	1	3			
<b>Virginia-Class (SSN-774)</b> Inventory: <b>17</b> Fleet age: <b>7</b> Date: <b>2004</b>  The <i>Virginia</i> -class is the U.S. Navy's next-generation attack submarine. The <i>Virginia</i> -class includes several improvements over previous attack submarine classes that provide increased acoustic stealth, improved SOF support, greater strike payload capacity, and reduced operating costs. The planned service life of the <i>Virginia</i> -class is 33 years. The <i>Virginia</i> -class is in production and will replace the <i>Los Angeles</i> -class and <i>Seawolf</i> -class attack submarines as they are decommissioned.	4	4			

NOTE: See page 392 for details on fleet ages, dates, and procurement spending.



# NAVY SCORES



1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## SSBN Ballistic Missile Submarine

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>Ohio-Class (SSBN)</b> Inventory: <b>14</b> Fleet age: <b>28.5</b> Date: <b>1981</b> The <i>Ohio</i> -class SSBN is the most survivable leg of the U.S. military's strategic nuclear triad. The <i>Ohio</i> SSBN's sole mission is strategic nuclear deterrence, for which it carries long-range submarine-launched ballistic missiles. The <i>Ohio</i> -class's expected service life is 42 years. The <i>Ohio</i> -class fleet will begin retiring in 2027 at an estimated rate of one submarine per year until 2039. The <i>Ohio</i> -class is being replaced by the <i>Columbia</i> -class SSBN	2	4	<b>Columbia-Class (SSBN-826)</b> The <i>Columbia</i> -class SSBN is the Navy's highest priority program. The 12 boats in the program will replace the current fleet of 14 <i>Ohio</i> -class ballistic missile submarines, with acquisition of the first boat to occur in FY 2021. The program will extend through the mid-2030s.		

## Amphibious Warfare Ship

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>Wasp-Class Amphibious Assault Ship (LHD-1)</b> Inventory: <b>8</b> Fleet age: <b>22</b> Date: <b>1989</b> The <i>Wasp</i> -class can support amphibious landing operations with Marine Corps landing craft via its well deck. It can also support a Marine Air Combat Element operations with helicopters, tilt-rotor aircraft and Vertical/Short Take-Off and Landing (V/STOL). This ship has a planned 40-year service life.	3	3	<b>America-Class (LHA-6)</b> Timeline: <b>2004-TBD</b> LHA Flight 0 (LHA-6 and 7) were built without a well deck to provide more space for Marine Corp aviation maintenance and storage as well as increased JP-5 fuel capacity. LHA Flight 1 (LHA-8 and beyond) will reincorporate a well deck for increased mission flexibility. The America-class is in production with three LHA-6s already fully procured. Advance procurement for LHA 9 will begin in FY 2023.	3	3
<b>America-Class Amphibious Assault Ship (LHA-6)</b> Inventory: <b>1</b> Fleet age: <b>5</b> Date: <b>2014</b> This new class of large-deck amphibious assault ships is meant to replace the retiring <i>Wasp</i> -Class LHD. LHAs are the largest of all amphibious warfare ships, resembling a small aircraft carrier. The America-class is designed to accommodate the Marine Corps' F-35Bs.	5	4	<b>PROCUREMENT</b>  <b>SPENDING (\$ millions)</b> 		





NOTE: See page 392 for details on fleet ages, dates, and procurement spending.

# NAVY SCORES

1 2 3 4 5  
Weakest → Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Amphibious Warfare Ship

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>San Antonio-Class Amphibious Transport Dock (LPD-17)</b>  Inventory: <b>11</b> Fleet age: <b>8</b> Date: <b>2006</b>  The LPDs have well decks that allow the USMC to conduct amphibious operations with its landing craft. The LPD can also carry 4 CH-46s or 2 MV-22s. 11 of the planned 13 Flight I LPD-17-class ships are operational with the remaining two under construction. The class has a 40-year planned service life.	5	3	<b>San Antonio-Class Amphibious Transport Dock (LPD-17)</b>  Timeline: <b>2006–2017</b>  The LPD-17s are replacements for the <i>San Antonio</i> -class LPDs. All 13 LPD-17s have been procured. Both Flight I and Flight II LPDs are multi-mission ships designed to embark, transport, and land elements of a Marine landing force by helicopters, tilt-rotor aircraft, landing craft, and amphibious vehicles.  <b>PROCUREMENT</b>  13  <b>SPENDING (\$ millions)</b>  \$21,309 \$63	5	4
<b>Whidbey Island-Class Dock Landing Ship (LSD-41)</b>  Inventory: <b>8</b> Fleet age: <b>30</b> Date: <b>1985</b>  LSD-41 <i>Whidbey Island</i> -class ships were designed specifically to transport and launch four Marine Corps Landing Craft Air Cushion vehicles. They have an expected service life of 40 years. All eight ships in the class will retire between FY 2026–2033. LSD-41-class will be replaced by LPD-17 Flight II program, which began procurement in FY 2018.	2		<b>LPD-17 Flight II</b>  Timeline: <b>2025–TBD</b>  Previously known as LX(R), the LPD-17 Flight II program will procure 13 ships to replace the Navy's LSD-type ships. The Navy originally planned to procure the first Flight II ship in FY 2020, however accelerated procurement funding enabled procurement of the first LPD-17 Flight II in FY 2018. The Navy delayed the second ship planned for FY 2020 until FY 2021.	5	4
<b>Harpers Ferry-Class Dock Landing Ships (LSD-49)</b>  Inventory: <b>4</b> Fleet age: <b>23</b> Date: <b>1994</b>  The <i>Harpers Ferry</i> -class reduced LCAC capacity to two while increasing cargo capacity. It has an expected service life of 40 years and all ships will be retired by FY 2038. The LSD-49 will be replaced by the LPD-17 Flight II, which began procurement in FY 2018.	3		<b>PROCUREMENT</b>  1 8  <b>SPENDING (\$ millions)</b>  \$2,164 \$3,577		

**NOTE:** See page 392 for details on fleet ages, dates, and procurement spending.

# NAVY SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019 ■ Pending

## Airborne Early Warning

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>E-2C Hawkeye</b> Inventory: <b>28</b> Fleet age: <b>36</b> Date: <b>1973</b>  The E-2C Hawkeye is a battle management and airborne early warning aircraft. The E-2C fleet received a series of upgrades to mechanical and computer systems around the year 2000. While still operational, the E-2C is nearing the end of its service life and is being replaced by the E-2D Advanced Hawkeye.	1	3	<b>E-2D Advanced Hawkeye</b>  Timeline: <b>2014–2022</b>  The E-2D Advanced Hawkeye replaces the legacy E-2C and is in production. The Navy received approval for a five year multi-year procurement plan beginning in FY 2019 for 24 aircraft to complete the program of record.	4	4
<b>E-2D Advanced Hawkeye</b> Inventory: <b>12</b> Fleet age: <b>3</b> Date: <b>2014</b>  The E-2D program is the next generation, carrier-based early warning, command, and control aircraft that provides improved battle space detection, supports theater air missile defense, and offers improved operational availability.	5	4	<div> <div> <b>PROCUREMENT</b> <div> <div></div> <div>96</div> <div>18</div> </div> </div> <div> <b>SPENDING (\$ millions)</b> <div> <div></div> <div>\$14,483</div> <div>\$3,910</div> </div> </div> </div>		

## Electronic Attack Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>EA-18G Growler</b> Inventory: <b>75</b> Fleet age: <b>6</b> Date: <b>2009</b>  The EA-18G Growler is the U.S. Navy's primary electronic attack aircraft, providing tactical jamming and suppression of enemy air defenses. The final EA-18G aircraft was delivered in FY 2018, bringing the total to 160 aircraft and fulfilling the Navy's requirement. It replaced the legacy EA-6B Prowlers.	5	4	None		

**NOTE:** See page 392 for details on fleet ages, dates, and procurement spending.

NAVY SCORES



Procurement and Spending ■ Through FY 2019 ■ Pending

Fighter/Attack Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<p><b>F/A-18E/F Super Hornet</b></p> <p>Inventory: <b>546</b> Fleet age: <b>15</b> Date: <b>2001</b></p> <p>The F/A-18E/F Super Hornet has longer range, greater weapons payload, and increased survivability when compared with the F/A-18A-D Legacy Hornet. The Navy plans to achieve a 50/50 mix of two F-35C squadrons and two F/A-18E/F Block III squadrons per carrier air wing by the mid-2030s. The ongoing service life extension program will extend the life of all Super Hornets to 9,000 flight hours.</p>	3	3	<p><b>F-35C Joint Strike Fighter</b></p> <p>Timeline: <b>2019-TBD</b></p> <p>The C-variant is the Navy's 5th generation aircraft, bringing radar-evading technology to the carrier deck for the first time. The F-35C performs a variety of missions to include air-to-air combat, air-to-ground strikes, and ISR missions.</p> <div><div><p>PROCUREMENT</p><div><div></div><div></div></div><div>98271</div></div><div><div><p>SPENDING (\$ millions)</p><div><div></div><div></div></div><div>\$19,549\$35,727</div></div></div></div>	2	3
<p><b>F-35C Joint Strike Fighter</b></p> <p>Inventory: <b>30</b> Fleet age: <b>1</b> Date: <b>2019</b></p> <p>The F-35C is the Navy's variant of the Joint Strike Fighter.</p>	5	4			

**NOTES:** See Methodology for descriptions of scores. Fleet age is the average of platform since commissioning. The date for ships is the year of commissioning. Inventory for aircraft is estimated based on the number of squadrons. The date for aircraft is the year of initial operational capability. The timeline for ships is from the year of first commissioning to the year of last delivery. The timeline for aircraft is from the year of first year of delivery to the last year of delivery. Spending does not include advanced procurement or research development test and evaluation. The total program dollar value reflects the full F-35 joint program, including engine procurement. The Navy is also procuring 67 F-35Cs for the Marine Corps. Age of fleet is calculated from date of commissioning to January 2016.

# U.S. Navy Modernization Table Citations

## MAIN SOURCES

- U.S. Department of Defense, Office of Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, March 2019, [https://www.navy.mil/strategic/PB20\\_Shipbuilding\\_Plan.pdf](https://www.navy.mil/strategic/PB20_Shipbuilding_Plan.pdf) (accessed September 5, 2019).
- U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *United States Department of Defense Fiscal Year 2020 Budget Request: Program Acquisition Cost by Weapon System*, March 2019, [https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/fy2020\\_Weapons.pdf](https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/fy2020_Weapons.pdf) (accessed September 5, 2019).
- U.S. Navy, Naval Sea Systems Command, Naval Vessel Register, “Ship Battle Forces,” <https://www.nvr.navy.mil/NVRSHIPS/SHIPBATTLEFORCE.HTML> (accessed September 5, 2019).
- U.S. Department of the Navy, “United States Navy *Fact File*,” <https://www.navy.mil/navydata/fact.asp> (accessed September 5, 2019).
- U.S. Department of the Navy, *Department of Defense Fiscal Year (FY) 2020 President’s Budget Estimate Submission, Navy, Justification Book Volume 1 of 1: Shipbuilding and Conversion, Navy*, March 2019, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/SCN\\_Book.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/SCN_Book.pdf) (accessed September 5, 2019).
- U.S. Department of the Navy, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Navy, Justification Book Volume 1 of 3: Aircraft Procurement, Navy, Budget Activities 01–04*, March 2019, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/APN\\_BA1-4\\_BOOK.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/APN_BA1-4_BOOK.pdf) (accessed September 5, 2019).
- U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, 2019, <https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/Budget%20Highlights%20Book.pdf> (accessed September 5, 2019).

## MISC. SOURCES

### *Ford-Class Aircraft Carrier (CVN-78):*

- Ben Werner, “Congress Unhappy with Ford-Class Inability to Deploy with F-35 Fighters,” U.S. Naval Institute News, June 3, 2019, <https://news.usni.org/2019/06/03/congress-unhappy-with-ford-class-inability-to-deploy-with-f-35-fighters> (accessed September 5, 2019).
- Ben Werner, “Nimitz and Ford Carriers Need Upgrades to Deploy with F-35Cs,” U.S. Naval Institute News, updated June 7, 2019, <https://news.usni.org/2019/06/06/nimitz-and-ford-carriers-need-upgrades-to-deploy-with-f-35cs> (accessed September 5, 2019).

### *Zumwalt-Class Destroyer:*

- U.S. Navy, “Upcoming US Navy Commissionings,” last data update August 3, 2019, <https://www.navycommissionings.org/> (accessed September 5, 2019).

### *Arleigh Burke-Class Destroyer (DDG-51):*

- Ronald O’Rourke, “Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 18, 2019, <https://fas.org/sgp/crs/weapons/RL32109.pdf> (accessed September 5, 2019).

### *Virginia-Class (SSN-774):*

- Ronald O’Rourke, “Navy Virginia (SSN-774) Class Attack Submarine Procurement: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 24, 2019, <https://fas.org/sgp/crs/weapons/R41129.pdf> (accessed September 5, 2019).

### *Ohio-Class (SSBN):*

- Ronald O’Rourke, “Navy Columbia (SSBN-826) Class Ballistic Missile Submarine Program: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 24, 2019, <https://fas.org/sgp/crs/weapons/R41129.pdf> (accessed September 5, 2019).

### *F/A-18 Super Hornet:*

- David Axe, “Bringing the Sting: The U.S. Navy Is Getting New F/A-18E/F Super Hornets,” *The National Interest*, March 22, 2019, <https://nationalinterest.org/blog/buzz/bringing-sting-us-navy-getting-new-fa-18ef-super-hornets-48562> (accessed September 5, 2019).
- David B. Larter, “The U.S. Navy’s Fight to Fix Its Worn-Out Super Hornet Fleet Is Making Way,” *Defense News*, August 16, 2018, <https://www.defensenews.com/naval/2018/08/16/the-us-navys-fight-to-fix-its-worn-out-super-hornet-fleet-is-making-way/> (accessed September 5, 2019).
- Sydney J. Freedberg Jr., “Navy, Boeing Tout Block III Super Hornet as Partner for F-35,” *Breaking Defense*, May 23, 2018, <https://breakingdefense.com/2018/05/navy-boeing-tout-block-iii-super-hornet-as-partner-for-f-35/> (accessed September 5, 2019).

*F-35C Joint Strike Fighter:*

- Megan Eckstein, "Navy Declares Initial Operational Capability for F-35C Joint Strike Fighter," U.S. Naval Institute News, February 28, 2019, <https://news.usni.org/2019/02/28/navy-declares-initial-operational-capability-for-f-35c-joint-strike-fighter> (accessed September 5, 2019).



## Endnotes

1. Admiral John M. Richardson, *A Design for Maintaining Maritime Superiority, Version 2.0*, U.S. Navy, Office of the Chief of Naval Operations, December 2018, p. 1, [https://www.navy.mil/navydata/people/cno/Richardson/Resource/Design\\_2.0.pdf](https://www.navy.mil/navydata/people/cno/Richardson/Resource/Design_2.0.pdf) (accessed July 1, 2019).
2. *National Security Strategy of the United States of America*, The White House, December 2017, <https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf> (accessed July 1, 2019).
3. James Mattis, U.S. Secretary of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge*, U.S. Department of Defense, <https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf> (accessed July 1, 2019).
4. The Global Force Management Allocation Plan (GFMAP) is a classified document that specifies the forces to be provided by the services for use by operational commanders. It is an extension of a reference manual maintained by the Joint Staff, *Global Force Management Allocation Policies and Procedures* (CJCSM 3130.06B), which is also a classified publication. See Enclosure B, "CJCS Family of Documents," in U.S. Department of Defense, Joint Chiefs of Staff, "Adaptive Planning and Execution Overview and Policy Framework," Chairman of the Joint Chiefs of Staff Guide 3130, March 5, 2019, pp. B-2 and B-4, <https://www.jcs.mil/Portals/36/Documents/Library/Handbooks/CJCS%20GUIDE%203130.pdf?ver=2019-03-18-122038-003> (accessed July 1, 2019).
5. Mattis, *Summary of the 2018 National Defense Strategy of the United States of America*, p. 4.
6. *Ibid.*, pp. 4–7.
7. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2019 Budget*, 2018, pp. 1-1 and 1-2, [http://www.secnave.navy.mil/fmc/fmb/Documents/19pres/Highlights\\_book.pdf](http://www.secnave.navy.mil/fmc/fmb/Documents/19pres/Highlights_book.pdf) (accessed August 20, 2019).
8. The Navy's FY 2020 budget request specifies that "the Navy and Marine Corps provide forward postured sea-based forces" that include "over 49,000 Sailors and over 40,000 Marines deployed or forward ashore on 94 ships, two Carrier Strike Groups, and two Amphibious Ready Groups around the world." U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, 2019, p. 1-4, <https://www.secnave.navy.mil/fmc/fmb/Documents/20pres/Budget%20Highlights%20Book.pdf> (accessed July 2, 2019).
9. Testimony of Vice Admiral William Merz, Deputy Chief of Naval Operations for Warfare Systems (OPNAV N9), in Congressional Quarterly, "House Armed Services Subcommittee on Seapower and Projection Forces Holds Hearing on Fiscal 2020 Defense Authorization for Seapower and Projection Forces," CQ Congressional Transcripts, March 26, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5495621?2> (accessed July 2, 2019).
10. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, March 2019, p. 5, <https://www.secnave.navy.mil/fmc/fmb/Documents/20pres/PB20%2030-year%20Shipbuilding%20Plan%20Final.pdf> (accessed July 2, 2019). Emphasis in original.
11. U.S. Department of Defense, Department of the Navy, Office of the Secretary, "General Guidance for the Classification of Naval Vessels and Battle Force Ship Counting Procedures," SECNAV Instruction 5030.8C, June 14, 2016, pp. 1–2, <http://www.nvr.navy.mil/5030.8C.pdf> (accessed July 2, 2019).
12. Ronald O'Rourke, "Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, July 24, 2019, p. 3, <https://crsreports.congress.gov/product/pdf/RL/RL32665> (accessed July 2, 2019).
13. U.S. Navy, "Executive Summary: 2016 Navy Force Structure Assessment (FSA)," December 14, 2016, p. 1, [https://news.usni.org/wp-content/uploads/2016/12/FSA\\_Executive-Summary.pdf](https://news.usni.org/wp-content/uploads/2016/12/FSA_Executive-Summary.pdf) (accessed August 5, 2019). The full FSA was not released to the public.
14. Mattis, *Summary of the 2018 National Defense Strategy of the United States of America*, pp. 1 and 2.
15. U.S. Department of Defense, Naval Vessel Register, "Fleet Size," last updated August 12, 2019, <http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML> (accessed August 20, 2019).
16. *2019 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2019), p. 346, [https://www.heritage.org/sites/default/files/2018-09/2019\\_IndexOfUSMilitaryStrength\\_WEB.pdf](https://www.heritage.org/sites/default/files/2018-09/2019_IndexOfUSMilitaryStrength_WEB.pdf).
17. Figure 4.2, "Shipbuilding Procurement Quantities and Total Funding," in U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 4-2.

18. The Honorable James F. Geurts, Assistant Secretary of the Navy for Research, Development and Acquisition ASN(RD&A); Vice Admiral William R. Merz, Deputy Chief of Naval Operations for Warfare Systems (OPNAV N9); and Lieutenant General David H. Berger, Deputy Commandant, Combat Development and Integration, and Commanding General, Marine Corps Combat Development Command, statement on “The Department of the Navy Fiscal Year 2020 Budget Request for Seapower and Projection Forces” before the Subcommittee on Seapower and Projection Forces, Committee on Armed Services, U.S. House of Representatives, March 26, 2019, p. 3, [https://armedservices.house.gov/\\_cache/files/9/1/919f5faa-95da-41d8-88b9-395b063c36ee/C72CB2C30F9989D64E8C8BF8F1A18801.hrrg-116-as28-wstate-geurtsj-20190326.pdf](https://armedservices.house.gov/_cache/files/9/1/919f5faa-95da-41d8-88b9-395b063c36ee/C72CB2C30F9989D64E8C8BF8F1A18801.hrrg-116-as28-wstate-geurtsj-20190326.pdf) (accessed August 20, 2019).
19. Navy League of the United States, “Upcoming US Navy Commissionings,” last data update August 12, 2019, <https://www.navycommissionings.org/> (accessed August 14, 2019), and U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 3-2.
20. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 3-2.
21. Table A6-1, “Ships Planned to Be Placed Out of Service During the FYDP,” in U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, pp. 21–22.
22. U.S. Department of the Navy, Naval Sea Systems Command, memorandum from Commander, Naval Sea Systems Command, to Deputy Chief of Naval Operations, Warfare Systems (OPNAV N9), on “Surface Ship Life Extensions,” April 25, 2018, <https://2.bp.blogspot.com/-B3as-Uf3EuM/WwK9IEVRthI/AAAAAAAAANBI/aOx4hOANKB4EN5tVyYufTHDHGslnxylGACLcBGAs/s1600/shiplife.jpeg> (accessed August 5, 2019).
23. See *2015 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2015), p. 247, [https://ims-2015.s3.amazonaws.com/2015\\_Index\\_of\\_US\\_Military\\_Strength\\_FINAL.pdf](https://ims-2015.s3.amazonaws.com/2015_Index_of_US_Military_Strength_FINAL.pdf); *2016 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2015), p. 236, [https://s3.amazonaws.com/ims-2016/PDF/2016\\_Index\\_of\\_US\\_Military\\_Strength\\_FULLL.pdf](https://s3.amazonaws.com/ims-2016/PDF/2016_Index_of_US_Military_Strength_FULLL.pdf); *2017 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2016), p. 292, [http://ims-2017.s3.amazonaws.com/2017\\_Index\\_of\\_Military\\_Strength\\_WEB.pdf](http://ims-2017.s3.amazonaws.com/2017_Index_of_Military_Strength_WEB.pdf); *2018 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2018), p. 334, [https://www.heritage.org/sites/default/files/2017-10/2018\\_IndexOfUSMilitaryStrength-2.pdf](https://www.heritage.org/sites/default/files/2017-10/2018_IndexOfUSMilitaryStrength-2.pdf); and *2019 Index of Military Strength*, p. 346.
24. U.S. Department of Defense, Naval Vessel Register, “Ship Battle Forces,” <http://www.nvr.navy.mil/NVRSHIPS/SHIPBATTLEFORCE.HTML> (accessed August 20, 2019).
25. U.S. Navy, “Executive Summary: 2016 Navy Force Structure Assessment (FSA),” p. 3.
26. Thomas Callender, “The Nation Needs a 400-Ship Navy,” Heritage Foundation *Special Report* No. 205, October 26, 2018, pp. 17–18, <https://www.heritage.org/sites/default/files/2018-10/SR205.pdf>. The SSC requirement is 71 ships, which includes 56 FFGs and 15 mine warfare (MIW) LCS.
27. U.S. Department of Defense, Naval Vessel Register, “Ship Battle Forces.”
28. Callender, “The Nation Needs a 400-Ship Navy,” pp. 18–19. The CLF requirement of 56 ships includes two T-AOE, 26 T-AKE, and 26 T-AO.
29. U.S. Department of Defense, Naval Vessel Register, “Ship Battle Forces.”
30. U.S. Navy, “Executive Summary: 2016 Navy Force Structure Assessment (FSA),” pp. 3 and 4.
31. Callender, “The Nation Needs a 400-Ship Navy,” pp. 3 and 21.
32. Ben Werner, “Indo-Pacom Commander Says Only Half of Sub Requests Are Met,” U.S. Naval Institute News, March 27, 2019, <https://news.usni.org/2019/03/27/42212> (accessed August 5, 2019).
33. Figure A2-2, “Procurement Profile,” in U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 14.
34. U.S. Department of Defense, Naval Vessel Register, “Ship Battle Forces.”
35. U.S. Code, Title 10, § 5062(b), <https://www.gpo.gov/fdsys/pkg/USCODE-2010-title10/pdf/USCODE-2010-title10-subtitleC-partI-chap507-sec5062.pdf> (accessed August 5, 2019).
36. Section 123, “Sense of Congress on Accelerated Production of Aircraft Carriers,” in H.R. 5515, John S. McCain National Defense Authorization Act for Fiscal Year 2019, Public Law 115-232, 115th Cong., August 13, 2018, <https://www.congress.gov/bill/115th-congress/house-bill/5515/text> (accessed August 5, 2019).
37. Ronald O’Rourke, “Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated July 24, 2019, p. 14, <https://fas.org/sgp/crs/weapons/RS20643.pdf> (accessed August 5, 2019). See also *ibid.*, p. 2.

38. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2019 Budget*, pp. 3-3 and 1-2.
39. Mike Fabey, "The U.S. Navy's Most Advanced Aircraft Carrier Will Soon Face Its Greatest Challenge," *The National Interest*, June 27, 2017, <http://nationalinterest.org/blog/the-buzz/the-us-navys-most-advanced-aircraft-carrier-will-soon-face-21336> (accessed August 5, 2019).
40. O'Rourke, "Navy Ford (CVN-78) Class Aircraft Carrier Program," p. 6.
41. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 6.
42. Testimony of Vice Admiral William Merz in Congressional Quarterly, "House Armed Services Subcommittee on Seapower and Projection Forces Holds Hearing on Fiscal 2020 Defense Authorization for Seapower and Projection Forces," March 26, 2019.
43. Admiral John M. Richardson, Chief of Naval Operations, statement on "Fiscal Year 2020 Navy Budget" before the Committee on Armed Services, U.S. House of Representatives, April 10, 2019, p. 9, [https://armedservices.house.gov/\\_cache/files/2/3/23a32790-b768-48de-83ac-6c6f12058d9a/2CCA8924047BDE7C56C85669AF88F236.fy20-cno-hasc-written-posture-statement-final.docx.pdf](https://armedservices.house.gov/_cache/files/2/3/23a32790-b768-48de-83ac-6c6f12058d9a/2CCA8924047BDE7C56C85669AF88F236.fy20-cno-hasc-written-posture-statement-final.docx.pdf) (accessed July 2, 2019), and Geurts, Merz, and Berger, statement on "The Department of the Navy Fiscal Year 2020 Budget Request for Seapower and Projection Forces," March 26, 2019, p. 7.
44. Ben Werner, "Pence: No Early Retirement for USS Harry S. Truman," U.S. Naval Institute News, updated May 2, 2019, <https://news.usni.org/2019/04/30/pence-no-early-retirement-for-uss-harry-s-truman> (accessed July 3, 2019).
45. Megan Eckstein, "Navy, Pentagon Looking Across Services' Budgets for Truman Refueling Funding," U.S. Naval Institute News, May 7, 2019, <https://news.usni.org/2019/05/07/navy-pentagon-looking-across-services-budgets-for-truman-refueling-funding> (accessed August 1, 2019).
46. O'Rourke, "Navy Ford (CVN-78) Class Aircraft Carrier Program," p. 41.
47. *Ibid.*, pp. 33–34.
48. U.S. Navy, "Executive Summary: 2016 Navy Force Structure Assessment (FSA)," p. 1.
49. *Ibid.*, p. 2.
50. *Ibid.*, pp. 2–3.
51. *Ibid.*, pp. 3–4.
52. O'Rourke, "Navy Force Structure and Shipbuilding Plans," p. 3.
53. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 4.
54. Testimony of Vice Admiral William Merz in Congressional Quarterly, "House Armed Services Subcommittee on Seapower and Projection Forces Holds Hearing on Fiscal 2020 Defense Authorization for Seapower and Projection Forces," March 26, 2019.
55. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 4.
56. *Ibid.*, p. 5. See also Table A2-1, "Long-Range Procurement Profile," in *ibid.*, p. 13.
57. Table A3-1, "Long-Range Naval Battle Force Construction Plan," in U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare Systems) (N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2019*, February 2018, p. 12, [https://www.secnav.navy.mil/fmc/fmb/Documents/19pres/LONGRANGE\\_SHIP\\_PLAN.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/19pres/LONGRANGE_SHIP_PLAN.pdf) (accessed August 5, 2019).
58. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, pp. 5–6.
59. Table A2-4, "Battle Force Inventory," in *ibid.*, p. 13.
60. *Ibid.*, p. 6.
61. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare Systems) (N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2019*, p. 5.
62. Megan Eckstein, "Navy Will Extend All DDGs to a 45-Year Service Life; 'No Destroyer Left Behind' Officials Say," U.S. Naval Institute News, updated April 12, 2018, <https://news.usni.org/2018/04/12/navy-will-extend-ddgs-45-year-service-life-no-destroyer-left-behind-officials-say> (accessed August 1, 2019).
63. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 6.

64. Testimony of Admiral John Richardson, Chief of Naval Operations, in Congressional Quarterly, “House Armed Services Committee Holds Hearing on the Navy Fiscal Year 2020 Defense Authorization Request,” CQ Congressional Transcripts, April 10, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5511018?2> (accessed August 5, 2019).
65. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 7, and Table A6-1, “Ships Planned to Be Placed Out of Service During the FYDP,” in *ibid.*, p. 21.
66. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 7.
67. Megan Eckstein, “LCS Mission Package Office Focused on Test, Fielding; IOC Dates Continue to Slip,” U.S. Naval Institute News, updated January 25, 2019, <https://news.usni.org/2019/01/25/lcs-mission-package-office-focused-on-test-fielding-ioc-dates-continue-to-slip> (accessed August 1, 2019).
68. U.S. Department of Defense, Department of the Navy, Office of the Chief of Naval Operations, “Optimized Fleet Response Plan,” OPNAV Instruction 3000.15A, November 10, 2014, p. [1], <https://www.secnav.navy.mil/doni/Directives/03000%20Naval%20Operations%20and%20Readiness/03-00%20General%20Operations%20and%20Readiness%20Support/3000.15A.pdf> (accessed August 11, 2019).
69. U.S. Naval Institute News, “USNI News Fleet and Marine Tracker, May 20, 2019,” <https://news.usni.org/2019/05/20/usni-news-fleet-and-marine-tracker-may-20-2019> (accessed August 11, 2019).
70. U.S. Department of the Navy, “Status of the Navy” as of August 9, 2019, [https://www.navy.mil/navydata/nav\\_legacy.asp?id=146](https://www.navy.mil/navydata/nav_legacy.asp?id=146) (accessed August 11, 2019).
71. Rotational deployments involve a ship sailing to a location for a set amount of time and returning to the United States, usually to be replaced by another ship although not always providing an overlapping or unbroken presence.
72. U.S. Navy, U.S. Marine Corps, and U.S. Coast Guard, *Naval Operations Concept 2010: Implementing the Maritime Strategy*, p. 26, <https://fas.org/irp/doddir/navy/noc2010.pdf> (accessed August 11, 2019).
73. On average, rotational deployments require four ships for one ship to be forward deployed. This is necessary because one ship is sailing out to a designated location, one is at location, one is sailing back to the CONUS, and one is in the CONUS for maintenance.
74. Figure 4, “Comparison of Forward-Presence Rates Provided on an Annual Basis for Ships Homeported in the United States and Overseas,” in U.S. Government Accountability Office, *Navy Force Structure: Sustainable Plan and Comprehensive Assessment Needed to Mitigate Long-Term Risks to Ships Assigned to Overseas Homeports*, GAO-15-329, May 2015, p. 13, <https://www.gao.gov/assets/680/670534.pdf> (accessed August 5, 2019).
75. This is based on a calculation of the total number of attack submarines (which includes three different classes), which was 51 as of publication, and the number of *Los Angeles*-class submarines, which was 31 as of publication.
76. Stephen J. Ilteris, “Build Strategic Fast Attack Submarines,” U.S. Naval Institute *Proceedings*, Vol. 142/10/1,364 (October 2016), <https://www.usni.org/magazines/proceedings/2016-10/build-strategic-fast-attack-submarines> (accessed August 11, 2019).
77. Figure 1, “Navy Lead Ships Consistently Cost More Than Initially Budgeted,” in U.S. Government Accountability Office, *Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments*, GAO-18-238SP, June 2018, p. 8, <https://www.gao.gov/assets/700/692331.pdf> (accessed August 5, 2019).
78. “Q&A with Rear Adm. [David] Goggins,” *Undersea Warfare Magazine*, Issue No. 64 (Winter 2018), pp. 10–12, [http://www.public.navy.mil/subfor/underseawarfaremagazine/Issues/PDF/USW\\_Winter\\_2018.pdf](http://www.public.navy.mil/subfor/underseawarfaremagazine/Issues/PDF/USW_Winter_2018.pdf) (accessed August 11, 2019).
79. U.S. Department of Defense, Naval Vessel Register, “Ship Battle Forces.”
80. Sam LaGrone, “Raytheon Awarded LCS Over-the-Horizon Anti-Surface Weapon Contract; Deal Could be Worth \$848M,” U.S. Naval Institute News, updated May 31, 2018, <https://news.usni.org/2018/05/31/raytheon-awarded-lcs-horizon-anti-surface-weapon-contract-deal-worth-848m> (accessed August 11, 2019).
81. Raytheon, “Naval Strike Missile: 5th Gen Over-the-Horizon Tech. Ready Now,” <https://www.raytheon.com/capabilities/products/naval-strike-missile-over-the-horizon-solution> (accessed August 11, 2019).
82. Ronald O’Rourke, “Navy Littoral Combat Ship (LCS) Program: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 18, 2019, p. 3, <https://fas.org/sgp/crs/weapons/RL33741.pdf> (accessed August 11, 2019).
83. U.S. Department of Defense, Office of the Secretary of Defense, Director, Operational Test and Evaluation, *FY 2017 Annual Report*, January 2018, pp. 187–191, <http://www.dote.osd.mil/pub/reports/FY2017/pdf/other/2017DOTEAnnualReport.pdf> (accessed August 11, 2019).

84. Ronald O'Rourke, "Navy Littoral Combat Ship (LCS) Program," p. 14.
85. U.S. Department of Defense, Assistant Secretary of the Navy, Research, Development, and Acquisition, *Report to Congress for the Littoral Combat Ship Mission Modules Program: Annual Report with President's Budget Fiscal Year 2019*, attached to letters from James F. Geurts, Assistant Secretary of the Navy (Research, Development and Acquisition), to The Honorable William M. "Mac" Thornberry, Chairman, Committee on Armed Services, U.S. House of Representatives; The Honorable Rodney P. Frelinghuysen, Chairman, Committee on Appropriations, U.S. House of Representatives; The Honorable Thad Cochran, Chairman, Committee on Appropriations, U.S. Senate; and The Honorable John McCain, Chairman, Committee on Armed Services, U.S. Senate, February 12, 2018, p. 3, <https://news.usni.org/2018/04/03/littoral-combat-ship-mission-package-annual-report> (accessed August 12, 2019).
86. O'Rourke, "Navy Littoral Combat Ship (LCS) Program," p. 14.
87. Eckstein, "LCS Mission Package Office Focused on Test, Fielding."
88. Ibid.
89. David B. Larter, "Congress to Buy 3 More LCS than the Navy Needs, but Gut Funding for Sensors that Make Them Valuable," *Defense News*, September 18, 2018, <https://www.defensenews.com/naval/2018/09/18/congress-to-buy-3-more-lcs-than-the-navy-needs-but-gut-funding-for-sensors-that-makes-them-valuable/> (accessed July 3, 2019).
90. Megan Eckstein, "Navy Set to Restart LCS Deployments this Year, Despite Challenges in Manning, Training," U.S. Naval Institute News, January 14, 2019, <https://news.usni.org/2019/01/14/navy-confident-in-lcs-deployments-this-year-despite-challenges-in-manning-training> (accessed August 1, 2019).
91. Figure 3-2, "DON Battle Force Ship Inventory," in U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 3-2.
92. Megan Eckstein, "Navy Slowing Frigate Procurement to Allow Careful Requirements Talks; Contract Award Set for FY2020," U.S. Naval Institute News, May 3, 2017, <https://news.usni.org/2017/05/03/navy-slowing-frigate-procurement-to-allow-careful-requirements-talks-contract-award-set-for-fy2020> (accessed August 1, 2019).
93. U.S. Department of the Navy, Naval Sea Systems Command, "RFI: FFG(X)—U.S. Navy Guided Missile Frigate Replacement Program," Solicitation Number N0002418R2300, July 10, 2017, <https://www.fbo.gov/index?s=opportunity&mode=form&id=cdf24447b8015337e910d330a87518c6&tab=core&tabmode=list&> (accessed August 10, 2019).
94. Ibid.
95. Ibid.
96. David B. Larter, "Navy Awards Design Contracts for Future Frigate," *Defense News*, February 16, 2018, <https://www.defensenews.com/naval/2018/02/16/navy-awards-design-contracts-for-for-future-frigate/> (accessed August 10, 2019).
97. Lee Hudson, "Navy to Downselect to One Vendor for Future Frigate Competition," *Inside Defense*, January 9, 2018, <https://insidedefense.com/daily-news/navy-downselect-one-vendor-future-frigate-competition> (accessed August 10, 2019).
98. Figure 1, "Navy Briefing Slide on Surface Combatant Force Architecture," in O'Rourke, "Navy Force Structure and Shipbuilding Plans," p. 6.
99. U.S. Department of Defense, Naval Vessel Register, "Ship Battle Forces."
100. Ronald O'Rourke, "Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, October 25, 2016, p. 1, [https://www.history.navy.mil/content/dam/nhhc/research/library/online-reading-room/technology/bmd/navyaegis\\_ballistic.pdf](https://www.history.navy.mil/content/dam/nhhc/research/library/online-reading-room/technology/bmd/navyaegis_ballistic.pdf) (accessed August 12, 2019).
101. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements—OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 6.
102. Exhibit P-40, "Budget Line Item Justification: PB 20 Navy," in U.S. Department of the Navy, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Navy, Justification Book Volume 1 of 5: Other Procurement, Navy, BA 01*, March 2019, Volume 1-489, [https://www.secnaw.navy.mil/fmc/fmb/Documents/20pres/OPN\\_BA1\\_BOOK.pdf](https://www.secnaw.navy.mil/fmc/fmb/Documents/20pres/OPN_BA1_BOOK.pdf) (accessed August 12, 2019).
103. Ibid.
104. Ronald O'Rourke, "Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, updated June 18, 2019, "Summary," <https://fas.org/sgp/crs/weapons/RL32109.pdf> (accessed August 12, 2019).
105. Admiral John M. Richardson, Chief of Naval Operations, written statement on "Fiscal Year 2020 Navy Budget" before the Subcommittee on Defense, Committee on Appropriations, U.S. Senate, May 1, 2019, p. 8, <https://www.appropriations.senate.gov/imo/media/doc/05.01.19--Richardson%20Testimony.pdf> (accessed August 20, 2019).



106. O'Rourke, "Navy DDG-51 and DDG-1000 Destroyer Programs," p. 4. See also *ibid.*, p. 14.
107. *Ibid.*, p. 18.
108. *Ibid.*, p. 4
109. Megan Eckstein, "New Requirements for DDG-1000 Focus on Surface Strike," U.S. Naval Institute News, December 4, 2017, <https://news.usni.org/2017/12/04/navy-refocus-ddg-1000-surface-strike> (accessed August 1, 2019).
110. David B. Larter, "The Navy's Stealth Destroyers to Get New Weapons and a New Mission: Killing Ships," *Defense News*, February 15, 2018, <https://www.defensenews.com/naval/2018/02/15/its-official-the-navys-new-stealth-destroyers-will-be-ship-killers/> (accessed August 12, 2019).
111. U.S. Government Accountability Office, *Weapon Systems Annual Assessment: Limited Use of Knowledge-Based Practices Continues to Undercut DOD's Investments*, GAO-19-336SP, May 2019, p. 106, <https://www.gao.gov/assets/700/698933.pdf> (accessed August 5, 2019).
112. Megan Eckstein, "Navy Stands Up Surface Development Squadron for DDG-1000 Unmanned Experimentation," U.S. Naval Institute News, updated May 22, 2019, <https://news.usni.org/2019/05/22/navy-stands-up-surface-development-squadron-for-ddg-1000-unmanned-experimentation> (accessed August 1, 2019).
113. Testimony of Lieutenant General David H. Berger, Deputy Commandant, Combat Development and Integration, and Commanding General, Marine Corps Combat Development Command, in Congressional Quarterly, "House Armed Services Subcommittee on Seapower and Projection Forces Holds Hearing on Fiscal 2020 Defense Authorization for Seapower and Projection Forces," March 26, 2019.
114. U.S. Department of Defense, Naval Vessel Register, "Ship Battle Forces."
115. Geurts, Merz, and Berger, statement on "The Department of the Navy Fiscal Year 2020 Budget Request for Seapower and Projection Forces," March 26, 2019, p. 11.
116. U.S. Marine Corps, "U.S. Marine Corps Concepts and Programs: EABO," <https://www.candp.marines.mil/Concepts/Subordinate-Operating-Concepts/Expeditionary-Advanced-Base-Operations/> (accessed August 6, 2019).
117. U.S. Navy, "Expeditionary Fast Transport (EFT)," U.S. Navy *Fact File*, last update April 29, 2010, [https://www.navy.mil/navydata/fact\\_display.asp?cid=4200&tid=1100&ct=4](https://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=1100&ct=4) (accessed August 6, 2019), and U.S. Navy, "Expeditionary Transfer Dock (ESD)/Expeditionary Sea Base (ESB)," U.S. Navy *Fact File*, last update January 28, 2019, [https://www.navy.mil/navydata/fact\\_display.asp?cid=4600&tid=675&ct=4](https://www.navy.mil/navydata/fact_display.asp?cid=4600&tid=675&ct=4) (accessed August 6, 2019).
118. Ronald O'Rourke, "Navy LPD-17 Flight II (LX[R]) Amphibious Ship Program: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, updated July 24, 2019, pp. 4–5, <https://fas.org/sgp/crs/weapons/R43543.pdf> (accessed August 6, 2019).
119. *Ibid.*, p. 1.
120. Geurts, Merz, and Berger, statement on "The Department of the Navy Fiscal Year 2020 Budget Request for Seapower and Projection Forces," March 26, 2019, p. 10.
121. U.S. Department of Defense, Naval Vessel Register, "Ship Battle Forces."
122. U.S. Navy, "Amphibious Assault Ships—LHD/LHA®," U.S. Navy *Fact File*, last update January 16, 2019, [https://www.navy.mil/navydata/fact\\_display.asp?cid=4200&tid=400&ct=4](https://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=400&ct=4) (accessed August 6, 2019).
123. Megan Eckstein, "USS America Will Head to Japan to Serve as Next Forward-Deployed Amphibious Flagship," U.S. Naval Institute News, January 17, 2019, <https://news.usni.org/2019/01/17/uss-america-to-japan> (accessed August 1, 2019).
124. *Ibid.* and U.S. Navy, "United States Navy Fact File: Amphibious Assault Ships—LHD/LHA(R)," last update January 16, 2019, [https://www.navy.mil/navydata/fact\\_display.asp?cid=4200&tid=400&ct=4](https://www.navy.mil/navydata/fact_display.asp?cid=4200&tid=400&ct=4) (accessed August 1, 2019).
125. Ronald O'Rourke, "Navy Ford (CVN-78) Class Aircraft Carrier Program: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, updated July 24, 2019, p. 4, <https://fas.org/sgp/crs/weapons/RS20643.pdf> (accessed August 6, 2019).
126. *Ibid.*, p. 21.
127. U.S. Navy, "USS Gerald R. Ford Accepts Second Advanced Weapons Elevator," March 6, 2019, [https://www.navy.mil/submit/display.asp?story\\_id=108809](https://www.navy.mil/submit/display.asp?story_id=108809) (accessed August 6, 2019).
128. Ben Werner and Sam LaGrone, "USS Gerald. R. Ford Weapons Elevator Certifications Will Extend Past October," U.S. Naval Institute News, May 29, 2019, <https://news.usni.org/2019/05/29/uss-gerald-r-ford-weapons-elevator-certifications-will-extend-past-october> (accessed August 6, 2019).



129. Paul McCleary, "Will Trump Fire SecNav? Super Carrier USS Ford Suffers New Setback," *Breaking Defense*, May 29, 2019, <https://breakingdefense.com/2019/05/will-trump-fire-secnav-super-carrier-uss-ford-suffers-new-setback/> (accessed August 6, 2019).
130. Paul McCleary, "Inhofe: Any Ford Delay Would Present 'a Dangerous Readiness Gap,'" *Breaking Defense*, May 30, 2019, [https://breakingdefense.com/2019/05/inhofe-any-ford-delay-would-present-a-dangerous-readiness-gap/?utm\\_source=Sailthru&utm\\_medium=email&utm\\_campaign=ebb%2005.31.19&utm\\_term=Editorial%20-%20Early%20Bird%20Brief](https://breakingdefense.com/2019/05/inhofe-any-ford-delay-would-present-a-dangerous-readiness-gap/?utm_source=Sailthru&utm_medium=email&utm_campaign=ebb%2005.31.19&utm_term=Editorial%20-%20Early%20Bird%20Brief) (accessed August 6, 2019).
131. Hans M. Kristensen, "New Data Shows Detail About Final Phase of US New START Treaty Reductions," Federation of American Scientists, January 13, 2018, <https://fas.org/blogs/security/2018/01/new-start-full-data/> (accessed May 22, 2019).
132. U.S. Navy, "Executive Summary: 2016 Navy Force Structure Assessment (FSA)," p. 3, and U.S. Department of Defense, *Nuclear Posture Review 2018*, February 2018, p. 49, <https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF> (accessed August 5, 2019).
133. Ronald O'Rourke, "Navy Columbia (SSBN-826) Class Ballistic Missile Submarine Program: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, updated June 4, 2019, p. 12, <https://fas.org/sgp/crs/weapons/R41129.pdf> (accessed August 5, 2019).
134. *Ibid.*, p. 6.
135. *Ibid.*, p. 21.
136. *Ibid.*, pp. 36 and 2.
137. *Ibid.*, p. 5.
138. U.S. Government Accountability Office, *Columbia Class Submarine: Overly Optimistic Cost Estimate Will Likely Lead to Budget Increases*, GAO-19-497, April 2019, p. 19, <https://www.gao.gov/assets/700/698320.pdf> (accessed August 5, 2019).
139. Ben Werner, "'Substantial' Columbia-class Missile Tube Weld Fix Will Cost \$27 Million, Take a Year," U.S. Naval Institute News, November 7, 2018, <https://news.usni.org/2018/11/07/columbia-class-missile-tube-weld-issues-to-cost-27-million-take-year-to-fix> (accessed August 6, 2019).
140. U.S. Government Accountability Office, *Columbia Class Submarine: Overly Optimistic Cost Estimate Will Likely Lead to Budget Increases*, p. 20.
141. U.S. Navy, "Navy Establishes New PEO Columbia," March 6, 2019, [https://www.navy.mil/submit/display.asp?story\\_id=108814](https://www.navy.mil/submit/display.asp?story_id=108814) (accessed August 6, 2019).
142. *Ibid.*
143. Ronald O'Rourke, "Navy Virginia (SSN-774) Class Attack Submarine Procurement: Background and Issues for Congress," Congressional Research Service *Report for Members and Committees of Congress*, June 24, 2019, pp. 1–2, <https://fas.org/sgp/crs/weapons/RL32418.pdf> (accessed August 9, 2019).
144. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 4–4.
145. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 6.
146. O'Rourke, "Navy Virginia (SSN-774) Class Attack Submarine Procurement," pp. 7 and 8.
147. David B. Larter, "The US Navy, Seeking Savings, Shakes up Its Plans for More Lethal Attack Submarines," *Defense News*, April 3, 2019, <https://www.defensenews.com/naval/2019/04/04/the-us-navy-seeking-savings-shakes-up-its-plans-for-more-lethal-attack-submarines/> (accessed August 9, 2019).
148. Captain Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406), "Unmanned Maritime Systems Update for Sea-Air-Space," Program Executive Office Unmanned and Small Combatants, May 6, 2019, p. 6, <https://www.navsea.navy.mil/Portals/103/Documents/Exhibits/SAS2019/Capt%20Small-SAS-05062019.pdf?ver=2019-05-06-200405-520> (accessed August 9, 2019).
149. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 5–3, and Small, "Unmanned Maritime Systems Update for Sea-Air-Space," p. 3.
150. Megan Eckstein, "Sea Hunter Unmanned Ship Continues Autonomy Testing as NAVSEA Moves Forward with Draft RFP," U.S. Naval Institute News, April 29, 2019, <https://news.usni.org/2019/04/29/sea-hunter-unmanned-ship-continues-autonomy-testing-as-navsea-moves-forward-with-draft-rfp> (accessed August 1, 2019).
151. Ben Werner, "Navy Awards Boeing \$43 Million to Build Four Orca XLUVs," U.S. Naval Institute News, February 13, 2019, <https://news.usni.org/2019/02/13/41119> (accessed August 12, 2019).
152. Small, "Unmanned Maritime Systems Update for Sea-Air-Space," p. 4.

153. Ibid.
154. Ibid.
155. Tyler Rogoway, "Navy F/A-18 Legacy Hornets Have Taken Their Last Cruise Aboard a U.S. Aircraft Carrier," The War Zone, April 14, 2018, <http://www.thedrive.com/the-war-zone/2018/navy-f-a-18-legacy-hornets-have-taken-their-last-cruise-aboard-a-u-s-aircraft-carrier> (accessed August 12, 2019).
156. Megan Eckstein, "Navy's Last F-18 Hornet Squadron Holds Sundowns Ahead of Transition to Super Hornet," U.S. Naval Institute News, February 4, 2019, <https://news.usni.org/2019/02/04/navys-last-f-18-hornet-squadron-holds-sundown-ceremony-will-transition-to-super-hornet> (accessed August 1, 2019).
157. Daniel L. Nega, Deputy Assistant Secretary of the Navy, Air Programs; Lieutenant General Steven Rudder, Deputy Commandant for Aviation; and Rear Admiral Scott Conn, Director, Air Warfare, statement on "Department of the Navy Aviation Programs" before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, U.S. House of Representatives, April 4, 2019, p.4, [https://armedservices.house.gov/\\_cache/files/7/4/7489a8f6-0498-4fe2-8121-62c4073fe7aa/142D16B3BD63F0EC49F88AE9AAF0E4E7.hrg-116-as25-wstate-rudders-20190404.pdf](https://armedservices.house.gov/_cache/files/7/4/7489a8f6-0498-4fe2-8121-62c4073fe7aa/142D16B3BD63F0EC49F88AE9AAF0E4E7.hrg-116-as25-wstate-rudders-20190404.pdf) (accessed August 1, 2019).
158. Figure 4.3, "Aircraft Procurement Quantities and Total Funding," in U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 4-5.
159. Sydney J. Freedberg Jr., "F-35C Readiness Rises, Navy Fighter Shortfall Fades," *Breaking Defense*, April 10, 2019, <https://breakingdefense.com/2019/04/navy-aviation-optimism-f-35c-readiness-rises-fighter-shortfall-fades/> (accessed August 12, 2019).
160. Nega, Rudder, and Conn, statement on "Department of the Navy's Aviation Programs," April 4, 2019, p. 6.
161. Ibid., pp. 6 and 22.
162. Ibid., pp. 22 and 23.
163. Jeremiah Gertler, "F-35 Joint Strike Fighter (JSF) Program," Congressional Research Service *Report for Members and Committees of Congress*, April 23, 2018, pp. 4 and 14, <https://fas.org/sgp/crs/weapons/RL30563.pdf> (accessed August 6, 2019).
164. Nega, Rudder, and Conn, statement on "Department of the Navy's Aviation Programs," April 4, 2019, p. 3.
165. U.S. Department of Defense, *Annual Aviation Inventory and Funding Plan Fiscal Years (FY) 2019–2048*, March 2018, p. 10, <https://apps.dtic.mil/docs/citations/AD1062648> (accessed August 6, 2019).
166. Megan Eckstein, "Navy Declares Initial Operational Capability for F-35C Joint Strike Fighter," U.S. Naval Institute News, February 28, 2019, <https://news.usni.org/2019/02/28/navy-declares-initial-operational-capability-for-f-35c-joint-strike-fighter> (accessed August 1, 2019).
167. U.S. Department of Defense, *Annual Aviation Inventory and Funding Plan Fiscal Years (FY) 2019–2048*, p. 8.
168. Eckstein, "Navy Declares Initial Operational Capability for F-35C Joint Strike Fighter."
169. Megan Eckstein, "Navy Deactivates VFA-101 Grim Reapers, Consolidates F-35Cs at NAS Lemoore," U.S. Naval Institute News, May 23, 2019, <https://news.usni.org/2019/05/23/navy-deactivates-vfa-101-grim-reapers-consolidates-f-35cs-at-nas-lemoore> (accessed August 1, 2019).
170. Nega, Rudder, and Conn, statement on "Department of the Navy's Aviation Programs," April 4, 2019, p. 7.
171. Figure 4-3, "Aircraft Procurement Quantities and Total Funding," in U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 4-5.
172. Geurts, Merz, and Berger, statement on "The Department of the Navy Fiscal Year 2020 Budget Request for Seapower and Projection Forces," March 26, 2019, p. 19.
173. Ibid., pp. 19–20, and U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, pp. 4-5 and 4-7.
174. Northrop Grumman, "MQ-4C Triton," <https://www.northropgrumman.com/Capabilities/Triton/Pages/default.aspx> (accessed August 8, 2019).
175. Megan Eckstein, "Navy Stand-Down of Triton Drones Will Continue Until Crash Investigation Concludes," U.S. Naval Institute News, September 21, 2018, <https://news.usni.org/2018/09/21/navy-stand-triton-operations-will-continue-mishap-investigation-wraps> (accessed August 1, 2019).
176. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 5-5.
177. Ibid., p. 5-6, and Geurts, Merz, and Berger, statement on "The Department of the Navy Fiscal Year 2020 Budget Request for Seapower and Projection Forces," March 26, 2019, p. 20.

178. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 1-5.
179. Nega, Rudder, and Conn, statement on “Department of the Navy’s Aviation Programs,” April 4, 2019, pp. 17 and 18.
180. U.S. Department of the Navy, Chief of Naval Operations, “Navy Fiscal Year 2020 Unfunded Priorities List Descriptions” attached to letters from Admiral John M. Richardson, Chief of Naval Operations, to The Honorable James M. Inhofe, Chairman, Committee on Armed Services, U.S. Senate, and The Honorable Adam Smith, Chairman, Committee on Armed Services, U.S. House of Representatives, March 22, 2109, p. 2, [https://www.defensedaily.com/wp-content/uploads/post\\_attachment/239633.pdf](https://www.defensedaily.com/wp-content/uploads/post_attachment/239633.pdf) (accessed August 8, 2019).
181. Megan Eckstein, “Navy Investing in Researching Next-Generation Missiles, Enhancing Current Ones,” U.S. Naval Institute News, April 15, 2019, <https://news.usni.org/2019/04/15/navy-investing-in-researching-next-generation-missiles-enhancing-current-ones> (accessed August 8, 2019).
182. Ron O’Rourke, “Navy Lasers, Railgun, and Gun-Launched Guided Projectile: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 19, 2019, pp. 4–5, <https://fas.org/sgp/crs/weapons/R44175.pdf> (accessed August 8, 2019).
183. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 5-6.
184. Ibid.
185. Ibid. and O’Rourke, “Navy Lasers, Railgun, and Gun-Launched Guided Projectile,” p. 9.
186. Sam LaGrone, “Navy Ready to ‘Burn the Boats’ with 2021 Laser Installation on a Destroyer,” U.S. Naval Institute News, March 20, 2019, <https://news.usni.org/2019/03/20/navy-ready-burn-boats-2021-laser-installation-destroyer> (accessed August 8, 2019).
187. O’Rourke, “Navy Lasers, Railgun, and Gun-Launched Guided Projectile,” p. 9.
188. Admiral William F. Moran, Vice Chief of Naval Operations, statement on “Current Readiness of U.S. Forces” before the Subcommittee on Readiness, Committee on Armed Services, U.S. Senate, February 14, 2018, pp. 3–4, [https://www.armed-services.senate.gov/imo/media/doc/Moran\\_02-14-18.pdf](https://www.armed-services.senate.gov/imo/media/doc/Moran_02-14-18.pdf) (accessed August 10, 2019).
189. Ibid.
190. Testimony of Admiral John M. Richardson, Chief of Naval Operations, in Congressional Quarterly, “Senate Armed Services Committee Holds Hearing on Navy Posture,” CQ Congressional Transcripts, April 19, 2018, <http://www.cq.com/doc/congressionaltranscripts-530284373> (accessed August 8, 2019).
191. Figure 2, “Aircraft Carrier, Surface Ship, and Submarine Days of Maintenance Delay, Fiscal Years 2012–2018,” in John H. Pendleton, Director, Defense Capabilities and Management, U.S. Government Accountability Office, “Navy and Marine Corps: Rebuilding Ship, Submarine, and Aviation Readiness Will Require Time and Sustained Management Attention,” GAO-19-225T, testimony before the Subcommittees on Seapower and Readiness and Management Support, Committee on Armed Services, U.S. Senate, December 12, 2018, p. 7, <https://www.gao.gov/assets/700/695911.pdf> (accessed July 3, 2019).
192. Ibid.
193. U.S. Department of the Navy, Chief of Naval Operations, “Navy Fiscal Year 2020 Unfunded Priorities List,” p. 1. Specifically, the \$763 million accounts for funding that is most directly related to deferred ship maintenance: \$290 million (*Boise*), \$306 million (*Hartford*); \$57 million (*Columbus*); \$40 million (*Stockdale/Michael Murphy*); and \$70 million (general additional deferred maintenance items) for a total of \$763 million. The remaining \$51 million is attributed to property and overhead.
194. U.S. Government Accountability Office, “Navy Readiness: Actions Needed to Address Costly Maintenance Delays Facing the Attack Submarine Fleet,” GAO-19-229, November 2018, p. 8, <https://www.gao.gov/assets/700/695577.pdf> (accessed August 5, 2019).
195. Ibid.
196. Hugh Lessig, “Submarine Maintenance Behind Schedule at Newport News Shipyard,” *The Virginian-Pilot*, April 18, 2019, [https://pilotonline.com/business/defense-shipyards/article\\_f2905e94-6142-11e9-b778-a7a333fd74e5.html](https://pilotonline.com/business/defense-shipyards/article_f2905e94-6142-11e9-b778-a7a333fd74e5.html) (accessed August 9, 2019).
197. Testimony of Admiral William Moran, Vice Chief of Naval Operations, in Congressional Quarterly, “House Armed Services Subcommittee on Readiness Holds Hearing on Fiscal 2020 Budget Request for Military Readiness,” CQ Congressional Transcripts, May 9, 2019, <https://plus.cq.com/doc/congressionaltranscripts-553472874> (accessed August 9, 2019).
198. Figure 3.5, “Department of the Navy Ship Maintenance,” in U.S. Department of the Navy, *Highlights of the Department of the Navy FY 2020 Budget*, p. 3-5.
199. Figure 3.8, “Aircraft Depot Maintenance and Aviation Logistics,” in U.S. Department of the Navy, *Highlights of the Department of the Navy FY 2020 Budget*, p. 3-9.
200. U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, p. 19.

201. Figure 2.10, “DON Civilian Manpower in Full-Time Equivalent Personnel,” in U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 2-13.
202. “Executive Summary” of U.S. Navy, Naval Sea Systems Command, Shipyard Optimization and Recapitalization Plan, released September 12, 2018, p. 3, <https://news.usni.org/2018/09/12/executive-summary-to-naval-shipyard-recapitalization-and-optimization-plan> (accessed August 9, 2019).
203. U.S. Navy, Naval Sea Systems Command, *Report to Congress on the Long-Range Plan for Maintenance and Modernization of Naval Vessels for Fiscal Year 2020*, March 21, 2019, pp. 1, 2–5, and 6, <https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/FY20%20Long%20Range%20Maintenance+Modernization%20Plan.pdf> (accessed August 5, 2019).
204. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 3-3.
205. *Ibid.*, p. 3-8.
206. U.S. Department of the Navy, *Naval Aviation Vision 2016–2025*, p. 12, [http://www.navy.mil/strategic/Naval\\_Aviation\\_Vision.pdf](http://www.navy.mil/strategic/Naval_Aviation_Vision.pdf) (accessed August 9, 2019).
207. Tara Copp, “Navy’s Spike in Aviation Mishaps Is the Military’s Worst, up 82 Percent,” *Military Times*, April 8, 2018, <https://www.militarytimes.com/news/your-military/2018/04/08/navys-spike-in-aviation-mishaps-is-the-militarys-worst-up-82-percent/> (accessed August 9, 2019).
208. Vice Admiral Troy M. Shoemaker, Commander, Naval Air Forces, statement on “Aviation Readiness” before the Subcommittee on Readiness, Committee on Armed Services, U.S. House of Representatives, November 9, 2017, pp. 3 and 4, <https://docs.house.gov/meetings/AS/AS03/20171109/106611/HHRG-115-AS03-Wstate-ShoemakerM-20171109.pdf> (accessed August 9, 2019).
209. James N. Mattis, U.S. Secretary of Defense, Memorandum for Secretaries of the Military Services, Under Secretary of Defense for Acquisition and Sustainment, and Under Secretary of Defense for Personnel and Readiness on “NDS Implementation—Mission Capability of Critical Aviation Platforms,” September 17, 2018, <https://news.usni.org/2018/10/09/secdef-mattis-wants-80-percent-super-hornet-mission-capable-next-year> (accessed August 6, 2019).
210. Sam LaGrone, “SECDEF Mattis Wants 80 Percent of Super Hornets Mission Capable by Next Year,” U.S. Naval Institute News, October 9, 2018, <https://news.usni.org/2018/10/09/secdef-mattis-wants-80-percent-super-hornet-mission-capable-next-year> (accessed August 6, 2019).
211. Testimony of Secretary of the Navy Richard Spencer in Congressional Quarterly, “House Armed Services Committee Holds Hearing on the Navy Fiscal Year 2020 Defense Authorization Request,” CQ Congressional Transcripts, April 10, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5511018?2> (accessed August 6, 2019).
212. Testimony of Rear Admiral Scott D. Conn, Director, Air Warfare, Office of the Chief of Naval Operations, in Congressional Quarterly, “House Armed Services Subcommittee on Tactical Air and Land Forces Holds Hearing on Navy and Marine Corps Tactical Aviation and Ground Modernization,” CQ Congressional Transcripts, April 4, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5505435?4> (accessed August 5, 2019).
213. Testimony of Vice Admiral Mathias W. Winter, Executive Officer, F-35 Lightning II Program, in *ibid.*
214. Corey Dickstein, “CNO Orders Navy-wide Pause, Broad Review After 2nd Pacific Collision in 2 Months,” *Stars and Stripes*, August 21, 2017, <https://www.stripes.com/news/pacific/cno-orders-navy-wide-pause-broad-review-after-2nd-pacific-collision-in-2-months-1.483806#.WZxmGumQyUk> (accessed August 9, 2019).
215. U.S. Department of the Navy, Fleet Forces Command, *Comprehensive Review of Recent Surface Force Incidents*, October 26, 2017, p. 6, [http://s3.amazonaws.com/CHINFO/Comprehensive+Review\\_Final.pdf](http://s3.amazonaws.com/CHINFO/Comprehensive+Review_Final.pdf) (accessed August 9, 2019).
216. *Ibid.*, pp. 6–7 and 107–114.
217. U.S. Department of the Navy, *Strategic Readiness Review 2017*, pp. 4–5, <http://s3.amazonaws.com/CHINFO/SRR+Final+12112017.pdf> (accessed August 9, 2019).
218. Naval Sea Systems Command Corporate Communication, “USS Fitzgerald Leaves Dry Dock, Continues Repairs Pierside in Pascagoula,” April 16, 2019, [https://www.navy.mil/submit/display.asp?story\\_id=109278](https://www.navy.mil/submit/display.asp?story_id=109278) (accessed August 9, 2019).
219. U.S. Navy, “USS John S. McCain Leaves Dry Dock, Continues Repairs in Yokosuka,” November 27, 2018, [https://www.navy.mil/submit/display.asp?story\\_id=107922](https://www.navy.mil/submit/display.asp?story_id=107922) (accessed August 9, 2019).
220. See note 164, *supra*.

221. U.S. Navy, Naval History and Heritage Command, “Naval Aviation Units Involved in the Persian Gulf War (16 January–27 February 1991),” August 30, 2018, <https://www.history.navy.mil/content/history/nhhc/research/histories/naval-aviation-history/involvement-by-conflict/gulf-war-carrier-deployments.html> (accessed August 10, 2019); Gregory Bereiter, “The US Navy in Operation Enduring Freedom, 2001–2002,” U.S. Navy, Naval History and Heritage Command, July 11, 2019, <https://www.history.navy.mil/research/library/online-reading-room/title-list-alphabetically/u/us-navy-operation-enduring-freedom-2001-2002.html> (accessed August 10, 2019); and U.S. Navy, Naval History and Heritage Command, “Operation Iraqi Freedom,” May 20, 2019, <https://www.history.navy.mil/content/history/nhhc/browse-by-topic/wars-conflicts-and-operations/middle-east/operation-iraqi-freedom.html> (accessed August 10, 2019).
222. Congressional Budget Office, *The U.S. Military’s Force Structure: A Primer*, July 2016, p. 45, <https://www.cbo.gov/sites/default/files/114th-congress-2015-2016/reports/51535-fsprimerlite.pdf> (accessed August 10, 2019).
223. This requirement is derived from the BUR’s requirement for four–five carrier strike groups per MRC; however, this *Index* finds that this number is low by historical accounts and therefore recommends one additional carrier per MRC.
224. The 2016 Force Structure Assessment established a requirement for “[a] minimum of 12 Aircraft Carriers...to meet the increased warfighting response requirements of the Defense Planning Guidance Defeat/Deny force sizing direction.” U.S. Navy, “Executive Summary: 2016 Navy Force Structure Assessment (FSA),” p. 3.
225. The Navy’s Optimized Fleet Response Plan dictates a 36-month cycle of maintenance, training, and forward deployment. The OFRP allows for six months of shipyard maintenance, eight months of basic and integrated training, and a seven-month deployment followed by a 15-month sustainment period in which the CSG will be at its homeport but maintaining a deployed-force level of proficiency. Assuming that the carrier and its escort ships are not available during their maintenance cycle for even a 30-day surge, this equates to just over 19 percent unavailability in the 36-month cycle. The seven-month deployment per each cycle also equates to five CVNs required for a 1.0 continuous CVN presence.
226. U.S. Department of the Navy, Office of the Chief of Naval Operations, “Force Composition of Afloat Navy and Naval Groups,” OPNAV INSTRUCTION 3501.316C, November 10, 2017, Enclosure (1), “Carrier Strike Group,” p. 2, <https://www.secnav.navy.mil/doni/Directives/03000%20Naval%20Operations%20and%20Readiness/03-500%20Training%20and%20Readiness%20Services/3501.316C.pdf> (accessed August 8, 2019).
227. Table 1.1, “Notional Configuration for a Carrier Battle Group,” in U.S. General Accounting Office, *Navy Carrier Battle Groups: The Structure and Affordability of the Future Force*, GAO/NSIAD-93-94, February 1993, p. 18, <https://www.gao.gov/assets/160/152948.pdf> (accessed August 5, 2019).
228. See note 221, *supra*.
229. U.S. Navy, “The Carrier Air Wing,” <http://www.navy.mil/navydata/ships/carriers/powerhouse/airwing.asp> (accessed August 8, 2019).
230. The full array of aircraft comprising a carrier air wing also includes one EA-18G Growler electronic attack squadron, one E-2D Hawkeye airborne early warning squadron, two SH-60 Seahawk helicopter squadrons, and one C-2 Greyhound logistics support squadron.
231. Table, “Features of Recent Navy Force Structure Plans,” in O’Rourke, “Navy Force Structure and Shipbuilding Plans,” p. 43, note 44.
232. U.S. Navy, “Executive Summary: 2016 Navy Force Structure Assessment (FSA),” p. 1.
233. The size and capability of amphibious ships also have grown over time, with smaller amphibious ships like the old landing ship tank (LST) replaced by the much larger LSD and LPD classes. Consequently, fewer ships are required to lift the same or an even larger amphibious force.
234. U.S. Marine Corps, “Concepts and Programs: Types of MAGTFs,” <http://www.candp.marines.mil/Organization/MAGTF/Types-of-MAGTFs/> (accessed August 8, 2019). See especially the included graphic, “Notional Laydown of a Marine Expeditionary Brigade (MEB).”
235. *Ibid.*
236. The Navy defines the requirements for an ESG as follows: “[a] minimum of three amphibious ships” based on Combatant Commander requirements and missions, including “[a]t least one amphibious assault ship, multi- or general purpose ship (landing ship assault (LHA) [or] landing helicopter dock (LHD));” “[a]t least one amphibious transport dock (LPD);” and “[a]t least one amphibious dock landing ship (LSD).” An ESG may also include “other forces assigned (surface combatants and auxiliary support vessels will be similar to those assigned to a CSG dependent on the threat and capabilities of the ships assigned).” U.S. Department of the Navy, Office of the Chief of Naval Operations, “Force Composition of Afloat Navy and Naval Groups,” Enclosure (2), “Amphibious Ready Group and Marine Expeditionary Unit,” p. 1, and Enclosure (3), “Expeditionary Strike Group.”

237. U.S. Department of the Navy, Office of the Chief of Naval Operations, "Force Composition of Afloat Navy and Naval Groups," Enclosure (3), "Expeditionary Strike Group."
238. Congressional Budget Office, *An Analysis of the Navy's Amphibious Warfare Ships for Deploying Marines Overseas*, November 2011, p. 1, <http://www.cbo.gov/sites/default/files/cbofiles/attachments/11-18-AmphibiousShips.pdf> (accessed August 8, 2019).
239. It is important to note that the two-MEB reference is tied to a conventional approach to major amphibious operations where, in the past, several amphibious ships were deployed or brought together to execute an insertion of Marine Corps forces onto some landing objective. As mentioned, the Navy and Marine Corps are in the lengthy process of determining what revised Marine operational concepts, such as LOCE and EABO, will mean for the size and shape of the Navy's amphibious fleet. Whether the numbers of specific types of ships—LHAs, LSDs, LPDs—will change to a different arrangement of a greater number of smaller amphibious platforms of different design remains to be seen.
240. For additional detail on the analysis behind the 400-ship benchmark, see Callender, "The Nation Needs a 400-Ship Navy."
241. U.S. Navy, "Executive Summary: 2016 Navy Force Structure Assessment (FSA)," p. 3.
242. *Ibid.*, p. 2.
243. Mattis, *Summary of the 2018 National Defense Strategy of the United States of America*, p. 4.
244. Congressional Quarterly, "Senate Armed Services Committee Holds Hearing on Navy Posture," April 19, 2018.
245. U.S. Department of the Navy, *Highlights of the Department of the Navy FY 2020 Budget*, March 12, 2019, p. 2-2.
246. Testimony of Admiral Christopher Grady, Commander, U.S. Naval Forces Northern Command, in Congressional Quarterly, "House Armed Services Subcommittee on Readiness and Subcommittee on Seapower and Projection Forces Hold Joint Hearing on Naval Surface Forces Readiness," CQ Congressional Transcripts, February 26, 2019, <https://plus.cq.com/doc/congressionaltranscripts-5471656?7> (accessed August 8, 2019).
247. Mark D. Faram, "How the Navy Got to Be 6K Sailors Short at Sea," *Navy Times*, March 25, 2019, <https://www.navytimes.com/news/your-navy/2019/03/25/how-the-navy-got-to-be-6k-sailors-short-at-sea/> (accessed July 3, 2019).
248. News release, "Department of Defense Announces Fiscal Year 2018 Recruiting and Retention Numbers—End of Year Report," U.S. Department of Defense, November 15, 2018, <https://dod.defense.gov/News/News-Releases/News-Release-View/Article/1691314/departement-of-defense-announces-fiscal-year-2018-recruiting-and-retention-numbe/> (accessed July 3, 2019).
249. Mark D. Faram, "Navy Sees Recruiting Challenges on the Horizon," *Navy Times*, November 2, 2018, <https://www.navytimes.com/news/your-navy/2018/11/02/navy-sees-recruiting-challenges-on-the-horizon/> (accessed July 3, 2019).
250. Stenographic transcript of *Hearing to Receive Testimony on the Current Readiness of U.S. Forces*, Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate, February 8, 2016, pp. 44–45, [https://www.armed-services.senate.gov/imo/media/doc/17-07\\_02-08-17.pdf](https://www.armed-services.senate.gov/imo/media/doc/17-07_02-08-17.pdf) (accessed July 3, 2019).
251. Hope Hodge Seck, "CNO Orders Operational Pause, Review After Latest Ship Collision," *Military.com*, August 21, 2017, <https://www.military.com/daily-news/2017/08/21/cno-orders-operational-pause-review-after-latest-ship-collision.html> (accessed July 3, 2019).
252. John H. Pendleton, Director, Defense Capabilities and Management, U.S. Government Accountability Office, "Navy Readiness: Actions Needed to Address Persistent Maintenance, Training, and Other Challenges Affecting the Fleet," GAO-17-809T, testimony before the Committee on Armed Services, U.S. Senate, September 19, 2017, p. 8, <https://www.gao.gov/assets/690/687224.pdf> (accessed July 3, 2019).
253. David B. Larter, "Troubling US Navy Review Finds Widespread Shortfalls in Basic Seamanship," *Defense News*, June 6, 2018, <https://www.defensenews.com/naval/2018/06/06/troubling-us-navy-review-finds-widespread-shortfalls-in-basic-seamanship/> (accessed August 7, 2019).
254. Congressional Quarterly, "House Armed Services Subcommittees on Readiness and Seapower and Projection Forces Holds [sic] Joint Hearing on Surface Warfare," CQ Congressional Transcripts, January 18, 2018, <http://www.cq.com/doc/congressionaltranscripts-5250864?2> (accessed July 3, 2019).
255. David B. Larter, "In Japan, a Hard-Hit US Navy Fleet Is Steadying on a New Course," *Defense News*, April 10, 2018, <https://www.defensenews.com/digital-show-dailies/navy-league/2018/04/10/in-japan-a-hard-hit-fleet-is-steadying-on-a-new-course/> (accessed July 3, 2019).
256. Admiral John M. Richardson, U.S. Navy, Chief of Naval Operations, statement on "Surface Warfare at a Crossroads" before the Subcommittee on Readiness and Subcommittee on Seapower and Projection Forces, Committee on Armed Services, U.S. House of Representatives, January 18, 2018, p. 2, <https://docs.house.gov/meetings/AS/AS03/20180118/106784/HHRG-115-AS03-Wstate-RichardsonJ-20180118.pdf> (accessed July 3, 2019).



- 257. Vice Admiral Richard Brown, Commander, Naval Surface Forces (COMNAVSURFOR), message on “Surface Warfare Officer Career Path and Training Continuum,” June 15, 2018, <https://news.usni.org/2018/06/28/new-career-path-surface-warfare-officers-stresses-fundamentals-training-first-ship-time-sea> (accessed July 3, 2019).
- 258. Enclosure (1), “Charter for the Readiness Reform and Oversight Council,” in William F. Moran, Vice Chief of Naval Operations, Memorandum for the Record, “Readiness Reform Oversight Committee,” February 25, 2019, <https://www.navy.mil/strategic/RROC1YR.pdf> (accessed July 3, 2019).
- 259. Enclosure (2), “RROC One Year Later,” in Moran, Memorandum for the Record, “Readiness Reform Oversight Committee.”
- 260. Richardson, statement on “Fiscal Year 2020 Navy Budget,” April 10, 2019, p. 12.



# U.S. Air Force

The U.S. Air Force (USAF) is the youngest of the U.S. military's four branches, having been born out of the Army Signal Corps to become its own service in 1947. The significant expansion of the USAF's mission over the years is reflected in the changes in its organizational structure. Initially, Air Force operations were divided among four major components—Strategic Air Command, Tactical Air Command, Air Defense Command, and Military Air Transport Service—that collectively reflected its “fly, fight, and win” nature. Space's rise to prominence began in the early 1950s, and with it came a host of faculties that would help to expand the service's impact and mission set.

Today, the Air Force focuses on five principal missions:

- Air and space superiority;
- Intelligence, surveillance, and reconnaissance (ISR);
- Mobility and lift;
- Global strike; and
- Command and control (C2).

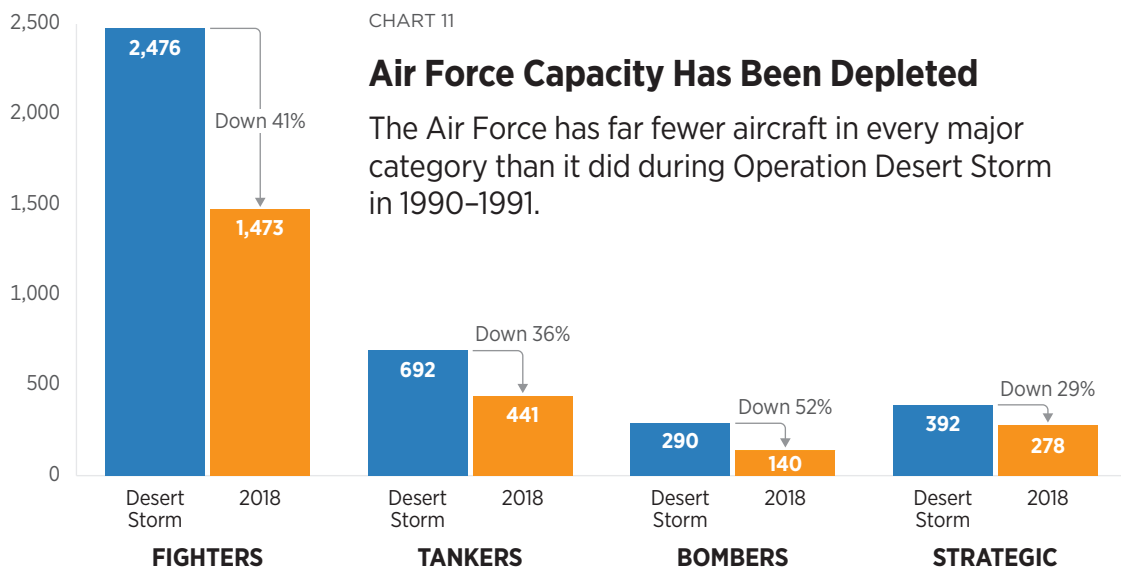
These missions, while all necessary, put even greater demands on the resources available to the Air Force in an incredibly strained and competitive fiscal environment. Unlike some of the other services, the Air Force did not expand in numbers during the post-9/11 buildup. Instead, it grew smaller as acquisitions of new aircraft failed to offset

programmed retirements of older aircraft. Following the sequestration debacle in 2012, the Air Force began to trade size for quality. Using the 2012 Defense Strategic Guidance (DSG) as its framework for determining investment priorities and posture, the Air Force “aim[ed] to be a smaller, but superb, force that maintains the agility, flexibility, and readiness to engage a full range of contingencies and threats.”<sup>1</sup>

There is no doubt that the Air Force has become smaller over the years, but there comes a point when capacity begins to limit operational capability. In the words of then-Secretary of the Air Force Heather Wilson, “It's no surprise that the Air Force we have is...smaller than the Air Force we need.”<sup>2</sup>

The years of funding shortfalls, coupled with wartime demands and the weight of an ever-aging fleet of aircraft, would not allow the service to reverse the downward spiral in capability, capacity, and readiness. The Air Force was forced to make strategic trades in capability, capacity, and readiness to meet the operational demands of the war on terrorism and develop the force it needed for the future. Budgetary uncertainty throughout the five years after passage of the Budget Control Act had many cumulative and detrimental effects on the USAF, which, while it sustained the war on terrorism and began to modernize its aging fleet of aircraft, struggled to sustain the type of readiness required to employ in a major regional contingency (MRC) against a near-peer threat.

Presidential defense budgets from 2012 through 2017 during the Obama Administration proved merely aspirational and forced



**SOURCE:** Stephen Losey, “Aircraft Mission-capable Rates Hit New Low in Air Force, Despite Efforts to Improve,” *Air Force Times*, July 26, 2019, <https://www.airforcetimes.com/news/your-air-force/2019/07/26/aircraft-mission-capable-rates-hit-new-low-in-air-force-despite-efforts-to-improve/> (accessed July 29, 2019).

heritage.org

deeper trade-offs in capability, capacity, and readiness for operational employment, all of which put the Air Force in an ever-expanding readiness trough. When funding did arrive, it was through continuing resolutions that, passed well into the year of execution, prevented any real form of strategic planning.<sup>3</sup> The collective effects left the Air Force of 2016 with just four of 32 active-duty fighter squadrons ready for conflict with a near-peer competitor and just 14 others that were considered ready for low-threat combat operations.<sup>4</sup>

During a series of speeches in 2018, Secretary Wilson and Air Force Chief of Staff General David Goldfein laid out a plan to build the “Air Force We Need” that included more flying hours for pilots and expanding the number of Air Force squadrons from 312 to 386.<sup>5</sup> Those goals, coupled with an order by then-Secretary of Defense James Mattis to increase mission-capable rates for the F-16, F-22, and F-35 aircraft to 80 percent by the end of September 2019,<sup>6</sup> has given the Air Force the potential to

reverse the critical areas of capacity, capability, and readiness trends.

Both the Air Force goals and the Mattis order assume that commensurate funding is made available and applied to those efforts, and the current Administration has taken significant steps to ensure that the money is available to make both happen. Since President Trump’s inauguration, the Air Force budget has increased incrementally to a level that is now 25 percent higher (\$33.2 billion) than it was when he took office.<sup>7</sup> Unfortunately, the Air Force has had little measurable success in using that funding to bolster any of those critical areas.

### Capacity

Fifteen years of trading capacity for readiness funding to further modernization has meant serious reductions in the bottom-line number of available fighter, bomber, tanker, and airlift platforms. In 1991, the USAF had 2,476 fighters and 290 bombers in its

TABLE 3

## Total Active-Duty Aircraft Inventory

	2016	2017	2018	End 2019 Total
A-10	143	143	143	143
AC-130J	29	28	35	41
B-1	61	62	62	62
B-2	20	20	20	20
B-52	58	58	58	58
C-130H	13	4	3	0
C-130J	85	94	104	105
C-5	36	33	36	36
C-12	28	28	28	28
C-17	170	147	154	146
C-20	5	0	—	0
C-21	17	17	19	19
C-32	4	4	4	4
C-37	12	12	12	12
C-40	4	4	4	4
CV-22	49	50	50	50
E-3	31	31	31	31
E-4	4	4	4	4
E-9	2	2	2	2
E-11A	—	—	4	4
EC-130H	14	14	14	13
F-15	317	313	316	316
F-16	570	570	557	548
F-22	165	166	166	166
F-35	102	123	161	212
HC-130J	19	19	19	23
HC-130N	2	2	0	0
HH-60	78	86	82	89
KC-10	59	59	59	53*
KC-135	156	155	147	146*
KC-46	11	16	28	34*
MC-130H	13	16	16	15
MC-130J	35	37	37	41
MQ-9	228	225	220	228
NC-135	1	1	1	1
OC-135	2	2	2	2
RC-135	22	22	22	22
RQ-4	7	33	36	36
T-1	178	178	178	178
T-6	445	445	444	444
T-38	506	505	504	504
T-41	4	4	3	3
T-51	3	3	3	3
T-53	25	24	24	24
TC-135	3	3	3	3
TG-15	5	5	5	5
TG-16	19	19	19	19
TH-1	28	28	28	28
TU-2	5	5	5	4
U-2	27	27	27	26
UH-1	68	68	68	68
UV-18B	3	3	3	3
VC-25	2	2	2	2
WC-135	2	2	2	2

\* FY 2019 total numbers are contingent upon acquisition of six KC-46 aircraft.

**SOURCE:** Headquarters U.S. Air Force response to query by The Heritage Foundation.

 [heritage.org](https://heritage.org)

active-duty inventory<sup>8</sup> in addition to 692 tankers and 392 strategic airlift platforms in its total force inventory that were available to execute Desert Storm.<sup>9</sup> The trade-offs in the following years resulted in a 2018 Air Force that had just 1,473 fighters and 140 bombers in its active force and 441 tankers and 278 strategic airlift assets in its total force inventory.<sup>10</sup> (See Chart 11).

The force required to fight, fuel, and resupply a war with China across the vast expanse of the Pacific would need to be much larger than the force that was employed in Desert Storm. The tanker bridge would need to be much longer and more robust,<sup>11</sup> and the airlift capacity required to move and sustain those assets would be greater even without the plethora of air bases that were available to the allied force in 1991. It is hard to fathom how the current number of total force tanker and strategic airlift aircraft assets would be sufficient to fulfill the associated requirements.

Facing shortfalls in the Air Force's current requirement to support combatant commanders' deterrence and warfighting requirements, Secretary Wilson commissioned a study to determine the size and composition of the force needed to meet the new defense strategy. The study revealed that the service requires another 74 operational squadrons, to include 14 more tanker, one more airlift, seven more fighter, and five more bomber squadrons, to meet those needs. In general terms, that equates to at least 210 more KC-46 tankers, 15 more C-17 transport aircraft, 50 more bombers, and 182 more fighter aircraft than the Air Force currently has in its inventory.

Considering such a finding, one would probably expect the Air Force to increase its procurement budget, both for FY 2020 and for the Future Years Defense Program (FYDP), by a substantial margin. However, and in spite of a \$10.8 billion increase in the FY 2020 budget, the procurement request submitted to the White House actually fell by \$100 million, while the research, development, test, and evaluation (RDT&E) request increased by \$4.5 billion. This left the acquisition rates for the

F-35 and KC-46 flat at 48 and 15 aircraft, respectively, throughout the FYDP.

The RDT&E budget has increased from \$19.6 billion to \$35.4 billion (more than 80 percent) since FY 2017, and many argue that this increase was hardwired to meet B-21 and follow-on air dominance platform requirements. However, it is hard to imagine the Air Force, if its FY 2020 budget had been reduced by \$4.5 billion rather than increased by \$10.8 billion, cutting the funding for other spending categories to sustain the \$4.5 billion increase in RDT&E. In short, increasing RDT&E at the expense of capacity and operational readiness was a strategic choice.

That said, the reduction in programmed fourth-generation fighter retirement rates, coupled with the arrival of F-35As on Air Force flight lines in Florida, Arizona, and Utah, finally reversed a 67-year downward spiral in the total Air Force aircraft inventory,<sup>12</sup> and for the first time in as many years, the Air Force added 53 aircraft to its roster for a projected total of 5,426 at the end of FY 2019.<sup>13</sup> (See Table 3.)

Today, the average age of Air Force aircraft is more than 29 years, yet the service—even with its FY 2018, FY 2019, and FY 2020 budget increases—has no plans to increase the acquisition rates for any major weapons system.<sup>14</sup> It is instead relying on Congress to increase the USAF procurement budget to cover what it perceives as a budget shortfall. The decades-long trend of steadily declining aircraft numbers, coupled with the fleet's ever-growing average age, may be lulling senior leaders into believing that the service can be fixed sometime in the future, but the numbers tell a different story.

In 1987, there were 29 active-duty Air Force fighter squadrons based in Europe alone. The combination of post-Cold War downsizing and spending caps mandated by the Budget Control Act of 2011 (BCA) caused the Air Force to shrink from 70 combat-coded<sup>15</sup> active-duty fighter squadrons during Operation Desert Storm<sup>16</sup> to just 55 across the whole of the Active, Guard, and Reserve force. As of 2019, just 32 of those fighter squadrons were in the active-duty force.<sup>17</sup>



For the purpose of assessing capacity and readiness, this *Index* uses “combat-coded” fighter aircraft maintained within the Active component of the U.S. Air Force as a primary indicator of capacity. Combat-coded aircraft and related squadrons are aircraft and units with an assigned wartime mission, which means those numbers exclude units and aircraft assigned to training, operational test and evaluation (OT&E), and other missions. The software and munitions carriage/delivery capability of aircraft in noncombat-coded units renders them incompatible with or less survivable than combat-coded versions of the same aircraft. For example, all F-35As may appear to be ready for combat, but training wings and test and evaluation jets have hardware and software limitations that would severely curtail their utility and effectiveness in combat. While those jets could be slated for upgrades, hardware updates sideline jets for several months, and training wings and certain test organizations generally will be the last to receive those upgrades.

The Heritage *Index of U.S. Military Strength* assesses that a force of 1,200 combat-coded fighter aircraft is required to execute a two-MRC strategy. This number is also reflected in testimony presented to Congress by Air Force leaders in 2015.<sup>18</sup>

Of the 5,426 manned and unmanned aircraft projected to be in the USAF’s inventory at the end of FY 2019, 1,374 are active-duty fighters, and 951 of these are combat-coded aircraft.<sup>19</sup> This number includes all active-duty backup inventory aircraft as well as attrition reserve spares.<sup>20</sup>

However, the number of fighters and fighter squadrons available to deploy to contingency operations affects more than wartime readiness; it also affects retention. The constant churn of overseas deployments and stateside temporary duty (TDY) assignments is one of the primary reasons cited by pilots for separating from the service. This problem can be solved in two ways: by decreasing operational tempo and/or by increasing capacity. When the order to deploy assets comes from the

President, the Air Force must answer that call with assets capable of executing the mission no matter what the effects on morale or retention might be, which means that reducing operational tempo is not an option for Air Force leadership. This leaves increasing capacity as the only fix, and while the Air Force made a budgetary decision *not* to increase the rate at which it builds additional capacity beyond 48 F-35s a year, Congress appears to be coming through with 12 additional F-35s and six new F-15Xs in the proposed FY 2020 budget.

Nevertheless, neither the Air Force nor Congress appears to be acting to fill the shortfall in air refueling or strategic lift assets more rapidly. In spite of the Air Force identified shortfall of 14 tanker squadrons/210 air refueling aircraft, that service will continue on an unaccelerated KC-46 procurement schedule of 15 aircraft a year throughout the FYDP, and there is no plan in place to acquire additional strategic airlift assets.


The funding that facilitated the Reagan buildup of the 1980s was available for just a few years, and the assets acquired during that period are now aging out. Even the most stalwart defense hawks are saying that growth in the defense budget is unlikely in the years beyond FY 2020, and unless Congress continues to intervene by acquiring more fighter assets, the opportunity to increase Air Force capacity beyond its current marginal level may be lost.

Capacity also relies on the stockpile of available munitions and the production capacity of the munitions industry. The actual number of munitions within the U.S. stockpile is classified, but there are indicators that make it possible to assess the overall health of this vital area. The inventory for precision-guided munitions (PGM) has been severely stressed by nearly 18 years of sustained combat operations and budget actions that limited the service’s ability to procure replacements and increase stockpiles. In an effort to continue rebuilding the PGM stockpile, the Air Force will purchase 53,976 precision-guided munitions and guidance kits in FY 2020. Typically, there is a delay of 24–36 months between conclusion of a contract and

TABLE 4

Precision-Guided Munitions: Expenditures and Programmed Acquisitions

	Expenditures FY 2018 (estimate)	Acquisitions FY 2019 (FN1)	Acquisitions FY 2020 (FN2)
JDAM	5,297	36,000	37,000
HELLFIRE	1,828	3,734	3,859
SDB-I/II	700	6,254	8,253
APKWS	–	6,879	5,400
JASSM	19	360	430
LGB	373	0	0
Maverick	16	0	0
Totals	8,982	53,976	55,691

SOURCE: Headquarters U.S. Air Force, A8XC/A5RW, written response to Heritage Foundation request for information on Air Force precision-guided munitions expenditures and programmed replenishments, July 10, 2018.  heritage.org

delivery of these weapons, which means that munitions are often replaced three years after they were expended.

During the past three years, however, funding for munitions has improved significantly, and the preferred munitions inventory is starting to recover to pre-war levels. (See Table 4).

Capability

The risk assumed with capacity has placed an ever-growing burden on the capability of Air Force assets. The ensuing capability-over-capacity strategy centers on the idea of developing and maintaining a *more*-capable force that can win against the advanced fighters and surface-to-air missile systems now being developed by top-tier potential adversaries like China and Russia, which are also increasing their capacity.

Any assessment of capability includes not only the incorporation of advanced technologies, but also the overall health of the inventory. Most aircraft have programmed life spans of 20 to 30 years based on a programmed level of annual flying hours. The bending and flexing of airframes over time in the air generates

predictable levels of stress and fatigue on everything from metal airframe structures to electrical wiring harnesses.

The average age of Air Force aircraft is 28 years, and some fleets, such as the B-52 bomber, average 58 years. In addition, KC-135s comprise 87 percent of the Air Force’s tankers and are over 57 years old on average. The average age of the F-15C fleet is over 35 years, leaving less than 6 percent of its useful service life remaining,<sup>21</sup> and that fleet comprises 44 percent of USAF air superiority platforms.<sup>22</sup> The Air Force is considering the F-15C for airframe modifications through a service life extension program (SLEP), but with or without a SLEP, that hard-to-maintain system will likely stay in the inventory at least through 2030.

The fleet of F-16Cs are 29 years old on average,<sup>23</sup> and the service has used up nearly 85 percent of its expected life span. The Air Force recently announced its intent to extend the service lives of 300 F-16s with a plan to keep those jets flying through 2050.<sup>24</sup> SLEPs lengthen the useful life of airframes, and these F-16 modifications also include programmed funding for the modernization of avionics within

TABLE 5

## Total Air Force Inventory (Page 1 of 3)

Aircraft	Total Aircraft Inventory	Average Age in Years	FY 2017 Mission-Capable Rate	FY 2018 Mission-Capable Rate	Change, 2017 to 2018	Average Number of Mission-Capable Aircraft
A010C	282	37	74%	73%	-1.25%	204
AC130J	11	2	91%	87%	-4.11%	9
AC130U	12	28	83%	87%	4.02%	10
B-1B	62	31	53%	52%	-1.04%	32
B-2A	20	24	54%	61%	6.87%	12
B-52H	75	57	72%	69%	-2.52%	52
C-130H	177	28	73%	68%	-4.84%	121
C-130J	124	9	77%	77%	-0.28%	95
C-17A	222	15	84%	83%	-1.12%	183
CV022B	50	6	67%	59%	-7.20%	30
E003B	11	40	69%	69%	-0.15%	8
E003C	2	35	67%	70%	2.99%	1
E003G	17	38	75%	66%	-8.73%	11
E008C	16	18	64%	67%	2.80%	11
EC130H	14	45	74%	73%	-1.09%	10
EC130J	7	18	66%	66%	0.40%	5
F015C	212	34	71%	71%	0.23%	152
F015D	23	34	70%	69%	-0.99%	16
F015E	218	26	75%	71%	-4.10%	155
F016C	785	28	70%	70%	-0.19%	550
F016D	154	28	66%	66%	0.28%	102
F022A	186	11	49%	52%	2.73%	96
F035A	148	3	55%	50%	-5.12%	73
HC130J	24	4	84%	81%	-3.58%	19
HC130N	6	24	55%	61%	6.89%	3
HC130P	3	52	34%	21%	13.13%	1
HH060G	97	28	69%	71%	1.72%	69
HH060U	3	7	0%	0%	—	—
KC010A	59	34	78%	80%	1.50%	47
KC135R	344	57	73%	73%	-0.17%	251
KC135T	54	58	75%	74%	-1.46%	40
LC130H	10	33	50%	45%	-5.17%	5
MC012W	35	8	0%	100%	—	35

TABLE 5

## Total Air Force Inventory (Page 2 of 3)

Aircraft	Total Aircraft Inventory	Average Age in Years	FY 2017 Mission-Capable Rate	FY 2018 Mission-Capable Rate	Change, 2017 to 2018	Average Number of Mission-Capable Aircraft
MC130H	17	30	69%	68%	-0.41%	11
MC130J	36	4	84%	79%	-5.05%	28
MC130P	2	52	46%	55%	9.07%	1
MQ001B	94	11	91%	92%	1.04%	86
MQ009A	247	5	90%	90%	0.66%	223
NC135W	1	56	0%	0%	—	—
OC135B	2	56	86%	65%	-21.39%	1
RC135S	3	56	69%	79%	10.34%	2
RC135U	2	53	82%	83%	1.57%	2
RC135V	8	54	71%	71%	-0.17%	6
RC135W	12	55	66%	60%	-5.52%	7
RC026B	11	24	0%	0%	—	—
RQ004B	35	7	74%	74%	-0.63%	25
T001A	178	24	56%	59%	2.96%	105
T038A	53	52	75%	73%	-1.95%	38
T038C	442	51	60%	61%	1.42%	270
T041D	4	49	0%	0%	—	—
T051A	3	13	0%	0%	—	—
T053A	24	6	0%	0%	—	—
T006A	444	13	76%	66%	-10.07%	293
TC135W	3	56	75%	76%	1.52%	2
TE008A	1	28	81%	85%	4.35%	1
TG010D	4	16	0%	0%	—	—
TG014A	4	15	0%	0%	—	—
TG015A	2	15	0%	0%	—	—
TG015B	3	15	0%	0%	—	—
TG016A	19	6	0%	0%	—	—
TH001H	28	37	65%	73%	7.93%	21
TU002S	4	34	73%	69%	-4.29%	3
U002S	27	35	75%	77%	1.70%	21
UH001N	63	46	84%	82%	-1.61%	52
UV018B	3	34	0%	0%	0.00%	—
VC025A	2	28	93%	90%	-2.94%	2

TABLE 5

Total Air Force Inventory (Page 3 of 3)

Aircraft	Total Aircraft Inventory	Average Age in Years	FY 2017 Mission-Capable Rate	FY 2018 Mission-Capable Rate	Change, 2017 to 2018	Average Number of Mission-Capable Aircraft
WC130H	5	52	53%	27%	-26.58%	1
WC130J	10	17	59%	65%	6.63%	7
WC135C	1	54	50%	72%	21.86%	1
WC135W	1	56	65%	75%	10.50%	1

**NOTE:** The average number of mission-capable aircraft is calculated as the Total Aircraft Inventory multiplied by the Mission-Capable Rate.  
**SOURCE:** Stephen Losey, “Aircraft Mission-capable Rates Hit New Low in Air Force, Despite Efforts to Improve,” *Air Force Times*, July 26, 2019, <https://www.airforcetimes.com/news/your-air-force/2019/07/26/aircraft-mission-capable-rates-hit-new-low-in-air-force-despite-efforts-to-improve/> (accessed July 29, 2019).

 heritage.org

those airframes. However, those modifications are costly, and the added expense consumes available funding, reducing the amount the services have to invest in modernization, which is critical to ensuring future capability. Even with a SLEP, there is a direct correlation between aircraft age and the maintainability of those platforms. (See Table 5.)

The Air Force’s ISR and lift capabilities face similar problems in specific areas that affect both capability and capacity. The majority of the Air Force’s ISR aircraft are now unmanned aerial vehicles (UAVs),<sup>25</sup> but even here the numbers fell in 2018 from 371<sup>26</sup> to 251 with the complete retirement of the MQ-1 Predator weapons system.<sup>27</sup> The RQ-4 Global Hawk is certainly one of the more reliable of those platforms, but gross weight restrictions limit the number of sensors that it can carry, and the warfighter still needs the capability of the U-2, a jet with an average age of 36 years and no scheduled retirement date.<sup>28</sup>

The E-8 Joint Surveillance Target Attack Radar System (J-STARS) and the RC-135 Rivet Joint are critical ISR platforms, and each was

built on the Boeing 707 platform, the last one of which came off the production line 40 years ago in 1979. The reliability of the USAF fleet of 707 airframes is at risk because of the challenges linked to aircraft age and flight hours, and those aircraft need to be modernized. In the 2019 National Defense Authorization Act (NDAA), Congress elected not to recapitalize the J-STARS fleet, a decision that is in line with the service’s belief that the platform could not survive in a modern high-threat environment. In its stead, the Air Force is working on an incremental approach for a J-STARS replacement that focuses on advanced and disaggregated sensors (a system of systems) that will require enhanced and hardened communications links. Known as the Air Battle Management System (ABMS), it is envisioned as an all-encompassing approach to both airborne and ground Battle Management Command and Control (BMC2) that will allow the Air Force to fight and support joint and coalition partners in the high-end engagements ahead.<sup>29</sup>

A service’s investment in modernization ensures that future capability remains healthy.

Investment programs aim not only to procure enough to fill current capacity requirements, but also to advance future capabilities with advanced technology.

The Active Air Force has just 105 F-15Cs left in its fleet, and concerns about what platform will fill this role when the F-15C is retired are well justified. The Department of Defense (DOD) planned to purchase 750 F-22A stealth air superiority fighters to replace the F-15C, but draconian cuts in the program of record reduced the acquisition to just 183 total F-22As for the Active, Guard, and Reserve force.<sup>30</sup>

Fulfilling the operational need for air superiority fighters will be further strained in the near term because of the F-22's low availability rates and a retrofit that always causes some portion of those jets to be unavailable for operational use. The retrofit is a mix of structural alterations required for the airframe to reach its promised service life, and the process takes six F-22s off the flight line for the retrofit at any given time. The retrofit is forecasted to continue through 2021.<sup>31</sup> The Raptor's 62.8 percent availability rate means that of the 138 combat-coded F-22As on active duty, approximately 72 are available to fly combat sorties at any given time.<sup>32</sup> That low mission-capable rate means in turn that even with their superior technology, and adding in the Guard's 20 jets, the total mission-capable inventory would be 85 jets, which likely would not be sufficient to fulfill the single-MRC wartime requirement for air superiority fighters.

The Air Force's number one priority remains the F-35A, the next-generation fighter scheduled to replace all legacy multirole and close air support aircraft. A host of developmental problems caused this new fighter's initial operating capability (IOC) date to be pushed from 2013 to 2016. However, the jet's full operating capability (FOC) was delivered in early 2018 with the fielding of 3F software, and every F-35 pilot interviewed at Hill Air Force Base voiced full confidence in this weapons system if called to employ the F-35A in the highest-threat environment.<sup>33</sup> The updated software and required hardware modifications

are already incorporated in jets coming off the production line<sup>34</sup>

The rationale for the Air Force's 1,763-aircraft program of record is to replace every F-117, F-16, and A-10 aircraft on a one-for-one basis.<sup>35</sup> The F-35A's multirole design favors the air-to-ground mission, but its fifth-generation faculties will also be dominant in an air-to-air role, allowing it to augment the F-22A in many scenarios.<sup>36</sup> As noted, Heritage analysis has identified a requirement for 1,200 combat-coded active-duty fighters. Even accounting for additional aircraft for training, testing, and OT&E, the acquisition of 1,763 would well exceed the combat-coded fighter requirement. The active-duty Air Force has 138 combat-coded F-22As and a stated intent to retain several hundred more fourth-generation fighters on active duty through the mid-2040s. Taking those aircraft into consideration, the Air Force should reduce the F-35A program of record to 1,260 fighters and move to accelerate the rate at which it acquires those platforms.<sup>37</sup>

A second top acquisition priority is the KC-46A air refueling tanker. The KC-46 has experienced a series of delays, the latest of which involves foreign object debris (FOD) inside the jet's cabin, which, in addition to being a safety hazard when operating the plane, implies poor quality control by the manufacturer. The Air Force expects to receive 24 KC-46s by the end of FY 2019 and an additional 28 in FY 2020 for a total of 52 on the ramp by the end of FY 2020.<sup>38</sup> It also intends to acquire 15 additional KC-46 Pegasus tankers a year through 2028, at which time it will have all 179 of these new tankers in service. The KC-46 will replace less than half of the current tanker fleet and will leave the Air Force with over 200 aging KC-135s that still need to be recapitalized.<sup>39</sup>

The third major USAF acquisition priority is the B-21 Raider, formerly called the Long-Range Strike Bomber (LRSB). The USAF awarded Northrop Grumman the B-21 contract to build the Engineering and Manufacturing Development (EMD) phase, which includes associated training and support systems and initial production lots. The program



completed an Integrated Baseline Review for the overall B-21 development effort as well as the jet's Preliminary Design Review. The Air Force is committed to a minimum of 100 B-21s at an average cost of \$564 million per plane.<sup>40</sup>

With the budget deal that was reached for FY 2018 and FY 2019, the Secretary of the Air Force announced the service's intent to retire all B-1s and B-2s and sustain a fleet comprised of 100 B-21s and 71 B-52s.<sup>41</sup> The B-21 is programmed to begin replacing portions of the B-52 and B-1B fleets by the mid-2020s.<sup>42</sup> In the interim, the Air Force continues to execute a SLEP on the entire fleet of 62 B-1s in the inventory to restore all 289 B-1 engines to their original specifications. The Air Force plans to modernize the B-2's Defense Management System, Stores Management Operational Flight Program, and Common Very-Low-Frequency/Low Frequency Receiver Program to ensure that this penetrating bomber remains viable in highly contested environments, keeping it fully mission capable until it is replaced by the B-21.

Modernization efforts are also underway for the B-52. The jet was designed in the 1950s, and the current fleet entered service in the 1960s. The FY 2018 budget funded the re-engineering of this fleet, and the aircraft will remain in the inventory through 2050.

When the Secretary of the Air Force and the Chief of Staff rolled out the Air Force's plan to expand the size of the service from 312 to 386 squadrons, one of the stated elements of that campaign was to fill the ranks of those new squadrons with only the newest generation of aircraft—F-35s, B-21s, and KC-46s—because of the capabilities that those platforms bring to bear.<sup>43</sup> Curiously, the Air Force is now seeking to acquire the fourth-generation F-15X, based primarily on projected operating cost savings, to increase fighter capacity.<sup>44</sup> Although the service will certainly increase its numbers with that approach, the capability of the F-15X system will not be survivable in the high-threat environment in which deployed assets will be required to fight by the time that fielding has been completed.

## Readiness

According to the USAF's official FY 2020 posture statement, more than 90 percent of the "lead force packages" within the service's 204 "pacing squadrons" are "ready to 'fight tonight.'" Unpacking that statement is challenging even for the most experienced airmen because the terms "pacing unit" and "pacing squadron" are new and the definition is somewhat elusive. Assuming that a pacing squadron is an operational unit that is fully qualified and ready to execute its primary wartime mission (C1), one is still left wondering what "lead force packages" within those 204 pacing/mission-ready units might mean. The posture statement goes on to say that those "pacing squadrons are on track to reach 80% readiness before the end of Fiscal Year 2020."<sup>45</sup>

When taken together, these statements imply that only portions of the Air force's mission-ready/pacing units are mission capable/currently qualified to execute the unit's primary wartime mission. The available open-source readiness indicators, coupled with Air Staff responses to direct requests for information, bring clarity and support to that assessment.

In 2017, the Secretary of the Air Force and the Chief of Staff informed Congress that "[w]e are at our lowest state of full spectrum readiness in our history."<sup>46</sup> In the two years since their testimony, however, the DOD seems to have stifled open conversation or testimony about readiness. Even though things have improved, there are enough facts and ancillary evidence to conclude that the substance of their statements still applies in 2019. Overcoming the effects of previous years of overtasking in low-threat contingency operations, as well as the lack of full-spectrum, high-threat training, is a task that clearly will require many years.

Full-spectrum operations include continued support of counterterrorism (CT) operations, the seamless conduct of nuclear deterrence operations, and readiness for potential conflict with a near-peer competitor. In 2016, Major General Scott West informed the House Armed Services Committee Subcommittee on Readiness that the Air Force was "able

TABLE 6

Air Force Maintenance Skill Level Manning

Skill Level	2017	2018
Apprentice: 3-level	119%	117%
Journeyman: 5-level	91%	91%
Craftsman: 7-level	96%	97%
Leadership: 9-level	96%	99%

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, April 9, 2018.

 heritage.org

to conduct nuclear deterrence operations and support CT operations, [but] operations against a near-peer competitor would require a significant amount of training” because readiness is out of balance “at a time when the Air Force is small, old, and heavily tasked.”<sup>47</sup> Two areas that offer insight into how well the Air Force is doing with regard to retraining for a near-peer fight are aircraft mission-capable (MC) rates and the rate at which aircrew members are flying, which is generally measured in sorties and hours per month.

MC rates are defined as the percentage of aircraft possessed by a unit that are capable of executing the unit’s mission set. Several factors drive MC rates, but two are common to mature systems: manning and operations and maintenance (O&M) funding. Taken together, they dictate the number of sorties and flight hours that units have available for aircrew training. One of sequestration’s many detrimental impacts on the Air Force became apparent in 2014 with a shortage of aircraft maintenance personnel (maintainers). At its height at the close of 2015, that shortfall grew to more than 4,000 highly skilled aircraft maintainers.<sup>48</sup> Senior leaders cited this gap in maintenance manning as the principal reason why fighter pilots who once averaged over 200 hours per year were fortunate to fly slightly more than 120 hours in 2014.<sup>49</sup>

By the close of FY 2017, the maintenance shortfall in both manning and qualifications

had been reduced significantly, and by the end of FY 2018, the gaps for all four qualification levels had reached or exceeded historical norms, removing maintenance manning as a primary reason for low sortie rates. (See Table 6.)

Another area of concern is pilot manning levels. In March 2017, Lieutenant General Gina M. Grosso, Air Force Deputy Chief of Staff for Manpower, Personnel, and Services, testified that at the end of FY 2016, the Air Force had a shortfall of 1,555 pilots across all mission areas (608 Active, 653 Guard, and 294 Reserve). Of that total, the Air Force was short 1,211 fighter pilots (873 Active, 272 Guard, and 66 Reserve).<sup>50</sup> The numbers continued to fall, and at the end of FY 2017, the Air Force was short more than 2,000 pilots. Although the Air Force stopped breaking the numbers down into Active, Guard, and Reserve numbers, the total pilot shortfall appears to remain at 9 percent.<sup>51</sup> Recovering from that shortfall will depend on how well the Air Force addresses several major issues, especially the available number of pilot training slots, an area in which it appears that some progress is being made.

In 2018, the Air Force graduated 1,200 pilots. The projections for 2019 forecast increases to 1,300, rising to 1,480 in 2020. Those projected numbers rely on a graduation rate of nearly 100 percent for every pilot training class, and the service is already close to that

TABLE 7

## Operational Fighter Pilot Manning

Weapons System	Pilot Manning Authorized	Qualified Fighter Pilots 2017	Qualified Fighter Pilots 2018
F-22	233	193	188
F-35A	107	33	46
F-15C	149	124	132
F-16C	787	677	771
F-15E	307	264	276
A-10	184	144	166
<b>All Jets</b>	<b>1,766</b>	<b>1,434</b> (81% manning)	<b>1,579</b> (89% manning)

**NOTES:** Pilot manning authorized figures are based on actual manning percentages (actual manning divided by authorized manning) in each major weapons system established in Air Force Instruction 11-102. Qualified fighter pilots figures are derived from actual manning percentages (actual manning divided by authorized manning) for each major weapons system.

**SOURCES:** Secretary of the Air Force, “Air Force Instruction (AFI) 11-102: Flying Hour Program Management,” August 30, 2011, p. 17, [https://static.e-publishing.af.mil/production/1/af\\_a3\\_5/publication/afi11-102/afi11-102.pdf](https://static.e-publishing.af.mil/production/1/af_a3_5/publication/afi11-102/afi11-102.pdf) (accessed July 24, 2019), and Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, April 9, 2018.

 [heritage.org](https://heritage.org)

mark. In 2016, the graduation rate was 93 percent; in 2017, it was 98 percent; and in 2018, it was 97 percent.<sup>52</sup> At the same time, however, the expectation of high graduation rates during years of significant pilot shortfalls puts quality at risk, and it is hard to fathom how the pilot production pipeline is going to ensure that all of those who earn their wings will be as competent and capable as they need to be in the years ahead.

The Air Force is still suffering a pilot shortage, but it has done an excellent job of emphasizing operational manning at the cost of placing experienced fighter pilots at staffs and schools. Operational fighter pilot manning in every major fighter weapons system increased by an average of 8 percent in 2018. (See Table 7.)

While pilot manning levels are improving, those numbers say little about the qualifications of the pilots within those weapons

systems. “Higher sortie rates mean increased proficiency for our combat aircrews,” in the words of General Bill Creech,<sup>53</sup> and given the right number of sorties and quality flight time, it takes seven years beyond mission qualification in a fighter for an individual to maximize his potential as a fighter pilot.<sup>54</sup> With an 18-year drought in training for combat with a near-peer competitor, it will take even highly experienced fighter pilots a year or two of training to master the skill sets required to dominate the air against a near-peer competitor in a high-threat environment—skill sets that most have never had the opportunity to develop. Because squadrons have a mix of experience and talent levels, it will take several years of robust training for any operational fighter squadron to become ready for a high-end fight.

The associated training requires sortie rates averaging above three sorties a week or

TABLE 8

Operational Sorties Pilots Received per Month, by Aircraft

	2017	2018	Difference
F-22	7.4	7.3	-1%
F-35A	7.9	7.5	-5%
F-15C	8.9	8.4	-6%
F-16C	9.1	9.3	2%
F-15E	8.8	8.5	-3%
A-10	9.2	9.7	6%
All Jets: Average Sorties per Month	8.8	9.5	8%
All Jets: Average Sorties per Week	2.2	2.4	9%

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 8, 2018.

 heritage.org

more and flying hours averaging more than 200 hours per year. Despite having made great strides in sortie production since 2014, the Air Force is still falling short of those thresholds

because of its low fighter mission-capable rates. (See Table 8.)  
As noted, the primary drivers for mission-capable rates are maintenance manning


TABLE 9

Average Hours Fighter Pilots Received per Month

	2017	2018	Difference
F-22	13.4	12.1	-10%
F-35A	11.5	11.0	-4%
F-15C	12.5	8.9	-29%
F-16C	14.2	13.9	-2%
F-15E	20.6	17.1	-17%
A-10	22.7	20.1	-11%
All Jets: Average Hours per Month	15.8	14.3	-9%
All Jets: Average Hours per Year	189.4	171.7	-9%

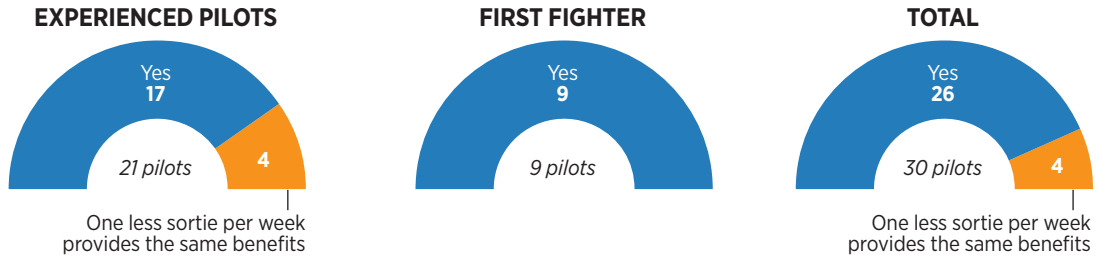
NOTE: Average hours are based on weighted fighter manning levels for each of the six major weapons systems.

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 8, 2018.

 heritage.org

## How Many Sorties per Week Should Pilots Fly?

Q: “Do you agree with this statement regarding proficiency and sorties per week? If I fly two sorties or less a week, my skills in the jet diminish; flying three per week maintains and sustains my skills, and when I fly four times or more a week, my skills in the jet improve across the board.”



**SOURCE:** John Venable, “The F-35A Fighter Is the Most Dominant and Lethal Multi-Role Weapons System in the World: Now Is the Time to Ramp Up Production,” Heritage Foundation *Backgrounder* No. 3406, May 14, 2019, <https://www.heritage.org/defense/report/the-f-35a-fighter-the-most-dominant-and-lethal-multi-role-weapons-system-the-world>.

heritage.org

and O&M funding. Maintenance manning has been healthy for more than two years, and O&M funding has risen by 16 percent since 2017, but flying hours across the fleet of fighters have increased by just 9 percent over that same period. USAF leadership has not increased the flying hour budget for FY 2020 because of an assessment that the Air Force is flying at the maximum executable levels.<sup>55</sup> This calls into question how well maintenance is organized to generate those sorties.

The sortie production recovery that took place at the end of the hollow-force days of the Carter Administration happened while levels of maintenance experience and inventories of spare parts were still low and well before the Reagan Administration’s increase in defense spending.<sup>56</sup> The maintenance organization that created that turnaround was changed in 1989 to “save money by reducing maintenance staffing, equipment and base level support,”<sup>57</sup> which may help to explain the lackluster performance. No matter what the rationale may

be, even with robust manpower and funding, flying hours and sortie rates are still short of the levels required for a rapid increase in readiness levels across the fighter force.

The sortie rate for the average Air Force fighter pilot was said to have risen to 16.4 hours a month in 2017,<sup>58</sup> but data provided by the Air Force organization charged with tracking these details revealed a less favorable picture. Fighter pilots actually received an average of 15.8 hours per month in 2017, and the average fell by 9 percent to 14.3 hours per month in 2018.<sup>59</sup> (See Table 9.)

The average line fighter pilot assigned to a combat-coded (operational) unit received a healthy rate of 17.6 hours per month in 2017, but that rate fell by 9 percent in 2018 to 16 hours per month.<sup>60</sup> Sortie rates for the same category of pilots increased from 2.2 to 2.4 sorties per week during the same years but remained well below the average of three sorties per week needed to sustain or grow readiness levels. (See Chart 12).

The current state of overall Air Force readiness includes many intangibles, but the things like averages for fighter pilot sortie rates and hours per month that can be measured all point to a readiness level that did not increase markedly between 2017 and 2018. The first five months of 2019 have shown an improvement in both sortie rates and hours, but the same was true in 2018, and flying hours fell to below 2017 levels by the end of 2018. With that in mind, any assessment of 2019 will have to wait until the end of the year.

## Space

The classified nature of deployed space assets and their capabilities makes any assessment of this mission area challenging. Nevertheless, the United States' constellation of ISR, navigation, and communication satellites is arguably unrivaled by any other nation-state. This array allows the Air Force and its sister services to find, fix, and target virtually any terrestrial or sea-based threat anywhere, anytime.

Unfortunately, America's historically unchecked dominance in space has encouraged an environment of overreliance on the domain and underappreciation of the vulnerabilities of its capabilities.<sup>61</sup> Some space assets represent nearly single-point failures in which a loss caused by a system failure or an attack could cripple a linchpin capability. Because of U.S. dominance of and nearly complete reliance on assets based in space, for everything from targeting to weapons guidance, other state actors have every incentive to target those assets.<sup>62</sup>

Adversaries will capture and hold the initiative by leveraging surprise and every asymmetric advantage that they possess while denying those warfighting elements to their opponents. Since Operation Desert Storm, the world and every American near-peer competitor therein have watched the United States employ satellite-enabled precision targeting to profound effect on the battlefield. That ability depends almost entirely on the kinetic end of the strike system: precision-guided munitions.<sup>63</sup>

China and Russia are investing heavily in ground-based anti-satellite (ASAT) missiles; orbital ASAT programs that can deliver a kinetic blow; or co-orbital robotic interference to alter signals, mask denial efforts, or even pull adversary satellites out of orbit.<sup>64</sup> If near-peer competitors were able to degrade regional GPS signals or blind GPS receivers, they could neutralize the PGMs that the U.S. uses to conduct virtually every aspect of its kinetic strike capability.

As General John Hyten, former Commander of Air Force Space Command, has clearly indicated, the vulnerability of the U.S. space constellation lies in its design.<sup>65</sup> Each of the satellites on which we currently rely costs millions of dollars and takes years to design, build, and launch into orbit. Until the Air Force shortens that time span or diversifies its ability to find, fix, and destroy targets with precision, space will remain both a dominant and an incredibly vulnerable domain for the U.S. Air Force.

## Scoring the U.S. Air Force

### Capacity Score: Marginal

One of the key elements of combat power in the U.S. Air Force is its fleet of fighter aircraft. In responding to major combat engagements since World War II, the Air Force has deployed an average of 28 fighter squadrons, based on an average of 18 aircraft per fighter squadron. That equates to a requirement of 500 active component fighter aircraft to execute

one MRC. Based on government force-sizing documents that count fighter aircraft, squadrons, or wings, an average of 55 squadrons (990 aircraft) is required to field a force capable of executing two MRCs (rounded up to 1,000 fighter aircraft to simplify the numbers). This *Index* looks for 1,200 active fighter aircraft to account for the 20 percent reserve necessary when considering availability for deployment



TABLE 10

## Mission-Capable Combat-Coded Fighters in Active Duty Air Force

Fighter	Combat-Coded Fighters	Average Age in Years	FY 2018 Mission-Capable Rate	Mission-Capable Combat-Coded Fighters
A-10C	116	37	0.73	84
F-15C	105	34	0.71	75
F-15E	158	26	0.71	112
F-16C	369	28	0.70	258
F-22A	138	11	0.52	72
F-35A	65	3	0.50	32
	<b>951</b>	<b>—</b>	<b>—</b>	<b>634</b>

**SOURCE:** Air Force Association, “USAF Almanac 2018,” *Air Force Magazine*, June 2018, “The Air Force in Facts and Figures,” <http://www.airforcemag.com/MagazineArchive/Pages/TableOfContents.aspx?Date=06/2018> (accessed July 25, 2019).

 heritage.org

and the risk of employing 100 percent of fighters at any one time.

- **Two-MRC Level:** 1,200 fighter aircraft.
- **Actual 2019 Level:** 951 fighter aircraft.

Based on a pure count of combat-coded fighter/attack platforms that have achieved IOC, the USAF currently is at 79 percent of the two-MRC benchmark. While the active fighter and bomber assets available would likely prove adequate to fight a single regional conflict, when coupled with the low mission capability rates of those aircraft (see Table 10), the global sourcing needed to field the required combat fighter force assets would leave the rest of the world uncovered. Nevertheless, the capacity level is well within the methodology’s range of “marginal.” This score is now trending upward.

### Capability Score: Marginal

The Air Force’s capability score is “marginal,” the result of being scored “strong” in “Size of Modernization Program,” “marginal” for “Age of Equipment” and “Health of

Modernization Programs,” but “weak” for “Capability of Equipment.” These scores have not changed from the *2019 Index*’s assessment. However, with new F-35 and KC-46 aircraft continuing to roll off their respective production lines, this score is now trending upward.

### Readiness Score: Marginal

The Air Force scores “marginal” in readiness in the *2020 Index*, the same grade it received in the *2019 Index*. The USAF’s sustained pilot deficit and systemically low sortie rates and flying hours are the principal reasons for this assessment.<sup>66</sup> The Air Force should be prepared to respond quickly to an emergent crisis and retain full readiness of its combat airpower and, with a significant curtailment in deployments to support the war on terrorism, begin to improve its full-spectrum readiness levels much more rapidly than we have witnessed to date.

Fighter pilots should receive an average of three or more sorties a week and 200 hours per year to develop the skill sets needed to survive in combat. Even with greatly improved maintenance manning/experience levels and

increased funding levels, average monthly sorties and flying hours have not reached those thresholds. Whether they can or will be sustained for the length of time it will take to recover from the ongoing readiness shortfall is therefore open to question.

**Overall U.S. Air Force Score: Marginal**

This is an unweighted average of the USAF’s capacity score of “marginal,” capability score of “marginal,” and readiness score of “marginal.”

The shortage of pilots and flying time for those pilots degrades the ability of the Air Force to generate the amount and quality of combat air power that would be needed to meet wartime requirements. Although it could eventually win a single major regional contingency in any theater, if the Air Force had to go to war today, its attrition rates would be significantly higher than those sustained by a ready, well-trained force.

**U.S. Military Power: Air Force**

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity			✓		
Capability			✓		
Readiness			✓		
OVERALL			✓		

# AIR FORCE SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Strategic Bomber

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>B-52 Stratofortress</b> Inventory: <b>75</b> Fleet age: <b>56.8</b> Date: <b>1961</b>  The B-52, the oldest of the bombers, provides global strike capabilities with conventional or nuclear payloads. Programmed upgrades for B-52 include a new communications, avionics, and Multi-Functional Color Displays. The Air Force plans to use this aircraft through the 2050s	1		The B-21 is an advanced stealth bomber that will replace all B-1s and B-2s within the Air Force bomber fleet. Flight testing is scheduled for 2021. Fielding is expected in the mid-2020s.		
<b>B-1 Lancer</b> Inventory: <b>62</b> Fleet age: <b>31.1</b> Date: <b>1986</b>  The B-1B is a supersonic all-weather conventional bomber. It was modified in the mid-1990s to disable its nuclear weapon delivery capability. Block 16 upgrades to be completed by 2020 include a fully integrated data link, navigation, radar, and diagnostic upgrades. B-1B phase-out is scheduled for 2032.		2			
<b>B-2 Spirit</b> Inventory: <b>20</b> Fleet age: <b>24.2</b> Date: <b>1997</b>  The B-2 bomber provides the USAF with global strike capabilities for both nuclear and conventional payloads. The stealth bomber's communication suite is currently being upgraded. The current plan is to begin phasing the B-2 out in 2032.		4			

**NOTE:** See page 433 for details on fleet ages, dates, and procurement spending.

# AIR FORCE SCORES



Procurement and Spending ■ Through FY 2019  
■ Pending

## Ground Attack/Multi-Role Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>A-10 Thunderbolt II</b> Inventory: <b>281</b> Fleet age: <b>37.4</b> Date: <b>1977</b>  The A-10 is the only USAF platform designed specifically for close air support mission using both self-designated precision guided munitions and an internal 30MM cannon. The A-10 is scheduled to be phased out in 2030.			<b>F-35A</b>  Timeline: <b>2016-TBD</b>  The F-35A “Lightning” is a multirole stealth fighter that became IOC on August 2, 2016. The Air Force plans to acquire 48 F-35As a year across the FYDP.  <b>PROCUREMENT</b> <div><div></div><div>3381,425</div></div> <b>SPENDING (\$ millions)</b> <div><div></div><div>\$45,485\$186,382</div></div>	<b>5</b>	<b>3</b>
<b>F-16C Falcon</b> Inventory: <b>235</b> Fleet age: <b>28</b> Date: <b>1980</b>  The F-16 is a multirole aircraft capable of tactical nuclear delivery, all-weather strike, and Suppression of Enemy Air Defenses (SEAD). An ongoing Service Life Extension Program (SLEP) will keep this jet in the inventory through the late 2040s.	<b>2</b>	<b>2</b>			
<b>F-35A Lightning</b> Inventory: <b>154</b> Fleet age: <b>3.6</b> Date: <b>2016</b>  The F-35 is a multirole stealth fighter that became operational in 2016. The Air Force has received more than 200 of a planned purchase of 1,763 aircraft.	<b>5</b>	<b>5</b>			
<b>F-15E Strike Eagle</b> Inventory: <b>218</b> Fleet age: <b>26.4</b> Date: <b>1989</b>  The F-15E is a multirole aircraft capable of all weather, deep interdiction/attack, and tactical nuclear weapons delivery. Upgrades include an AESA radar, EPAWSS self-defense suite, a new central computer, and cockpit displays.	<b>2</b>	<b>2</b>			

NOTE: See page 433 for details on fleet ages, dates, and procurement spending.

# AIR FORCE SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Fighter Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>F-15C/D Eagle</b> Inventory: <b>235</b> Fleet age: <b>34.2</b> Date: <b>1975</b>  The F-15C/D is an air superiority fighter that has been in service since the late 1970s. The jet is receiving upgrades including a new AESA radar and self-defenses needed to survive and fight in contested airspace. Discussions are underway to retire the F-15C in late 2020s.	1	2	The F-15EX will be based on the 2-seat F-15QA (Qatar) configuration upgraded with USAF-only capabilities, including the Eagle Passive Active Warning and Survivability System (EPAWSS) and advanced Operational Flight Program (OFP) software. The PB for FY20 will acquire 8 F-15EXs in FY20 and a total of 80 over the FYDP.		
<b>F-22A Raptor</b> Inventory: <b>187</b> Fleet age: <b>11</b> Date: <b>2005</b>  The F-22 is the preeminent air superiority stealth fighter aircraft, modified to enable delivery of precision guided weapons delivery. The jet is currently undergoing a modification called RAAMP that will improve reliability, maintainability and performance	4	5			

**NOTE:** See page 433 for details on fleet ages, dates, and procurement spending.

# AIR FORCE SCORES



Procurement and Spending ■ Through FY 2019 ■ Pending

## Tanker

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>KC-10 Extender</b> Inventory: <b>59</b> Fleet age: <b>33.7</b> Date: <b>1981</b>  The KC-10 is a multirole tanker and airlift platform that can refuel both boom and drogue compatible fighters on the same mission. Recent modifications have enabled a service life extension through 2045. The Air Force planned to retire the KC-10 by 2024, but with a shortfall of refueling platforms, and slow acquisition of the KC-46, that appears unlikely.	2	5	<b>KC-46</b>  Timeline: <b>TBD</b>  The KC-46 Pegasus will replace portions of the KC-135 tanker fleet. The program entered low rate initial production in August 2016 and the Air Force accepted the first Pegasus on January 10, 2019. After several production and delivery delays, Boeing is on track to deliver three jets a month through the end of 2019 and 15 a year throughout the FYDP.  <b>PROCUREMENT</b> <div><div></div></div> 67108 <b>SPENDING (\$ millions)</b> <div><div></div></div> \$11,238\$21,177	3	3
<b>KC-135 Stratotanker</b> Inventory: <b>344</b> Fleet age: <b>57.8</b> Date: <b>1957</b>  The KC-135 is a multirole tanker/airlift platform. The aircraft has undergone several modifications, mainly engine upgrades, to improve performance and reliability. Part of the fleet will be replaced with the KC-46, with the remainder scheduled to be in service through 2040.	1				
<b>KC-46 Pegasus</b> Inventory: <b>67</b> Fleet age: <b>n/a</b> Date: <b>n/a</b>  The Pegasus is a multirole tanker/airlift platform that can refuel both boom and drogue compatible fighters on the same mission. The Air Force accepted the first of 179 programmed aircraft in 2019. Deliveries will continue at a rate of 15 aircraft a year.	5	n/a			

NOTE: See page 433 for details on fleet ages, dates, and procurement spending.



# AIR FORCE SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>C-5M Galaxy</b> Inventory: <b>51</b> Fleet age: <b>31.4</b> Date: <b>1970</b>  The C-5 is the USAF's largest mobility aircraft. It can transport 270,000 pounds of cargo over intercontinental ranges. The "M" models are heavily modified C-5A/Bs that have new engines, avionics, and structural/reliability fixes. Ongoing mods include a new weather radar and mission computer, and improved Large Aircraft IR Countermeasures (LAIRCM).	2	5	None		
<b>C-17 Globemaster III</b> Inventory: <b>222</b> Fleet age: <b>15</b> Date: <b>1995</b>  The C-17 is a large, air refuellable transport aircraft that is capable of operating on small, austere airfields (3,500 ft by 90 ft). Ongoing mods include next generation Large Aircraft Infrared Countermeasures (LAIRCM), structural, safety, and sustainment mods.	4				

## Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>C-130J Super Hercules</b> Inventory: <b>110</b> Fleet age: <b>9.8</b> Date: <b>2006</b>  The C-130J is an improved tactical airlift platform that can operate from small, austere airfields, and provide inter-theater airlift and airdrop and humanitarian support. The Air Force active component completed transition to the C-130J in October 2017.	5	5	<b>C-130J</b>  Timeline: <b>2006–2022</b>  An upgraded medium-lift capability with multiple variants including the C-130J-30, AC-130J gunship, and HC-130 rescue/air refueling platform. The C-130J-30 can carry 92 Airborne troops and lift over 40,000 pounds of cargo. The current MYP procures 16 C-130Js per year through FY2023.	5	4

### PROCUREMENT



### SPENDING (\$ millions)



**NOTE:** See page 433 for details on fleet ages, dates, and procurement spending.

# AIR FORCE SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019 ■ Pending

## Intelligence, Surveillance, and Reconnaissance (ISR)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>RQ-4 Global Hawk</b> Inventory: <b>33</b> Fleet age: <b>7.6</b> Date: <b>2011</b> <p>The RQ-4 is an unmanned aerial vehicle (UAV). Unlike the MQ-1 or MQ-9, the RQ-4 is a high-altitude, long-endurance (HALE) UAV, which in addition to higher altitude has a longer range than medium-altitude, long-endurance (MALE) UAVs.</p>	4	3	None		
<b>MQ-9 A/B Reaper</b> Inventory: <b>218</b> Fleet age: <b>5.4</b> Date: <b>2007</b> <p>The MQ-9 is a hunter/killer Remotely Piloted Aircraft (RPA) with EO/IR and SAR targeting capabilities and is capable of station times in excess of 24 hours. The Extended Range modification adds external fuel tanks, a four-bladed propeller, engine alcohol/water injection, heavyweight landing gear, longer wings and tail surfaces.</p>	5	2	<b>MQ-9</b> Timeline: <b>2007–2017</b> <p>The MQ-9 “Reaper” is a proven hunter/killer unmanned Aerial Vehicle (UAV). The PB for FY 2019 budget funds the procurement of 24 Reapers, and the proposed PB for 2020 will fund 12 more.</p> <div> <div> <b>PROCUREMENT</b>  <div> <div></div> <div></div> </div> <div>38743</div> </div> <div> <b>SPENDING (\$ millions)</b>  <div> <div></div> <div></div> </div> <div>\$6,996\$1,664</div> </div> </div>	5	5
<b>RC-135 Rivet Joint</b> Inventory: <b>25</b> Fleet age: <b>55</b> Date: <b>1972</b> <p>The RC-135 is a manned ISR platform that collects electronic and signals intelligence with real time analysis and dissemination for tactical forces, combatant commanders, and National Command Authorities. Ongoing upgrades include new direction finding COMINT, precision ELINT/SIGINT system integration, wideband SATCOMS, enhanced near real-time data dissemination, and new steerable beam antenna.</p>	1	4	None		
<b>U-2 Dragon Lady</b> Inventory: <b>27</b> Fleet age: <b>34.7</b> Date: <b>1956</b> <p>The U-2 is a manned strategic high-altitude, long-endurance ISR platform. Capable of SIGINT, IMINT, and MASINT collection, it can carry a variety of advanced optical, multispectral, EO/IR, SAR, SIGINT, and other payloads simultaneously. No other aircraft in the US inventory has this capability, which will indefinitely delay the U-2's retirement.</p>	1				

**NOTE:** See page 433 for details on fleet ages, dates, and procurement spending.

# AIR FORCE SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Command and Control

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>E-3 AWACS</b> Inventory: <b>31</b> Fleet age: <b>38.2</b> Date: <b>1977</b> <p>The E-3 is an airborne warning and control system (AWACS) that delivers all-weather, air and maritime surveillance, command and control, battle management, target, threat, and emitter detection, classification, and tracking. Ongoing upgrades include an urgent operational requirement to shorten kill-chains on time-sensitive targets, modernizing airborne moving target indication, and adding high-speed jam-resistant Link 16. The E-3 is scheduled to stay in service through the 2040s.</p>	1	2	None		
<b>E-8 JSTARS</b> Inventory: <b>16</b> Fleet age: <b>17.8</b> Date: <b>2010</b> <p>The E-8 is a ground moving target indication (GMTI), airborne battlefield management/command and control platform. Its primary mission is providing theater commanders with ground surveillance data to support tactical operations. The Air Force plans to retire this platform in the mid-2020s.</p>					

**NOTES:** See Methodology for descriptions of scores. The date is the year the platform reached initial operational capability. The timeline is from the year the platform reached initial operational capability until its final procurement. Spending does not include advanced procurement or research, development, test, and evaluation.

# U.S. Air Force Modernization Table Citations

## MAIN SOURCES

- “USAF Almanac 2018,” *Air Force Magazine*, Vol. 100, No. 6 (June 2018), <http://www.airforcemag.com/MagazineArchive/Magazine%20Documents/2018/June%202018/Air%20Force%20Magazine%202018%20USAF%20Almanac.pdf> (accessed September 5, 2019).
- “USAF Almanac 2019,” *Air Force Magazine*, Vol. 102, No. 5 (June 2019), [http://www.airforcemag.com/MagazineArchive/Magazine%20Documents/2019/June%202019/AFM\\_June2019%20Full%20Issue.pdf](http://www.airforcemag.com/MagazineArchive/Magazine%20Documents/2019/June%202019/AFM_June2019%20Full%20Issue.pdf) (accessed September 5, 2019).
- U.S. Department of the Air Force, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Air Force, Justification Book Volume 1 of 2: Aircraft Procurement, Air Force Vol-1*, March 2019, [https://www.saffm.hq.af.mil/Portals/84/documents/FY20/PROCUREMENT/FY20\\_PB\\_3010\\_Aircraft\\_Vol-1.pdf?ver=2019-03-18-152821-713](https://www.saffm.hq.af.mil/Portals/84/documents/FY20/PROCUREMENT/FY20_PB_3010_Aircraft_Vol-1.pdf?ver=2019-03-18-152821-713) (accessed September 5, 2019).
- U.S. Department of the Air Force, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Air Force, Justification Book Volume 2 of 2: Aircraft Procurement, Air Force Vol 2-Mods*, March 2019, [https://www.saffm.hq.af.mil/Portals/84/documents/FY20/PROCUREMENT/FY20\\_PB\\_3010\\_Aircraft\\_Vol-2\\_Mods.pdf?ver=2019-03-18-152848-747](https://www.saffm.hq.af.mil/Portals/84/documents/FY20/PROCUREMENT/FY20_PB_3010_Aircraft_Vol-2_Mods.pdf?ver=2019-03-18-152848-747) (accessed September 5, 2019).

## MISC. SOURCES

### *B-1B Lancer:*

- Airman 1st Class Charles V. Rivezzo, “Airmen Gear up for Largest B-1 Modification,” U.S. Air Force, January 31, 2013, <https://www.af.mil/News/Article-Display/Article/109777/airmen-gear-up-for-largest-b-1-modification/> (accessed September 5, 2019).

### *KC-10:*

- Larry Merritt, “Extended Term of Service: KC-10 Turns 25; Introduced Widebody Tanker/Cargo Concept,” *Boeing Frontiers*, September 2006, [https://www.boeing.com/news/frontiers/archive/2006/september/i\\_history.pdf](https://www.boeing.com/news/frontiers/archive/2006/september/i_history.pdf) (accessed September 5, 2019).

### *F-16 Falcon:*

- News release, “U.S. Air Force Authorizes Extended Service Life for F-16,” Lockheed Martin, April 12, 2017, <https://news.lockheedmartin.com/2017-04-12-U-S-Air-Force-Authorizes-Extended-Service-Life-for-F-16> (accessed September 5, 2019).

## Endnotes

1. The Honorable Michael B. Donley, Secretary of the Air Force, and General Mark A. Welsh III, Chief of Staff, United States Air Force, “Fiscal Year 2014 Air Force Posture Statement,” statement before the Committee on Armed Services, U.S. House of Representatives, April 12, 2013, p. 2, [http://www.au.af.mil/au/awc/awcgate/af/posture\\_usaf\\_12apr2013.pdf](http://www.au.af.mil/au/awc/awcgate/af/posture_usaf_12apr2013.pdf) (accessed August 8, 2018).
2. U.S. Air Force, “Wilson, Goldfein Outline Air Force Progress, Need for Larger Force,” April 2, 2019, <https://www.af.mil/News/Article-Display/Article/1802885/wilson-goldfein-outline-air-force-progress-need-for-larger-force/> (accessed July 25, 2019).
3. General David Goldfein, Chief of Staff, U.S. Air Force, “Rebuilding Air Force Readiness,” remarks at The Heritage Foundation, Washington, D.C., April 12, 2017, <http://www.heritage.org/defense/event/rebuilding-air-force-readiness> (accessed July 25, 2019).
4. John Venable, “Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force,” Heritage Foundation *Backgrounder* No. 3208, April 17, 2017, p. 2, <https://www.heritage.org/sites/default/files/2017-04/BG3208.pdf>.
5. Stephen Losey, “Pilots Are Flying 17 Hours per Month, but It’s Still Not Enough, Air Force Secretary Says,” *Air Force Times*, March 1, 2018, <https://www.airforcetimes.com/news/your-air-force/2018/03/01/secaf-air-force-pilots-are-flying-17-hours-per-month-but-its-still-not-enough/> (accessed July 25, 2019), and U.S. Air Force, “The Air Force We Need: 386 Operational Squadrons,” September 17, 2018, <https://www.af.mil/News/Article-Display/Article/1635070/the-air-force-we-need-386-operational-squadrons/> (accessed July 25, 2019).
6. Aaron Mehta, “M Mattis Orders Fighter Jet Readiness to Jump to 80 Percent—in One Year,” *Defense News*, October 9, 2018, <https://www.defensenews.com/air/2018/10/09/mattis-orders-fighter-jet-readiness-to-jump-to-80-percent-in-one-year/> (accessed July 25, 2019).
7. Table 1, “Air Force Budget Highlights Summary,” in U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2018 Budget Overview*, May 2017, p. 15, <http://www.saffm.hq.af.mil/LinkClick.aspx?fileticket=m3vZOmFR368%3d&portalid=84> (accessed August 2, 2019), and Table 1, “Air Force Budget Highlights Summary,” in U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2020 Budget Overview*, March 2019, p. 5, <https://www.saffm.hq.af.mil/Portals/84/documents/FY20/FY2020%20Air%20Force%20Budget%20Overview%20Book%20Final%20v3.pdf?ver=2019-03-13-082653-843> (accessed August 2, 2019).
8. The rationale for using active-duty fighter and bomber aircraft and total force numbers for Tanker and Strategic Airlift platforms is based on the mission set. Active-duty fighter and bomber squadrons are required to maintain readiness levels that allow them to deploy and successfully employ into a full-spectrum combat situation within days if not hours of notification. Readiness levels in Guard and Reserve squadrons are such that those units may require six months to a year of training before their qualified manning levels enable them to deploy with the same expectations for success. The mission demands and requirements for Tanker and Strategic Airlift squadrons allow Guard and Reserve squadrons to deploy rapidly and employ as effectively as any active-duty unit with the same mission. As will be noted in the paragraphs on capacity, due to years of underfunding of operational training, even active-duty pilots are nowhere near the level of readiness required to employ successfully against a near-peer competitor without taking serious losses.
9. Table E-2, “Air Force Total Aircraft Inventory (TAI) by Mission”; Table E-5, “Air Force Selected Total Aircraft Inventory (TAI) by Mission/Designation”; and Table E-6, “Air Force Reserve Selected Total Aircraft Invent[ory] (TAI) by Mission/Designation,” in U.S. Air Force, Deputy Assistant Secretary (Cost and Economics), Assistant Secretary of the Air Force (Financial Management and Comptroller of the Air Force), *United States Air Force Statistical Digest, Fiscal Year 1992*, 1994, pp. E-103, E-107, and E-108, <https://media.defense.gov/2011/Apr/19/2001330026/-1/-1/0/AFD-110419-005.pdf> (accessed July 29, 2019).
10. Data extracted from Table, “Air Force Total Aircraft Inventory (TAI),” in U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2020 Budget Overview*, p. 38.
11. Air mileage from Spokane, Washington, to Manila, Philippines, is roughly equal to the distance from New York, New York, to Doha, Qatar, (6,693 miles and 6,836 miles, respectively), but the lack of available intermediate stopover/refueling locations means that more tanker aircraft would be required just to move assets from one location to another. Sustaining an air war in the Pacific would be that much more challenging.
12. Technological advances in aircraft materials and structure greatly extended the service life of USAF equipment. As a result, the USAF was able to sustain its force structure while procuring fewer aircraft. See Colonel James C. Ruehrmund Jr. and Christopher J. Bowie, *Arsenal of Airpower: USAF Aircraft Inventory 1950–2009*, Mitchell Institute for Airpower Studies, November 2010, p. 8, [http://docs.wixstatic.com/ugd/a2dd91\\_5ddb04fd26e4f72aef6cfd5ee87913f.pdf](http://docs.wixstatic.com/ugd/a2dd91_5ddb04fd26e4f72aef6cfd5ee87913f.pdf) (accessed July 29, 2019).

13. Table 1, "Air Force Budget Highlights Summary," in U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2019 Budget Overview*, February 2018, p. 5, [https://www.saffm.hq.af.mil/Portals/84/documents/FY19/FY19\\_BOB\\_FINAL\\_v3.pdf?ver=2018-02-13-150300-757](https://www.saffm.hq.af.mil/Portals/84/documents/FY19/FY19_BOB_FINAL_v3.pdf?ver=2018-02-13-150300-757) (accessed July 29, 2019).
14. The Honorable Heather A. Wilson, "A Conversation with the Secretary of the Air Force," The Heritage Foundation, March 1, 2018, <https://www.heritage.org/defense/event/conversation-the-secretary-the-air-force> (accessed July 29, 2019).
15. See Report No. 112-329, *National Defense Authorization Act for Fiscal Year 2012*, Conference Report to Accompany H.R. 1540, U.S. House of Representatives, 112th Cong, 1st Sess., December 12, 2011, p. 25, <https://www.gpo.gov/fdsys/pkg/CRPT-112hrpt329/pdf/CRPT-112hrpt329-pt1.pdf> (accessed July 29, 2019).
16. Table, "USAF Flying Squadrons by Mission Type," in "The Air Force in Facts and Figures," *Air Force Magazine*, Vol. 79, No. 5 (May 1996), p. 59, [http://www.airforcemag.com/MagazineArchive/Magazine%20Documents/1996/May%201996/0596facts\\_figures.pdf](http://www.airforcemag.com/MagazineArchive/Magazine%20Documents/1996/May%201996/0596facts_figures.pdf) (accessed July 29, 2019). The Air Force uses a variety of categorizations to describe or refer to its inventory of aircraft and units. This can make assessing Air Force capacity a challenging exercise.
17. *2019 Index of U.S. Military Strength*, ed. Dakota L. Wood (Washington: The Heritage Foundation, 2019), p. 386, [http://thf-graphics.s3.amazonaws.com/2018/2019%20Index%20of%20Military%20Strength/Section%20PDFs/2019\\_IndexOfUSMilitaryStrength.pdf](http://thf-graphics.s3.amazonaws.com/2018/2019%20Index%20of%20Military%20Strength/Section%20PDFs/2019_IndexOfUSMilitaryStrength.pdf).
18. Dr. William A. LaPlante, Assistant Secretary of the Air Force (Acquisition); Lieutenant General James M. "Mike" Holmes, Deputy Chief of Staff (Strategic Plans and Requirements); and Lieutenant General Tod D. Wolters, Deputy Chief of Staff (Operations), "Fiscal Year 2016 Air Force, Force Structure and Modernization Programs," statement before the Subcommittee on Airland Forces, Committee on Armed Services, U.S. Senate, March 19, 2015, p. 8, [http://www.armed-services.senate.gov/imo/media/doc/LaPlante\\_Holmes\\_Wolters\\_03-19-15.pdf](http://www.armed-services.senate.gov/imo/media/doc/LaPlante_Holmes_Wolters_03-19-15.pdf) (accessed August 9, 2018). In 2015, pressured by a third year of budget caps dictated by the BCA, the service acknowledged that it could assume more risk and reduce the requirement for 1,200 fighters by 100 jets. *Ibid.*
19. The numbers of total aircraft inventory (TAI) and combat-coded aircraft for the active-duty Air Force were derived through review of U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2020 Budget Overview*, and International Institute for Strategic Studies, *The Military Balance 2019: The Annual Assessment of Global Military Capabilities and Defence Economics* (London: Routledge, 2019), pp. 56-57. Where the two publications were in conflict for TAI, the SAF/FMB numbers were adopted. Neither document specifies the number of active-duty combat-coded aircraft. That number was derived by tallying the total number of fighters by type and dividing that number by the total number of active-duty squadrons flying those types of aircraft. The numbers and types of aircraft associated with Weapons Instructor Course Squadrons, Adversary Tactics, Test, OT&E, and other units are not standard/determinable and could not be assessed. The associated error is minimized by totaling all like fighter aircraft (F-16, F-15C, etc.); dividing them by the total number of squadrons flying those aircraft; and spreading the error equally across all combat-coded fighter and training units. The total number of fighters associated with non-Fighter Training Unit (FTU) squadrons was counted as "combat-coded."
20. The numbers here are complicated. Air Force formulas contained in Adam J. Herbert, "The Fighter Numbers Flap," *Air Force Magazine*, Vol. 91, No. 4 (April 2008), p. 26, <http://www.airforcemag.com/MagazineArchive/Documents/2008/April%202008/0408issue.pdf> (accessed July 29, 2019), convey how the service estimates this number, but it is merely an estimate. Using this formula on an AF/A8XC-provided (as of June 9, 2018) figure of 710 PMAI fighters renders a total of 1,136 total Air Force active-duty fighters, a number that is well short of the 1,374 carried on the Air Force roster. This calls for the use of a different method to determine the actual number of combat-coded fighters as detailed in note 19, *supra*.
21. Table, "Total Force Average Aircraft Age (As of Sept. 30, 2018)," in "USAF Almanac 2019," *Air Force Magazine*, Vol. 102, No. 5 (June 2019), p. 59, [http://www.airforcemag.com/MagazineArchive/Magazine%20Documents/2019/June%202019/AFM\\_June2019%20Full%20Issue.pdf](http://www.airforcemag.com/MagazineArchive/Magazine%20Documents/2019/June%202019/AFM_June2019%20Full%20Issue.pdf) (accessed July 29, 2019). Ten months were added because of the difference between the aircraft data capture dates for the 2019 USAF Almanac and publication of this edition of the *Index*.
22. Comparison made between U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2019 Budget Overview*, p. 37, and International Institute for Strategic Studies, *The Military Balance 2019*, pp. 55-57.
23. Table, "Total Force Average Aircraft Age (As of Sept. 30, 2018)," in "USAF Almanac 2019," p. 59. Ten months were added because of the difference between the aircraft data capture dates for the 2019 USAF Almanac and publication of this edition of the *Index*.
24. Micah Garbarino, "F-16 Service Life Extension Program a 'Great Deal' for Department of Defense, Taxpayers," Air Force Materiel Command, March 3, 2018, <http://www.afmc.af.mil/News/Article-Display/Article/1512449/f-16-service-life-extension-program-a-great-deal-for-department-of-defense-taxp/> (accessed July 29, 2019).
25. Comparison made between U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2019 Budget Overview*, and International Institute for Strategic Studies, *The Military Balance 2019*, pp. 54-55.



26. U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2019 Budget Overview*, p. 37.
27. Comparison made between U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2019 Budget Overview*, p. 37, and International Institute for Strategic Studies, *The Military Balance 2019*, pp. 54–56.
28. “U-2 Dragon Lady,” in “USAF Almanac 2019,” pp. 59 and 111. Ten months were added to the U-2’s age because of the difference between the data capture date for the 2019 USAF Almanac and publication of this edition of the *Index*.
29. Headquarters U.S. Air Force, A8XC/A5RW, written response to Heritage Foundation request for information on Air Force PGM expenditures and programmed replenishments, June 10, 2018.
30. Jeremiah Gertler, “Air Force F-22 Fighter Program,” Congressional Research Service *Report for Congress*, July 11, 2013, p. 7, <https://www.fas.org/sgp/crs/weapons/RL31673.pdf> (accessed July 29, 2019), and Rebecca Grant and Loren Thompson, “Losing Air Dominance? The Air Force and Its Future Roles,” presentation at Air Force Association Air & Space Conference, Washington, D.C., September 16, 2008, p. 3, [https://secure.afa.org/Mitchell/presentations/091608LosingAirDominance\\_tnx.pdf](https://secure.afa.org/Mitchell/presentations/091608LosingAirDominance_tnx.pdf) (accessed July 29, 2019).
31. James Drew, “F-22 Raptor Retrofit to Take Longer, but Availability Hits 63%,” *FlightGlobal*, July 6, 2015, <http://www.flightglobal.com/news/articles/f-22-raptor-retrofit-to-take-longer-but-availability-hits-414341/> (accessed July 29, 2019).
32. The 2019 *Index of U.S. Military Strength* stated that 103 of 166 of the active-duty mission fleet of F-22As are currently available. 2019 *Index of U.S. Military Strength*, p. 391. The actual number of combat-coded F-22As on active duty is 138. With a mission-capable rate of 62.8 percent, just 72 are flyable to fly combat sorties at any given time, including the retrofit.
33. Kris Osborn, “Air Force: F-35 3F Software Drop Challenges Resolved,” *Defense Systems*, May 17, 2017, <https://defensesystems.com/articles/2017/05/17/f35.aspx> (accessed July 29, 2019).
34. John Venable, “The F-35A Fighter Is the Most Dominant and Lethal Multi-Role Weapons System in the World: Now Is the Time to Ramp Up Production,” Heritage Foundation *Backgrounder* No. 3406, May 14, 2019, pp. 8–9, <https://www.heritage.org/sites/default/files/2019-05/BG3406.pdf>.
35. See Colonel Michael W. Pietrucha, “The Comanche and the Albatross: About Our Neck Was Hung,” *Air & Space Power Journal*, Vol. 28, No. 3 (May–June 2014), pp. 133–156, [https://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-28\\_Issue-3/F-Pietrucha.pdf](https://www.airuniversity.af.mil/Portals/10/ASPJ/journals/Volume-28_Issue-3/F-Pietrucha.pdf) (accessed July 29, 2019).
36. Venable, “Independent Capability Assessment of U.S Air Force Reveals Readiness Level Below Carter Administration Hollow Force,” p. 2, and Dave Majumdar, “Can the F-35 Win a Dogfight?” *War Is Boring*, December 17, 2013, <https://warisboring.com/can-the-f-35-win-a-dogfight/> (accessed July 29, 2019).
37. Thomas W. Spoehr and Rachel Zissimos, eds., “Preventing a Defense Crisis: The 2018 National Defense Authorization Act *Must* Begin to Restore U.S. Military Strength,” Heritage Foundation *Backgrounder* No. 3205, March 29, 2017, p. 8, <https://www.heritage.org/sites/default/files/2017-03/BG3205.pdf>.
38. Headquarters U.S. Air Force, A8XC/A5RW, written response to Heritage Foundation request for information on Air Force PGM expenditures and programmed replenishments, July 10, 2019.
39. Lieutenant General Arnold W. Bunch, Jr., Military Deputy, Office of the Assistant Secretary of the Air Force (Acquisition); Lieutenant General Jerry D. Harris, Deputy Chief of Staff (Strategic Plans and Requirements); and Major General Scott A. Vander Hamm, Assistant Deputy Chief of Staff (Operations), statement on “Air Force Bomber/Tanker/Airlift Acquisition Programs” before the Subcommittee on Seapower and Projection Forces, Committee on Armed Services, U.S. House of Representatives, May 25, 2017, p. 10, <http://docs.house.gov/meetings/AS/AS28/20170525/106013/HHRG-115-AS28-Wstate-BunchA-20170525.pdf> (accessed July 30, 2019).
40. *Ibid.*, p. 4, and Lieutenant General James M. “Mike” Holmes, Deputy Chief of Staff (Strategic Plans and Requirements), and Lieutenant General Arnold W. Bunch, Jr., Military Deputy, Office of the Assistant Secretary of the Air Force (Acquisition), statement on “Air Force Bomber/Tanker/Airlift Acquisition Programs” before the Subcommittee on Seapower and Projection Forces, Committee on Armed Services, U.S. House of Representatives, March 1, 2016, p. 4, <http://docs.house.gov/meetings/AS/AS28/20160301/104353/HHRG-114-AS28-Wstate-BunchA-20160301.pdf> (accessed July 30, 2019).
41. Small group discussion with the Honorable Heather Wilson, Secretary of the Air Force, February 9, 2018.
42. Holmes and Bunch, statement on “Air Force Bomber/Tanker/Airlift Acquisition Programs,” March 1, 2016, pp. 2–3.
43. Dave Majumdar, “Why the Air Force Won’t Buy the F-15X or ‘New’ F-22 Raptor,” *Real Clear Defense*, September 18, 2018, [https://www.realcleardefense.com/articles/2018/09/18/why\\_the\\_air\\_force\\_wont\\_buy\\_the\\_f-15x\\_or\\_new\\_f-22\\_raptor\\_113808.html](https://www.realcleardefense.com/articles/2018/09/18/why_the_air_force_wont_buy_the_f-15x_or_new_f-22_raptor_113808.html) (accessed July 30, 2019).

44. Joe Gould, "US Air Force Defends F-15X Buy to Skeptical Inhofe, Reed," *Defense News*, April 4, 2019, <https://www.defensenews.com/congress/2019/04/04/usaf-defends-f-15x-buy-to-skeptical-inhofe-reed/> (accessed July 30, 2019).
45. The Honorable Dr. Heather Wilson, Secretary of the Air Force, and General David L. Goldfein, Chief of Staff, United States Air Force, "USAF Posture Statement, Fiscal Year 2020," Department of the Air Force Presentation to the Committees and Subcommittees of the United States Senate and the House of Representatives, 116th Cong., 1st Sess., p. 4, [https://www.af.mil/Portals/1/images/posturestatement/FY20\\_POSTURE\\_STATEMENT\\_OMB\\_Cleared\\_12MAR\\_1310L.pdf](https://www.af.mil/Portals/1/images/posturestatement/FY20_POSTURE_STATEMENT_OMB_Cleared_12MAR_1310L.pdf) (accessed July 30, 2019).
46. The Honorable Heather A. Wilson, Secretary of the Air Force, and General David L. Goldfein, Chief of Staff of the Air Force, statement on "Air Force Budget Posture" before the Committee on Armed Services, U.S. Senate, June 6, 2017, p. 3, [https://www.armed-services.senate.gov/imo/media/doc/Wilson-Goldfein\\_06-06-17.pdf](https://www.armed-services.senate.gov/imo/media/doc/Wilson-Goldfein_06-06-17.pdf) (accessed July 30, 2019).
47. Major General Scott West, Director of Current Operations, Deputy Chief of Staff for Operations, Headquarters, U.S. Air Force, statement on "Military Aviation Readiness and Safety" before the Subcommittee on Readiness, Committee on Armed Services, U.S. House of Representatives, July 6, 2016, p. 2, <http://docs.house.gov/meetings/AS/AS03/20160706/105159/HHRG-114-AS03-Wstate-WestS-20160706.pdf> (accessed July 30, 2019).
48. Stephen Losey, "The Air Force Still Has a Serious Maintainer Staffing Problem, GAO Says—but No Strategy to Fix It," *Air Force Times*, February 8, 2019, <https://www.airforcetimes.com/news/your-air-force/2019/02/08/the-air-force-still-has-a-serious-maintainer-staffing-problem-gao-says-but-no-strategy-to-fix-it/> (accessed July 25, 2019).
49. Julian E. Barnes, "Warning Sounded on Cuts to Pilot Training," *The Wall Street Journal*, December 19, 2013, <http://www.wsj.com/articles/SB10001424052702304773104579268651994849572> (accessed July 30, 2019).
50. Lieutenant General Gina M. Grosso, Deputy Chief of Staff Manpower, Personnel and Services, United States Air Force, statement on "Military Pilot Shortage" before the Subcommittee on Personnel, Committee on Armed Services, U.S. House of Representatives, March 29, 2017, p. 2, <http://docs.house.gov/meetings/AS/AS02/20170329/105795/HHRG-115-AS02-Wstate-GrossoG-20170329.pdf> (accessed July 30, 2019).
51. Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, June 10, 2018.
52. Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, April 9, 2019.
53. James C. Slife, *Creech Blue: Gen Bill Creech and the Reformation of the Tactical Air Forces, 1978–1984* (Maxwell Air Force Base: Air University Press, October 2004), p. 92, [https://www.airuniversity.af.edu/Portals/10/AUPress/Books/B\\_0095\\_SLIFE\\_CREECH\\_BLUE.pdf](https://www.airuniversity.af.edu/Portals/10/AUPress/Books/B_0095_SLIFE_CREECH_BLUE.pdf) <https://www.airuniversity.af.edu/AUPress/Display/Article/1534424/creech-blue/> (accessed July 30, 2019).
54. John Venable, "A Plan for Keeping the U.S. Air Force's Best Pilots in Service," Heritage Foundation *Commentary*, November 14, 2017, <https://www.heritage.org/defense/commentary/plan-keeping-the-us-air-forces-best-pilots-service>.
55. The Honorable Heather A. Wilson, "A Budget Conversation with the Secretary of the Air Force," The Heritage Foundation, March 27, 2019, <https://www.heritage.org/defense/event/budget-conversation-the-secretary-the-air-force> (accessed July 30, 2019).
56. Slife, *Creech Blue: Gen. Bill Creech and the Reformation of the Tactical Air Forces, 1978–1984*, pp. 92–95.
57. U.S. General Accounting Office, "Air Force Maintenance: Two Level Maintenance Program Assessment," GAO/NSAID-96-86, March 1996, p. 1, <https://www.gao.gov/assets/230/222350.pdf> (accessed July 30, 2019).
58. Wilson, "A Conversation with the Secretary of the Air Force."
59. Averages for sorties and hours are based on weighted fighter manning levels for each of the five major weapons systems provided in Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force manning levels, July 8, 2018. The numbers were weighted based on aircraft numbers as explained in note 19, *supra*, as well as standard aircrew ratios established in Figure A8.1, "Air Force Single Flying Hour Model F-16C Example," in U.S. Air Force, "Flying Operations: Flying Hour Program Management," Air Force Instruction 11-102, August 30, 2011, p 17, [https://static.e-publishing.af.mil/production/1/af\\_a3\\_5/publication/afi11-102/afi11-102.pdf](https://static.e-publishing.af.mil/production/1/af_a3_5/publication/afi11-102/afi11-102.pdf) (accessed July 14, 2019).
60. See note 59, *supra*.
61. U.S. Air Force, "Hyten Announces Space Enterprise Vision," April 13, 2016, <http://www.af.mil/News/Article-Display/Article/719941/hyten-announces-space-enterprise-vision/> (accessed July 30, 2019).
62. Colin Clark, "Space Command Readies for War with 'Space Enterprise Vision,'" *Breaking Defense*, June 20, 2016, <http://breakingdefense.com/2016/06/space-command-readies-for-war-with-space-enterprise-vision/> (accessed July 30, 2019).
63. Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force," p. 10.

64. Bill Gertz, "China Tests Anti-Satellite Missile," *The Washington Free Beacon*, November 9, 2015, <http://freebeacon.com/national-security/china-tests-anti-satellite-missile/> (accessed July 30, 2019); Weston Williams, "Russia Launches Anti-Satellite Weapon: A New Warfront in Space?" *The Christian Science Monitor*, December 22, 2016, <http://www.csmonitor.com/USA/Military/2016/1222/Russia-launches-anti-satellite-weapon-A-new-warfront-in-space> (accessed July 30, 2019); and Brid-Aine Parnell, "Mystery Russian Satellite: Orbital Weapon? Sat Gobbler? What?" *The Register*, November 18, 2014, [http://www.theregister.co.uk/2014/11/18/russia\\_secret\\_satellite\\_kosmos\\_2499/](http://www.theregister.co.uk/2014/11/18/russia_secret_satellite_kosmos_2499/) (accessed July 30, 2019).
65. U.S. Air Force, "Hyten Announces Space Enterprise Vision."
66. Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force."



# U.S. Marine Corps

The U.S. Marine Corps (USMC) is the nation's expeditionary armed force, positioned and ready to respond to crises around the world. Marine units assigned aboard ships ("soldiers of the sea") or at bases abroad stand ready to project U.S. power into crisis areas. Marines also serve in a range of unique missions, from combat defense of U.S. embassies under attack abroad to operating the President's helicopter fleet.

Although Marines have a wide variety of individual assignments, the focus of every Marine is on combat: Every Marine is first a rifleman. The USMC has positioned itself for crisis response and has evolved its concepts to leverage its equipment more effectively to support operations in a heavily contested maritime environment such as the one found in the Western Pacific.

As of March 2019, according to the U.S. Navy's budget highlights document for fiscal year (FY) 2020, more than 40,000 Marines (roughly one-third of Marine Corps operating forces) were deployed around the world, "providing immediate options, assuring allies and deterring our adversaries." During the preceding year, "the Marine Corps executed 170 operations, eight amphibious operations, [and] 115 theater security cooperation events and participated in 51 exercises and relief operations for Hurricanes Maria, Florence, and Michael."<sup>1</sup>

Pursuant to the national-level and service-level strategic guidance documents that provide direction and focus for the military services,<sup>2</sup> maintaining the Marines' crisis response capability is critical. Thus, given the fiscal constraints imposed on it, the Corps has

continued to prioritize "near-term readiness" at the expense of other areas such as capacity, capability, modernization, home station readiness, and infrastructure.<sup>3</sup> However, as stated in the President's FY 2019 budget of \$43.1 billion for the Corps, the service elevated modernization as a means to improve readiness for combat.<sup>4</sup> This is consistent with and central to its readiness-recovery efforts and represents a shift to a longer-term perspective. Recapitalization and repair of legacy systems is no longer sufficient to sustain current operational requirements. New equipment is necessary.

## Capacity

The measures of Marine Corps capacity in this *Index* are similar to those used to assess the Army's: end strength and units (battalions for the Marines and brigades for the Army).

**Ground Forces.** The Marine Corps' basic combat unit is the infantry battalion, which is composed of approximately 900 Marines and includes three rifle companies, a weapons company, and a headquarters and service company.<sup>5</sup> In FY 2011, the Marine Corps maintained 27 infantry battalions in its active component at an authorized end strength of 202,100.<sup>6</sup> As budgets declined, the Corps prioritized readiness through managed reductions in capacity, including a drawdown of forces, and delays or reductions in planned procurement levels. After the Marine Corps fell to a low of 23 active component infantry battalions in FY 2015, Congress began to fund gradual increases in end strength, returning the Corps to 24 infantry battalions.<sup>7</sup>

President Donald Trump's FY 2019 budget request increased the size of the active

component Marine Corps by 1,100 Marines to an authorized level of 186,100,<sup>8</sup> sustaining enough support for 24 infantry battalions. The additional manpower backfilled existing units and helped the Marine Corps to recruit and retain individuals with critical skill sets and specialties.

One impact of reduced capacity is a strain on Marines' dwell time. Cuts in capacity—the number of units and individual Marines—enabled the Marine Corps to disperse the resources it did receive among fewer units, thus maintaining higher readiness levels throughout a smaller force. However, without a corresponding decrease in operational requirements, demand for Marine Corps units and assets has resulted in grueling deployment rates, a situation that has remained largely unchanged since 2018.<sup>9</sup> High deployment frequency exacerbates the degradation of readiness as people and equipment are used more frequently with less time to recover between deployments.

The stated ideal deployment-to-dwell (D2D) time ratio is 1:3 (seven months deployed for every 21 months at home).<sup>10</sup> This leaves more time available for training and recovery and provides support for a “ready bench,” without which readiness investments are immediately consumed. FY 2019 budget constraints support only “an approximate 1:2 D2D ratio in the aggregate”<sup>11</sup> with the roughly 5 percent increase in funding (compared to FY 2018) going toward readiness and modernization at the expense of capacity or number of units.

Infantry battalions serve as a surrogate measure for the Corps' total force. As the first to respond to many contingencies, the Marine Corps requires a large degree of flexibility and self-sufficiency, and this drives its approach to organization and deployment of operational formations that, although typically centered on infantry units, are composed of ground, air, and logistics elements. Each of these assets and capabilities is critical to effective deployment of force, and any one of them can be a limiting factor in the conduct of training and operations.

**Aviation.** Marine aviation has been particularly stressed by insufficient funding. Although operational requirements have not decreased, fewer Marine aircraft have been available for tasking or training. For example, according to its 2019 aviation plan, the USMC currently fields 16 tactical fighter squadrons, compared to 19 in FY 2017 and around 28 during Desert Storm.<sup>12</sup> Though the availability of legacy aircraft has slowly improved—the result of increased funding for spare parts and implementation of recommendations from independent readiness reviews—the Marine Corps “is still challenged with low readiness rates in specific communities,” such as F/A-18 squadrons.<sup>13</sup>

The Corps is introducing the F-35 platform into the fleet, but F/A-18 Hornets remain “the primary bridging platform to F-35B/C” and will remain in the force until 2030.<sup>14</sup> This primary tactical air (TACAIR) capability has to be carefully managed as it is no longer in production. The Navy completed its divestment of F/A-18 A-D models during FY 2019, making them available to the Marines and enabling the Corps to replace its older aircraft with planes that are less old.<sup>15</sup> To further mitigate the aging of its fleet until full transition to the F-35, the Corps is also looking to acquire F/A-18s from other countries as opportunities arise.<sup>16</sup>

The Corps will maintain five squadrons of AV-8B Harriers, introduced in 1985, until FY 2022.<sup>17</sup> In its heavy-lift rotary wing fleet, the Corps began a reset of the CH-53E in 2016 to bridge the procurement gap to the CH-53K and aims to “reset...the entire 143-aircraft fleet by FY20,” but this will still leave the service 57 aircraft short of the stated heavy-lift requirement of 200 airframes, and the Marine Corps will not have enough helicopters to meet its heavy-lift requirement without the transition to the CH-53K.<sup>18</sup>

According to the Corps' 2019 aviation plan, the transition to the MV-22 Osprey is complete, with 18 fully operational squadrons in the active component.<sup>19</sup> However, depending on the results of an ongoing requirements-based analysis, the procurement objective could increase to 380 aircraft.<sup>20</sup> The Osprey has been



called “our most in-demand aircraft,”<sup>21</sup> which means the Marine Corps has to reconcile high operational tempos (OPTEMPOs) with the objective of maintaining the platform in its inventory “for at least the next 40 years.”<sup>22</sup> At present, MV-22 readiness has plateaued at 55 percent due to a wide variety in aircraft configuration, which complicates assessing problems and ordering parts—affecting repairs—and shortfalls in maintenance personnel.<sup>23</sup> The Corps has committed to funding its Common Configuration-Readiness and Modernization (CC-RAM) and Nacelle Improvement (NI) programs to increase availability by 15 percent.<sup>24</sup>

**Amphibious Ships.** Although amphibious ships are assessed as part of the Navy’s fleet capacity, Marines operate and train aboard naval vessels. This makes “the shortage of amphibious ships...the quintessential challenge to amphibious training.”<sup>25</sup> The Navy was operating only 32 amphibious warfare ships as of August 20, 2019,<sup>26</sup> and is projected to continue operating short of the 38-ship requirement until FY 2033, thus limiting what the Marine Corps can do in operational, training, and experimentation settings.<sup>27</sup>

Because of this chronic shortfall in amphibious ships, the USMC has relied partially on land-based Special Purpose Marine Air-Ground Task Forces (SPMAGTFs). SPMAGTFs have enabled the Corps to meet Joint Force requirements, but land-based locations still “lack the full capability, capacity and strategic and operational agility that results when Marine Air-Ground Task Forces (MAGTFs) are embarked aboard Navy amphibious ships.”<sup>28</sup> The lack of variety in amphibious shipping, especially as the Corps considers the implications of evolving enemy capabilities, and concerns about the shortage of amphibious lift in general make the exploration of alternatives with the Navy an increasingly urgent need.<sup>29</sup>

The USMC continues to invest in the recapitalization of legacy platforms in order to extend platform service life and keep aircraft and amphibious vehicles in the fleet, but as these platforms age, they also become less relevant to the evolving modern operating environment.

Thus, while they do help to maintain capacity, programs to extend service life do not provide the capability enhancements that modernization programs provide. The result is an older, less-capable fleet of equipment that costs more to maintain.

## Capability

The nature of the Marine Corps’ crisis response role requires capabilities that span all domains. The USMC ship requirement is managed by the Navy and is covered in the Navy’s section of the *Index*. The Marine Corps has been focusing on “essential modernization” and emphasizing programs that “underpin our core competencies,” making the Amphibious Combat Vehicle (ACV) and F-35 JSF programs its top two priorities.<sup>30</sup> The Corps has committed nearly one-third of its overall budget—\$13.8 billion in FY 2019 and a requested \$13.9 billion for FY 2020—to force modernization.<sup>31</sup>

Of the Marine Corps’ current fleet of vehicles, its amphibious vehicles—specifically, the Assault Amphibious Vehicle (AAV-7A1) and Light Armored Vehicle (LAV)—are the oldest, with the AAV-7A1 averaging over 40 years old and the LAV averaging 26 years old.<sup>32</sup> The Corps had pursued a survivability upgrade for the AAV to extend its useful service life, but progress with the ACV program was better than expected, so the service canceled its contract with Science Applications International Corporation (SAIC) in September 2018.<sup>33</sup>

Service testimony notes that the Marine Corps is “beginning to look at a replacement” for the LAV, which will “help accelerate movement to the acquisition phase within the next four to five years.”<sup>34</sup> As noted, the average age of the LAV is 26 years. Comparatively, the Corps’ M1A1 Abrams inventory is 28 years old with an estimated 33-year life span,<sup>35</sup> while as of 2014, the newest HMMWV variant had already consumed half of its projected 15-year service life.<sup>36</sup>

All of the Corps’ main combat vehicles entered service in the 1970s and 1980s, and service life extensions, upgrades, and new

generations of designs have allowed the platforms to remain in service. However, these vehicles are rapidly becoming poorly suited to the changing threat environment. The President's FY 2020 budget seeks to provide \$13.9 billion for modernization across the service, with \$3.1 billion of this amount to be used for ground-related procurement in an effort to update key combat and combat-related systems that will extend the service utility of aging primary ground combat platforms.<sup>37</sup>

The age profiles of the Corps' aircraft are similar to those of the Navy's. In 2018, the USMC had 251 F/A-18A-Ds (including one reserve squadron) and six EA-6Bs in its primary mission aircraft inventory,<sup>38</sup> and both aircraft had already surpassed their originally intended life spans. The Marine Corps completed retirement of its EA-6B squadrons in FY 2019.<sup>39</sup>

Unlike the Navy, the Corps did not acquire the newer F/A-18 E/F Super Hornets; thus, a portion of the older F/A-18 Hornets are going through a service life extension program to extend their life span to 10,000 flight hours from the original 6,000 hours.<sup>40</sup> This is intended to bridge the gap until the F-35Bs and F-35Cs enter service to replace the Harriers and most of the Hornets.

As the Navy accelerated its transition to the Super Hornet, it transferred its "best of breed" aircraft from its F/A-18A-D inventory to the Marine Corps and scrapped the remaining for parts to help maintain the Corps' legacy fleet through FY 2030.<sup>41</sup> The AV-8B Harrier, designed to take off from the LHA and LHD amphibious assault ships, will be retired from Marine Corps service by 2026.<sup>42</sup> The AV-8B received near-term capability upgrades in 2015, which continued in 2017 in order to maintain its lethality and interoperability until the F-35 transition is completed in FY 2022.<sup>43</sup>

The Corps declared its first F-35B squadron operationally capable on July 31, 2015, after it passed an "Operational Readiness Inspection" test and has reported that the aircraft reached full operational capability in late 2018.<sup>44</sup> During FY 2019, VMFA-211 made the first full operational deployment with a Marine

Expeditionary Unit (MEU) when it sailed with the 13th MEU from September 2018 to February 2019, supporting combat operations in Afghanistan, Iraq, and Syria.<sup>45</sup> To date, three F-35B squadrons have been delivered to the Marine Corps, including two operational squadrons and one fleet replacement squadron, totaling 158 aircraft comprised of 135 F-35Bs and 23 F-35Cs.<sup>46</sup>

The Marine Corps has two Major Defense Acquisition (MDAP) vehicle programs: the Joint Light Tactical Vehicle (JLTV) and Amphibious Combat Vehicle (ACV).<sup>47</sup> The JLTV is a joint program with the Army to acquire a more survivable light tactical vehicle that was originally intended to replace a percentage of the older HMMWV fleet, introduced in 1985, although that objective changed in 2019. The Army retains overall responsibility for JLTV development through its Joint Program Office.<sup>48</sup>

Following FY 2015 plans for the JLTV, the program awarded a low-rate initial production contract, which included a future option of producing JLTVs for the Marine Corps, to defense contractor Oshkosh.<sup>49</sup> As of June 2017, despite a delay in the program's full-rate production decision and reduced procurement quantities in FY 2016 and FY 2017, the Corps expected to complete its prior acquisition objective of 5,500 by FY 2023.<sup>50</sup> In mid-August 2019, the Corps announced that it would increase its procurement of JLTVs to around 15,000, effectively enabling replacement of its 15,390-vehicle HMMWV fleet.<sup>51</sup> The JLTV program has reached sufficient production maturity that the Corps is fielding the vehicle to its first operational unit, 3rd Battalion, 8th Marines, located at MCB Camp Lejeune, North Carolina.<sup>52</sup>

The Marine Corps is replacing the AAV-7A1 with the ACV. The ACV, which took the place of the Expeditionary Fighting Vehicle (EFV), "has been structured to provide a phased, incremental capability."<sup>53</sup> The AAV-7A1 was to be replaced by the EFV, a follow-on to the cancelled Advanced AAV, but the EFV was also cancelled in 2011 as a result of technical obstacles and cost overruns. Similarly, the Corps planned to replace the LAV inventory with the Marine

Personnel Carrier (MPC), which would serve as a Light Armored Vehicle with modest amphibious capabilities but would be designed primarily to provide enhanced survivability and mobility once ashore.<sup>54</sup> However, budgetary constraints led the Corps to shelve the program, leaving open the possibility that it might be resumed in the future.

After restructuring its ground modernization portfolio, the Marine Corps determined that it would combine its efforts by upgrading 392 of its legacy AAVs and continuing development of the ACV to replace part of the existing fleet and complement its AAVs.<sup>55</sup> This would help the Corps to meet its requirement of armored lift for 10 battalions of infantry.<sup>56</sup> BAE Systems won the contract award to build the ACV 1.1 in June 2018<sup>57</sup> and is expected to deliver the first 30 vehicles by the fall of 2019, for which the FY 2019 budget provided funding. The Marine Corps plans to field 204 vehicles in the first increment—enough to support lift requirements for two infantry battalions.<sup>58</sup>

The ACV 1.1 platform is notable because it is an amphibious wheeled vehicle instead of a tracked vehicle, capable of traversing open water only with the assistance of Navy shore connectors such as Landing Craft, Air Cushion Vehicles (LCAC). Development and procurement of the ACV program will be phased so that the new platforms can be fielded incrementally alongside a number of modernized AAVs.<sup>59</sup> Plans call for a 694-vehicle program of record (a combination of upgraded AAVs and ACVs), with the first battalion to reach initial operating capability (IOC) in FY 2020, and for modernizing enough of the current AAV fleet to outfit six additional battalions, two in the first increment and four in the second. The Corps has requested \$318 million in its FY 2020 budget to fund the “first full-rate production lot of 56 vehicles,” nearly double the \$167 million it received for the ACV in FY 2019.<sup>60</sup>

Regarding aviation, Lieutenant General Brian Beaudreault, then Marine Corps Deputy Commandant for Plans, Policies, and Operations, testified in 2018 that “[t]he single most effective way to meet our NDS responsibilities,

improve overall readiness, and gain the competitive advantage required for combat against state threats is through the modernization of our aviation platforms.”<sup>61</sup> The F-35B remained the Marine Corps’ largest investment program in FY 2019. The Corps announced IOC of the F-35B variant in July 2015.<sup>62</sup> Total procurement will consist of 420 F-35s (353 F-35Bs and 67 F-35Cs), 158 of which have been acquired.<sup>63</sup> AV-8Bs and F/A-18A-Ds continue to receive interoperability and lethality enhancements in order to extend their useful service lives during the transition to the F-35.

Today, the USMC MV-22 Osprey program is operating with few problems and nearing completion of the full acquisition objective of 360 aircraft.<sup>64</sup> The Marine Corps has increased its total of MV-22 squadrons to 16 fully operational squadrons in the active component toward a final objective of 18 active and two reserve component squadrons.<sup>65</sup> The MV-22’s capabilities are in high demand from the Combatant Commanders (CCDR), and the Corps is adding capabilities such as fuel delivery and use of precision-guided munitions to the MV-22 to enhance its value to the CCDR.

The Corps continues to struggle with sustainment challenges in the Osprey fleet. Since procurement of the first MV-22 in 1999, the fleet has developed more than 70 different configurations.<sup>66</sup> This has resulted in increased logistical requirements, as maintainers must be trained to each configuration and spare parts are not all shared. The Marine Corps developed its CC-RAM program to consolidate the inventory to a common configuration at a rate of “2–23 aircraft installs per year” beginning in FY 2018.<sup>67</sup>

The USMC’s heavy-lift replacement program, the CH-53K, conducted its first flight on October 27, 2015.<sup>68</sup> The CH-53K will replace the Corps’ CH-53E, which is now 29 years old. Although “unexpected redesigns to critical components” delayed a low-rate initial production decision, the program achieved Milestone C in April 2017, and the President’s FY 2019 budget requested \$1,601.8 million for the procurement of eight aircraft in its second

year of low-rate initial production.<sup>69</sup> The Corps continued this effort by purchasing another six aircraft in FY 2020 for \$1.0 billion and determined that it would invest an additional almost \$517 million in continued engineering manufacturing development initiatives.<sup>70</sup>

The helicopter is now forecast to reach IOC in FY 2021,<sup>71</sup> six years later than initially anticipated. This is of increasing concern as the Marine Corps maintains only 138 CH-53Es and will not have enough helicopters to meet its heavy-lift requirement of 220 aircraft without the transition to the CH-53K, which even when fully implemented will still fall short by 20 aircraft.<sup>72</sup>

## Readiness

The Marine Corps' first priority is to be the military's crisis response force, which is why investment in immediate readiness has been prioritized over capacity and capability.<sup>73</sup> Although this is sustainable for a short time, concerns expressed when the Budget Control Act was passed in 2011 have proved to be impediments in the present. Modernization is now a primary inhibitor of readiness as keeping aging platforms in working order becomes increasingly challenging and aircraft are retired before they can be replaced, leaving a smaller force available to meet operational requirements and further increasing the use of remaining platforms.

With respect to training, the Marine Corps continues to prioritize training for deploying and next-to-deploy units. Marine operating forces as a whole continue to average a 1:2 deployment-to-dwell ratio.<sup>74</sup> At this pace, readiness is consumed as quickly as it is built, leaving minimal flexibility to respond to contingencies.

Marine Corps guidance identifies multiple levels of readiness that can affect the ability to conduct operations:

Readiness is the synthesis of two distinct but interrelated levels. a. unit readiness—The ability to provide capabilities required by the combatant commanders to execute

their assigned missions. This is derived from the ability of each unit to deliver the outputs for which it was designed. b. joint readiness—The combatant commander's ability to integrate and synchronize ready combat and support forces to execute his or her assigned missions.<sup>75</sup>

As noted, the availability of amphibious ships, although funded through the Navy budget, has a direct impact on the Marine Corps' joint readiness. For example, while shore-based MAGTFs can maintain unit-level readiness and conduct training for local contingencies, a shortfall in amphibious lift capabilities leaves these units without “the strategic flexibility and responsiveness of afloat forces and... constrained by host nation permissions.”<sup>76</sup>

In December 2017, a U.S. Government Accountability Office (GAO) official testified that even though deploying units completed all necessary pre-deployment training for amphibious operations, the Marine Corps was “unable to fully accomplish...home-station unit training to support contingency requirements, service-level exercises, and experimentation and concept development for amphibious operations.”<sup>77</sup> Lieutenant General Beaudreault identified the shortage of available amphibious ships as the primary factor in training limitations. Of the 32 amphibious ships in the U.S. fleet at the time, only 16 were considered “available to support current or contingency operations.”<sup>78</sup> Regrettably, conditions have not improved since then. While infantry battalions can maintain unit-level readiness requirements, their utility depends equally on their ability to deploy in defense of U.S. interests.

Marine aviation in particular is experiencing significant readiness shortfalls. Last year, the *2018 Marine Aviation Plan* found that “[a]cross all of Marine aviation, readiness is below steady-state requirements.”<sup>79</sup> With a smaller force structure and fewer aircraft available for training, aviation units were having difficulty keeping up with demanding operational requirements. Lieutenant General Stephen Rudder, Marine Corps Deputy Commandant for



Aviation, testified in December 2017 that most Marine aviation squadrons lacked the “number of ready aircraft required to ‘fight tonight.’”<sup>80</sup>

In 2019, progress has been made, but the Corps still cites challenges: “[Aviation] readiness trend lines [are] moving up,” but “our backlog of deferred readiness, procurement, and modernization requirements has grown in the last decade and a half and can no longer be ignored,” and Marine aviation is “still challenged with low readiness rates in specific communities.”<sup>81</sup> The Corps has not been explicit in citing specific readiness rates in public testimony, but it is clear that readiness problems remain

despite some improvement in Marine aviation readiness over the past few years.

The Marines Corps’ Ground Equipment Reset Strategy, developed to recover from the strain of years of sustained operations in Iraq and Afghanistan, has had a positive impact after being delayed from the end of FY 2017 to FY 2019. As of May 2019, the Marine Corps had reset approximately 99 percent of its ground equipment and “returned 72% of [its] ground equipment to the operating forces.”<sup>82</sup> Reconstituting equipment and ensuring that the Corps’ inventory can meet operational requirements are critical aspects of readiness.

## Scoring the U.S. Marine Corps

### Capacity Score: Weak

Based on the deployment of Marines across major engagements since the Korean War, the Corps requires roughly 15 battalions for one MRC.<sup>83</sup> This translates to a force of approximately 30 battalions to fight two MRCs simultaneously. The government force-sizing documents that discuss Marine Corps composition support this. Though the documents that make such a recommendation count the Marines by divisions, not battalions, they are consistent in arguing for three Active Marine Corps divisions, which in turn requires roughly 30 battalions.

With a 20 percent strategic reserve, the ideal USMC capacity for a two-MRC force-sizing construct is 36 battalions. Unless a dramatic change in circumstances were to occur, such as the onset of a major conflict, it is unlikely that the Corps will push to expand end strength to this number. In fact, the prevailing federal budget environment and the effects of nearly 20 years of operations on equipment and readiness have led the Corps to prioritize modernization and readiness over force capacity and even to consider trading capacity for improvements in the other two areas.<sup>84</sup>

Manpower is by far the biggest expense for the Marines. As requested for the Corps’ FY 2020 budget, the military personnel account

at \$14.2 billion<sup>85</sup> dwarfs both the funding requested for operations and maintenance (\$3.9 billion)<sup>86</sup> and the funding requested for procurement of new equipment (\$3.1 billion).<sup>87</sup> Nevertheless, the historical record of the use of Marine Corps forces in a major contingency argues for the larger number.

More than 33,000 Marines were deployed in Korea, and more than 44,000 were deployed in Vietnam. In the Persian Gulf, one of the largest Marine Corps missions in U.S. history, some 90,000 Marines were deployed, and approximately 66,000 were deployed for Operation Iraqi Freedom.

As the Persian Gulf War is the most pertinent example for this construct, an operating force of 180,000 Marines is a reasonable benchmark for a two-MRC force, not counting Marines that would be unavailable for deployment (assigned to institutional portions of the Corps) or that are deployed elsewhere. This is supported by government documents that have advocated a force as low as 174,000 (1993 Bottom-Up Review) and as high as 202,000 (2010 Quadrennial Defense Review), with an average end strength of 185,000 being recommended. However, as recent increases in end strength have not corresponded with deployable combat power, these government recommendations may have to be reassessed.

- **Two-MRC Level:** 36 battalions.
- **Actual 2018 Level:** 24 battalions.

Despite an increase in manpower, the Corps continues to operate with less than 67 percent of the number of battalions relative to the two-MRC benchmark. Marine Corps capacity is therefore again scored as “weak.”

**Capability Score: Marginal**

The Corps receives scores of “weak” for “Capability of Equipment,” “marginal” for “Age of Equipment” and “Health of Modernization Programs,” but “strong” for “Size of Modernization Program.” Therefore, the aggregate score for Marine Corps capability is “marginal.”

**Readiness Score: Marginal**

As in FY 2018, the Marine Corps again prioritized next-to-deploy units during FY 2019. As the nation’s crisis response force, the Corps requires that all units, whether deployed or non-deployed, must be ready. However, since most Marine Corps ground units are meeting readiness requirements only immediately before deployment and the Corps’ “ready bench” would “not be as capable as necessary” if deployed on short notice, USMC readiness is sufficient to meet ongoing commitments only at reported deployment-to-dwell ratios of 1:2. This means that only a third of the force—the deployed force—could be considered fully ready. Furthermore, in testimony provided to various committees of the House and Senate

and in its publicly available program documents, the USMC has continued to report challenges in aviation unit readiness.

Marine Corps officials have not been clear as to the status of ground component readiness during FY 2019, but in testimony to Congress during the year, as noted, they have emphasized a positive upward trend as a consequence of additional funding provided by Congress in FY 2018 and FY 2019 and a shift in focus toward high-end conventional warfare. The lack of a “ready bench” in depth (too few units and short-ages of personnel in key maintenance fields) and continued challenges in readiness levels among the USMC aircraft fleet perhaps offset some of the gains made by increased effort, funding, and focus, but the *2020 Index* assesses Marine Corps readiness levels as “marginal,” an improvement over the *2019* score of “weak.”

**Overall U.S. Marine Corps Score: Marginal**

Marine Corps congressional testimony during 2019 struck an optimistic note, and increased funding for readiness and an emphasis on modernization give strong support to the Corps’ readiness-recovery efforts, but effects will take time to materialize across the force. Hence, the need for continued attention and support from the Administration and Congress. However, gains have been made over the past year, and the Marine Corps has increased its overall score to “marginal” in the *2020 Index*, which is both in line with its sister services and a welcome return from its overall assessment of “weak” in 2018 and 2019.

**U.S. Military Power: Marine Corps**

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness			✓		
<b>OVERALL</b>			✓		



# MARINE CORPS SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019 ■ Pending

## Main Battle Tank

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>M1A1 Abrams</b> Inventory: <b>447</b> Fleet age: <b>16</b> Date: <b>1990</b>  The M1A1 Abrams is the main battle tank and provides the Marine Corps with heavy-armor direct fire capabilities. It is expected to remain in service beyond 2028.	2	1	None		

## Light Wheeled Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>HMMWV</b> Inventory: <b>15,390</b> Fleet age: <b>21</b> Date: <b>1983</b>  The HMMWV is a light wheeled vehicle used to transport troops with some measure of protection against light arms, blast, and fragmentation. The expected life span of the HMMWV is 15 years. Some HMMWVs will be replaced by the Joint Light Tactical Vehicle (JLTV).	2	1	<b>Joint Light Tactical Vehicle (JLTV)</b>  Timeline: <b>2017-2022</b>  The JLTV is a vehicle program meant to replace all of the HMMWVs and improve reliability, survivability, and strategic and operational transportability. This is a joint program with the Army. Full-rate production is scheduled for early 2019. JLTVs should be at full operational capability in FY2022. The first set of JLTVs were fielded in March 2019; IOC was achieved in mid-summer 2019 with fielding at Camp Lejeune, NC	5	5

**PROCUREMENT**

2,51512,485

**SPENDING (\$ millions)**

\$1,001\$4,999

**NOTES:** See page 452 for details on fleet ages, dates, and procurement spending. JLTV spending figures reflect the full joint program spending.

# MARINE CORPS SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Amphibious Assault Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>AAV</b> Inventory: <b>1,200</b> Fleet age: <b>41</b> Date: <b>1972</b> <p>The Amphibious Assault Vehicle transports troops and cargo from ship to shore. In September 2018, the USMC cancelled a survivability upgrade for this platform.</p>	1	1	<b>Amphibious Combat Vehicle (ACV)</b> Timeline: <b>2018–2021</b> <p>The ACV is intended to replace the aging AAV. The first ACVs are expected to be fielded in 2020. Full operational capability is scheduled for 2023.</p> <div> <div> <b>PROCUREMENT</b>  <div> <div>56</div> <div>148</div> </div> </div> <div> <b>SPENDING (\$ millions)</b>  <div> <div>\$324</div> <div>\$811</div> </div> </div> </div>	3	5
<b>LAV-25</b> Inventory: <b>625</b> Fleet age: <b>37</b> Date: <b>1983</b> <p>The LAV is a wheeled light armor vehicle with modest amphibious capability used for armored reconnaissance and highly mobile fire support. It has undergone several service life extensions (most recently in 2012) and will be in service until 2035.</p>	2	1			

## Attack Helicopters

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>AH-1W Super Cobra</b> Inventory: <b>77</b> Fleet age: <b>24</b> Date: <b>1986</b> <p>The Super Cobra is an attack helicopter that provides the Marines with close air support and armed reconnaissance. The Super Cobra will remain in service until 2021; it is being replaced by the AH-1Z.</p>	1	2	<b>AH-1Z</b> Timeline: <b>2014–2022</b> <p>The new AH-1Z Viper program is part of a larger modification program to the H-1 platform. Replacing the AH-1W, the Z-Variant will serve as the next generation of attack aircraft. The new H-1 rotorcraft will have upgraded avionics, rotor blades, transmissions, landing gear, and structural modifications to enhance speed, maneuverability, and payload. It is scheduled for full operational capability in 2021.</p> <div> <div> <b>PROCUREMENT</b>  <div> <div>187</div> </div> </div> <div> <b>SPENDING (\$ millions)</b>  <div> <div>\$6,314</div> <div>\$62</div> </div> </div> </div>	5	4
<b>AH-1Z Viper</b> Inventory: <b>100</b> Fleet age: <b>6</b> Date: <b>2010</b> <p>The AH-1Z Viper is the follow on to the AH-1W Cobra attack helicopter. The Viper has greater speed, payload, and range, as well as a more advanced cockpit. It is gradually replacing the Cobra-variant and should do so fully by 2021. The expected operational life span of the Viper is 30 years.</p>	5	5			

**NOTE:** See page 452 for details on fleet ages, dates, and procurement spending.

# MARINE CORPS SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending

## Airborne Electronic Attack Aircraft/ Ground Attack Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>AV-8B</b> Inventory: <b>110</b> Fleet age: <b>28</b> Date: <b>1985</b> <p>The Harrier is a vertical/short takeoff and landing aircraft designed to fly from LHA/LHDs. It provides strike and reconnaissance capabilities. The aircraft is being replaced by the F-35B and will be fully retired around 2024.</p>	5	1	<b>F-35B/C</b> Timeline: <b>2007–2031</b>	4	4
<b>F-35B</b> Inventory: <b>61</b> Fleet age: <b>3</b> Date: <b>2015</b> <p>The F-35B is the Marine Corps' short takeoff and vertical landing variant replacing the AV-8B Harrier. Despite some development problems, the F-35B achieved IOC in July 2015.</p>	5	5	<p><b>PROCUREMENT</b> <b>SPENDING (\$ millions)</b></p> <div> <div>98271</div> <div>\$19,549\$35,727</div> </div>		
<b>F/A-18 A-D</b> Inventory: <b>251</b> Fleet age: <b>29</b> Date: <b>1978</b> <p>Many aircraft in the F/A-18 fleet have logged about 8,000 hours compared with the originally intended 6,000. However, the fleet life has been extended until 2030. This is necessary to bridge the gap to when the F-35Bs and F-35Cs are available.</p>	3	2			



**NOTE:** See page 452 for details on fleet ages, dates, and procurement spending.

# MARINE CORPS SCORES

1 2 3 4 5  
Weakest ← Strongest

Procurement and Spending ■ Through FY 2019  
■ Pending



## Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>MV-22</b> Inventory: <b>306</b> Fleet age: <b>13</b> Date: <b>2007</b> <p>The Osprey is a vertical takeoff and landing tilt-rotor platform designed to support expeditionary assault, cargo lift, and raid operations. The program is still in production. The life expectancy of the MV-22 is 23 years.</p>	4	5	<b>MV-22B</b> Timeline: <b>2007–2019</b> <p>Fielding of the Osprey is nearly complete, and the platform is meeting performance requirements. The modernization program is not facing any serious issues. Full operational capability is expected in September 2019.</p> <p><b>PROCUREMENT</b></p>  <p>366 44</p> <p><b>SPENDING (\$ millions)</b></p>  <p>\$31,194 \$4,794</p>	5	5

## Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>CH-53E Super Stallion</b> Inventory: <b>138</b> Fleet age: <b>28</b> Date: <b>1981</b> <p>The CH-53E is a heavy-lift rotorcraft. The aircraft will be replaced by the CH-53K, which will have a greater lift capacity. The program life of the CH-53E is 41 years.</p>	2	1	<b>CH-53K</b> Timeline: <b>2017–2029</b> <p>The program is in development. It is meant to replace the CH-53E and provide increased range, survivability, and payload. The program still has not fully developed the critical technology necessary. The program is expected to reach initial operational capability in December 2019 and full operational capability in 2029.</p> <p><b>PROCUREMENT</b></p>  <p>16 178</p> <p><b>SPENDING (\$ millions)</b></p>  <p>\$2,576 \$21,016</p>	5	3

## Tanker

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
<b>KC-130J</b> Inventory: <b>45</b> Fleet age: <b>8</b> Date: <b>2005</b> <p>The KC-130J is both a tanker and transport aircraft. It can transport troops, provide imagery reconnaissance, and perform tactical aerial refueling. This platform is currently in production. The airframe is expected to last 38 years.</p>	4	5	<b>KC-130J</b> Timeline: <b>2005–2031</b> <p>The KC-130J is both a tanker and transport aircraft. The procurement program for the KC-130J is not facing acquisition problems.</p> <p><b>PROCUREMENT</b></p>  <p>65 46</p> <p><b>SPENDING (\$ millions)</b></p>  <p>\$4,928 \$5,593</p>	4	4

**NOTES:** See Methodology for descriptions of scores. The Fleet age is the average between the last year of procurement and the first year of initial operational capability. The date is when the platform reached initial operational capability. The timeline is from the start of the platform's program to its budgetary conclusion. Spending does not include advanced procurement or research, development, test, and evaluation. The total program dollar value reflects the full F-35 joint program, including engine procurement. As part of the F-35 program, the Navy is purchasing 67 F-35Cs for the U.S. Marine Corps, which are included here. The MV-22B program also includes some costs from the U.S. Air Force procurement. The AH-1Z costs include costs of UH-1 procurement.

# U.S. Marine Corps Modernization Table Citations

## MAIN SOURCES

- U.S. Department of the Navy, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Navy, Justification Book Volume 1 of 3: Aircraft Procurement, Navy, Budget Activities 01–04*, March 2019, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/APN\\_BA1-4\\_BOOK.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/APN_BA1-4_BOOK.pdf) (accessed September 5, 2019).
- U.S. Department of the Navy, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Navy, Justification Book Volume 2 of 3: Aircraft Procurement, Navy Budget, Activity 05*, March 2019, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/APN\\_BA5\\_BOOK.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/APN_BA5_BOOK.pdf) (accessed September 5, 2019).
- U.S. Department of the Navy, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Navy, Justification Book Volume 1 of 1: Procurement, Marine Corps*, March 2019, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/PMC\\_Book.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/PMC_Book.pdf) (accessed September 6, 2019).
- U.S. Marine Corps, Concepts and Programs, “F-35B and F-35C Lightning II,” <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-5-Aviation/F-35B-and-F-35C-Lightning-II/> (accessed September 6, 2019).

## MISC. SOURCES

### M1A1 Abrams:

- “M1A2 Abrams Main Battle Tank,” Military.com, <https://www.military.com/equipment/m1a2-abrams-main-battle-tank> (accessed September 6, 2019).

### HMMWV:

- Grant Turnball, “End of an Icon: The Rise and Fall of the Humvee,” *army-technology.com*, September 30, 2014, <https://web.archive.org/web/20141030021334/http://www.army-technology.com/features/featureend-of-an-icon-the-rise-and-fall-of-the-humvee-4381884/> (accessed June 26, 2019).
- Jeff Schogol, “Why the Hell Are Marines Still Driving Humvees?” *Marine Corps Times*, November 20, 2017, <https://www.marinecorpstimes.com/news/your-marine-corps/2017/11/21/why-the-hell-are-marines-still-driving-humvees/> (accessed September 6, 2019).
- Megan Eckstein, “Marine Corps Fields First JLTV This Week; IOC Planned for July,” *U.S. Naval Institute News*, February 27, 2019, <https://news.usni.org/2019/02/27/marine-corps-fields-first-jltv-week-ioc-declaration-planned-july> (accessed September 6, 2019).
- U.S. Marine Corps, Concepts and Programs, “Joint Light Tactical Vehicle,” <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-3-Ground-Combat-Tactical-Vehicles/Joint-Light-Tactical-Vehicle-Family-of-Vehicles/> (accessed September 6, 2019).
- Todd South, “These Marine Units Are the First to Field the Newest Ground Combat Vehicle, the JLTV,” *Marine Corps Times*, February 28, 2019, <https://www.marinecorpstimes.com/news/your-marine-corps/2019/02/28/these-marine-units-are-the-first-to-field-the-newest-ground-combat-vehicle-the-jltv/> (accessed September 6, 2019).
- Matthew Cox, “Marine Corps to Increase JLTV Buy to 15,000 to Replace Its Humvee Fleet,” *Military.com*, August 15, 2019, <https://www.military.com/daily-news/2019/08/15/marine-corps-increase-jltv-buy-15000-replace-its-humvee-fleet.html> (accessed September 6, 2019).

### Amphibious Assault Vehicle:

- Andrew Feickert, “Marine Corps Amphibious Combat Vehicle (ACV): Background and Issues for Congress,” *Congressional Research Service Report for Members and Committees of Congress*, updated June 28, 2019, <https://fas.org/sgp/crs/weapons/R42723.pdf> (accessed September 6, 2019).
- Jen Judson, “US Marine Corps Kills Amphibious Assault Vehicle Upgrade Program,” *Defense News*, September 23, 2018, <https://www.defensenews.com/land/2018/09/24/us-marine-corps-kills-amphibious-assault-vehicle-upgrade-program/> (accessed September 6, 2019).
- U.S. Marine Corps, Concepts and Programs, “Amphibious Combat Vehicle 1.1,” <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-3-Ground-Combat-Tactical-Vehicles/Amphibious-Combat-Vehicle/> (accessed September 6, 2019).
- U.S. Marine Corps, “PEO Land Systems,” <https://www.marcorsyscom.marines.mil/PEOs/-PEO-LS/PM-AAA/> (accessed September 6, 2019).

### LAV-25:

- “LAV-25 Armored Reconnaissance Vehicle,” *Military-Today.com*, [http://www.military-today.com/apc/lav\\_25.htm](http://www.military-today.com/apc/lav_25.htm) (accessed September 6, 2019).

#### ***AH-1W Cobra:***

- “AH-1W/AH-1Z Super Cobra Attack Helicopter,” Naval Technology, <https://www.naval-technology.com/projects/ah1w-supercobra-helicopter/> (accessed September 6, 2019).
- U.S. Marine Corps, “AH-1W Cobra,” <https://web.archive.org/web/20070816230216/http://hqinet001.hqmc.usmc.mil/AVN/documents/aircraft/rotarywing/ah1.htm> (accessed September 6, 2019).

#### ***AH-1Z Viper:***

- Zaal Tchkuaseli, “AH-1Z Viper Attack Helicopter,” Military-Today.com, [http://www.military-today.com/helicopters/ah1z\\_viper.htm](http://www.military-today.com/helicopters/ah1z_viper.htm) (accessed September 6, 2019).
- John Keller, “Navy Asks Bell to Build 25 AH-1Z Viper Attack Helicopters and Avionics for Marine Corps,” *Military & Aerospace Electronics*, January 21, 2019, <https://www.militaryaerospace.com/sensors/article/16722056/navy-asks-bell-to-build-25-ah1z-viper-attack-helicopters-and-avionics-for-marine-corps> (accessed September 6, 2019).
- U.S. Marine Corps, Concepts and Programs, “H-1,” <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-5-Aviation/H-1/> (accessed September 6, 2019).

#### ***AV-8B:***

- Boeing, “AV-8B Harrier II (V/STOL) Aircraft,” <https://www.boeing.com/history/products/av-8-harrier-ii.page> (accessed September 6, 2019).
- Dan Alex, “Boeing (BAE Systems / McDonnell Douglas) AV-8B Harrier II,” Military Factory, edited October 17, 2018, [https://www.militaryfactory.com/aircraft/detail.asp?aircraft\\_id=47](https://www.militaryfactory.com/aircraft/detail.asp?aircraft_id=47) (accessed September 6, 2019).

#### ***F-35B:***

- Lockheed Martin, “F-35B Lightning II,” *F-35 Lightning II Lockheed Martin*, <https://www.f35.com/about/variants/f35b> (accessed September 6, 2019).

#### ***F/A-18 A-D***

- Boeing, “Defense, Space & Security: F/A-18 Hornet,” last updated July 29, 2005, [https://web.archive.org/web/20120521030622/http://www.boeing.com/defense-space/military/fa18/fa18\\_milestones.htm](https://web.archive.org/web/20120521030622/http://www.boeing.com/defense-space/military/fa18/fa18_milestones.htm) (accessed September 6, 2019).

#### ***MV-22***

- U.S. Marine Corps, Concepts and Programs, “MV-22B Osprey,” <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-5-Aviation/MV-22B-Osprey/> (accessed September 6, 2019).
- U.S. Marine Corps, Marine Aviation, “Tilt Rotor: V-22 Osprey,” <https://www.aviation.marines.mil/About/Aircraft/Tilt-Rotor/> (accessed September 6, 2019).

#### ***CH-53E Sea Stallion:***

- “CH-53E Super Stallion,” Military.com, <https://www.military.com/equipment/ch-53e-super-stallion> (accessed September 6, 2019).
- “CH-53E Super Stallion Heavy-Lift Helicopter,” Air Force Technology, <https://www.airforce-technology.com/projects/sikorsky-ch53e-super-stallion/> (accessed September 6, 2019).
- U.S. Marine Corps, Concepts and Programs, “CH-53K King Stallion,” <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-5-Aviation/CH-53K/> (accessed September 6, 2019).

#### ***KC-130J:***

- U.S. Marine Corps, Concepts and Programs, “KC-130J Hercules,” <https://www.candp.marines.mil/Programs/Focus-Area-4-Modernization-Technology/Part-5-Aviation/KC-130J/> (accessed September 6, 2019).



## Endnotes

1. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, 2019, pp. 1-4 and 2-8, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/Highlights\\_book.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/Highlights_book.pdf) (accessed August 26, 2019).
2. *National Security Strategy of the United States of America*, The White House, December 2017, p. 47 (maintain a responsive forward presence in the Indo-Pacific region) and p. 49 (provide protection from terrorist attacks in the Middle East), <https://www.whitehouse.gov/wp-content/uploads/2017/12/NSS-Final-12-18-2017-0905.pdf> (accessed August 27, 2019); James Mattis, U.S. Secretary of Defense, *Summary of the 2018 National Defense Strategy of the United States of America: Sharpening the American Military's Competitive Edge*, U.S. Department of Defense, p. 4 (key objectives highlight the need to defend, dissuade, deter, and prevent aggressors from acting against U.S. interests), <https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf> (accessed August 27, 2019); and General David H. Berger, Commandant of the Marine Corps, "Commandant's Planning Guidance: 38th Commandant of the Marine Corps," p. 1 (directs the Corps to be "trained and equipped as a naval expeditionary force-in-readiness...first on the scene, first to help, first to contain a brewing crisis, and first to fight if required to do so"), [https://www.hqmc.marines.mil/Portals/142/Docs/%2038th%20Commandant%27s%20Planning%20Guidance\\_2019.pdf?ver=2019-07-16-200152-700](https://www.hqmc.marines.mil/Portals/142/Docs/%2038th%20Commandant%27s%20Planning%20Guidance_2019.pdf?ver=2019-07-16-200152-700) (accessed August 27, 2019).
3. General Joseph Dunford, Commandant, United States Marine Corps, statement on Marine Corps readiness before the Subcommittee on Defense, Committee on Appropriations, U.S. House of Representatives, February 26, 2015, p. 10, [http://www.hqmc.marines.mil/Portals/142/Docs/CMC%20Testimony%202015/USMC%20FY16%20Written%20Posture%20Statement\\_FINAL.pdf](http://www.hqmc.marines.mil/Portals/142/Docs/CMC%20Testimony%202015/USMC%20FY16%20Written%20Posture%20Statement_FINAL.pdf) (accessed August 22, 2019).
4. U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *United States Department of Defense Fiscal Year 2019 Budget Request: Defense Budget Overview*, revised February 13, 2018, p. 3-13, [https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/FY2019\\_Budget\\_Request\\_Overview\\_Book.pdf](https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/FY2019_Budget_Request_Overview_Book.pdf) (accessed August 22, 2019).
5. To be clear, the Corps has thought of itself in terms of Marine Air Ground Task Forces (MAGTFs), a collection of ground, aviation, and logistics capabilities under a common commander, for nearly six decades, but because their size and composition vary by task, MAGTFs are not helpful as a consistent reference for capacity; thus, we use battalions as a measure that is generally understood by most students of military affairs. For an expanded discussion, see Dakota L. Wood, *Rebuilding America's Military: The United States Marine Corps*, Heritage Foundation *Special Report* No. 211, March 21, 2019, pp. 15-16, <https://www.heritage.org/defense/report/rebuilding-americas-military-the-united-states-marine-corps>.
6. U.S. Department of the Navy, *Department of the Navy Fiscal Year (FY) 2011 Budget Estimates, Justification of Estimates: Military Personnel, Marine Corps*, February 2010, p. 4, [http://www.secnav.navy.mil/fmc/fmb/Documents/11pres/MPMC\\_Book.pdf](http://www.secnav.navy.mil/fmc/fmb/Documents/11pres/MPMC_Book.pdf) (accessed August 22, 2019).
7. Table A-1, "Combat Force Structure Overview," in U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *United States Department of Defense Fiscal Year 2016 Budget Request: Overview*, February 2015, p. A-1, [http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2016/FY2016\\_Budget\\_Request\\_Overview\\_Book.pdf](http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2016/FY2016_Budget_Request_Overview_Book.pdf) (accessed August 22, 2019).
8. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2019 Budget*, 2018, p. 2-6, [http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/Highlights\\_book.pdf](http://www.secnav.navy.mil/fmc/fmb/Documents/19pres/Highlights_book.pdf) (accessed August 22, 2019).
9. General Robert B. Neller, Commandant of the Marine Corps, statement on "The Posture of the United States Marine Corps" before the Committee on Appropriations, U.S. House of Representatives, March 7, 2018, p. 15, <https://docs.house.gov/meetings/AP/AP02/20180307/106932/HHRG-115-AP02-Wstate-NellerR-20180307.pdf> (accessed August 22, 2019).
10. General John Paxton, Assistant Commandant of the Marine Corps, statement on "U.S. Marine Corps Readiness" before the Subcommittee on Readiness, Committee on Armed Services, U.S. Senate, March 15, 2016, p. 8, [https://www.armed-services.senate.gov/imo/media/doc/Paxton\\_03-15-16.pdf](https://www.armed-services.senate.gov/imo/media/doc/Paxton_03-15-16.pdf) (accessed August 22, 2019).
11. Neller, statement on "The Posture of the United States Marine Corps," March 7, 2018, p. 16.
12. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, p. [39], <https://www.aviation.marines.mil/portals/11/2019%20avplan.pdf> (accessed August 23, 2019); U.S. Marine Corps, *2017 Marine Aviation Plan*, p. 54, [www.aviation.marines.mil/Portals/11/2017%20MARINE%20AVIATION%20PLAN.pdf](http://www.aviation.marines.mil/Portals/11/2017%20MARINE%20AVIATION%20PLAN.pdf) (accessed August 23, 2019); and testimony of Lieutenant General Jon Davis, Deputy Commandant for Aviation, U.S. Marine Corps, in Congressional Quarterly, "House Armed Services Committee Holds Hearing on Aviation Readiness," CQ Congressional Transcripts, July 6, 2016, <http://www.cq.com/doc/congressionaltranscripts-4922435?3&search=IXdIKGHk> (accessed August 23, 2019).
13. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, p. [14].
14. *Ibid.*, p. [43].

15. The Honorable James F. Geurts, Assistant Secretary of the Navy for Research, Development and Acquisition ASN(RD&A); Lieutenant General Steven Rudder, Deputy Commandant for Aviation; and Rear Admiral Scott Conn, Director Air Warfare, statement on “Department of the Navy Aviation Programs” before the Subcommittee on Seapower, Committee on Armed Services, U.S. Senate, April 10, 2019, p. 3, [https://www.armed-services.senate.gov/imo/media/doc/Geurts\\_Rudder\\_Conn\\_04-10-19.pdf](https://www.armed-services.senate.gov/imo/media/doc/Geurts_Rudder_Conn_04-10-19.pdf) (accessed August 23, 2019).
16. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, p. [45].
17. Harold C. Hutchinson, “Marines Have Been Flying the Harrier Jet for over 30 Years – Here’s Why They Still Keep It Around,” *Business Insider*, August 1, 2018, <https://www.businessinsider.com/why-marines-still-love-av-8b-harrier-after-decades-of-us-2018-8> (accessed August 23, 2019), and U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, p. [51].
18. U.S. Marine Corps, *2018 Marine Aviation Plan*, p. 10, <https://www.aviation.marines.mil/Portals/11/2018%20AvPlan%20FINAL.pdf> (accessed August 23, 2019), and Lieutenant General Steven R. Rudder, Deputy Commandant for Aviation, U.S. Marine Corps, statement on “Aviation Readiness” before the Subcommittee on Readiness, Committee on Armed Services, U.S. House of Representatives, November 9, 2017, p. 7, <https://docs.house.gov/meetings/AS/AS03/20171109/106611/HHRG-115-AS03-Bio-RudderS-20171109.pdf> (accessed August 23, 2019).
19. U.S. Marine Corps, *2019 Marine Aviation Plan*, p. [69].
20. U.S. Marine Corps, *2017 Marine Aviation Plan*, pp. 70 and 76.
21. Lieutenant General Jon Davis, “Naval Aviation Reflections,” *Naval Aviation News*, Vol. 99, No. 3 (Summer 2017), p. 5, [http://navalaviationnews.navylive.dodlive.mil/files/2017/08/NAN-Summer2017\\_web.pdf](http://navalaviationnews.navylive.dodlive.mil/files/2017/08/NAN-Summer2017_web.pdf) (accessed August 23, 2019).
22. Kris Osborn, “Marines: ‘We Plan to Have the MV-22B Osprey for at Least the Next 40 Years,’” *National Interest*, May 2, 2018, <https://nationalinterest.org/blog/the-buzz/marines-%E2%80%9Cwe-plan-have-the-mv-22b-osprey-least-the-next-40-25654> (accessed August 23, 2019).
23. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, pp. 71 and 70.
24. Geurts, Rudder, and Conn, statement on “Department of the Navy Aviation Programs,” April 10, 2019, p. 8.
25. Lieutenant General Brian D. Beaudreault, Deputy Commandant, Plans, Policies, and Operations, statement on “Amphibious Warfare Readiness and Training—Interoperability, Shortfalls, and the Way Ahead” before the Subcommittee on Readiness, Committee on Armed Services, U.S. House of Representatives, December 1, 2017, p. 3, <https://docs.house.gov/meetings/AS/AS03/20171201/106681/HHRG-115-AS03-Wstate-BeaudreaultB-20171201.pdf> (accessed August 23, 2019).
26. U.S. Navy, Naval Sea Systems Command, Naval Vessel Register, “Fleet Size,” last updated August 20, 2019, <https://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML> (accessed August 23, 2019).
27. On July 11, 2019, General David Berger assumed command of the U.S. Marine Corps as the 38th Commandant. A short five days later, General Berger issued his Commandant’s Planning Guidance to announce his priorities for the service. Parting with years of practice, General Berger stated that the Corps would “no longer use a ‘2.0 MEB requirement’ as the foundation for our arguments regarding amphibious ship building” and would “no longer reference the 38-ship requirement memo from 2009, or the 2016 Force Structure Assessment, as the basis for” force structure naval amphibious support requirements. Coming in the fourth quarter of FY 2019, it remains to be seen what impact this will have on the Navy’s shipbuilding program. See Megan Eckstein, “Berger Takes Command of Marine Corps, Neller Reflects on 45 Years of Service,” *U.S. Naval Institute News*, July 11, 2019, <https://news.usni.org/2019/07/11/berger-takes-command-of-marine-corps-neller-reflects-on-45-years-of-service> (accessed August 23, 2019); Berger, “Commandant’s Planning Guidance: 38th Commandant of the Marine Corps,” p. 4; and Beaudreault, statement on “Amphibious Warfare Readiness and Training,” December 1, 2017, pp. 4–5.
28. General Glenn Walters, Assistant Commandant of the Marine Corps, statement on “Marine Corps Readiness” before the Subcommittee on Readiness, Committee on Armed Services, U.S. Senate, February 8, 2017, p. 5, [https://www.armed-services.senate.gov/imo/media/doc/Walters\\_02-08-17.pdf](https://www.armed-services.senate.gov/imo/media/doc/Walters_02-08-17.pdf) (accessed August 26, 2019).
29. Berger, “Commandant’s Planning Guidance: 38th Commandant of the Marine Corps,” p. 4.
30. General John Paxton, Assistant Commandant, United States Marine Corps, statement on Marine Corps readiness and FY 2016 budget request before the Subcommittee on Readiness and Management Support, Committee on Armed Services, U.S. Senate, March 25, 2015, pp. 10–11, [http://www.armed-services.senate.gov/imo/media/doc/Paxton\\_03-25-15.pdf](http://www.armed-services.senate.gov/imo/media/doc/Paxton_03-25-15.pdf) (accessed August 26, 2019). The Corps’ emphasis on acquiring the ACV was revalidated during recent congressional testimony; see The Honorable James F. Geurts, Assistant Secretary of the Navy for Research, Development and Acquisition ASN(RD&A), and Lieutenant General David H. Berger, Deputy Commandant, Combat Development and Integration, and Commanding General, Marine Corps Combat Development Command, statement on “Fiscal Year 2020 Navy Modernization Programs” before the Subcommittee on Seapower, Committee on Armed Services, U.S. Senate, April 10, 2019, p. 5, [https://www.armed-services.senate.gov/imo/media/doc/Geurts\\_Berger\\_04-10-19.pdf](https://www.armed-services.senate.gov/imo/media/doc/Geurts_Berger_04-10-19.pdf) (accessed August 23, 2019).

31. Robert B. Neller, Commandant of the Marine Corps, statement on “The Posture of the United States Marine Corps” before the Committee on Armed Services, U.S. Senate, April 19, 2018, p. 8, [https://www.armed-services.senate.gov/imo/media/doc/Neller\\_04-19-18.pdf](https://www.armed-services.senate.gov/imo/media/doc/Neller_04-19-18.pdf) (accessed August 27, 2019), and Robert B. Neller, Commandant of the Marine Corps, statement on “The Posture of the United States Marine Corps” before the Subcommittee on Defense, Committee on Appropriations, U.S. Senate, May 1, 2019, p. [9], <https://www.appropriations.senate.gov/imo/media/doc/05.01.19--Neller%20Testimony.pdf> (accessed August 26, 2019).
32. Lieutenant General Michael Dana, Deputy Commandant, Installations and Logistics, statement on “Marine Corps Readiness” before the Subcommittee on Readiness, Committee on Armed Services, U.S. House of Representatives, March 6, 2018, p. 3, <https://docs.house.gov/meetings/AS/AS03/20180306/106942/HHRG-115-AS03-Wstate-DanaM-20180306.pdf> (accessed August 26, 2019).
33. Megan Eckstein, “Marine Corps Cancels AAV Survivability Upgrade,” U.S. Naval Institute News, September 25, 2018 <https://news.usni.org/2018/09/25/marine-corps-cancels-aav-survivability-upgrade> (accessed August 26, 2019).
34. Lieutenant General Robert S. Walsh, Deputy Commandant, Combat Development and Integration, and Commanding General, Marine Corps Combat Development Command, and Brigadier General Joseph Shrader, Commander, Marine Corps Systems Command, statement on “Fiscal Year 2019 Ground Forces Modernization Programs” before the Subcommittee on Tactical Air and Land Forces, Committee on Armed Services, U.S. House of Representatives, April 18, 2018, p. 10, <https://docs.house.gov/meetings/AS/AS25/20180418/108159/HHRG-115-AS25-Wstate-ShraderJ-20180418.pdf> (accessed August 26, 2019).
35. The average age of the M1A1 was 26 in 2016. Paxton, statement on “U.S. Marine Corps Readiness,” March 15, 2016, p. 15. No new M1A1 Abrams have been commissioned since that time, so the average age is estimated as 28 in 2018.
36. Chart, “Ground Equipment Age,” in U.S. Marine Corps, *U.S. Marine Corps Concepts and Programs*, “Ground Equipment Age,” last revised April 3, 2014, p. 261, [https://www.candp.marines.mil/Portals/216/documents/CNP%20Publications/CNP\\_2014.pdf?ver=2018-03-08-090028-247](https://www.candp.marines.mil/Portals/216/documents/CNP%20Publications/CNP_2014.pdf?ver=2018-03-08-090028-247) (accessed August 26, 2019).
37. Neller, statement on “The Posture of the United States Marine Corps,” May 1, 2019, p. [9]; U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, p. 4-13; and Walsh and Shrader, statement on “Fiscal Year 2019 Ground Forces Modernization Programs,” April 18, 2018, p. 9.
38. International Institute for Strategic Studies, *The Military Balance 2018: The Annual Assessment of Global Military Capabilities and Defence Economics* (London: Routledge, 2017), p. 53, and U.S. Marine Corps, *2018 Marine Aviation Plan*, p. 45.
39. U.S. Marine Corps, *2018 Marine Aviation Plan*, p. 44.
40. Geurts, Rudder, and Conn, statement on “Department of the Navy Aviation Programs,” April 10, 2019, p. 4.
41. Ibid., p. 3.
42. U.S. Marine Corps, *2018 Marine Aviation Plan*, p. 56.
43. Vice Admiral Paul Grosklags, Representing Assistant Secretary of the Navy (Research, Development and Acquisition); Lieutenant General Jon Davis, Deputy Commandant for Aviation; and Rear Admiral Michael C. Manazir, Director Air Warfare, statement on “Department of the Navy’s Aviation Programs” before the Subcommittee on Seapower, Committee on Armed Services, U.S. Senate, April 20, 2016, p. 3, [http://www.armed-services.senate.gov/imo/media/doc/Grosklags-Davis-Manazir\\_04-20-16.pdf](http://www.armed-services.senate.gov/imo/media/doc/Grosklags-Davis-Manazir_04-20-16.pdf) (accessed August 23, 2019), and U.S. Marine Corps, *2018 Marine Aviation Plan*, p. 36.
44. Megan Eckstein, “Marines Declare Initial Operational Capability on F-35B Joint Strike Fighter,” U.S. Naval Institute News, July 31, 2015, <https://news.usni.org/2015/07/31/marines-declare-initial-operational-capability-on-f-35b-joint-strike-fighter> (accessed August 23, 2019), and U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, p. 36.
45. Gina Harkins, “Marine F-35s Dropped a Bunch of Bombs on ISIS During 1st Middle East Deployment,” Military.com, February 25, 2019, <https://www.military.com/daily-news/2019/02/25/marine-f-35s-dropped-bunch-bombs-isis-during-1st-middle-east-deployment.html> (accessed August 23, 2019).
46. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, pp. 36 and 39.
47. U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *United States Department of Defense Fiscal Year 2018 Budget Request: Program Acquisition Cost by Weapon System*, May 2017, pp. 3-2 and 3-9, [http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2018/fy2018\\_Weapons.pdf](http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2018/fy2018_Weapons.pdf) (accessed August 26, 2019).
48. Andrew Feickert, “Joint Light Tactical Vehicle (JLTV): Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees Congress*, updated June 24, 2019, pp. 1-2, <https://fas.org/sgp/crs/weapons/RS22942.pdf> (accessed August 26, 2019).
49. Joe Gould, “Oshkosh Awaits Protest After JLTV Win,” *Defense News*, August 29, 2015, <http://www.defensenews.com/story/defense/land/vehicles/2015/08/29/oshkosh-awaits-protests-jltv-win/71325838> (accessed August 26, 2019).

50. Testimony of John M. Garner, Program Executive Office, Land Systems Marine Corps, in stenographic transcript of *Hearing to Receive Testimony on Marine Corps Ground Modernization in Review of the Defense Authorization Request for Fiscal Year 2018 and the Future Years Defense Program*, Subcommittee on Seapower, Committee on Armed Services, U.S. Senate, June 6, 2017, p. 63, [https://www.armed-services.senate.gov/imo/media/doc/17-56\\_06-06-17.pdf](https://www.armed-services.senate.gov/imo/media/doc/17-56_06-06-17.pdf) (accessed August 26, 2019).
51. Matthew Cox, “Marine Corps to Increase JLTV Buy to 15,000 to Replace Its Humvee Fleet,” *Military.com*, August 15, 2019, <https://www.military.com/daily-news/2019/08/15/marine-corps-increase-jltv-buy-15000-replace-its-humvee-fleet.html> (accessed August 26, 2019).
52. “Marine Infantry Battalion Becomes First Operational Unit to Receive JLTVs,” *Seapower*, July 24, 2019, <https://seapowermagazine.org/marine-infantry-battalion-becomes-first-operational-unit-to-receive-jltvs/> (accessed August 26, 2019).
53. U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *United States Department of Defense Fiscal Year 2018 Budget Request: Program Acquisition Cost by Weapon System*, p. 3-9.
54. Andrew Feickert, “Marine Corps Amphibious Combat Vehicle (ACV): Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated June 28, 2019, Summary, <https://www.fas.org/sgp/crs/weapons/R42723.pdf> (accessed August 26, 2019).
55. Lieutenant General Kenneth J. Glueck Jr., Deputy Commandant, Combat Development and Integration, and Commanding General, Marine Corps Combat Development Command, and Thomas P. Dee, Deputy Assistant Secretary of the Navy, Expeditionary Programs and Logistics Management, statement on “Marine Corps Modernization” before the Subcommittee on Seapower, Committee on Armed Services, U.S. Senate, March 11, 2015, pp. 8-9, [https://www.armed-services.senate.gov/imo/media/doc/Glueck-Dee\\_03-11-15.pdf](https://www.armed-services.senate.gov/imo/media/doc/Glueck-Dee_03-11-15.pdf) (accessed August 26, 2019).
56. With regard to this overall requirement—armored lift for 10 battalions of infantry—the AAV Survivability Upgrade Program would provide for four battalions, and ACV 1.1 and ACV 1.2 would account for six battalions. *Ibid.*, pp. 7-8.
57. Jen Judson, “BAE Wins Marine Corps Contract to Build New Amphibious Combat Vehicle,” *Defense News*, June 19, 2018, <https://www.defensenews.com/land/2018/06/19/bae-wins-marine-corps-contract-to-build-new-amphibious-combat-vehicle/> (accessed August 26, 2019).
58. Feickert, “Marine Corps Amphibious Combat Vehicle (ACV),” pp. 6, 7, 8, and 9.
59. Dunford, statement on Marine Corps readiness, February 26, 2015, p. 28.
60. U.S. Department of the Navy, Office of Budget, *Highlights of the Department of the Navy FY 2020 Budget*, pp. A-10 and A-14.
61. Lieutenant General Brian Beaudreault, U.S. Marine Corps, Deputy Commandant, Plans, Policies, and Operations, statement on “Marine Corps Readiness” before the Subcommittee on Readiness, Committee on Armed Services, U.S. House of Representatives, March 6, 2018, p. 5, <https://docs.house.gov/meetings/AS/AS03/20180306/106942/HHRG-115-AS03-Wstate-BeaudreaultB-20180306.pdf> (accessed August 23, 2019).
62. Grosklags, Davis, and Manazir, statement on “Department of the Navy’s Aviation Programs,” April 20, 2016, p. 7.
63. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, pp. 36 and 39.
64. U.S. Department of Defense, *Selected Acquisition Report (SAR): V-22 Osprey Joint Services Advanced Vertical Lift Aircraft (V22) as of FY 2019 President’s Budget*, RCS: DD-A&T(Q&A)823-212, March 12, 2018, p. 63, [https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected\\_Acquisition\\_Reports/18-F-1016\\_DOC\\_82\\_Navy\\_V-22\\_SAR\\_Dec\\_2017.pdf](https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/18-F-1016_DOC_82_Navy_V-22_SAR_Dec_2017.pdf) (accessed August 26, 2019).
65. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, p. 72.
66. U.S. Marine Corps, *2018 Marine Aviation Plan*, pp. 76 and 84.
67. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, pp. 71 and 84.
68. Grosklags, Davis, and Manazir, statement on “Department of the Navy’s Aviation Programs,” April 20, 2016, p. 21.
69. U.S. Government Accountability Office, *Defense Acquisitions: Assessments of Selected Weapons Programs*, GAO-16-329SP, March 2016, p. 93, <http://www.gao.gov/assets/680/676281.pdf> (accessed August 26, 2019), and U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer, *United States Department of Defense Fiscal Year 2019 Budget Request: Program Acquisition Cost by Weapon System*, February 2018, p. 1-16, [https://comptroller.defense.gov/Portals/45/documents/defbudget/FY2019/FY2019\\_Weapons.pdf](https://comptroller.defense.gov/Portals/45/documents/defbudget/FY2019/FY2019_Weapons.pdf) (accessed August 26, 2019).
70. Geurts, Rudder, and Conn, statement on “Department of the Navy Aviation Programs,” April 10, 2019, p. 9.
71. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, p. 88.
72. International Institute for Strategic Studies, *The Military Balance 2019: The Annual Assessment of Global Military Capabilities and Defence Economics* (London: Routledge, 2019) p. 54, and U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, p. 88.

73. Neller, statement on “The Posture of the United States Marine Corps,” May 1, 2019, p. [1], and reiterated in Berger, “Commandant’s Planning Guidance: 38th Commandant of the Marine Corps,” p. 1.
74. Neller, statement on “The Posture of the United States Marine Corps,” May 1, 2019, p. [15].
75. U.S. Marine Corps, *Commander’s Readiness Handbook*, May 2014, p. iv, <https://www.hqmc.marines.mil/Portals/138/HiRes%20Commanders%20Readiness%20Handbook.pdf> (accessed August 26, 2019).
76. Beaudreault, statement on “Amphibious Warfare Readiness and Training,” December 1, 2017, pp. 6 and 7.
77. Cary B. Russell, Director, Defense Capabilities and Management, U.S. Government Accountability Office, “Navy and Marine Corps Training: Further Planning Needed for Amphibious Operations Training,” GAO-18-212T, testimony before the Subcommittee on Readiness, Committee on Armed Services, U.S. House of Representatives, December 1, 2017, p. 5, <https://docs.house.gov/meetings/AS/AS03/20171201/106681/HHRG-115-AS03-Wstate-RussellC-20171201.pdf> (accessed August 23, 2019).
78. Beaudreault, statement on “Amphibious Warfare Readiness and Training,” December 1, 2017, p. 4.
79. U.S. Marine Corps, *2018 Marine Aviation Plan*, p. 8.
80. Rudder, statement on “Aviation Readiness,” November 9, 2017, p. 3.
81. U.S. Marine Corps, *2019 Marine Corps Aviation Plan*, pp. 6, 10, and 14.
82. Neller, statement on “The Posture of the United States Marine Corps,” May 1, 2019, p. [13].
83. This count is based on an average number of 1.5 divisions deployed to major wars (see Table 3, pp. 311–312) and an average of 10–11 battalions per division.
84. “Senate Armed Service[s] Committee Advance Policy Questions for Lieutenant General David Berger, USMC, Nominee for Appointment to the Grade of General and to Be Commandant of the Marine Corps,” April 30, 2019, p. 16, [https://www.armed-services.senate.gov/imo/media/doc/Berger\\_APQs\\_04-30-19.pdf](https://www.armed-services.senate.gov/imo/media/doc/Berger_APQs_04-30-19.pdf) (accessed August 26, 2019).
85. Exhibit PB-30A, “Summary of Requirements by Budget Program (Active),” in U.S. Department of the Navy, *Department of the Navy Fiscal Year (FY) 2020 Budget Estimates, Justification of Estimates: Military Personnel, Marine Corps (MPMC)*, March 2019, p. 3, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/MPMC\\_Book.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/MPMC_Book.pdf) (accessed August 26, 2019).
86. Exhibit O-1, “FY 2020 President’s Budget Total Obligational Authority,” February 21, 2019, in U.S. Department of the Navy, *Department of the Navy Fiscal Year (FY) 2020 Budget Estimates, Justification of Estimates: Operations and Maintenance, Marine Corps (OMMC)*, March 2019, p. 10, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/OMMC\\_Book.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/OMMC_Book.pdf) (accessed August 26, 2019).
87. U.S. Department of the Navy, *Department of Defense Fiscal Year (FY) 2020 Budget Estimates, Navy, Justification Book Volume 1 of 1: Procurement, Marine Corps*, March 2019, p. v, [https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/PMC\\_Book.pdf](https://www.secnav.navy.mil/fmc/fmb/Documents/20pres/PMC_Book.pdf) (accessed August 26, 2019).





# U.S. Nuclear Weapons Capability

In today's rapidly changing world, the U.S. nuclear weapons enterprise must be, in the words of President Donald Trump, "*modern, robust, flexible, resilient, ready and appropriately tailored to deter 21st-century threats and reassure our allies.*"<sup>1</sup> If the U.S. detects a game-changing nuclear weapons development in another country, the nuclear weapons complex must be able to provide a timely response.

After shifting focus away from maintaining nuclear dominance following the Cold War, the U.S. nuclear enterprise must again focus on its main mission. If it is going to continue its policy of deterrence through strength and assure its allies while promoting nuclear non-proliferation, the U.S. must overcome multiple challenges: an aging nuclear stockpile, aging infrastructure, and aging experts combined with an uncertain funding environment and issues surrounding overall force readiness.

The U.S. maintains an inactive stockpile that includes near-term hedge warheads that can be put back into operational status within six to 24 months. Extended hedge warheads purportedly can be made ready within 24 to 60 months.<sup>2</sup> The U.S. preserves upload capability on its strategic delivery vehicles, which means that in principle, the nation could increase the number of nuclear warheads on each type of its delivery vehicles if contingencies warrant. For example, the U.S. Minuteman III intercontinental ballistic missile (ICBM) can carry up to three nuclear warheads, although it is currently deployed with only one.<sup>3</sup>

While the United States preserves these capabilities, increasing capacity would be not only costly, but also difficult and

time-consuming in practice. Certain modernization decisions (e.g., 12 instead of 14 *Columbia*-class ballistic missile submarines, with 16 missile tubes per submarine instead of 24) will limit upload capacity on the strategic submarine force. U.S. heavy bombers will continue to retain a robust upload capability.

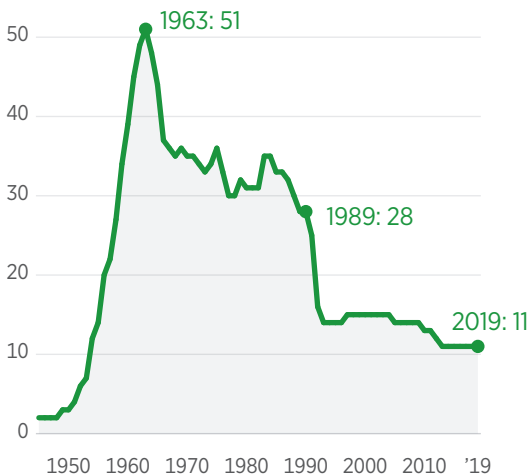
Presidential Decision Directive-15 (PDD-15) requires the U.S. "to maintain the ability to conduct a nuclear test within 24-to-36 months of direction by the President to do so."<sup>4</sup> However, successive governmental reports have noted the continued deterioration of technical and diagnostics equipment and the inability to fill technical positions supporting nuclear testing readiness.<sup>5</sup> A lack of congressional support for improvements in technical readiness further undermines efforts by the National Nuclear Security Administration (NNSA) to comply with the directive.

The nuclear weapons labs face demographic challenges of their own. Most scientists and engineers with practical hands-on experience in nuclear weapon design or testing experience (or both) are retired. This means that the U.S. must rely on the scientific judgment of designers and engineers who were involved neither in nuclear tests nor in weapons design and development and who must now continue to certify weapons designed and tested over 30 years ago.

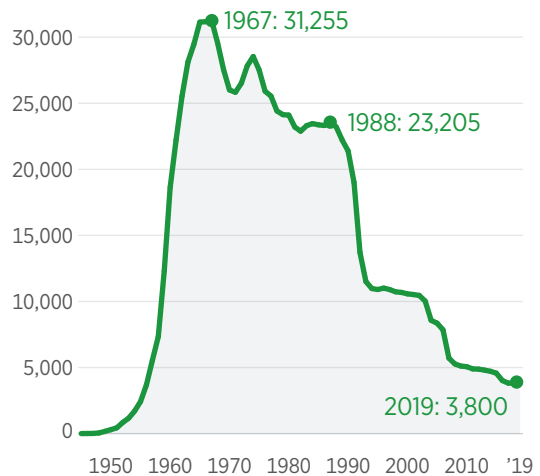
Not all of the existing inactive stockpile will go through life-extension programs (LEPs). Hence, the U.S.'s ability to respond to contingencies by uploading weapons kept in an inactive status will decline with the passage of time. This means that even with LEPs, the U.S. may not be able to sustain the necessary reliability.

## A Smaller and Less Diverse Nuclear Arsenal

TYPES OF WARHEADS IN THE U.S. NUCLEAR STOCKPILE



TOTAL WARHEADS IN THE U.S. NUCLEAR STOCKPILE



**SOURCES:** Robert S. Norris and Hans M. Kristensen, “U.S. Nuclear Warheads, 1945–2009,” *Bulletin of the Atomic Scientists*, 2009, <https://www.tandfonline.com/doi/full/10.2968/065004008> (accessed April 20, 2018); U.S. Department of Energy, *Report to Congress, “Stockpile Stewardship and Management Plan,”* November 2017, [https://www.energy.gov/sites/prod/files/2017/11/f46/fy18ssmp\\_final\\_november\\_2017%5B1%5D\\_0.pdf](https://www.energy.gov/sites/prod/files/2017/11/f46/fy18ssmp_final_november_2017%5B1%5D_0.pdf) (accessed April 23, 2018); U.S. Department of Energy, “Restricted Data Declassification Decisions, 1946 to the Present,” <https://fas.org/sgp/library/rdd-5.html> (accessed April 23, 2018); U.S. Department of Defense, “Stockpile Numbers,” [http://open.defense.gov/Portals/23/Documents/frddwg/2017\\_Tables\\_UNCLASS.pdf](http://open.defense.gov/Portals/23/Documents/frddwg/2017_Tables_UNCLASS.pdf) (accessed April 23, 2018); Hans M. Kristensen and Matt Korda, “United States Nuclear Forces, 2019,” *Bulletin of the Atomic Scientists*, April 29, 2019, <https://www.tandfonline.com/doi/pdf/10.1080/00963402.2019.1606503?needAccess=true> (accessed July 11, 2019); and Hans M. Kristensen and Matt Korda, “Status of World Nuclear Forces,” May 2019, <https://fas.org/issues/nuclear-weapons/status-world-nuclear-forces/> (accessed July 11, 2019).

heritage.org

After the end of the Cold War, the shift in emphasis away from the nuclear mission caused the nuclear laboratories to lose a sense of purpose. They felt compelled to reorient and broaden their mission focus. According to a number of studies, their relationship with the government also evolved in ways that reduced output and increased costs. The NNSA was supposed to address these problems but has largely failed in this task, partly because “the relationship with the NNSA and the National security labs appears [to] be broken.”<sup>6</sup>

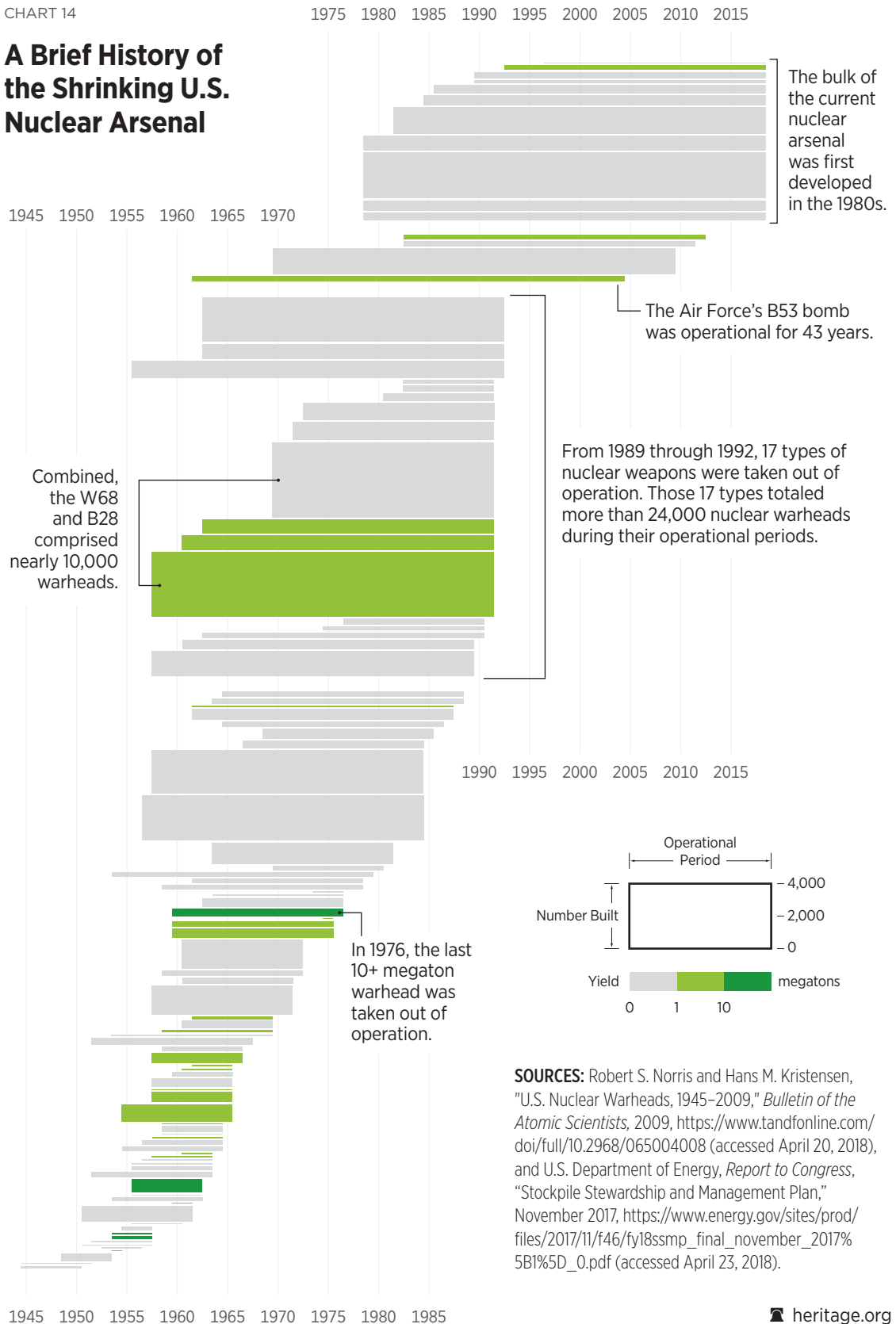
In 1999, the Commission on Maintaining U.S. Nuclear Weapons Expertise concluded

that 34 percent of the employees supplying critical skills to the weapons program were more than 50 years old. Almost 19 percent of the NNSA’s workforce is eligible for retirement, and the number will likely increase to 38.5 percent in fiscal year (FY) 2023.<sup>7</sup> On average, the U.S. high-technology industry has a more balanced employee age distribution.<sup>8</sup>

Both the lack of resources and the lack of sound, consistent policy guidance have undermined workforce morale. The Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise recommended fundamental changes in the nuclear weapons

CHART 14

## A Brief History of the Shrinking U.S. Nuclear Arsenal



enterprise's culture, business practices, project management, and organization. Others proposed moving the NNSA to the Department of Defense (DOD).<sup>9</sup>

The U.S. nuclear laboratories must rediscover their mission focus so that they can be ready to meet the challenges that lie ahead.

The readiness of forces that operate U.S. nuclear systems is another important indication of the health of the overall force. Despite the changes instituted by the Air Force following mishaps in 2006 and 2007, success was limited, as evidenced by further mishaps. In January 2014, for example, the Air Force discovered widespread cheating on nuclear proficiency exams and charged over 100 officers with misconduct. The Navy had a similar problem, albeit on a smaller scale.<sup>10</sup>

The DOD conducted two nuclear enterprise reviews, one internal and one external. Both reviews identified a lack of leadership attention, a lack of resources with which to modernize the atrophied infrastructure, and unduly burdensome implementation of the personnel reliability program as some of the core challenges preventing a sole focus on accomplishing the nuclear mission.<sup>11</sup>

In 2014, the Secretary of Defense created the Nuclear Deterrent Enterprise Review Group (NDERG) to ensure the long-term health of the nuclear enterprise by addressing resourcing, personnel, organizational, and enterprise policy issues. In the past several years, the DOD has significantly improved morale throughout the nuclear weapons enterprise by forcefully stating (and at the highest levels) that nuclear deterrence is the DOD's "number one job" and that related modernization programs still receive the highest priority. Recently, the Government Accountability Office found that the DOD not only has made significant progress in implementing the recommendations from the 2014 nuclear enterprise reviews and a 2015 NC3 review, but also has improved its tracking and evaluation of this progress.<sup>12</sup>

Among other things, the ICBM Force Improvement Program was initiated and mostly implemented throughout 2014 and into 2015,

and the Air Force shifted over \$160 million to address problems, modernize certain facilities, and generally improve morale. The Air Force also has seen an increase in badly needed manpower, although not enough of an increase to alleviate manpower concerns. If changes in the nuclear enterprise are to be effective, leaders across the executive and legislative branches must continue to provide the resources and attention needed to mitigate readiness and morale issues within the force.

In the past, fiscal uncertainty and a steady decline in resources for the nuclear weapons enterprise have had a negative effect on the nuclear deterrence mission. As David Trachtenberg, Deputy Under Secretary of Defense for Policy, testified in March 2019:

For decades, the United States led the world in efforts to reduce the role and number of nuclear weapons.... Overall, the U.S. nuclear weapons stockpile has drawn down by more than 85 percent from its Cold War high.

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

For this reason, a robust and modern U.S. nuclear deterrent helps ensure the United States competes from a position of strength and can deter nuclear attack and prevent large-scale conventional warfare between nuclear-armed states for the foreseeable future.<sup>13</sup>

In recent years, bipartisan congressional support for the nuclear mission has been strong, and additional funding has been provided for nuclear modernization. It is critical that this bipartisan consensus be preserved as these programs mature and begin to introduce modern nuclear systems to the force.

The Trump Administration has inherited an insufficiently funded comprehensive

modernization program for nuclear forces: warheads, delivery systems, and command and control. The Obama Administration included this program in its budget requests, and Congress has funded it to some extent while constraining the ability of the enterprise to execute its mission (e.g., by allocating inadequate funding for pit production). Because such modernization activities require consistent, stable, long-term funding commitments, it is essential that Congress continue to invest in the cornerstone of our nation's security.

The Trump Administration's 2018 NPR recognized worsening security conditions, the rise of competition with a revisionist and resurgent Russia, an increasingly threatening China, and other growing strategic threats.<sup>14</sup> It also called for the tailoring of U.S. nuclear deterrence strategies and rearticulated the importance of deterring any large-scale attack against the U.S., its allies, or partners as a key priority of U.S. nuclear weapons policy. To that end, the 2018 NPR called for modernization of nuclear weapons and the nuclear weapons complex, as well as significant reinvestments in the nuclear triad (intercontinental-range ballistic missiles, *Columbia*-class submarines, bombers, and associated infrastructure), and proposed two additional nuclear capabilities: a low-yield warhead for strategic submarine-launched ballistic missiles (SLBMs) in the near term and a low-yield, nuclear-armed, sea-launched cruise missile in the longer term.

### Implications for U.S. National Security

U.S. nuclear forces are not designed to shield the nation from all types of attacks from all adversaries. They are designed to deter large-scale attacks that threaten America's sovereignty, allies, and forward-deployed troops and to assure our allies and partners.

U.S. nuclear forces play an absolutely essential role in underpinning the broad non-proliferation regime by providing security guarantees that assure allies, including NATO, Japan, and South Korea, that they can forgo development of nuclear capabilities. In part, U.S. deterrence capabilities also enable the United

Kingdom and France to limit their numbers of nuclear weapons to levels to which they might not otherwise agree.

North Korea has demonstrated that a country with limited intellectual and financial resources can develop a nuclear weapon. Despite U.S. and international pressure, Iran appears to be continuing on a path that largely retains its ability to develop a nuclear weapon capability. In such an international climate, U.S. nuclear assurances to allies and partners become ever more important. If the credibility of American nuclear forces continues to degrade, for example, countries like Japan or South Korea could choose to pursue an independent nuclear option, adding to instability across the region.

Several negative trends could undermine the overall effectiveness of U.S. nuclear deterrence if not addressed. Adversaries—particularly Russia and China—are modernizing their nuclear forces. Additional challenges include increasingly aged nuclear warheads; an aging and crumbling nuclear weapons infrastructure; an aging workforce; and the need to fully recapitalize all three legs (land, air, and sea) of the nuclear triad, including the systems for nuclear command and control, while also conducting timely and cost-efficient life-extension programs—all while maintaining the nation's commitment to a testing moratorium under the signed (but rejected by the Senate) Comprehensive Test Ban Treaty.

The 2018 NPR notes a rapid deterioration of the threat environment since 2010 and identifies four enduring roles for U.S. nuclear capabilities:

- Deterring nuclear and non-nuclear attack;
- Assuring allies and partners;
- Achieving U.S. objectives if deterrence fails; and
- Providing the capacity to hedge against an uncertain future.<sup>15</sup>

Recognizing that capabilities can vary, the 2018 NPR emphasizes the need for tailored deterrence strategies to deal with each U.S. adversary. For example, Russia is engaged in an aggressive nuclear buildup, having added several new modern nuclear systems to its arsenal since 2010. According to General John Hyten, Commander, U.S. Strategic Command (STRATCOM), “Russia started their modernization program in 2006. They’re about 80 percent through completing the modernization of their triad. They’ll be pretty close to being through by about 2020.”<sup>16</sup> Concurrently, Russia is using its dual-capable (nuclear/conventional-capable) platforms to threaten the sovereignty of U.S. allies in Eastern Europe and the Baltics.

China is engaging in a similarly provocative nuclear buildup as it attempts to project power into the South China Sea, in part through illegally created islands on which China has installed offensive capabilities. North Korea “has accelerated its provocative pursuit of nuclear weapons and missile capabilities.”<sup>17</sup> Iran “retains the technological capability and much of the capacity necessary to develop a nuclear weapon within one year of a decision to do so” and is the world’s principal state sponsor of terrorism.<sup>18</sup>

Deterrence is an intricate interaction between U.S. conventional and nuclear forces and the psychological perceptions of both allies and adversaries with respect to the willingness of the U.S. to use such forces to defend its own interests and those of its allies and partners. Nuclear deterrence must reflect and be attuned to the mindset of any particular adversary that the U.S. seeks to deter. If an adversary believes that he can fight and win a limited nuclear war, the task for U.S. leaders

is to convince that adversary otherwise. The U.S. nuclear portfolio must be structured in terms of capacity, capability, variety, flexibility, and readiness to achieve these objectives. In addition, military roles and requirements for nuclear weapons will be inherently different depending on which actor is being deterred, what that actor values, and what kinds of action the U.S. is seeking to deter.

Due to the complex interplay among strategy, policy, and actions that any given state may take, as well as other actors’ perceptions of the world around them, it is not possible to know whether and when a nuclear deterrent or conventional forces provided by U.S. forces might be perceived as insufficient. Nuclear weapon capabilities take years or decades to develop, as does the infrastructure supporting them—an infrastructure that the U.S. has neglected for decades. We can be reasonably certain that a robust, well-resourced, focused, and reliable nuclear enterprise is much more likely to maintain the sense of the U.S. as a deterring force than is one that is outdated, questionable, or both.

The U.S. has demonstrated that it is capable of incredible mobilization when danger materializes. Today’s nuclear threat environment is evolving, dynamic, and proliferating in unpredictable ways, with new actors and resurgent old actors developing new capabilities. Meanwhile, the U.S. enterprise remains largely static (despite the promise of additional funding) and likely at a technological disadvantage.

This posture is worrisome and must be changed. Unless it is fixed, the implications, both for the security of the United States and for the security of its allies and the free world, are extremely serious.

## Scoring U.S. Nuclear Weapons Capabilities

The U.S. nuclear weapons enterprise is composed of several key elements that include warheads; delivery systems; nuclear command and control; intelligence, surveillance, and

reconnaissance (ISR); aerial refueling; and the physical infrastructure that designs, manufactures, and maintains U.S. nuclear weapons. The nuclear enterprise also includes and must



sustain the talent of its people, from nuclear designers to engineers, manufacturing personnel, securers, planners, maintainers, and operators, all of whom can help to ensure a nuclear deterrent that is second to none.

At the same time, assessing whether any one piece of this enterprise is sufficiently funded, focused, and/or effective with regard to the U.S. nuclear mission presents several challenges.

*First*, the United States is not taking full advantage of technologically available developments to field modern (often incorrectly referred to as “new”) warheads that could be designed to be safer, more secure, and more effective and that could give the United States better options for strengthening a credible deterrent. Rather the U.S. has elected to largely maintain aging nuclear warheads—based on designs from the 1960s, 1970s, and 1980s—that were in the stockpile when the Cold War ended.

*Second*, the lack of detailed publicly available data about the readiness of nuclear forces, their capabilities, and weapon reliability makes analysis difficult.

*Third*, the U.S. nuclear enterprise has many components, some of which are also involved in supporting other conventional military and extended deterrence missions. For example:

- Dual-capable bombers no longer fly airborne alert with nuclear weapons as they routinely did in the 1960s (although they are capable of resuming the practice if necessary).
- The three key national security laboratories (Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories) no longer focus solely on the nuclear weapons mission. Although this remains their primary mission, they also perform extensive national security research related to nuclear nonproliferation, counterproliferation, intelligence, biological/medical research, threat reduction, and counter-ing nuclear terrorism, including a variety of nuclear-related detection activities.

- The Nuclear Command, Control, and Communications (NC3) system “performs five crucial functions: detection, warning, and attack characterization; adaptive nuclear planning; decision-making conferencing; receiving Presidential orders; and enabling the management and direction of forces.”<sup>19</sup>

The factors listed and explained below are the most important elements of the nuclear weapons complex. They are judged on a five-grade scale according to which “very strong” means that a sustainable, viable, and funded plan is in place and “very weak” means that the U.S. is not meeting its security requirements and has no program in place to redress the shortfall—a situation that if left uncorrected could seriously damage vital national interests. The other three possible scores are “strong,” “marginal,” and “weak.”

### **Current U.S. Nuclear Stockpile Score: Strong**

U.S. warheads must be safe, secure, effective, and reliable. The Department of Energy (DOE) defines reliability as “the ability of the weapon to perform its intended function at the intended time under environments considered to be normal” and as “*the probability of achieving the specified yield, at the target, across the Stockpile-to-Target Sequence of environments, throughout the weapon’s lifetime, assuming proper inputs.*”<sup>20</sup> In the years since the cessation of nuclear testing in 1993, reliability has been determined through an intensive warhead surveillance program; non-nuclear experiments (that is, without the use of experiments producing nuclear yield); sophisticated calculations using high-performance computing; and related annual assessments and evaluations.

The reliability of nuclear warheads and delivery systems becomes even more important as the number and diversity of nuclear weapons in the stockpile decrease. Possession of fewer types of nuclear weapons means a smaller margin for error in the event that all of one

type is affected by a technical problem that might cause that type of weapon, its delivery system, or both to be decommissioned. Less diversity also means that a problem is more likely to affect multiple systems. America and its allies must have high confidence that U.S. nuclear warheads will perform as expected.

As warheads age, our uncertainty about their ability to perform their mission as expected could increase, significantly complicating military planning. Despite the impressive knowledge about nuclear weapons physics and materials chemistry that it has amassed, the U.S. could find itself surprised by unanticipated long-term effects on aging components of nuclear weapons. “The scientific foundation of assessments of the nuclear performance of US weapons is eroding as a result of the moratorium on nuclear testing,” argue John Hopkins, nuclear physicist and a former leader of the Los Alamos National Laboratory’s nuclear weapons program, and David Sharp, former Laboratory Fellow and a guest scientist at Los Alamos National Laboratory.<sup>21</sup>

The United States currently has the world’s safest and most secure stockpile, but concerns about overseas storage sites, potential problems introduced by improper handling, or the unanticipated effects of aging could compromise the integrity and reliability of U.S. warheads. In addition, nuclear warheads themselves contain security measures that are designed to make it difficult, if not impossible, to detonate a weapon without proper authorization.

**Grade:** The Department of Energy and Department of Defense are required to produce annual assessments of the nuclear stockpile’s reliability. Each of the three nuclear weapons labs (Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories) reports its findings on the safety, security, and reliability of the nation’s nuclear warheads to the DOE and the DOD, which in turn brief the President. Detailed classified reports are also provided to Congress. While these assessments do not include the nuclear weapons delivery systems,

U.S. STRATCOM does assess the overall reliability of the U.S. nuclear weapons system, including both warheads and delivery platforms.

Absent nuclear weapons testing, the national laboratories’ assessment of weapons reliability, based on the full range of surveillance, scientific, and technical activities carried out in the NNSA’s stockpile stewardship program, depends on the expert judgment of the laboratory directors, which, although it is based on experience and non-nuclear experimentation and extensive modeling and simulation, is inherently subjective. While certainly a well-educated opinion, it cannot substitute for objective data obtained through direct nuclear testing.

Nuclear testing was used in the past to diagnose potential problems with warheads and to certify the effectiveness of fixes to those problems. It was also used originally to certify today’s nuclear warheads, as well as to detect potential problems and to confirm the effectiveness of fixes to those problems. Given that modern simulation is based on nuclear tests that were conducted primarily in the 1950s and 1960s, using testing equipment from that era, there is a great deal more that more modern nuclear testing and detection equipment could teach us about nuclear weapons physics.

In 2005, according to one authoritative account, “two DoD study teams, each looking at options for the future nuclear stockpile, reached similar conclusions—the U.S. approach to sustain its existing nuclear warhead stockpile needed to be redirected.”<sup>22</sup>

Continuing:

Both studies expressed concern over the prospect of long-term success of the plan to sustain the Cold War-era nuclear stockpile indefinitely through periodic refurbishments (e.g., life extension programs). The indefinite refurbishment plan will be extremely difficult to execute (because many warhead components can not [*sic*] be replicated as originally built), and would result in modifications on top of other modifications that will be

increasingly difficult to certify without nuclear testing. Both studies concluded that the Reliable Replacement Warhead (RRW) concept, if feasible, would be a preferred alternative to the indefinite refurbishment strategy.<sup>23</sup>

When the U.S. did conduct nuclear tests, it frequently found that small changes in a weapon's tested configuration had a dramatic impact on weapons performance. In fact, the 1958–1961 testing moratorium resulted in the introduction of weapons with serious problems into the U.S. stockpile.<sup>24</sup> These problems were discovered only after the resumption of U.S. nuclear weapons testing after the Soviet Union's unannounced breakout from the 1962 agreed moratorium.

America's commitment to sustaining its nuclear stockpile without nuclear testing creates inherent uncertainty concerning the adequacy of "fixes" to the stockpile when problems are found. The number of additional uncertainties is growing and includes updates made to correct problems that were found in the weapons or changes in the weapons resulting from life-extension programs. It is simply impossible to duplicate exactly weapons that were designed and built many decades ago. According to Dr. Stephen Younger, Director of Sandia National Laboratories, "[we have had to fix] a number of problems that were never anticipated" by using "similar but not quite identical parts."<sup>25</sup>

One of the results of having to certify weapons without nuclear testing, at least to date, has been fewer types of weapons (i.e., reduced diversity in the stockpile) and, consequently, a greater potential impact across the inventory of warheads should there be an unknown or misidentified error in the certification process. Loss of diversity in the stockpile also increases the risk that "common-mode" failure might affect multiple systems simultaneously, making the push for commonality with potential single points of failure in U.S. warheads worrisome.

"To be blunt," warned Secretary of Defense Robert Gates in October 2008, "there is absolutely no way we can maintain a credible

deterrent *and* reduce the number of weapons in our stockpile *without* either resorting to testing our stockpile or pursuing a modernization program."<sup>26</sup>

The U.S. is pursuing warhead life-extension programs that replace aging components before they can cause reliability problems. The number and scope of LEPs being carried out over the next two decades will stress the NNSA's warhead design and production complex and remains a concern, particularly given uncertainties regarding the congressional budget process. In spite of these concerns, in FY 2018 and FY 2019, the NNSA continued to assert that the stockpile "remains safe, secure, and reliable" (FY 2018) and "safe, secure, and effective" (FY 2019).<sup>27</sup>

In light of our overall assessment, we grade the U.S. stockpile conditionally as "strong," subject to continued strong support from Congress and the Administration.

### **Reliability of U.S. Delivery Platforms Score: Marginal**

Reliability encompasses not only the warhead, but strategic delivery vehicles as well. For ICBMs and SLBMs, in addition to a successful missile launch, this includes the separation of missile boost stages, performance of the missile guidance system, separation of the reentry vehicles from the missile post-boost vehicle, and accuracy of the final reentry vehicle in reaching its target.<sup>28</sup>

The U.S. conducts flight tests of ICBMs and SLBMs every year to ensure the reliability of its delivery systems with high-fidelity "mock" warheads. Anything from faulty electrical wiring to booster separations could degrade the reliability and safety of the U.S. strategic deterrent. U.S. strategic long-range bombers also regularly conduct continental United States and intercontinental exercises and receive upgrades to sustain a demonstrated high level of combat readiness. Nevertheless, challenges are on the horizon as platforms have to be modernized and replaced simultaneously and with little margin for error to allow for already significantly diminished gaps in capabilities.

**Grade:** The Air Force picked up the pace of its ICBM testing last year relative to the previously covered period. With four successes during the covered period, the Air Force also suffered its first unsuccessful ICBM test since 2001. The SLBM tests were successful in 2018 and 2019. To the extent that data from these tests are publicly available, they provide objective evidence of the delivery systems' reliability and send a message to U.S. allies and adversaries alike that the U.S. system works and the nuclear deterrent is ready if needed. The aged systems, however, occasionally have reliability problems, as evidenced by a July 2018 failed Minuteman III launch.<sup>29</sup>

Overall, this factor earns a grade of "marginal," the same grade as the previous year's score.

### **Nuclear Warhead Modernization Score: Marginal**

During the Cold War, the United States maintained a strong focus on developing new nuclear warhead designs, both to counter Soviet advances and modernization efforts and to leverage advances in the physics, chemistry, and design of nuclear weapons. Today, although it also seeks to retain the skills and capabilities required to design, develop, and produce new warheads, the United States is focused on sustaining its aging stockpile rather than on fielding new nuclear warheads. This could increase the risk of failure due to aging components and signal to adversaries that the United States is less committed to nuclear deterrence.

In FY 2016, the United States established the Stockpile Responsiveness Program (SRP) and charged it with building up and exercising all capabilities needed to "conceptualize, study, design, develop, engineer, certify, produce, and deploy nuclear weapons."<sup>30</sup> The Administration requested \$34 million for the SRP in FY 2019.

New weapon designs could allow American engineers and scientists to improve previous designs and devise more effective ways to address existing military requirements (e.g., the need to destroy deeply buried and hardened

targets) that have emerged in recent years. Future warheads could improve reliability (e.g., by remedying such ongoing aging concerns as the need to replace aged nuclear components) while also enhancing the safety and security of American weapons.

Working on new weapon design options would help to ensure that America's nuclear experts remain engaged and knowledgeable, would help to attract the best talent to the nuclear enterprise, and would help the nation gain additional insights into adversaries' nuclear weapons programs. Merely updating Cold War designs is not enough to constrain potential adversaries and current and future proliferators of nuclear technology, all of whom can seek designs apart from those of the U.S.

As the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile noted, "Only through work on advanced designs will it be possible to train the next generation of weapon designers and producers. Such efforts are also needed to exercise the DoD/NNSA weapon development interface."<sup>31</sup> The nuclear enterprise was able to display improved flexibility when it produced a low-yield version of the W76-2 warhead designed to counter Russia's perception of an exploitable gap within the U.S. nuclear force posture within a year. Other nations maintain their levels of proficiency by having their scientists work on new nuclear warheads and possibly by conducting very low-yield nuclear weapons tests.<sup>32</sup>

**Grade:** Despite continued nuclear policy restrictions and a preference for life-extension programs, U.S. efforts under the SRP and the NNSA's demonstrated ability to produce a low-yield version of the W76-2 warhead in a timely manner warrant improving this score to "marginal" this year. The success of the SRP will be an important consideration in future assessments.

### **Nuclear Delivery Systems Modernization Score: Strong**

Today, the United States fields a triad of nuclear forces with delivery systems that are



safe and reliable, but as these systems age, the risk of a significantly negative impact on operational capabilities increases, and any allowance for delay of platform replacement is significantly diminished. Age degrades reliability by increasing the potential for systems to break down or fail to respond correctly. The older weapons systems are, the more at risk they are that faulty components, malfunctioning equipment, or technological developments will limit their reliability in the operating environment.

Corrupted systems, defective electronics, or performance degradation due to long-term storage defects (including for nuclear warheads) can have serious implications for American deterrence and assurance. Because it cannot be assumed (especially with respect to systems approaching end of life) that a strategic delivery vehicle will always operate reliably, that vehicle's deterrence and assurance value may be significantly reduced, with consequent impact on the deterrence perceptions of both allies and adversaries.

The U.S. Air Force and Navy plan to modernize or replace each leg of the nuclear triad in the next few decades, but fiscal constraints, inconsistent levels of funding, and issues related to "continuing resolutions" will make such efforts difficult at best. Sustained leadership focus is imperative if the modernization program is to succeed.

The Navy is fully funding its programs to replace the *Ohio*-class submarine with the *Columbia*-class submarine, but issues early in the program that were identified last year have caused the margin for slippage in the overall schedule of the program itself to decrease.<sup>33</sup> The Air Force is funding the B-21 Raider long-range bomber. Existing ICBMs and SLBMs are expected to remain in service until 2032 and 2042, respectively.

Remanufacturing some weapon parts is difficult and expensive either because the manufacturers are no longer in business or because the materials that constituted the original weapons are no longer available (e.g., due to environmental restrictions). Modernization of the U.S. triad is a requirement validated by all

four of the NPRs since the end of the Cold War and will remain a must in all future deterrence scenarios. Plans for modernization of U.S. nuclear weapons benefited from the predictability associated with the FY2018/FY 2019 budget deal, but the return of sequestration threatens this progress.

The ability of the U.S. to produce sufficient numbers of solid-fuel rocket engines and possible U.S. dependence on Russia as a source of such engines are other significant long-range concerns.<sup>34</sup>

**Grade:** U.S. nuclear platforms are in dire need of recapitalization. Plans for modernization of the nuclear triad are in place, and Congress and the services have largely sustained funding for these programs, notwithstanding difficulties caused by the Budget Control Act of 2011. This demonstration of commitment to nuclear weapons modernization earns this indicator a grade of "strong," although possible delays in modernization could cause this score to be downgraded in the near future.

## **Nuclear Weapons Complex**

### **Score: Marginal**

Maintaining a reliable and effective nuclear stockpile depends in large part on the facilities where U.S. devices and components are developed, tested, and produced. These facilities constitute the foundation of our strategic arsenal and include the:

- Los Alamos National Laboratory,
- Lawrence Livermore National Laboratory,
- Sandia National Laboratories,
- Nevada National Security Site,
- Pantex Plant,
- Kansas City Plant,
- Savannah River Site, and
- Y-12 National Security Complex.

In addition to these government sites, the defense industrial base supports the development and maintenance of American delivery platforms.

These complexes design, develop, test, and produce the weapons in the U.S. nuclear arsenal, and their maintenance is of critical importance. As the 2018 NPR states:

An effective, responsive, and resilient nuclear weapons infrastructure is essential to the U.S. capacity to adapt flexibly to shifting requirements. Such an infrastructure offers tangible evidence to both allies and potential adversaries of U.S. nuclear weapons capabilities and thus contributes to deterrence, assurance, and hedging against adverse developments. It also discourages adversary interest in arms competition.<sup>35</sup>

Maintaining a safe, secure, effective, and reliable nuclear stockpile requires modern facilities, technical expertise, and tools both to repair any malfunctions quickly, safely, and securely and to produce new nuclear weapons if required to do so. The existing nuclear weapons complex, however, is not fully functional. The United States, for example, has not had a substantial plutonium-pit production capability since 1993. A plutonium pit is the heart of a nuclear weapon, and the NNSA currently plans to produce no fewer than 80 pits a year by 2030—a challenge by its own admission.<sup>36</sup> In 2005, it was reported that the U.S. cannot “serially produce many crucial components of our nuclear weapons.”<sup>37</sup>

If the facilities are not properly funded, the U.S. will gradually lose the ability to conduct the required high-quality experiments that are needed to ensure the stockpile’s reliability without nuclear testing. In addition to demoralizing the workforce and hampering recruitment, old and/or obsolete facilities and poor working environments make maintaining a safe, secure, reliable, and militarily effective nuclear stockpile difficult. Upwards of 50 percent of the NNSA’s facilities are more than 40

years old, nearly 30 percent date to the Manhattan Project of the 1940s, and 12 percent are considered excess or no longer needed.<sup>38</sup> The NNSA reported \$2.5 billion in deferred maintenance as of February 2019.<sup>39</sup>

The U.S. currently retains over 5,000 old plutonium pits in strategic reserve in addition to pits for use in future LEPs. There are disagreements as to the effect of aging on plutonium pits and on how long the U.S. will be able to depend on them before replacement. In 2006, then-NNSA Administrator Linton Brooks estimated that the life span of warhead plutonium is “somewhere between 45 and 60 years,” which means that in the near future, the United States may have to start replacing core components of its nuclear warheads.<sup>40</sup>

Current capacities to do so are insufficient because the U.S. has demonstrated an ability to produce only about 10 plutonium pits a year at the Los Alamos PF-4 facility. If executed as planned, infrastructure modernization plans for PF-4 as mandated by the 2018 NPR will boost that number to about 30 by the middle of the next decade.

A second plutonium-pit production facility is being planned to exploit the Mixed Oxide Fuel (MOX) facility that until last year was under construction at the Savannah River Plant in Tennessee. The MOX building is being repurposed for a production capacity of no fewer than 50 plutonium pits per year to be achieved by 2030 for an overall requirement of no fewer than 80 pits per year. The challenge of achieving this timeline is exacerbated by the fact that the NNSA is embarking on the most ambitious warhead sustainment program since the end of the Cold War, overhauling some five warhead types and stressing the demands on both workforce and facilities.

Manufacturing non-nuclear components can be extremely challenging either because some materials may no longer exist or because manufacturing processes have been forgotten and must be retrieved. There is a certain element of art to building a nuclear weapon, and such a skill can be acquired and maintained only through hands-on experience.



**Grade:** On one hand, the U.S. maintains some of the world’s most advanced nuclear facilities. On the other, some parts of the complex—importantly, the plutonium and highly enriched uranium component manufacturing infrastructure—have not been modernized since the 1950s. Plans for long-term infrastructure recapitalization remain essential, even as the NNSA is embarking upon an aggressive warhead life-extension effort. Sustaining and/or increasing critically essential tritium gas is likewise essential because tritium gas is subject to deterioration, and a delay in production increases the amount that must be produced to cover our baseline needs.

Significant progress has been made over the past year, however, both in recapitalizing uranium infrastructure and in getting funded plans in place to recapitalize plutonium-pit production capacity. The infrastructure is improved and therefore receives a grade of “marginal.”

## Personnel Challenges Within the National Nuclear Laboratories

### Score: Marginal

Combined with nuclear facilities, U.S. nuclear weapons scientists and engineers are critical to the health of the complex and the stockpile. The 2018 NPR emphasizes that:

The nuclear weapons infrastructure depends on a highly skilled, world-class workforce from a broad array of disciplines, including engineering, the physical sciences, mathematics, and computer science. Maintaining the necessary critical skills and retaining personnel with the needed expertise requires sufficient opportunities to exercise those skills.<sup>41</sup>

The ability to maintain and attract a high-quality workforce is critical to assuring the future of the American nuclear deterrent, and hiring the best and brightest is especially challenging in a strong employment atmosphere. Today’s weapons designers and

engineers are first-rate, but they also are aging and retiring, and their knowledge must be passed on to the next generation of experts. This means that young designers need meaningful and challenging warhead design and development programs to hone their skills.

The SRP offers one visible means by which to address such concerns. The NNSA and its weapons labs understand this problem and, with the support of Congress, are beginning to take the necessary steps through SRP and foreign weapon assessment to mentor the next generation. To continue this progress, SRP funding will need to be sustained and ideally increased from the current rate of about \$30 million a year.

The U.S. currently relies on non-yield-producing laboratory experiments, flight tests, and the judgment of experienced nuclear scientists and engineers, using robust modeling and simulation, to ensure continued confidence in the safety, security, effectiveness, and reliability of its nuclear deterrent. Without their experience, the nuclear weapons complex could not function. Few of today’s remaining scientists or engineers at the NNSA weapons labs have had the experience of taking a warhead from initial concept to a “clean sheet” design, engineering development, production, and fielding. The SRP is helping to remedy some of these shortfalls by having the workforce exercise most of the skills required for nuclear weapons design and engineering.

The average age of the NNSA’s workforce decreased slightly to 47.8 years as of September 2018.<sup>42</sup> Still worrisome, however, is that over a third of this workforce will be eligible for retirement in the next four years. Given the distribution of workforce by age, these retirements will create a significant knowledge and experience gap.

**Grade:** In addition to employing world-class experts, the NNSA labs have had some success in attracting and retaining talent. As many scientists and engineers with practical nuclear weapon design and testing experience retire, the annual assessment and certification of nuclear weapons will rely increasingly on

the judgments of people who have never tested or designed a nuclear weapon. In light of these issues, the complex earns a score of “marginal,” albeit with signs of improvement.

### **Readiness of Forces Score: Strong**

The people and units that operate U.S. delivery platforms are essential to the successful operation of America’s strategic forces. The military personnel operating the three legs of the nuclear triad must be properly trained and equipped, and the crews responsible for the nuclear mission must be maintained in an appropriate state of readiness.

During FY 2019, the services have continued to align resources in order to preserve strategic capabilities in the short term. Nevertheless, a return to sequestration could have major negative effects on the timely execution of programs. U.S. general-purpose forces help to ensure the overall effectiveness of our nuclear forces by, among other things, providing a pool of qualified candidates to operate nuclear weapon delivery systems. Changes prompted in part by the 2014 Navy and Air Force cheating scandals have addressed most morale issues and have recast the role of forces supporting the nuclear deterrent by providing additional funding for equipment purchases, creating more mid-career billets to help career-field continuity, focusing leadership attention, and changing training to focus on mission in the field rather than on a theoretical ideal. Sustained attention to the situation in the nuclear enterprise is critical.

**Grade:** Despite uncertainties regarding the future impact of budgetary shortfalls, the young men and women who secure, maintain, plan for, and operate U.S. nuclear forces are of extremely high caliber. Force readiness thus receives a grade of “strong.”

### **Allied Assurance Score: Strong**

The credibility of U.S. nuclear deterrence is one of the most important components of allied assurances. U.S. allies that already have nuclear weapons can coordinate actions with the United States or act independently. During

the Cold War, the U.S. and the United Kingdom cooperated to the point where joint targeting was included. France maintains its independent nuclear arsenal. The U.S. also deploys nuclear gravity bombs in Europe as a visible manifestation of its commitment to its NATO allies.

Similarly, the U.S. has an enduring extended deterrence role with its Asian allies. The United States provides nuclear assurances to Japan and South Korea, both of which are technologically advanced industrial economies that face aggressive nuclear-armed regional adversaries such as China, Russia, and North Korea. Continued assurances and guarantees of U.S. nuclear deterrence must therefore be perceived as credible. Both Japan and South Korea have the capability and basic know-how to build their own nuclear weapons (even quickly) should they chose to do so. That would be a major setback for U.S. nonproliferation policies.

The 2018 NPR took a step in the right direction when it placed “[a]ssurance of allies and partners” second on its list of four “critical roles” (immediately following “[d]eterrence of nuclear and non-nuclear attack”) that nuclear forces play in America’s national security strategy. The 2018 NPR proposed two supplements to existing capabilities—a low-yield SLBM warhead and a new nuclear sea-launched cruise missile—as important initiatives to strengthen assurance, along with the Obama and Trump Administrations’ initiatives to bolster conventional forces in NATO. Work on the low-yield warhead is progressing, and deployment of this capability will be an important factor in deterring aggression against America’s Asian and NATO allies in the years ahead.

**Grade:** At this time, most U.S. allies are not seriously considering developing their own nuclear weapons. European members of NATO continue to express their commitment to and appreciation of NATO as a nuclear alliance even as they worry about the impact of Russia’s violations of the Intermediate Nuclear Forces Treaty and the regional implications of other arms control treaties, including the New Strategic Arms Reduction Treaty. Because uncertainties surrounding the purchase and

modernization of NATO's dual-capable aircraft and the time line for replacing existing U.S. nuclear weapons with the B61-12, as well as NATO's seeming lack of attention to the nuclear mission and its intellectual underpinnings, do not justify a score of "very strong," allied assurance receives a score of "strong."

### **Nuclear Test Readiness Score: Weak**

In the past, nuclear testing was one of the key elements of a safe, secure, effective, and reliable nuclear deterrent. Today, even though the U.S. is under a self-imposed nuclear testing moratorium, it is still required to maintain a low level of nuclear test readiness at the Nevada National Security Site (formerly Nevada Test Site).

"Test readiness" refers to a single test or a very short series of tests, not a sustained nuclear testing program, reestablishment of which would require significant additional resources. Specifically, under President Bill Clinton's 1993 PDD-15, "[i]n order to resume underground nuclear tests, a capability to conduct a nuclear test within 6 months up to FY 1996, and to conduct a nuclear test within 2–3 years after that time will be assumed by the Department of Energy [now NNSA]."<sup>43</sup> Because of a shortage of resources, the NNSA has been unable to achieve this goal. The test readiness program is supported by experimental programs at the Nevada National Security Site, nuclear laboratory experiments, and advanced diagnostics development.<sup>44</sup>

The ability of the U.S. to conduct yield-producing experiments in a timely manner if it should discover a flaw in one or more types of its nuclear weapons that requires experimentation to correct seems questionable. The U.S. might need to test to assure certain weapon characteristics that could possibly be validated only by nuclear testing and to verify render-safe procedures. The ability to conduct yield-producing experiments rapidly is likewise important, especially if the U.S. needs to react strongly to another nation's nuclear weapons tests and/or communicate unquestioned resolve.

As noted, current law requires that the U.S. must maintain a capability to conduct a nuclear test within 24 to 36 months of a presidential decision to do so. The NNSA states in its *Fiscal Year 2018 Stockpile Stewardship and Management Plan* that its "fundamental approach taken to achieve test readiness has also changed" and lists a general time frame of six to 10 months for a simple test with waivers and simplified processes.<sup>45</sup> The time frame "for a fully instrumented test to address stockpile needs with the existing stockpile" is 24 to 36 months, and "a test to develop a new capability" would take 60 months.<sup>46</sup> A test within 18 months might be possible, "but only if 'some domestic regulations, agreements and laws' were to be waived."<sup>47</sup> Because the United States is rapidly losing its remaining practical nuclear testing experience, including instrumentation of very sensitive equipment, "there is essentially no test readiness," and "[t]he whole testing process—whether to conduct one test or many—would in essence have to be reinvented, not simply resumed."<sup>48</sup>

**Grade:** As noted, the U.S. can meet the legally required readiness requirement through the NNSA only if certain domestic regulations, agreements, and laws are waived. In addition, the U.S. is not prepared to sustain testing activities beyond a few limited experiments because it no longer retains the deep drilling technology in Nevada and has only a few "holes" capable of containing a nuclear test if required. Thus, testing readiness earns a grade of "weak."

### **Overall U.S. Nuclear Weapons Capability Score: "Marginal" Trending Toward "Strong"**

It should be emphasized that "trending toward 'strong'" assumes that the U.S. maintains its commitment to modernization of the entire enterprise, from warheads to platforms to personnel to infrastructure, and allocates needed resources accordingly. Absent this commitment, this overall score will degrade rapidly to "weak." Continued attention to this mission is therefore critical.

Although a bipartisan commitment has led to continued progress on the modernization of U.S. nuclear forces and sustainment of warheads, these programs remain seriously threatened by potential future fiscal uncertainties. The infrastructure that supports nuclear programs is very aged, and nuclear test readiness has revealed troubling problems within the forces.

On the plus side, the 2018 NPR strongly articulates a core nuclear weapons policy grounded in the reality of today’s threats and growing international development concerns.

The 2018 NPR clearly and strongly articulates our continued commitment to extended deterrence. The commitment to warhead life-extension programs, the exercise of skills that are critical for the development of new nuclear warheads under the SRP, and the just-in-time modernization of nuclear delivery platforms represent a positive trend that must be maintained.

Averaging the subscores across the nuclear enterprise in light of our concerns about the future results in an overall score of “marginal.”

### U.S. Military Power: Nuclear

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Nuclear Stockpile				✓	
Delivery Platform Reliability			✓		
Warhead Modernization			✓		
Delivery Systems Modernization				✓	
Nuclear Weapons Complex			✓		
National Labs Talent			✓		
Force Readiness				✓	
Allied Assurance				✓	
Nuclear Test Readiness		✓			
<b>OVERALL</b>			✓		

## Endnotes

1. Quoted in U.S. Department of Defense, Office of the Secretary of Defense, *Nuclear Posture Review 2018*, February 2018, p. 1, <https://media.defense.gov/2018/Feb/02/2001872886/-1/-1/2018-NUCLEAR-POSTURE-REVIEW-FINAL-REPORT.PDF> (accessed June 27, 2019).
2. “U.S. Nuclear Forces,” Chapter 3 in U.S. Department of Defense, Office of the Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs, *The Nuclear Matters Handbook, Expanded Edition*, 2011, p. 39, [https://www.ipndv.org/wp-content/uploads/2017/10/Nuclear\\_Matters\\_Handbook\\_2011.pdf](https://www.ipndv.org/wp-content/uploads/2017/10/Nuclear_Matters_Handbook_2011.pdf) (accessed June 27, 2019).
3. Center for Strategic and International Studies, Missile Defense Project, “Minuteman III,” *Missile Threat*, last updated June 15, 2018, <https://missilethreat.csis.org/missile/minuteman-iii/> (accessed June 27, 2019).
4. “Test Readiness,” in Chapter 1, “Safety, Security, and Reliability of the U.S. Nuclear Weapons Stockpile,” in National Research Council, Committee on Reviewing and Updating Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty, *The Comprehensive Nuclear Test Ban Treaty: Technical Issues for the United States* (Washington: National Academies Press, 2012), p. 30, [http://www.nap.edu/openbook.php?record\\_id=12849&page=30](http://www.nap.edu/openbook.php?record_id=12849&page=30) (accessed June 27, 2019).
5. Memorandum, “Report on the ‘Follow-up Audit of the Test Readiness at the Nevada Test Site,’” U.S. Department of Energy, Office of Inspector General, *Audit Report* No. OAS-L-10-02, October 21, 2009, <http://energy.gov/sites/prod/files/igprod/documents/OAS-L-10-02.pdf> (accessed June 27, 2019).
6. Dr. Charles V. Shank, Senior Fellow, Howard Hughes Medical Institute, and Co-chair, National Research Council Committee on Review of the Quality of the Management and of the Science and Engineering Research at the DOE’s National Security Laboratories—Phase 1, statement in *Hearing to Receive Testimony on National Nuclear Security Administration Management of Its National Security Laboratories*, Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate, April 18, 2012, p. 5, <http://www.armed-services.senate.gov/imo/media/doc/12-28%20-%204-18-12.pdf> (accessed June 13, 2017).
7. Table, “Retirement Eligibility,” in U.S. Department of Energy, National Nuclear Security Administration, “National Nuclear Security Administration as of September 30, 2018,” <https://www.energy.gov/sites/prod/files/2019/01/f58/201809%20NNSA%20workforce%20diversity%20statistics%20report.pdf> (accessed April 10, 2019).
8. See chart, “Median Age of Employees Working at Selected Tech and Online Companies as of April 2016 (in Years),” Statista, last edited May 31, 2016, <https://www.statista.com/statistics/653789/average-age-of-tech-company-employees/> (accessed July 26, 2019), and Robert Allen, “Average Age of Tech Company’s Employees [ChartoftheDay],” Smart Insights, May 31, 2016, <https://www.smartinsights.com/manage-digital-transformation/average-age-tech-companys-employees-chartoftheday/> (accessed July 26, 2019).
9. The report also recommends that the Department of Energy be renamed the “Department of Energy and Nuclear Security” to “highlight the prominence and importance of the Department’s nuclear security mission.” Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise, *A New Foundation for the Nuclear Enterprise: Report of the Congressional Advisory Panel on the Governance of the Nuclear Security Enterprise*, November 2014, p. xii, [http://cdn.knoxblogs.com/atomiccity/wp-content/uploads/sites/11/2014/12/Governance.pdf?\\_ga=1.83182294.1320535883.1415285934](http://cdn.knoxblogs.com/atomiccity/wp-content/uploads/sites/11/2014/12/Governance.pdf?_ga=1.83182294.1320535883.1415285934) (accessed June 27, 2019).
10. Kevin Liptak, “U.S. Navy Discloses Nuclear Exam Cheating,” CNN, updated February 4, 2014, <http://www.cnn.com/2014/02/04/us/navy-cheating-investigation/index.html> (accessed June 27, 2019).
11. See Section IV, “Underlying Issues: Leadership Focus, the Nuclear Enterprise Culture, Command Oversight, Investment—Visible Support, the Security Burden, and the Personnel Reliability Program,” in U.S. Department of Defense, *Independent Review of the Department of Defense Nuclear Enterprise*, June 2, 2014, pp. 21–38, <https://dod.defense.gov/Portals/1/Documents/pubs/Independent-Nuclear-Enterprise-Review-Report-30-June-2014.pdf> (accessed June 27, 2019).
12. U.S. Government Accountability Office, *Defense Nuclear Enterprise: DOD Continues to Address Challenges but Needs to Better Define Roles and Responsibilities and Approaches to Collaboration*, GAO-19-29, November 2018, <https://www.gao.gov/assets/700/695197.pdf> (accessed June 27, 2019).
13. David J. Trachtenberg, Deputy Under Secretary of Defense for Policy, statement in hearing, *Fiscal Year 2020 Priorities for Department of Defense Nuclear Priorities*, Subcommittee on Strategic Forces, Committee on Armed Services, U.S. House of Representatives, March 28, 2019, p. 1, <https://armedservices.house.gov/hearings?ID=FA8DBDAB-5585-4437-AF88-61FBB1B7D428> (accessed June 27, 2019). In 2012, it was estimated that Russia can produce “about 2,000 new warheads each year.” Robert G. Joseph, “Second to One,” *National Review*, July 2, 2012, <http://www.nationalreview.com/article/304310/second-one-robert-g-joseph> (accessed June 28, 2019). According to an assessment published 10 years earlier, “a worst-case analysis (from the U.S. point of view) is that Russia could make 7,000 new warheads per year in a surge production.” Oleg Bukharin, “A Breakdown of Breakout: U.S. and Russian Warhead Production Capabilities,” Arms Control Association, October 2002, [http://www.armscontrol.org/act/2002\\_10/bukharinoct02](http://www.armscontrol.org/act/2002_10/bukharinoct02) (accessed June 28, 2019).



14. See, for example, Section II, “An Evolving and Uncertain International Security Environment,” in U.S. Department of Defense, Office of the Secretary of Defense, *Nuclear Posture Review 2018*, pp. 5–14.
15. U.S. Department of Defense, *Nuclear Posture Review*, p. VII.
16. Testimony of General John E. Hyten, Commander, United States Strategic Command, in transcript, “U.S. Strategic Command and U.S. Northern Command SASC [Senate Armed Services Committee] Testimony,” U.S. Strategic Command, March 1, 2019, <https://www.stratcom.mil/Media/Speeches/Article/1771903/us-strategic-command-and-us-northern-command-sasc-testimony/> (accessed June 28, 2019).
17. U.S. Department of Defense, *Nuclear Posture Review*, p. 11.
18. *Ibid.*, p. 13.
19. U.S. Department of Defense, Office of the Secretary of Defense, *Nuclear Posture Review 2018*, p. XIII.
20. R. L. Bierbaum, J. J. Cashen, T. J. Kerschen, J. M. Sjulin, and D. L. Wright, “DOE Nuclear Weapon Reliability Definition: History, Description, and Implementation,” Sandia National Laboratories, *Sandia Report* No. SAND99-8240, April 1999, pp. 7–8, <http://www.wslfweb.org/docs/usg/reli99.pdf> (accessed June 28, 2019). Emphasis in original.
21. John C. Hopkins and David H. Sharp, “The Scientific Foundation for Assessing the Nuclear Performance of Weapons in the US Stockpile Is Eroding,” *Issues in Science and Technology*, Vol. XXXV, No. 2 (Winter 2019), p. 23, <https://issues.org/wp-content/uploads/2019/01/Hopkins-Sharp-The-Scientific-Foundation-23-25-Winter-2019.pdf> (accessed June 28, 2019).
22. Thomas Scheber, *Reliable Replacement Warheads: Perspectives and Issues*, United States Nuclear Strategy Forum Publication No. 0005 (Fairfax, VA: National Institute Press, 2007), p. 3, <http://www.bits.de/NRANEU/docs/RRW07.pdf> (accessed June 28, 2019).
23. *Ibid.*, p. 4.
24. National Institute for Public Policy, *The Comprehensive Test Ban Treaty: An Assessment of the Benefits, Costs, and Risks* (Fairfax, VA: National Institute Press, 2011), pp. 24–25, <http://www.nipp.org/wp-content/uploads/2014/12/CTBT-3.11.11-electronic-version.pdf> (accessed June 28, 2019).
25. Stephen M. Younger, *The Bomb: A New History* (New York: HarperCollins, 2009), p. 192.
26. Robert M. Gates, speech delivered at Carnegie Endowment for International Peace, Washington, DC, October 28, 2008, <http://archive.defense.gov/Speeches/Speech.aspx?SpeechID=1305> (accessed June 28, 2019). Emphasis in original.
27. U.S. Department of Energy, National Nuclear Security Administration, *Report to Congress: Fiscal Year 2018 Stockpile Stewardship and Management Plan*, November 2017, p. v, [https://www.nukewatch.org/importantdocs/resources/fy18ssmp\\_final\\_november\\_2017.pdf](https://www.nukewatch.org/importantdocs/resources/fy18ssmp_final_november_2017.pdf) (accessed June 28, 2019), and U.S. Department of Energy, National Nuclear Security Administration, *Report to Congress: Fiscal Year 2019 Stockpile Stewardship and Management Plan—Biennial Plan Summary*, October 2018, p. 1–8, <https://www.energy.gov/sites/prod/files/2018/10/f57/FY2019%20SSMP.pdf> (accessed June 28, 2019).
28. Robert W. Nelson, “What Does Reliability Mean?” in “If It Ain’t Broke: The Already Reliable U.S. Nuclear Arsenal,” Arms Control Association, corrected online August 29, 2008, [https://www.armscontrol.org/act/2006\\_04/ReliableFeature](https://www.armscontrol.org/act/2006_04/ReliableFeature) (accessed June 28, 2019).
29. Joe Pappalardo, “The Air Force Destroyed an Unarmed Minuteman III ICBM During a Test Gone Wrong,” *Popular Mechanics*, July 31, 2018, <https://www.popularmechanics.com/military/weapons/a22604568/air-force-minuteman-iii-icbm-test/> (accessed July 26, 2019).
30. U.S. Department of Energy, National Nuclear Security Administration, *Report to Congress: Fiscal Year 2019 Stockpile Stewardship and Management Plan—Biennial Plan Summary*, p. 1–16.
31. Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile, *Expectations for the U.S. Nuclear Stockpile Program: FY 2001 Report of the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile*, 2002, p. 9, <http://fas.org/programs/ssp/nukes/testing/fosterpnlrpt01.pdf> (accessed June 28, 2019).
32. See, for example, Congressional Commission on the Strategic Posture of the United States, *America’s Strategic Posture. The Final Report of the Congressional Commission on the Strategic Posture of the United States*, 2009, p. 83, [https://www.usip.org/sites/default/files/America’s\\_Strategic\\_Posture\\_Auth\\_Ed.pdf](https://www.usip.org/sites/default/files/America’s_Strategic_Posture_Auth_Ed.pdf) (accessed June 28, 2019).
33. “Officers Send Conflicting Signals on Columbia Sub Margin,” *ExchangeMonitor*, February 27, 2019, <https://www.exchangemonitor.com/officers-send-conflicting-signals-columbia-margin/> (accessed April 15, 2019). Subscription required.
34. Sydney J. Freedberg Jr., “Fading Solid Fuel Engine Biz Threatens Navy’s Trident Missile,” *Breaking Defense*, June 16, 2014, <http://breakingdefense.com/2014/06/fading-solid-fuel-engine-biz-threatens-navys-trident-missile/> (accessed June 28, 2019).
35. U.S. Department of Defense, *Nuclear Posture Review Report*, February 2018, p. xiv.



36. Rick Perry, Secretary of Energy, and Lisa E. Gordon-Hagerty, Under Secretary for Nuclear Security and Administrator of the National Nuclear Security Administration, U.S. Department of Energy, statement in hearing, *Department of Energy's Atomic Energy Defense Programs*, Committee on Armed Services, U.S. Senate, March 28, 2019, p. 2, <https://www.armed-services.senate.gov/hearings/19-03-28-department-of-energys-atomic-energy-defense-programs> (accessed June 28, 2019).
37. John S. Foster, Jr., "Nuclear Weapons and the New Triad," in conference proceedings, *Implementing the New Triad: Nuclear Security in Twenty-First Century Deterrence, Final Report*, Institute for Foreign Policy Analysis and International Security Studies Program of the Fletcher School, Tufts University, December 14–15, 2005, p. 69. See also Amy F. Woolf, "Defense Primer: Strategic Nuclear Forces," Congressional Research Service *In Focus* No. 10519, updated December 11, 2018, <https://crsreports.congress.gov/product/pdf/IF/IF10519> (accessed July 26, 2019), p. 15., and Amy F. Woolf and James D. Werner, "The U.S. Nuclear Weapons Complex: Overview of Department of Energy Sites," Congressional Research Service *Report for Members and Committees of Congress*, updated September 6, 2018, pp. 1 and 8, <https://fas.org/sgp/crs/nuke/R45306.pdf> (accessed July 26, 2019).
38. U.S. Department of Energy, National Nuclear Security Administration, *Prevent, Counter, and Respond—A Strategic Plan to Reduce Global Nuclear Threats, FY 2017–FY 2021*, March 2016, [https://nnsa.energy.gov/sites/default/files/nnsa/inlinefiles/NPCR%20FINAL%203-31-16%20\(with%20signatures\).pdf](https://nnsa.energy.gov/sites/default/files/nnsa/inlinefiles/NPCR%20FINAL%203-31-16%20(with%20signatures).pdf) (accessed June 13, 2017).
39. U.S. Department of Energy, National Nuclear Security Administration, "Infrastructure Modernization," February 2019, <https://www.energy.gov/sites/prod/files/2019/02/f59/2019-02-14-FACTSHEET-Infrastructure-Modernization.pdf> (accessed June 28, 2019).
40. David Ruppe, "Research Suggests Warhead Plutonium Pits Last Longer," Nuclear Threat Initiative, March 2, 2006, <https://www.nti.org/gsn/article/research-suggests-warhead-plutonium-pits-last-longer/> (accessed June 28, 2019).
41. U.S. Department of Defense, *Nuclear Posture Review*, p. 63.
42. Table, "Age," in U.S. Department of Energy, National Nuclear Security Administration, "National Nuclear Security Administration as of September 30, 2018."
43. Presidential Decision Directive/NSC-15, "U.S. Policy on Stockpile Stewardship Under an Extended Moratorium and a Comprehensive Test Ban," November 3, 1993, p. 5, <https://fas.org/irp/offdocs/pdd/pdd-15.pdf> (accessed June 29, 2019).
44. U.S. Department of Energy, National Nuclear Security Administration, Nevada National Security Site, "Stockpile Stewardship Program," January 10, 2019, <https://www.nnss.gov/pages/programs/StockpileStewardship.html> (accessed June 29, 2019).
45. U.S. Department of Energy, National Nuclear Security Administration, *Report to Congress: Fiscal Year 2018 Stockpile Stewardship and Management Plan*, p. 3-26.
46. Ibid.
47. National Research Council, Committee on Reviewing and Updating Technical Issues Related to the Comprehensive Nuclear Test Ban Treaty, *The Comprehensive Nuclear Test Ban Treaty: Technical Issues for the United States*, p. 30.
48. John C. Hopkins, "Nuclear Test Readiness: What Is Needed? Why?" *National Security Science*, December 2016, p. 10, [http://www.lanl.gov/discover/publications/national-security-science/2016-december/\\_assets/docs/NSS-dec2016\\_nuclear-test-readiness.pdf](http://www.lanl.gov/discover/publications/national-security-science/2016-december/_assets/docs/NSS-dec2016_nuclear-test-readiness.pdf) (accessed June 29, 2019).



# Missile Defense

**M**issile defense is a critical component of the U.S. national security architecture.<sup>1</sup> It can protect critical infrastructure, ranging from population and industrial centers to politically and historically important sites; strengthen U.S. diplomatic and deterrence efforts; and provide both time and options to senior decision-makers amid crises that involve missiles flying on ballistic and non-ballistic trajectories (e.g., hypersonic weapons).

Missiles remain a weapon of choice for many of America's adversaries because of such important attributes as their extraordinarily high speed (against which the U.S. has a limited ability to defend) and relative cost-effectiveness compared to other types of conventional attacks.<sup>2</sup> As the number of states that possess missiles continues to increase, so will the sophistication of these weapons as modern technologies become cheaper and more widely available. In April 2019, Under Secretary of Defense for Policy John Rood testified before the Senate Armed Services Subcommittee on Strategic Forces that:

Potential adversaries are developing sophisticated ballistic and cruise missile systems with increased speed, range, accuracy, and lethality.

Over the past decade, North Korea and Iran have accelerated efforts to develop and field missiles capable of threatening U.S. strategic interests. While North Korea has not tested a nuclear-capable missile in over a year, it possesses a range of systems including road-mobile

intercontinental-range ballistic missiles, solid-propellant medium-range ballistic missiles, and submarine-launched ballistic missiles.

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

We also see the re-emergence of long-term, strategic competition by revisionist powers in Russia and China. Russia and China are expanding and modernizing a wide range of offensive missile capabilities.<sup>3</sup>

An additional concern is ballistic missile cooperation between state and non-state actors. Such cooperation furthers the spread of sophisticated technologies and compounds challenges to U.S. defense planning.<sup>4</sup>

To deter an enemy from attacking, one must be able to convince him that his attack will fail, that the cost of carrying out a successful attack is prohibitively high, or that the consequences of an attack will be so painful that they will outweigh any perceived benefit. A U.S. missile defense system strengthens deterrence by offering a degree of protection to the American people, as well as the economic base on which their well-being depends, and making it harder

for an adversary to threaten forward-deployed troops and allies with ballistic missiles.

In addition, a missile defense system gives a decision-maker a significant political advantage: By protecting key elements of U.S. well-being, it mitigates an adversary's ability to intimidate the United States into conceding important security, diplomatic, or economic interests. Missile defense systems also enable U.S. and allied conventional operations.

A missile defense system gives decision-makers more time to choose the most de-escalatory course of action from an array of options that can range from preemptively attacking an adversary to attacking his ballistic missiles on launch pads or even conceding to an enemy's demands or actions. Though engaging in a preemptive attack would likely be seen as an act of war by adversaries and could result in highly escalatory scenarios, the United States would do so if there was a substantiated concern that an adversary was about to attack the United States with a nuclear-armed missile. The United States would have an option to back down, thus handing a "win" to the enemy, but at the cost of losing credibility in its many alliance relationships.

Backing down could also undermine U.S. nonproliferation efforts. More than 30 allies around the world rely on U.S. nuclear security guarantees, and questioning the U.S. commitment to allied safety in the face of a ballistic missile threat would translate into questioning the U.S. commitment to allied nuclear safety in the most fundamental sense. Robust missile defense systems would affect the dynamics of decision-making, creating additional options and providing more time to sort through them and their implications to arrive at the option that best serves U.S. security interests. The effect could well be profoundly stabilizing.

Missile defense is an important enabler in nonproliferation efforts and alliance management. Many U.S. allies have the technological capability and expertise to produce their own nuclear weapons. They have not done so because of their belief in U.S. assurances to protect them. U.S. missile defense systems are

seen as an integral part of America's visible commitment to its allies' security.

The U.S. missile defense system comprises three critical physical parts: sensors, interceptors, and command and control infrastructure that provides data from sensors to interceptors. Of these, interceptors receive much of the public's attention because of their very visible and kinetic nature. Different physical components of a ballistic missile defense system are designed with the phase of flight in which an intercept occurs in mind, although some of them—for example, the command and control infrastructure or radars—can support intercepts in various phases of a ballistic missile flight. Interceptors can shoot down an adversary's missile in the boost, ascent, midcourse, or terminal phase of its flight.

Another way to consider ballistic missile defense systems is by the range of an incoming ballistic missile (short-range, medium-range, intermediate-range, or long-range) that an interceptor is designed to shoot down. The length of the interceptor's flight time determines how much time is available to conduct an intercept and where the various components of a defense system must be placed to improve the probability of such an intercept. With long-range ballistic missiles, the United States has no more than 33 minutes to detect the missile, track it, provide the information to the missile defense system, come up with the most optimal firing solution, launch an interceptor, and shoot down an incoming missile, ideally with enough time to fire another interceptor if the first attempt fails. The time frame is shorter when it comes to medium-range and short-range ballistic missiles.

Finally, missile defense can be framed by the origin of interceptor launch. At present, U.S. interceptors are launched from the ground or from the sea. In the past, the United States explored concepts to launch interceptors from the air or from space, but limited efforts have been made on that front since the U.S. withdrawal from the Anti-Ballistic Missile Treaty in 2002.<sup>5</sup> There is renewed interest in boost-phase missile defense concepts within

the Trump Administration, although the fiscal year (FY) 2020 budget submission for the Missile Defense Agency (MDA) allocates only about \$34 million for boost-phase missile defense systems, which is certainly not enough to develop and deploy a boost-phase missile defense system anytime soon.

The current U.S. missile defense system is a result of investments made by successive U.S. Administrations. President Ronald Reagan's vision for the program was to have a layered ballistic missile defense system that would render nuclear weapons "impotent and obsolete," including ballistic missile defense interceptors in space.<sup>6</sup> These layers would include boost, ascent, midcourse, and terminal interceptors, including directed-energy interceptors, so that the United States would have more than one opportunity to shoot down an incoming missile.

The United States stopped far short of this goal, even though the Strategic Defense Initiative (SDI) program resulted in tremendous technological advances and benefits.<sup>7</sup> Instead of a comprehensive layered system, the U.S. has no boost-phase ballistic missile defense systems and is unable to handle more qualitatively and quantitatively advanced ballistic missile threats like those from China or Russia.

Regrettably, the volatility and inconsistency of priority and funding for ballistic missile defense by successive Administrations and Congresses controlled by both major political parties have led to the current system, which is numerically and technologically limited and cannot address more sophisticated or more numerous long-range ballistic missile attacks. Until the 2017 National Defense Authorization Act (NDAA), U.S. policy was one of protection only from a "limited" ballistic missile attack.<sup>8</sup> The 2017 NDAA dropped the word "limited" that had been a fixture of policy since enactment of the National Missile Defense Act of 1999<sup>9</sup> even as it continued to focus on ballistic missiles.

In the future, as technological trends progress and modern technologies become cheaper and more widely available, North Korean or

Iranian ballistic missiles may rival in sophistication if not numbers those of Russia or China. Consequently, the U.S. must remain aware of how such threats are evolving and alter its missile defense posture accordingly.

In January 2019, the Trump Administration published its congressionally mandated *Missile Defense Review* (MDR), a statement of policy intended to guide the Administration's missile defense programs. The MDR endorses a space-based sensor layer,<sup>10</sup> which is needed to make existing missile defense systems more effective, but the Administration failed to request resources for such a sensor layer in the MDA's FY 2020 budget. In FY 2020, the Trump Administration requested \$9.431 billion for the MDA, the government agency with primary responsibility for developing, testing, fielding, and integrating a layered ballistic missile defense system. The request is a decrease of \$1.06 billion from the FY 2019 enacted budget.<sup>11</sup>

## Interceptors

A limited U.S. missile defense system has been supported by Administrations and Congresses controlled by both major political parties, Republican and Democrat, as all have found such a system to be of immense importance in dealing with some of the most challenging national security problems of our time, including the North Korean and Iranian ballistic missile threats. That said, different types of interceptors have been emphasized over the years, and the composition of today's U.S. missile defense reflects these choices.

Ballistic missile defense interceptors are designed to intercept ballistic missiles in three different phases of their flight.

- **The boost phase** lasts from the launch of a missile from its platform until its engines stop thrusting.
- **The midcourse phase** is the longest and thus offers a unique opportunity to intercept an incoming threat and, depending on other circumstances like the trajectory of the incoming threat and quality of U.S.

tracking data, even a second shot at it if the first intercept attempt fails.

- **The terminal phase** is less than one minute long and offers a very limited opportunity to intercept a ballistic missile threat.

**Boost-Phase Interceptors.** The United States currently has no capability to shoot down ballistic missiles in their boost phase. Boost-phase intercept is the most challenging option technologically because of the very short time frame in which a missile is boosting, the missile's extraordinary rate of acceleration during this brief window of time, and the need to have the interceptor close to the launch site.<sup>12</sup> It is, however, also the most beneficial time to strike. A boosting ballistic missile is at its slowest speed compared to other phases; it is therefore not yet able to maneuver evasively and has not yet deployed decoys that complicate the targeting and intercept problem.

In the past, the United States pursued several boost-phase programs, including the Airborne Laser; the Network Centric Air Defense Element (NCADE); the Kinetic Energy Interceptor (KEI); and the Air Launched Hit-to-Kill (ALHK) missile. Each of these programs was eventually cancelled because of insurmountable technical challenges, unworkable operational concepts, or unaffordable costs. As stated in the MDR, the Trump Administration is exploiting an option of incorporating the F-35 initially as a sensor platform and later potentially as an interceptor platform for boost-phase intercepts.<sup>13</sup>

The MDA is working to leverage unmanned and space-based sensor technologies to utilize existing SM-3 interceptors (typically carried aboard ships for long-range anti-aircraft defense) for a boost-phase ballistic missile intercept, but these sensors are years from being deployed. In addition, the current budget environment does not adequately fund research into future missile defense technologies and is barely enough to keep the existing missile defense programs going or enable even their marginal improvement.

**Midcourse-Phase Interceptors.** The United States deploys two systems that can shoot down incoming ballistic missiles in the midcourse phase of flight. This phase offers more predictability as to where the missile is headed than is possible in the boost phase, but it also allows the missile time to deploy decoys and countermeasures that are designed to complicate interception by confusing sensors and radars.

The Ground-Based Midcourse Defense (GMD) system is the only system capable of shooting down a long-range ballistic missile headed for the U.S. homeland. The Trump Administration decided to increase the number of GMD interceptors in Alaska and California from 44 to 64 early in its term to keep up with the advancing ballistic missile threat. At about \$70 million apiece, the GMD interceptors may be rather expensive, but they are also a lot cheaper than a successful ballistic missile attack. In March 2019, the MDA conducted a groundbreaking and successful GMD test against a target simulating an intercontinental-range ballistic missile.

The Aegis defense system is a sea-based component of the U.S. missile defense system that is designed to address the threat of short-range; medium-range (1,000–3,000 kilometers); and intermediate-range (3,000–5,500 kilometers) ballistic missiles. It utilizes different versions of the Standard Missile-3 (SM-3) depending on the threat and other considerations like ship location and quality of tracking data. The U.S. Navy is planning to increase the number of BMD-capable ships “from 38 at the end of FY2018 to 59 at the end of FY2024.”<sup>14</sup> This planned increase reflects an increase in demands for these assets.

The Aegis-Ashore system in Romania and one being deployed to Poland will relieve some of the stress on the fleet because missile defense-capable cruisers and destroyers are multi-mission and are used for other purposes, such as anti-piracy operations, when released from ballistic missile missions by the shore-based systems. The Aegis-Ashore site is meant to protect U.S. European allies and



U.S. forces in Europe from the Iranian ballistic missile threat.

In order to increase the probability of an intercept, the United States has to shoot multiple interceptors at each incoming ballistic missile. At present, because its inventory of ballistic missile defense interceptors is limited, the United States can shoot down only a handful of ballistic missiles that have relatively unsophisticated countermeasures. Different technological solutions will have to be found to address more comprehensive and advanced ballistic missile threats like those from China or Russia.

**Terminal-Phase Interceptors.** The United States currently deploys three terminal-phase missile defense systems: Terminal High Altitude Area Defense (THAAD); Patriot Advanced Capability-3 (PAC-3); and Aegis BMD.

The THAAD system is capable of shooting down short-range and intermediate-range ballistic missiles inside and just outside of the atmosphere.<sup>15</sup> It consists of a launcher, interceptors, AN/TPY-2 radar, and fire control. The system is transportable and rapidly deployable. THAAD batteries have been deployed to such countries as Japan, South Korea, Israel, and the United Arab Emirates. The United States has also been planning to deploy a THAAD battery to Romania in support of NATO ballistic missile defense in the summer of 2019.<sup>16</sup>

The PAC-3 is an air-defense and short-range ballistic missile defense system. A battery is comprised of a launcher, interceptors, AN/MPQ-53/65 radar, an engagement control station, and diesel-powered generator units. The system is transportable, and the United States currently deploys it in several theaters around the world.<sup>17</sup> The system is the most mature of the U.S. missile defense systems.

The predecessor of the PAC-3 system, the Patriot, played a critical role in allied assurance during the First Gulf War when it was deployed to Israel. The purpose was to assure Israeli citizens by protecting them from Iraqi missiles, thereby decreasing the pressure on Israel's government to enter the war against Iraq. The

U.S. sought to prevent Israel from joining the U.S. coalition against Saddam Hussein's forces in Iraq, which would have fractured the Arab coalition.

The Aegis defense system also provides terminal capability against short-range and medium-range ballistic missiles, aerial threats, and cruise missiles, among others.<sup>18</sup>

## Sensors

The space sensor component of the U.S. missile defense system is distributed across three major domains—land, sea, and space—that are meant to provide the U.S. and its allies with the earliest possible warning of a launch of enemy ballistic missiles. Sensors can also provide information about activities preceding the launch itself, but from the intercept perspective, those are less relevant for the missile defense system.

Additionally, new threats are not flying on ballistic (and therefore relatively more predictable) trajectories, and U.S. sensors are not well equipped to handle these developments. Sensors do this by detecting the heat generated by a missile's engine, or booster. They can detect a missile launch, acquire and track a missile in flight, and even classify the type of projectile, its speed, and the target against which the missile has been directed. The sensors relay this information to the command and control stations that operate interceptor systems like Aegis (primarily a sea-based system) or THAAD (a land-based system).

On land, the major sensor installations are the upgraded early warning radars (UEWRs), which are concentrated along the North Atlantic and Pacific corridors that present the most direct flight path for a missile aimed at the U.S. This includes the phased array early warning radars based in California, the United Kingdom, and Greenland that scan objects up to 3,000 miles away.<sup>19</sup> These sensors focus on threats that can be detected starting in the missile's boost or launch phase when the release of exhaust gases creates a heat trail that is "relatively easy for sensors to detect and track."<sup>20</sup>

A shorter-range (2,000-mile) radar is based in Shemya, Alaska. Two additional sites, one in Cape Cod, Massachusetts, and the other in Clear, Alaska, are being modernized for use in the layered ballistic missile defense system.<sup>21</sup>

The other land-based sensors are mobile. These sensors are known as the Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2) and can be forward-deployed for early threat detection or retained closer to the homeland to track missiles in their terminal phase. Of the United States' 12 AN/TPY-2 systems, five are forward-deployed with U.S. allies.<sup>22</sup>

In March 2017, in cooperation with the Republic of Korea, the United States deployed a THAAD missile system to the Korean peninsula. This system was then accompanied in April by an AN/TPY-2. The THAAD deployment was heavily criticized by China for allegedly destabilizing China's nuclear deterrence credibility because the system would allegedly be able to shoot down any Chinese nuclear-tipped missiles after a U.S. first strike.<sup>23</sup> However, the THAAD system deployed in South Korea for the purposes of intercepting North Korean missiles is not set up in a way that could track or shoot down Chinese ICBMs directed toward the United States, which calls into question why China would be so opposed.<sup>24</sup>

There are two types of sea-based sensors. The first is the Sea-Based X-band (SBX) radar mounted on an oil-drilling platform, which can be relocated to different parts of the globe as threats evolve.<sup>25</sup> SBX is used primarily in the Pacific. The second is the SPY-1 radar system that is mounted on all 85 U.S. Navy vessels equipped with the Aegis Combat system, which means they can provide data that can be utilized for ballistic missile missions. Of these 85 ships, 38 are BMD-capable vessels that carry missile defense interceptors.<sup>26</sup>

The final domain in which U.S. missile defense operates is space. In a July 2017 conference call with reporters, the head of U.S. Strategic Command, General John Hyten, stated that space-based sensors are "the most important thing for [the U.S. government] to invest in right

now."<sup>27</sup> Control of the space BMD system is divided between the MDA and the U.S. Air Force. Regrettably, as noted, the Trump Administration largely failed to request funding for a space-based sensor layer in the MDA's FY 2020 budget.

The oldest system that contributes to the missile defense mission is the Defense Support Program (DSP) constellation of satellites, which use infrared sensors to identify heat from booster and missile plumes. The DSP satellite system is set to be replaced by the Space-Based Infrared Radar System (SBIRS) to improve the delivery of missile defense and battlefield intelligence.<sup>28</sup> One of the advantages of SBIRS is its ability to scan a wide swath of territory while simultaneously tracking a specific target, making it a good scanner for observing tactical, or short-range, ballistic missiles.<sup>29</sup> However, congressional funding delays have left SBIRS underfunded and hampered the system's full development and deployment.<sup>30</sup>

Finally, the MDA operates the Space Tracking and Surveillance System-Demonstrators (STSS-D) satellite system. Two STSS-D satellites were launched into orbit in 2009 to track ballistic missiles that exit and reenter the Earth's atmosphere during the midcourse phase.<sup>31</sup> Although still considered an experimental system, STSS-D satellites provide operational surveillance and tracking capabilities and have the advantage of a variable waveband infrared system to maximize their detection capabilities. Data obtained by STSS-D have been used in ballistic missile defense tests.

## Command and Control

The command and control architecture established for the U.S. ballistic missile defense system brings together data from U.S. sensors and relays them to interceptor operators to enable them to destroy incoming missile threats against the U.S. and its allies. The operational hub of missile defense command and control is assigned to the Joint Functional Component Command for Integrated Missile Defense (JFCC IMD) housed at Schriever Air Force Base, Colorado.

Under the jurisdiction of U.S. Strategic Command, JFCC IMD brings together Army, Navy, Marine Corps, and Air Force personnel. It is co-located with the MDA's Missile Defense Integration and Operation Center (MDIOC). This concentration of leadership from across the various agencies helps to streamline decision-making for those who command and operate the U.S. missile defense system.<sup>32</sup>

Command and control operates through a series of data collection and communication relay nodes between military operators, sensors, radars, and missile interceptors. The first step is the Ground-based Midcourse Defense Fire Control (GFC) process, which involves assimilating data on missile movement from the United States' global network of sensors.

Missile tracking data travel through the Defense Satellite Communications System (DSCS), which is operated from Fort Greeley, Alaska, and Vandenberg Air Force Base, or through ground-based redundant communication lines to the Command Launch Equipment (CLE) software that develops fire response options, telling interceptors where and when to fire. Once U.S. Strategic Command, in consultation with the President, has determined the most effective response to a missile threat, the CLE fire response option is relayed to the appropriate ground-based interceptors in the field. When the selected missiles have been fired, they maintain contact with an In-Flight Interceptor Communications System (IFICS) Data Terminal (IDT) to receive updated flight correction guidance to ensure that they hit their target.<sup>33</sup>

Overlaying the command and control operation is the Command and Control, Battle Management and Communication (C2BMC) program. Through its software and network systems, C2BMC feeds information to and synchronizes coordination between the multiple layers of the ballistic missile defense system.<sup>34</sup> More than 70 C2BMC workstations are distributed throughout the world at U.S. military bases.<sup>35</sup> C2BMC has undergone multiple technical upgrades since 2004.

## Conclusion

By successive choices of post-Cold War Administrations and Congresses, the United States does not have in place a comprehensive set of missile defense systems that would be capable of defending the homeland and allies from robust ballistic missile threats. U.S. efforts have focused on a limited architecture protecting the homeland and on deploying and advancing regional missile defense systems.

The pace of the development of missile threats, both qualitative and quantitative, outpaces the speed of missile defense research, development, and deployment. To make matters worse, the United States has not invested sufficiently in future ballistic missile defense technologies, has canceled future missile defense programs like the Airborne Laser and the Multiple Kill Vehicle, and has never invested in space-based interceptors that would make U.S. defenses more robust and comprehensive.

## Endnotes

1. Following missile threat developments, Congress mandated that the Trump Administration conduct a review of missile threats to the U.S. and its interests, as opposed to the Obama Administration's mandate to focus on ballistic missiles only. This section of the *Index* has been updated to reflect these developments.
2. U.S. Air Force, National Air and Space Intelligence Center (NASIC), and Defense Intelligence Ballistic Missile Analysis Committee (DIBMAC), *2017 Ballistic and Cruise Missile Threat*, NASIC-1031-0985-17, June 2017, pp. 38–39, [http://www.nasic.af.mil/Portals/19/images/Fact%20Sheet%20Images/2017%20Ballistic%20and%20Cruise%20Missile%20Threat\\_Final\\_small.pdf?ver=2017-07-21-083234-343](http://www.nasic.af.mil/Portals/19/images/Fact%20Sheet%20Images/2017%20Ballistic%20and%20Cruise%20Missile%20Threat_Final_small.pdf?ver=2017-07-21-083234-343) (accessed August 25, 2019).
3. John Rood, Undersecretary of Defense for Policy, statement on missile defense policy, posture, and budget before the Subcommittee on Strategic Forces, Committee on Armed Services, U.S. Senate, April 3, 2019, p. 1, <https://www.armed-services.senate.gov/hearings/19-04-03-missile-defense-policies-and-programs> (accessed August 23, 2019).
4. “Moreover, these potentially peer strategic competitors [Russia and China] are ‘root sources’ for enabling rogue states and non-state armed groups that are developing asymmetrical strategies and capabilities to employ cyber and EMP attacks to disrupt or destroy critically important space systems and essential civil infrastructure, such as electric power grids, communication, financial, transportation, and food distribution systems—as well as key military systems. Such an attack would represent the ultimate asymmetrical act by a smaller state or terrorists against the United States.” Henry F. Cooper, Malcolm R. O'Neill, Robert L. Pfaltzgraff, Jr., and Rowland H. Worrell, “Missile Defense: Challenges and Opportunities for the Trump Administration,” Institute for Foreign Policy Analysis, Independent Working Group on Missile Defense *White Paper*, 2016, pp. 12–13, <http://www.ifpa.org/pdf/IWGWhitePaper16.pdf> (accessed August 24, 2019).
5. The platform carrying air-launched ballistic missile interceptors has to be close to the launch area, aloft, oriented in a proper way, and generally within the range of enemies' anti-access/area-denial systems because of payload limits on airborne platforms themselves. These requirements make airborne intercepts particularly challenging.
6. Ronald Reagan, “Address to the Nation on National Security,” March 23, 1983, <https://millercenter.org/the-presidency/presidential-speeches/march-23-1983-address-nation-national-security> (accessed August 24, 2019).
7. For example, SDI Organization investment contributed to making certain electronic and optical components cheaper and more effective. It helped to reduce the cost per pixel on a display screen by a factor of 20. Additional advances were made in areas of sensor technology, communications, and computers. For more information, see James A. Abrahamson and Henry F. Cooper, *What Did We Get for Our \$30-Billion Investment in SDI/BMD?* National Institute for Public Policy, September 1993, pp. 9–11, [http://www.nipp.org/wp-content/uploads/2014/11/What-for-30B\\_.pdf](http://www.nipp.org/wp-content/uploads/2014/11/What-for-30B_.pdf) (accessed August 24, 2019).
8. National Defense Authorization Act for Fiscal Year 2017, Public Law 114–328, 114th Cong., December 23, 2016, <https://www.congress.gov/114/plaws/publ328/PLAW-114publ328.pdf> (accessed August 24, 2019). The understanding of the word “limited” itself changed over time, from scaling a missile defense system to shoot down about 200 reentry vehicles right after the end of the Cold War (because that is how many a rogue Soviet commander was believed to be able to launch from a submarine) to only a handful of relatively less sophisticated North Korean or Iranian ballistic missiles. For more information, see Independent Working Group on Missile Defense, the Space Relationship, and the Twenty-First Century, *2009 Report*, Institute for Foreign Policy Research and Analysis, 2009, p. 17, <http://www.ifpa.org/pdf/IWG2009.pdf> (accessed August 24, 2019).
9. National Missile Defense Act of 1999, Public Law 106–38, 106th Cong., July 22, 1999, <https://www.congress.gov/106/plaws/publ38/PLAW-106publ38.pdf> (accessed August 25, 2019).
10. U.S. Department of Defense, Missile Defense Agency, *2019 Missile Defense Review*, p. VII, [https://www.defense.gov/Portals/1/Interactive/2018/11-2019-Missile-Defense-Review/The%202019%20MDR\\_Executive%20Summary.pdf](https://www.defense.gov/Portals/1/Interactive/2018/11-2019-Missile-Defense-Review/The%202019%20MDR_Executive%20Summary.pdf) (accessed August 25, 2019).
11. U.S. Department of Defense, Missile Defense Agency, *Missile Defense Agency Fiscal Year (FY) 2020 Budget Estimates: Overview*, approved for public release March 7, 2019, p. 2, <https://www.mda.mil/global/documents/pdf/budgetfy20.pdf> (accessed August 24, 2019).
12. See Chapter 4, “Comparison of Utility, Maturity, and Cost-Effectiveness,” in National Research Council of the National Academies, Committee on an Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives, Division on Engineering and Physical Sciences, *Making Sense of Ballistic Missile Defense: An Assessment of Concepts and Systems for U.S. Boost-Phase Missile Defense in Comparison to Other Alternatives* (Washington: National Academies Press, 2012), pp. 107–129, <https://www.nap.edu/read/13189/chapter/6> (accessed August 25, 2019).
13. U.S. Department of Defense, Missile Defense Agency, *2019 Missile Defense Review*, pp. XIII–XIV.
14. Ronald O'Rourke, “Navy Aegis Ballistic Missile Defense (BMD) Program: Background and Issues for Congress,” Congressional Research Service *Report for Members and Committees of Congress*, updated July 24, 2019, p. 7, <https://crsreports.congress.gov/product/pdf/RL/RL33745> (accessed August 24, 2019).

15. Fact Sheet, "Terminal High Altitude Area Defense," U.S. Department of Defense, Missile Defense Agency, approved for public release September 24, 2018, <https://www.mda.mil/global/documents/pdf/thaad.pdf> (accessed August 24, 2019), and Phil Stewart and Idrees Ali, "U.S. THAAD Missile Defenses Hit Test Target as North Korea Tension Rises," Reuters, July 11, 2017, <https://www.reuters.com/article/us-northkorea-missiles-usa-defenses/u-s-thaad-missile-defenses-hit-test-target-as-north-korea-tension-rises-idUSKBN19W15R> (accessed August 24, 2019).
16. David Axe, "Russia Won't Like This: THAAD Missile Defense System Headed to Europe," *The National Interest*, April 14, 2019, <https://nationalinterest.org/blog/buzz/russia-wont-thaad-missile-defense-system-headed-europe-52437> (accessed August 24, 2019).
17. Fact Sheet, "Patriot Advanced Capability-3," U.S. Department of Defense, Missile Defense Agency, approved for public release July 18, 2016, <https://www.mda.mil/global/documents/pdf/pac3.pdf> (accessed August 24, 2019).
18. Fact Sheet, "Aegis Ballistic Missile Defense," U.S. Department of Defense, Missile Defense Agency, approved for public release July 28, 2016, <https://www.mda.mil/global/documents/pdf/aegis.pdf> (accessed August 24, 2019).
19. Fact Sheet, "Upgraded Early Warning Radars, AN/FPS-132," U.S. Department of Defense, Missile Defense Agency, approved for public release July 28, 2016, <https://www.mda.mil/global/documents/pdf/uewr1.pdf> (accessed August 24, 2019).
20. Cooper, O'Neill, Pfaltzgraff, and Worrell, "Missile Defense: Challenges and Opportunities for the Trump Administration," p. 23, note 47.
21. Fact Sheet, "Cobra Dane," U.S. Department of Defense, Missile Defense Agency, approved for public release July 28, 2016, <https://www.mda.mil/global/documents/pdf/cobradane.pdf> (accessed August 24, 2019).
22. Fact Sheet, "Army Navy/Transportable Radar Surveillance (AN/TYP-2)," approved for public release July 28, 2016, [https://www.mda.mil/global/documents/pdf/an\\_tpy2.pdf](https://www.mda.mil/global/documents/pdf/an_tpy2.pdf) (accessed August 24, 2019).
23. Ankit Panda, "THAAD and China's Nuclear Second-Strike Capability," *The Diplomat*, March 8, 2017, <https://thediplomat.com/2017/03/thaad-and-chinas-nuclear-second-strike-capability/> (accessed August 24, 2019).
24. Bruce Klingner, "South Korea Needs THAAD Missile Defense," Heritage Foundation *Backgrounder* No. 3024, June 12, 2015, <http://www.heritage.org/defense/report/south-korea-needs-thaad-missile-defense>.
25. Fact Sheet, "Sea-Based X-Band Radar," U.S. Department of Defense, Missile Defense Agency, approved for public release February 1, 2018, <https://www.mda.mil/global/documents/pdf/sbx.pdf> (accessed August 24, 2019).
26. Thomas Karako, Ian Williams, and Wes Rumbaugh, *Missile Defense 2020: Next Steps for Defending the Homeland*, Center for Strategic and International Studies, Missile Defense Project, April 2017, [https://missilethreat.csis.org/wp-content/uploads/2017/04/170406\\_Karako\\_MissileDefense2020\\_Web.pdf](https://missilethreat.csis.org/wp-content/uploads/2017/04/170406_Karako_MissileDefense2020_Web.pdf) (accessed August 24, 2019); Fact Sheet, "Aegis Ballistic Missile Defense," and Missile Defense Advocacy Alliance, "AN/SPY-1 Radar," <http://missiledefenseadvocacy.org/missile-defense-systems-2/missile-defense-systems/u-s-deployed-sensor-systems/anspy-1-radar/> (accessed August 24, 2019).
27. Wilson Brissett, "U.S. Missile Defense Needs Space-Based Sensors, Hyten Says," *Air Force Magazine*, July 27, 2017, <http://www.airforcemag.com/Features/Pages/2017/July%202017/US-Missile-Defense-Needs-Space-Based-Sensors-Hyten-Says.aspx> (accessed August 24, 2019).
28. U.S. Air Force, Air Force Space Command, "Space Based Infrared System," published March 22, 2017, current as of April 2019, <http://www.afspc.af.mil/About-Us/Fact-Sheets/Display/Article/1012596/space-based-infrared-system/> (accessed on August 24, 2019).
29. Center for Strategic and International Studies, Missile Defense Project, "Space-based Infrared System (SBIRS)," last updated June 15, 2018, <https://missilethreat.csis.org/defsys/sbirs/> (accessed August 24, 2019).
30. Sandra Erwin, "Production of New Missile Warning Satellites Likely Delayed by Budget Impasse," *SpaceNews*, October 20, 2017, <http://spacenews.com/production-of-new-missile-warning-satellites-likely-delayed-by-budget-impasse/> (accessed August 24, 2019).
31. Fact Sheet, "Space Tracking and Surveillance System," U.S. Department of Defense, Missile Defense Agency, approved for public release March 27, 2017, <https://www.mda.mil/global/documents/pdf/stss.pdf> (accessed August 24, 2019).
32. U.S. Strategic Command, "Joint Functional Component Command for Integrated Missile Defense (JFCC IMD)," current as of February 2016, <http://www.stratcom.mil/Portals/8/Documents/JFCC%20IMD%20Fact%20Sheet.pdf> (accessed August 24, 2019).
33. Karako, Williams, and Rumbaugh, *Missile Defense 2020: Next Steps for Defending the Homeland*, pp. 101-103.
34. Fact Sheet, "Command and Control, Battle Management, and Communications," U.S. Department of Defense, Missile Defense Agency, approved for public release July 28, 2016, <https://www.mda.mil/global/documents/pdf/c2bmc.pdf> (accessed August 24, 2019).
35. "C2BMC: Putting the 'System' in Ballistic Missile Defense," *Defense Industry Daily*, May 11, 2017, <https://www.defenseindustrydaily.com/c2bmc-putting-the-system-in-ballistic-missile-defense-06323/> (accessed August 24, 2019).





# Conclusion: U.S. Military Power

The Active Component of the U.S. military is two-thirds the size it should be, operates equipment that is older than should be the case, and is burdened by readiness levels that are problematic. Accordingly, this *Index* assesses the:

- **Army as “Marginal.”** The Army’s score remains “marginal” in the *2020 Index*. The Army has continued to increase its readiness, earning the score of “very strong” with 77 percent of its brigade combat teams assessed as ready. However, it continues to struggle to rebuild end strength and modernization for improved readiness in some units for current operations.
- **Navy as “Marginal.”** The Navy’s overall score remains “marginal” in the *2020 Index*. The Navy’s emphasis on restoring readiness and increasing its capacity signals that its overall score could improve in the near future if needed levels of funding are sustained. However, manpower presents a potential problem as the Navy looks to increase the size of the fleet.
- **Air Force as “Marginal.”** This score has trended downward over the past few years largely because of a drop in “capacity” that has not effectively changed and a readiness score of “weak.” Shortages of pilots and flying time have degraded the ability of the Air Force to generate the air power that would be needed to meet wartime requirements.
- **Marine Corps as “Marginal.”** The Marine Corps has improved from “weak” to “marginal” in the *2020 Index*. This change is based on an improvement in readiness following increased investment of funds and focus on high-end warfare. Capacity issues remain an issue because the force still falls well below the recommended number of battalions.
- **Nuclear Capabilities as “Marginal.”** The U.S. nuclear complex is “trending toward strong,” but this assumes that the U.S. maintains its commitment to modernization and allocates needed resources accordingly. Although bipartisan attention has led to continued progress on U.S. nuclear forces modernization and warhead sustainment, these programs remain threatened by potential future fiscal uncertainties, as do the infrastructure, testing regime, and manpower pool on which the nuclear enterprise depends.

**In the aggregate, the United States’ military posture is rated “marginal.” The *2020 Index* concludes that the current U.S. military force is likely capable of meeting the demands of a single major regional conflict** while also attending to various presence and engagement activities but that it would be very hard-pressed to do more and certainly would be ill-equipped to handle two nearly simultaneous major regional contingencies (MRCs).

The military services have prioritized readiness and have seen improvement over the

past couple of years. However, modernization programs continue to suffer as resources are redirected toward current operations and sustainment of readiness levels. The services have also normalized the reduction in size and number of military units, and the forces remain well below the level they need to meet the two-MRC benchmark.

Congress and the Administration took positive steps to stabilize funding for FY 2018 and FY 2019 through the Bipartisan

Budget Agreement of 2018 and, through the Bipartisan Budget Act of 2019, managed to sustain such support for funding above the caps imposed by the Budget Control Act of 2011 (BCA). While this allays the most serious concerns about a return to the damaging levels of the BCA, more will be needed in the years to come to ensure that the U.S. military is properly sized, equipped, trained, and ready to meet the missions that the services are called upon to fulfill.

### U.S. Military Power: Army

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness					✓
<b>OVERALL</b>			✓		

### U.S. Military Power: Navy

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness			✓		
<b>OVERALL</b>			✓		

### U.S. Military Power: Air Force

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity			✓		
Capability			✓		
Readiness			✓		
<b>OVERALL</b>			✓		

## U.S. Military Power: Marine Corps

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Capacity		✓			
Capability			✓		
Readiness			✓		
<b>OVERALL</b>			✓		

## U.S. Military Power: Nuclear

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Nuclear Stockpile				✓	
Delivery Platform Reliability			✓		
Warhead Modernization			✓		
Delivery Systems Modernization				✓	
Nuclear Weapons Complex			✓		
National Labs Talent			✓		
Force Readiness				✓	
Allied Assurance				✓	
Nuclear Test Readiness		✓			
<b>OVERALL</b>			✓		

## U.S. Military Power

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Army			✓		
Navy			✓		
Air Force			✓		
Marine Corps			✓		
Nuclear			✓		
<b>OVERALL</b>			✓		