U.S. Military Power

An Assessment of U.S. Military Power

America is a global power with global interests. Its military is meant first and foremost to defend America from attack. Beyond that, it is meant to protect 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 preventing the destabilization of a region and guarding against threats to the peace and security of America's friends.

As noted in the four 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 ill-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 the conditions of the 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 bear upon 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. Regardless of the difficulty of determining the adequacy of one's military forces, 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 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."[1]

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."[2] 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.[3] 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.[4]

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.

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 increasingly means 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 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 instead of focusing primarily on how many ships or airplanes the enemy can bring to bear against one's own force.[5]

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 with fewer assets than ever before.

- 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 be that the outcomes of future wars will depend on the skill of the forces and their capacity to sustain operations over time far more than it depends 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*, on military capabilities, 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 over 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 utilized 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 references 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), while the Marine Corps structures itself by battalions. For the Navy, it is the number of ships in its combat fleet, and the most consistent reference 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 surrogate measures 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 likely 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.

This assessment also does not assess the Reserve and National Guard components of the services, although they account for roughly one-third of the U.S. military force[6] 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 between the elements, and political considerations.[7]

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 bound the challenge of annually assessing the status of U.S. military strength using consistent metrics over time, this *Index* looks at the baseline requirement for a given amount of combat power that is readily available for use in a major combat operation, something that is usually associated with the Active components of each service. 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 the prioritization of federal spending.

Absent a significant threat to the survival of the country, the U.S. government will always balance expenditures on defense with spending in all of the other areas of government activity that are deemed necessary or desirable. Some have argued that a defense budget indexed to a percent of gross domestic product (GDP) is a reasonable reference. However, a fixed percentage of GDP does not accurately reflect national security requirements *per se* any more than the size of the budget alone correlates to levels of capability. Additionally, the fact that the economy changes over time does not necessarily mean that defense spending should increase or decrease in lockstep by default.

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 (DOD) is the department's current effort to establish the connection among interests, threats, requirements, and resources.[8] It serves to orient how DOD intends to prepare the country's defense and, importantly, 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).

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) 2018 base discretionary budget for defense was $629 billion.[9] 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 over how much funding to allocate 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 was determined once again by larger political dynamics that pitted those who wanted 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.

FY 2018 was marred from the beginning by multiple continuing resolutions (CRs) that temporarily funded the federal government and the Department of Defense at roughly FY 2017 levels. This funding mechanism is inherently inefficient and often wasteful because of the limitations it places on how funds can be used and the start-and-stop disruption that CRs introduce into defense planning and program execution.[10] Passage of the Bipartisan Budget Act of 2018 (BBA) in early February 2018 brought CR volatility to an end and raised the BCA caps for FY 2018 and FY 2019.[11] 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 DOD and, given its two-year coverage, a modicum of stability.

Unfortunately, because the legislation did not alter the caps for 2020 and 2021, the restrictions placed on defense spending by the BCA continue to be a major concern of the military service chiefs, who have testified consistently about the damage these restrictions are causing to readiness, modernization, and capacity for operations.

In testimony before the House Armed Services Committee, for example, 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.[12] "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."[13] The BCA limits the increases to little over inflation, and the current budget request projects increases that are slightly below the inflationary rate.[14]

President Barack Obama's 2012 defense budget, the last sent to Congress before passage of the BCA, proposed $673 billion in defense spending for FY 2019, $26 billion more than the temporary increase provided by the 2018 BBA. A bipartisan consensus, as seen in the National Defense Panel report in 2014, identified the so-called Gates budget (named after then-Secretary of Defense Robert Gates) as the "minimal baseline for appropriate defense spending in the future."[15] It recommended a topline of $661 billion for 2018 and $673 billion for 2019, $32 billion and $26 billion more than the 2018 BBA, respectively. As seen in Chart 9, despite consistent pushes toward a higher topline, the current and projected defense budget still trails this minimum.

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 15–20 years between occurrences.[16] 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.

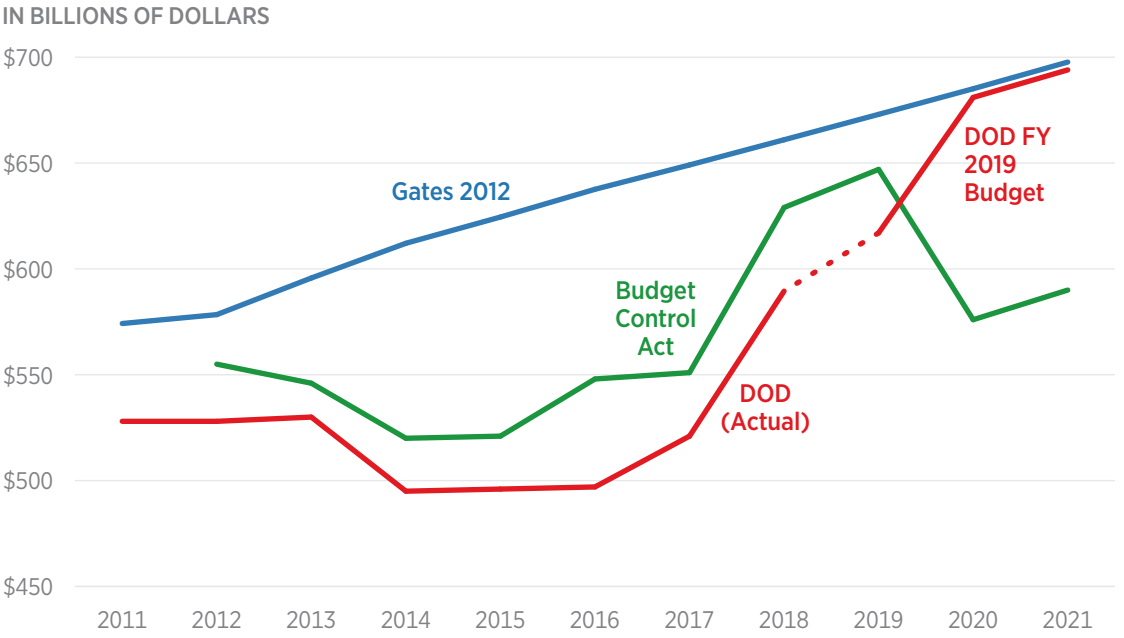
The U.S. Unified Geographic Combatant Commands, or COCOMS—Northern Command (NORTHCOM); European Command (EUCOM); Central Command (CENTCOM); Indo-Pacific Command (INDOPACOM); Southern Command (SOUTHCOM); and Africa Command (AFRICOM)—all have annual and long-term plans through which they engage with countries 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

CHART 9

Defense Spending to Receive Long-Overdue Boost

Long hindered by the Budget Control Act, defense spending is projected to approach levels requested by former Secretary of Defense Robert Gates back in 2012.



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services must maintain a base force that is sufficiently large to train, deploy, support, receive back, and make ready again 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 a healthy home and family life. This ensures that units are fully prepared for the next deployment cycle and that servicemembers 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.
- **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 due to 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 military affairs for 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.

- 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 at the "pointy end of the spear" 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-day "major combat operation"[17] 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.

During 2018, the military community reenergized its debate over 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.[18] 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 addressing 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), 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.

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 (for Navy ships in particular); 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 the U.S. Army commits 21 BCTs on average 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.

Again, this *Index* assesses only the Active component of the services, 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

TABLE 5

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
ARMY									
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
NAVY									
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
MARINE CORPS									
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
AIR FORCE									
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

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,[19] 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 5. 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.[20] 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 and a higher topline in FY 2018 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 could threaten to undo these gains, readiness reporting has been largely optimistic compared to recent years. For example:

- Secretary of the Army Mark T. Esper testified in March 2018 that FY 2017 and FY 2018 appropriations funded additional manning requirements and combat training center rotations. "As a result, the number of brigade combat teams (BCTs) in the highest state of personnel readiness has more than doubled."[21]
- In April 2018, Secretary of the Air Force Heather A. Wilson testified that in 2017, the Air Force "started to turn the corner" and that "additional resources added by the Congress in fiscal year 2018 are helping us to start to climb out of a readiness deficit...."[22]
- Admiral John Richardson, Chief of Naval Operations, reported similar trends, testifying in March 2018 that "[i]n FY17 [the Navy] arrested readiness decline with the Request for Additional Appropriations, and the FY18 and FY19 budget requests further restore readiness while beginning to increase warfighting capacity and capability."[23]
- General Robert Neller, Commandant of the Marine Corps, agreed in April 2018 that additional appropriations for readiness in FY 2017 "provided the investment needed to arrest this decline, and the PB18 and PB19 budget submissions provide the resources needed to accelerate our readiness recovery."[24]

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 over time and many battles against an enemy, especially when attrition or dispersed operations are significant factors. But sufficient numbers of the right capabilities are rather meaningless if the force is unready to engage in the task.

U.S. Military Power: Five-Grade Scale

VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG

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, since simple numbers do not tell the whole story.

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 deployment/employment patterns 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 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.

U.S. Military Power

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Army			✓		
Navy			✓		
Air Force			✓		
Marine Corps		✓			
Nuclear			✓		
OVERALL			✓		

Endnotes

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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 Man-aging 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 (accessed August 1, 2017).
5. 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).
6. For a complete discussion of this force, see Richard J. Dunn III, "America's Reserve and National Guard Components: Key Contributors to U.S. Military Strength," 2016 Index of U.S. Military Strength (Washington: The Heritage Foundation, 2015), pp. 61–73, 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.
7. 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, a plan that the Guard has contended 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, April 27, 2015, http://www.gao.gov/assets/670/669857.pdf (accessed August 6, 2018).
8. 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 August 6, 2018).
9. H.R. 1892, 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 (accessed August 6, 2018).
10. 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.
11. 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 August 6, 2018).
12. 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 August 6, 2018).
13. 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 July 24, 2017). Emphasis added.
14. For future year projections, see 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, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/FY2019_Budget_Request_Overview_Book.pdf (accessed August 13, 2018); for future inflationary rate, see U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2019*, April 2018, https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2019/FY19_Green_Book.pdf (accessed August 13, 2018).

15. See *Ensuring a Strong U.S. Defense for the Future: The National Defense Panel Review of the 2014 Quadrennial Defense Review*, Advance Copy, U.S. Institute of Peace, released July 31, 2014, p. 4, http://www.usip.org/sites/default/files/Ensuring-a-Strong-U.S.-Defense-for-the-Future-NDP-Review-of-the-QDR_0.pdf (accessed August 6, 2018).
16. 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).
17. 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.
18. Mattis, *Summary of the 2018 National Defense Strategy of the United States of America*, p. 4.
19. 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.
20. 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 August 6, 2018), 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 July 31, 2017).
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22. Testimony of The Honorable Heather A. Wilson, Secretary of the Air Force, in stenographic transcript of *Hearing to Receive Testimony on the Posture of the Department of the Air Force in Review of the Defense Authorization Request for Fiscal Year 2019 and The Future Years Defense Program*, Committee on Armed Services, U.S. Senate, April 24, 2018, p. 9, https://www.armed-services.senate.gov/imo/media/doc/18-43_04-24-18.pdf (accessed August 6, 2018).
23. Admiral John Richardson, Chief of Naval Operations, statement on "Fiscal Year 2019 Navy Budget" before the Subcommittee on Defense, Committee on Appropriations, U.S. House of Representatives, March 7, 2018, p. 2, http://www.navy.mil/navydata/people/cno/Richardson/Speech/07MAR18_HAC-D_FY19_DON_Posture.pdf (accessed July 12, 2018).
24. General 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. 12, https://www.armed-services.senate.gov/imo/media/doc/Neller_04-19-18.pdf (accessed August 6, 2018).

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.

Secretary of Defense James Mattis has warned that a decade of combat operations and a lack of reliable and predictable funds have left the U.S. military in "a position where we are losing or eroding our competitive edge."[1] Fiscal challenges have similarly strained the ability of the Army to meet the national security requirements outlined in the Defense Planning Guidance as it works to balance readiness, modernization, and end strength.

Secretary of the Army Mark Esper and Army Chief of Staff General Mark Milley have testified that "strong support" from Congress "has enabled the Army to halt the decline in our warfighting readiness,"[2] but despite the inclusion of additional Army end strength in the 2018 National Defense Authorization Act (NDAA) and increased funding in the omnibus Consolidated Appropriations Act, 2018, issues of inadequate size, readiness, modernization, and high operational tempo remain to be addressed.

- General Milley has testified that the Army is too small and needs to grow to "north of 500,000...in the regular Army" to accomplish the missions outlined in the National Security and Defense Strategies.[3]

- Secretary Esper and General Milley have further testified that the Army "can no longer afford to delay modernization without risking overmatch on future battlefields."[4]

- Although the Army's internal goal is to have 66 percent of its brigade combat teams considered ready at any given time, the number considered ready today is only "in the range of the 50 percent mark."[5] (This is an improvement over 2017 when only one-third were considered ready.[6])

- Of the 15 of 31 Active BCTs considered "ready," only eight are considered "fully ready,"[7] which limits options for the President. According to Vice Chief of Staff General Daniel Allyn, the Army considers a unit fully ready if it "needs no additional people, no additional training, and no additional equipment."[8]

In fiscal year (FY) 2018, the Army's authorized active-duty end strength was 483,500, down from 566,000 as recently as FY 2011.[9] The Obama Administration had planned to cut Active Army end strength further still to 450,000 by 2018,[10] but President Trump's election forestalled those cuts. Although the Bipartisan Budget Act of 2018 has provided a period of stability in 2018–2019 for the Department of Defense (DOD), unless Congress acts, the return of the Budget Control Act (BCA) in 2020 and beyond will serve to reverse recent hard-fought gains in readiness.[11] Army leaders have testified that if BCA-mandated budget caps return in FY 2020, the Army will be able to conduct at best platoon-level training and

that "squad and platoon training an Army does not make."[12]

Operationally, the Army has approximately 178,000 soldiers forward stationed across 140 countries. Of the total number of U.S. forces deployed globally, according to Army Deputy Chief of Staff Lieutenant General Joseph Anderson, "[t]he U.S. Army currently fills 50 percent of Combatant Command base force demand and 70 percent of emergent force demand,"[13] which highlights the oversized role that the Army plays in the nation's defense.

Capacity

The 2018 NDAA increased Army authorized end strength to 1,026,500 soldiers: 483,500 in the Regular Army, 199,500 in the Army Reserve, and 343,500 in the Army National Guard, reversing years of reductions.[14] As noted, General Milley has testified that the Army is too small for the missions it has been assigned and that the Army is "shooting to get north of 500,000...in the regular Army."[15] He has previously testified that he believes that the Active Army should number from 540,000 to 550,000, the Army National Guard from 350,000 to 355,000, and the Army Reserve from 205,000 to 209,000.[16]

The Army normally refers to its 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.[17] 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 principally employ the M1 Abrams main battle tank and the M2 Bradley fighting vehicle. An Infantry BCT is a highly maneuverable motorized unit. Variants of the Infantry BCT are the Airmobile BCT (optimized for helicopter assault) and the Airborne BCT (optimized for parachute forcible entry operations).

The Army also has a separate air component organized into combat aviation brigades (CABs), which can operate independently.[18] CABs are made up of Army rotorcraft, such as the AH-64 Apache, and perform various roles including attack, reconnaissance, and lift.

CABs and Stryker, Infantry, and Armored BCTs make up the Army's main combat forces, but they do not make up 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."[19] 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[20]) 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.

While end strength is a valuable metric in understanding Army capacity, the number of BCTs is a more telling measure of actual hard power. In preparation for the reduction of its end strength to 460,000, the planned level for FY 2017,[21] the Active Army underwent brigade restructuring that decreased the number of BCTs from 38 to 31. When Congress reversed the reduction in end strength and authorized growth starting in 2017 and reaching an active-duty level of 483,500 for 2018, 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.[22] The Army recently reported that 21 of its 31 BCTs are now manned at 100 percent.[23]

The 2015 NDAA established a National Commission on the Future of the Army to conduct a comprehensive study of Army structure. To meet the threat posed by a resurgent Russia and others, the commission recommended that the Army increase its numbers of Armored BCTs.[24] The Army converted one Infantry BCT to Armored in 2018, and the FY 2019 budget supports the conversion of another Infantry BCT to Armored, marking the creation of the Army's 16th Armored BCT.[25]

In 2017, in a major initiative personally 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.[26] The Army activated its second SFAB in January 2018 at Fort Bragg, North Carolina. It also plans to activate a third Regular Army and first National Guard unit later in 2018 and the final two SFABs in 2019. The first SFAB is currently in Afghanistan.[27]

The number of Army aviation units also has been reduced. In May 2015, the Army deactivated one of its 12 Combat Aviation Brigades (CABs),[28] leaving only 11 in the Regular Army.[29]

The reductions in end strength since 2011 have had a disproportionate effect on BCTs. Authorized end strength for the Active Army has decreased from 45 BCTs (552,100 soldiers) in FY 2013 to 31 BCTs (483,500 soldiers) in FY 2019.[30] Put another way, a 14 percent reduction in troop numbers has led to a 31 percent reduction in BCTs.

In addition to the increased strategic risk, the result of fewer BCTs and a reduced Army end strength, combined with an undiminished daily global demand, has been a sustained level of operational tempo (OPTEMPO). Despite a reduction in large unit deployments, particularly to Iraq and Afghanistan, Army units continue to experience sustained demand. General Robert Abrams, Commander of Army Forces Command, recently put it bluntly: "[T]he deployment tempo has not slowed down." Recent Army Forces Command data reflect that division headquarters are deploying every 14 to 16 months, Armored Brigade Combat Teams every 15 months, and Stryker and Infantry BCTs every 12–14 months.[31]

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 whether the rotational BCT or the forward-stationed BCT represents the best option. Proponents of rotational BCTs argue that the BCTs 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.[32]

In the past 24 months, the Army has made a deliberate decision to increase the integration and readiness of select Army National Guard and Reserve formations so that they can be employed more easily when needed. In March 2016, the Army initiated an Associated Units pilot program to link select Regular Army and Reserve component units. As one such example, Georgia's National Guard 48th Infantry BCT was associated with the Regular Army's 3rd Infantry Division at Fort Stewart, Georgia. Twenty-seven units across the country are participating in the pilot program, which will be evaluated in March 2019 to determine whether it should be made permanent.[33]

Additionally, the Army is resourcing select Army National Guard 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 is implementing a multi-year training cycle to build

readiness over time. As part of this concept, the Army has increased the number of Army Reserve/National Guard (ARNG) BCTs participating in a Combat Training Center (CTC) rotation from two to four starting in FY 2019.[34]

As a result of this change in strategy and the increased investment in the National Guard, the 2019 *Index of U.S. Military Strength* counts four ARNG BCTs in the overall Army BCT capacity count, reflecting 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'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.[35] Also in Armored BCTs, the venerable M113 personnel carrier is scheduled to be replaced by the new Armored Multi-Purpose Vehicle (AMPV), which is entering its late testing phase.[36] Stryker BCTs are equipped with Stryker vehicles. In response to an Operational Needs Statement, the Stryker BCT in Europe is receiving Strykers fitted with a 30mm cannon to provide an improved anti-armor capability. Fielding began in 2017.[37] Infantry BCTs have fewer vehicles and rely on lighter platforms such as trucks and High Mobility Multipurpose Wheeled Vehicles (HMMWVs) for mobility. Airborne BCTs are scheduled to receive a new platform, the Ground Mobility Vehicle (GMV), starting in 2019 to increase their speed and mobility.[38] 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 the service life of both vehicles beyond FY 2028.[39] While the current equipment is well maintained and has received several incremental upgrades, Abrams and Bradley fighting vehicles first entered service in the early 1980s, making them 38 years old in many cases.

The Army has also been methodically upgrading the oldest variants of its rotorcraft. Today, the UH-60M, the newest version of the UH-60, makes up 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."[40] Despite major plus-ups to Army procurement in 2019, the 2019 budget request for aircraft procurement, at $2.8 billion,[41] is $172 million less than the FY 2018 President's budget, reflecting that the Army has beefed up procurement programs other than aviation.

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 due to 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. Army leaders have testified that "a combination of strategic, technological, institutional, and budgetary trends places at risk the Army's

competitive edge over near-peer competitors in the next fight."[42]

Secretary of the Army Mark 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.[43] Additionally, the Army has established eight cross-functional teams (CFTs) to better manage its top modernization priorities.[44] Army leadership, in particular the Under Secretary and Vice Chief of Staff of the Army, are said to be 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. When asked to summarize the situation with respect to Army modernization in November 2016, Major General Eric Wesley, Commanding General, U.S. Army Maneuver Center of Excellence, repeated an assessment that "of 10 major capabilities that we use for warfighting, by the year 2030, Russia will have exceeded our capacity in six, we will have parity in three, and the United States will dominate in one."[45] This assessment has not materially changed since then.

The anemic nature of the Army's modernization program is best illustrated by the fact that its highest-profile Major Defense Acquisition Program (MDAP) is a *truck* program, the Joint Light Tactical Vehicle (JLTV). Intended to combine the protection offered by Mine Resistant Ambush Protected Vehicles (MRAPs) with the mobility of the original unarmored HMMWV, the JLTV is a follow-on to the HMMWV (also known as the Humvee) and features design improvements that will increase its survivability against anti-armor weapons and improvised explosive devices (IEDs). The Army plans to procure 49,099 vehicles over the life of the program, replacing only a portion of the current HMMWV fleet. The program is heavily focused on vehicle survivability and is not intended as a one-for-one replacement of the HMMWV. In fact, the JLTV is intended to take on high-risk missions traditionally tasked to the HMMWV, to include scouting and troop transport in adverse environments, guerrilla ambushes, and artillery bombardment.[46]

FY 2019 Base Procurement of $1.3 billion supports 3,390 JLTVs of various configurations to fulfill the requirements of multiple mission roles and minimize ownership costs for the Army's Light Tactical Vehicle fleet.[47]

Other notable Army procurements requested in the FY 2019 budget include the M1A2 Abrams SEPv3 upgrade (135); M2 Bradley modifications (210); M109A6 Paladin 155mm Howitzers (Paladin Integrated Management) (36); and munitions including the Guided Multiple Launch Rocket System (GMLRS) (9,450) and a large number of 155mm artillery projectiles (148,287).[48]

Similar to the rest of their 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.

The Army's main modernization programs are not currently encumbered by any major problems, but there is justifiable concern about the lack of new development programs underway. "The Army is engaged in a protracted struggle to out-innovate future competitors," in the words of the two senior Army officers directly responsible for equipment modernization, "and right now, we are not postured for success. If the Army does not modernize its force to expand and maintain overmatch, we face the potential of being out-matched in high-end conventional combat."[49]

Readiness

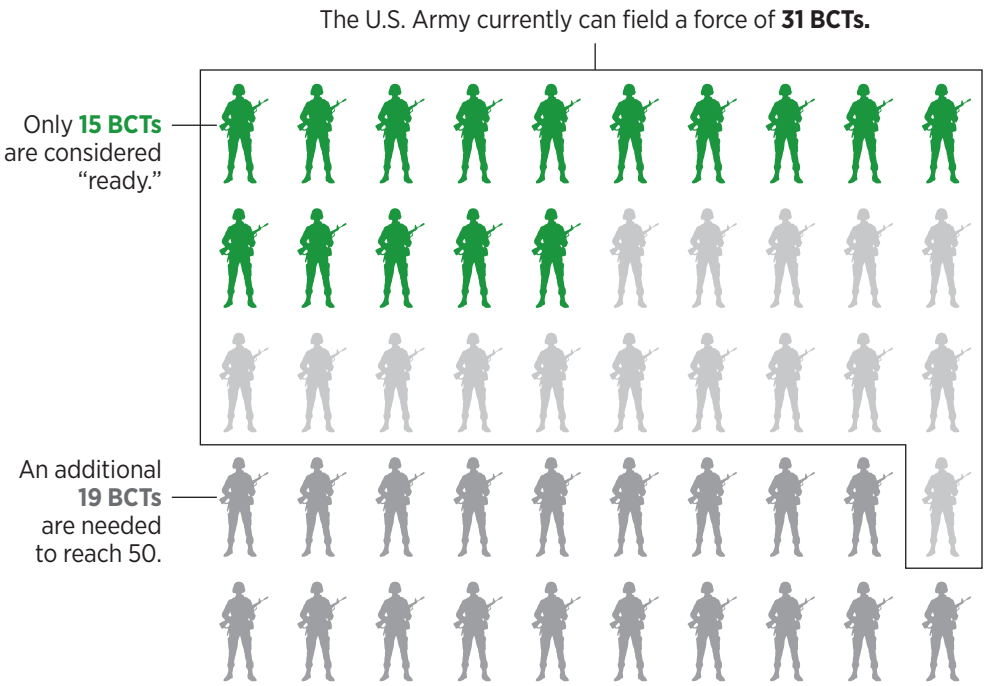
The combined effects of the Budget Control Act of 2011, the unrelenting global demand for forces, and reductions in end strength have caused Army readiness to decline to the point where only half of Active Army BCTs are now considered "ready" and only eight are considered "fully ready."[50] The Chief of Staff of the Army has testified that the Army's goal is to have two-thirds of Active Army BCTs ready.[51]

As part of the $700 billion provided for defense in the 2018 omnibus appropriations bill,

FIGURE 1

Army Readiness: Brigade Combat Teams

Based on historical force requirements, Heritage 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*, "House Armed Services Committee Holds Hearing on the State of the Military," CQ Congressional Transcripts, February 7, 2017, https://plus.cq.com/doc/congressionaltranscripts-5036905?7 (accessed May 23, 2018), and Heritage Foundation research.

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Congress provided much-needed relief to the Army by appropriating approximately $164 billion. Combined with the total increase of 12,334 soldiers in all components of Army end strength authorized in the 2018 NDAA, this provided critical resources needed to rebuild Army readiness.

In the FY 2019 budget request, training activities are relatively well resourced. When measuring training resourcing, the Army uses training miles and flying hours, which reflect the number of miles that formations are resourced to drive their primary vehicles and aviators can fly their helicopters.[52] According to the Department of the Army's budget justification exhibits, "[t]he FY 2019 budget funds 1,279 annual Operating Tempo Full Spectrum Training Miles and 10.8 flying hours per crew, per month for an expected overall training proficiency of BCT(–)."[53] These are higher than resourced levels of 1,188 miles and 10.6 hours in FY 2018.[54]

Nonetheless, structural readiness problems summarized by too small a force attempting to satisfy too many global presence requirements and Operations Plan (OPLAN) warfighting

requirements have led to a force that is both unable to achieve all required training events and overly stressed. As a result, the Army reports that "[d]espite increased funding in 2017 and 2018, the Army remains at high military risk of not meeting the demands of current operations while also responding to two near-simultaneous contingencies."[55] As a result of years of high operational tempos and sustained budget cuts, the Army now does not expect to return to desired levels of "full spectrum readiness" until 2022.[56]

These reduced levels of readiness mean that only a select number of BCTs are available and ready for decisive action. As a function of resources, time, and available force structure, this has resulted in approximately one-half of the 31 Active BCTs being ready for contingency operations in FY 2018 compared to a desired readiness level of two-thirds, although this is still an improvement over 2017, when only one-third of the Active BCTs were judged "ready."[57]

As part of its new Sustainable Readiness Model (SRM),[58] the Army uses Combat Training Centers (CTCs) 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."[59] The Army requested resources for 20 CTC rotations in FY 2019, including four for the Army National Guard.[60] 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.[61]

The ongoing challenge for the Army remains a serious one: Despite increased levels of funding for training and modernization, if the size of the Army remains the same and global demand does not diminish, the Army risks consuming readiness as fast as it builds it, which means that the date by which Army leaders hope to regain full spectrum readiness (2022) could continue to be pushed back, prolonging strategic risk for the nation.

Another key factor in readiness is available quantities of munitions. The Army's chief logistician, Lieutenant General Aundre Piggee, Deputy Chief of Staff, G-4, testified in 2017 about shortages of "preferred munitions—Patriot, THAAD, Hellfire and our Excalibur which are howitzer munitions," adding that "if we had to surge, if we had a contingency operation, and if there...continue to be emerging threats which we see around the world, I am very concerned with our current stockage of munitions."[62] These shortages have persisted into 2018.

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; they consistently advocate for 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.[63] 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 plus four ARNG), but 35 is still not enough to meet the two-MRC construct. The service's overall capability score therefore remains unchanged from 2018.

- **Two-MRC Benchmark:** 50 brigade combat teams.
- **Actual 2018 Level:** 35 (31 active + four ARNG) brigade combat teams.

The Army's current BCT capacity meets 70 percent of the two-MRC benchmark and thus is 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 new modernization priorities, Army equipment programs are largely still in the planning stage and have not entered procurement phases and thus are not yet replacing legacy platforms. These planned procurements are highly sensitive to any turbulence or reduction in funding.

Readiness Score: Strong

About half of Active BCTs were ready according to the Army Chief of Staff in April 2018.[64] The Army has 31 Active BCTs; therefore, roughly 15 of the Active Army BCTs were considered ready. 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 73 percent, or "strong." However, it should be noted that Lieutenant General Joseph Anderson, the Army Operations Officer, also reported in April 2018 that of the 15 BCTs considered "ready," only eight were considered "fully ready," meaning that they needed no additional training, personnel or equipment.[65]

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 average score was 3; thus, the overall Army score is "marginal." This was derived from the aggregate score for capacity ("weak"); capability ("marginal"); and readiness ("strong"). This score is an increase over the assessment of the 2018 *Index*, which rated the Army as "weak." The increase was driven by increased BCT readiness.

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 2018 ■ Pending

Main Battle Tank

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
M1A1/2 Abrams Inventory: **775/1,609** Fleet age: **28/7.5** Date: **1980** The Abrams is the main battle tank used by the Army in its armored brigade combat teams (BCTs). The Abrams went through a remanufacture program to extend its life to 2045.	4	4	**Next Generation Combat Vehicles (NGCV)** The NGCV program is intended to replace the Bradley fighting vehicle and the Abrams tank, and is number two among the Army's "Big Six" modernization priorities.		

Infantry Fighting Vehicle

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
M2 Bradley Inventory: **6,547** Fleet age: **13** Date: **1981** The Bradley is a tracked infantry fighting vehicle (IFV) 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 (now canceled), the Bradley underwent a remanufacture program to extend the life of the platform. The Army plans to keep the Bradley in service until 2045.	4	2	**Next Generation Combat Vehicles (NGCV)** The NGCV program is intended to replace the Bradley fighting vehicle and the Abrams tank, and is number two among the Army's "Big Six" modernization priorities.		

Armored Fighting Vehicle

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
Stryker Inventory: **3,892** Fleet age: **12** Date: **2002** The Stryker is a wheeled armored fighting vehicle that makes up the 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 Stryker is undergoing modifications to receive a double-v hull (DVH) to increase survivability. The Stryker is expected to remain in service for 30 years.	4	3	None		

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Armored Personnel Carrier

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
M113 Armored Personnel Carrier Inventory: **3,000** Fleet age: **19** Date: **1960** The M113 is a tracked APC that plays a supporting role for armored BCTs and infantry BCTs. The APC was also to be replaced by the GCV. Plans are to use the platform until 2045.	3	1	**Armored Multi-Purpose Vehicle (AMPV)** Timeline: **2018–2035** The AMPV will be adapted from an existing vehicle design which allowed the program to bypass the technology development phase. Initial operation capability is not expected until 2022. **PROCUREMENT** 42 2,894 **SPENDING** *($ millions)* $739 $13,036	2	5

Light Wheeled Vehicle

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
HMMWV Inventory: **150,000** Fleet age: **10.5** Date: **1985** The HMMWV is a light wheeled vehicle used to transport troops under some level of protection. The expected life span of the HMMWV is 15 years. Some HMMWVs will be replaced by the Joint Light Tactical Vehicle (JLTV).	2	1	**Joint Light Tactical Vehicle (JLTV)** Timeline: **2015–2036** Currently in development, the JLTV is a vehicle program meant to replace some of the HMMWVs and improve 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. IOC is anticipated at the end of 2019 for the Army. **PROCUREMENT** 4,800 44,299 **SPENDING** *($ millions)* $3,001 $25,028	1	4

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Attack Helicopter

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
AH-64 D Apache Inventory: **400** Fleet age: **13** Date: **1984** The Apache is an attack helicopter that makes up the Army Combat Aviation Brigades. The expected life cycle is about 20 years.	1	2	**AH-64E Reman** Timeline: **2010–2024** The AH-64E Reman is a program to remanufacture old 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. **PROCUREMENT** 341 / 298 **SPENDING** *($ millions)* $8,500 / $6,048	2	4
AH-64E Inventory: **203** Fleet age: **4** Date: **2013** The AH-64E variant of the Apache is a remanufactured version with substantial upgrades in powerplant, avionics, communications, and weapons capabilities. The expected life cycle is about 20 years.	5		**AH-64E New Build** Timeline: **2013–2028** The AH-64E New Build pays for the production of new Apaches. The program is meant to modernize and sustain the current Apache inventory. The AH-64E will have more modern and interoperable systems and be able to carry modern munitions. FY 2019 defense appropriation support increased procurement quantities to address national guard shortfalls. **PROCUREMENT** 58 **SPENDING** *($ millions)* $1,528	2	4

Medium Lift

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
UH-60A Black Hawk Inventory: **802** Fleet age: **25** Date: **1979** The Black Hawk UH-60A is a medium-lift utility helicopter. 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	3	**UH-60M Black Hawk** Timeline: **2005–2030** The UH-60Ms, currently in production, are 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. **PROCUREMENT** 926 / 444 **SPENDING** *($ millions)* $18,149 / $9,290	5	4
UH-60M Black Hawk Inventory: **621** Fleet age: **9** Date: **2006** The Black Hawk UH-60M is a medium-lift utility helicopter that is a follow-on to the UH-60A. As the UH-60A is retired, the M variant will be the main medium-lift rotorcraft used by the Army. Expected to remain in service until 2030.	4				

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Heavy Lift

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
CH-47D Chinook Inventory: **60** Fleet age: **28** Date: **1962** The Chinook is a heavy-lift helicopter. It has an expected life cycle of 20 years. The CH-47Ds were originally upgraded from earlier variants of the CH-47s.	1	5	**CH-47F** Timeline: **2003–TBD** 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 (67 total). FY2018 funding exceeded stated acquisition objectives, citing "emergency requirements." **PROCUREMENT** 548 **SPENDING** *($ millions)* $15,077	5	4
CH-47F Chinook Inventory: **390** Fleet age: **4.4** Date: **2001** CH-47F is "a remanufactured version of the CH-47D with a new digital cockpit and modified airframe to reduce vibrations." It also includes a common aviation architecture cockpit and advanced cargo-handling capabilities. The expected life span is 35 years.	5				

Intelligence, Surveillance, and Reconnaissance (ISR)

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
MQ-1C Gray Eagle Inventory: **125** Fleet age: **3** Date: **2009** 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.	5	5	**MQ-1C Gray Eagle** Timeline: **2010–2016** The MQ-1C UAV provides Army reconnaissance, surveillance, and target acquisition capabilities. The army is continuing to procure MQ1Cs to replace combat losses. **PROCUREMENT** 204 **SPENDING** *($ millions)* $5,761 $146	5	4

SOURCE: Heritage Foundation research using data from government documents and websites. See also Dakota L. Wood, ed., *2018 Index of U.S. Military Strength* (Washington, DC: The Heritage Foundation, 2018), http://index.heritage.org/militarystrength/.

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

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U.S. Navy

In *A Design for Maintaining Maritime Superiority, Version 1.0,* issued in January 2016, Chief of Naval Operations Admiral John M. Richardson describes the U.S. Navy's mission as follows:

> 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.[1]

The March 2015 update to *A Cooperative Strategy for 21st Century Seapower* provided the basis for understanding the key functions necessary to accomplish this mission.[2]

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 land forces (or even, to a large extent, air forces), which are tethered to a set of fixed, larger-scale support bases that require consent from host nations, the U.S. Navy can operate freely across the globe and shift its presence wherever 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. In addition to the ability to project combat power rapidly anywhere in the world, 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 2018 National Defense Strategy (NDS);[3]

- The Global Force Management Allocation Plan (GFMAP);[4]
- The 2015 update to *A Cooperative Strategy for 21st Century Seapower*; and
- The 2016 *Design for Maintaining Maritime Superiority, Version 1.0*.

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."[5] 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.[6]

In addition, the U.S. Navy must meet forward presence requirements laid out in the fiscal year (FY) 2017 GFMAP, which specifies the force presence needed around the world as determined by the combatant commanders (COCOMs) and the Secretary of Defense. To meet the objectives of the NDS and GFMAP, "the Navy and Marine Corps primary combat force contributors are two Carrier Strike Groups (CSGs) and two Amphibious Ready Groups (ARGs) 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."[7]

The Navy's maritime manifestation of the NDS, the *Navy the Nation Needs (NNN)*, stresses that credible and effective naval power is based on six key pillars—Readiness, Capability, Capacity, Manning, Networks, and Operating Concepts—and that:

> These six pillars must remain balanced and scalable in order to field the needed credible naval power, guarding against over-investment in one area that might disadvantage another. This disciplined approach ensures force structure growth accounts for commensurate, properly phased investments across all six pillars—a balanced warfighting investment strategy to fund the total ownership cost of the Navy (manning, support, training, infrastructure, etc.).[8]

This *Index* focuses on three of these pillars—capacity, capability, and readiness—as the primary means to measure U.S. naval strength.

- Sufficient capacity is required 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 also 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 performance measures 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 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. The Navy focuses mainly on the size of its "battle force," which is composed of ships it considers to be directly related to its combat missions.[9]

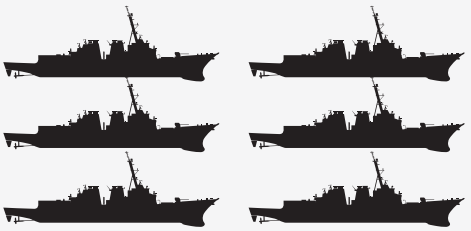
FIGURE 2

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.

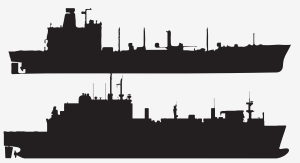


Guided Missile Cruiser (CG)
Large surface combatant (LSC) capable of conducting integrated air and missile defense (IAMD), anti-air warfare (AAW), anti-surface warfare (ASuW), and anti-submarine warfare (ASW). CGs are the preferred platform for serving as the Air and Missile Defense Commander.

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)
Multi-mission 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: The Heritage Foundation research.

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The first edition of this *Index* established a benchmark of 346 ships for the minimum battle force fleet required to "fight and win two MRCs and a 20 percent margin that serves as a strategic reserve" as well as maintain a peacetime global forward 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 groundwork for this year's *Index* 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 to determine whether the *Index* benchmark should be updated.

To provide the 13 carrier strike groups and 12 expeditionary strike groups (ESGs) required to meet the simultaneous two-MRC construct, meet the historical steady-state demand of approximately 100 ships constantly forward deployed, and ensure that ships and aircraft are properly maintained and sailors are adequately trained to "fight tonight," this *Index* assesses that the U.S. requires a minimum of 400 ships. While this represents a significant increase both from the previous benchmark of 346 ships and 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,"[10] the Navy's recent fleet readiness issues and the 2018 NDS's focus on the "reemergence of long-term strategic competition"[11] 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 not only includes 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 shipbuilding industrial base capacity, this *Index* benchmark is budget agnostic and based strictly on assessed force-sizing requirements.

The Navy currently sails 284 vessels as part of its battle force fleet,[12] up from 276 in 2017[13] 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 2018 NDAA provides $23.8 billion for the construction of 14 new ships, including one additional Littoral Combat Ship (LCS); accelerates the procurement of the first LPD Flight II and one additional Expeditionary Fast Transport (T-EPF); and adds one ocean survey ship (T-AGS).[14] The Navy has requested the procurement of 10 ships in FY 2019. This is two fewer than recommended in the Congressional Budget Office (CBO) assessment of the average annual ship procurement needed to achieve a 355-ship fleet by 2037.[15]

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 six additional ships and submarines by the end of 2018[16] and 11 ships and submarines in FY 2019.[17] It also will retire one *Los Angeles*-class nuclear attack submarine (SSN) in FY 2019.[18] The number of ships decommissioned will increase significantly over the next five years as additional *Los Angeles*-class SSNs and mine countermeasure ships (MCMs) reach the end of their service life, slowing the pace at which fleet size can grow.[19] The Navy recently completed a technical evaluation of the "feasibility of extending the service life of selected non-nuclear vessels" and may decide to extend the life of numerous ship 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.[20]

The largest proportional shortfall in the Navy fleet assessed in the *2019 Index* is the same as in past editions: small surface combatants.[21] The Navy's current SSC inventory include 13 Littoral Combat Ships and 11 MCM ships for a total of 24 SSCs,[22] 28 below the

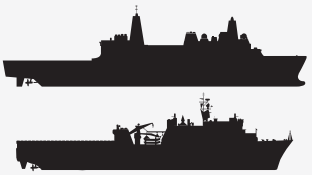
FIGURE 3

Expeditionary Strike Group

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

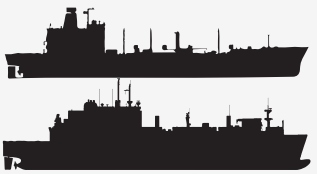
Amphibious Assault Ship LHA or LHD
A landing helicopter assault ship (LHA) or landing helicopter dock (LHD). Capable of supporting short take-off vertical landing (STOVL) operations for embarked Marine strike aircraft squadron as well as tilt-rotor and helicopter squadrons. Some of these ships possess 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)
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.

SOURCE: The Heritage Foundation research.

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objective requirement of 52 established by the Navy[23] and 47 less than the 2018 Heritage Foundation requirement of 71.[24]

The next largest shortfall occurs in CLF ships. The Navy's current CLF inventory is comprised of 12 *Lewis and Clark*-class dry cargo and ammunition ships (T-AKE); 15 *Henry J. Kaiser*-class fleet replenishment oilers (T-AO); and two *Supply*-class fast combat support ships (T-AOE), for a total of 29 CLF ships.[25] This is three below the Navy requirement of 32 ships and 25 less than the *Index* requirement of 54.[26]

The aircraft carrier force suffers a capacity shortfall of two hulls: 11 are currently in the fleet, and the two-MRC construct requires 13.[27] Current U.S. law requires the Navy to maintain

FIGURE 4

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 properly handle this large mission, Heritage Foundation experts recommend a fleet of 13 carriers.

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a force of "not less than 11 operational aircraft carriers."[28] Representative K. Michael Conaway (R–TX) introduced an amendment to H.R. 5515, the National Defense Authorization Act (NDAA) for Fiscal Year 2019, that would have amended U.S. Code, Title 10, § 5062(b), effective September 30, 2022, to require a minimum of "12 operational aircraft carriers," that the U.S. Navy "expedite delivery of 12 aircraft carriers," and that "an aircraft carrier should be authorized every three years" to keep pace with the loss of carriers as they are retired.[29] The final version of the NDAA as enacted specifies only that "It is 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."[30]

The Congressional Research Service (CRS) has assessed that "increasing aircraft carrier procurement from the currently planned rate of one ship every five years...to a rate of one ship every three years...would achieve a 12-carrier force on a sustained basis by about 2030...."[31] The Navy has stated that with its current fleet of only 11 carriers, it cannot meet the requirement to maintain two carriers deployed at all times and three ready to surge deploy within 30 days.[32]

The carrier force fell to 10 from December 2012 until July 2017. During the first week of January 2017, for the first time since World War II, no U.S. aircraft carriers were deployed.[33] 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, it will not be ready for routine flight operations until 2020 and will not operationally deploy until 2022.[34] 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. Although the carrier in RCOH will count as a battle force ship, it 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.

In December 2016, the U.S. Navy released its latest study of forecasted fleet requirements. The Navy Force Structure Assessment (FSA) was developed to determine the correct balance of existing forces for "ever-evolving and increasingly complex maritime security threats."[35] 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. 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 accept risk in providing continual presence missions.[36] 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."[37]

The final recommendation for a 355-ship force 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 (DDG) and cruisers (CG)), 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.[38]

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."[39] According to the CBO:

> [O]ver the next 30 years, meeting the 355-ship objective would cost the Navy an average of about $26.6 billion (in 2017 dollars) annually for ship construction, which is more than 60 percent above the average amount the Congress has appropriated each year for that purpose over the past 30 years and 40 percent more than the amount appropriated for 2016.[40]

The Navy's SCN (Shipbuilding and Conversion, Navy) request for FY 2019 totaled approximately $21.8 billion,[41] well below the level that the CBO has assessed is necessary to reach fleet goals. As noted, this includes funding for procurement of only 10 battle force ships during this fiscal year, which will make it difficult to increase the fleet size.

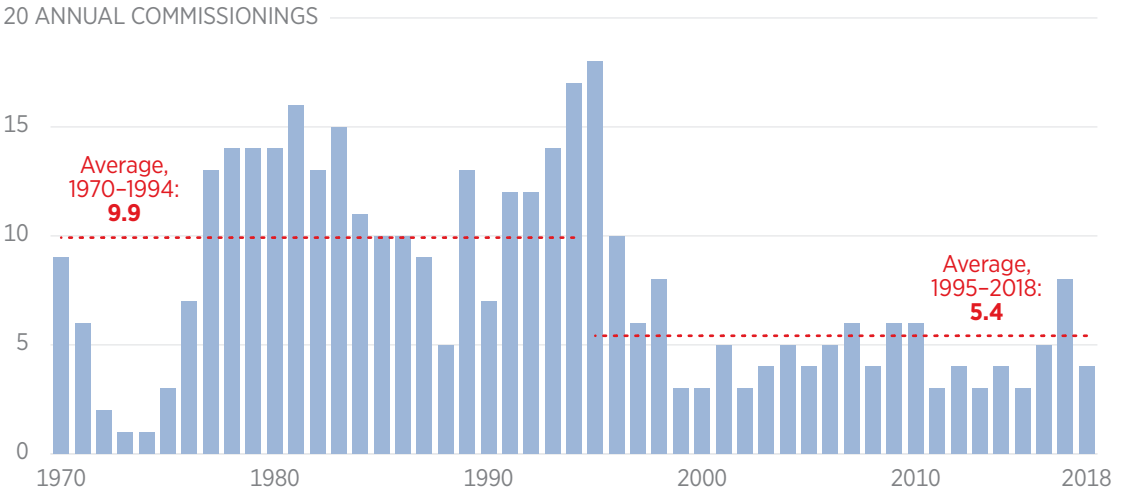
The seeming anomaly of increased funding for shipbuilding without a corresponding increase in fleet force structure is due in part to the fact that a significant portion of this funding is dedicated to advanced procurement of the next-generation ballistic missile submarine program (SSBN(X) *Columbia*-class).[42] Additionally, the CRS has estimated that "roughly 15,000 additional sailors and aviation personnel would be needed at sea to operate those 47 additional ships."[43] Although the Department of Defense updated the NDS in early 2018, the Navy has not formally announced any intention to update its 2016 FSA to reflect this new guidance.

The Navy released its *Report to Congress on the Annual Long-Range Plan for the Construction of Naval Vessels for Fiscal Year 2019* (or the 30-year shipbuilding plan) in February

CHART 10

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.



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

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2018. This updated plan provides the foundation for building the *Navy the Nation Needs* and ultimately achieving the congressionally mandated requirement for 355 battle force ships. While this plan includes 54 ships within the Future Years Defense Program (FYDP) FY 2019–FY 2023 and 301 ships over the next 30 years, it fails to achieve a 355-ship Navy until beyond 2050. Of significant note, the plan will only reach the 2016 FSA requirements for attack submarines, ballistic submarines, and combat logistics force ships by 2048.[44] The plan averages 10 new ships per year, two fewer than the average number of new ships per year that the CBO assesses is required to reach 355 ships by 2037.[45]

The 30-year shipbuilding plan also includes plans for service life extensions (SLEs) for qualified candidate vessels. The Navy's FY 2019 budget submission includes SLEs for six *Ticonderoga*-class cruisers, four mine countermeasure ships, and the first of potentially five improved *Los Angeles*-class attack submarines.[46] On April 12, 2018, Vice Admiral William Merz, Deputy Chief of Naval Operations for Warfare Systems, informed the House Armed Services Committee's Seapower and Force Projection Subcommittee that the Navy will extend the entire *Arleigh Burke* destroyer class to a service life of 45 years, enabling the Navy to achieve 355 ships by 2036 or 2037.[47] This destroyer class extension will not provide the required mix of ships per the 2016 FSA, but it will provide additional fleet capacity.

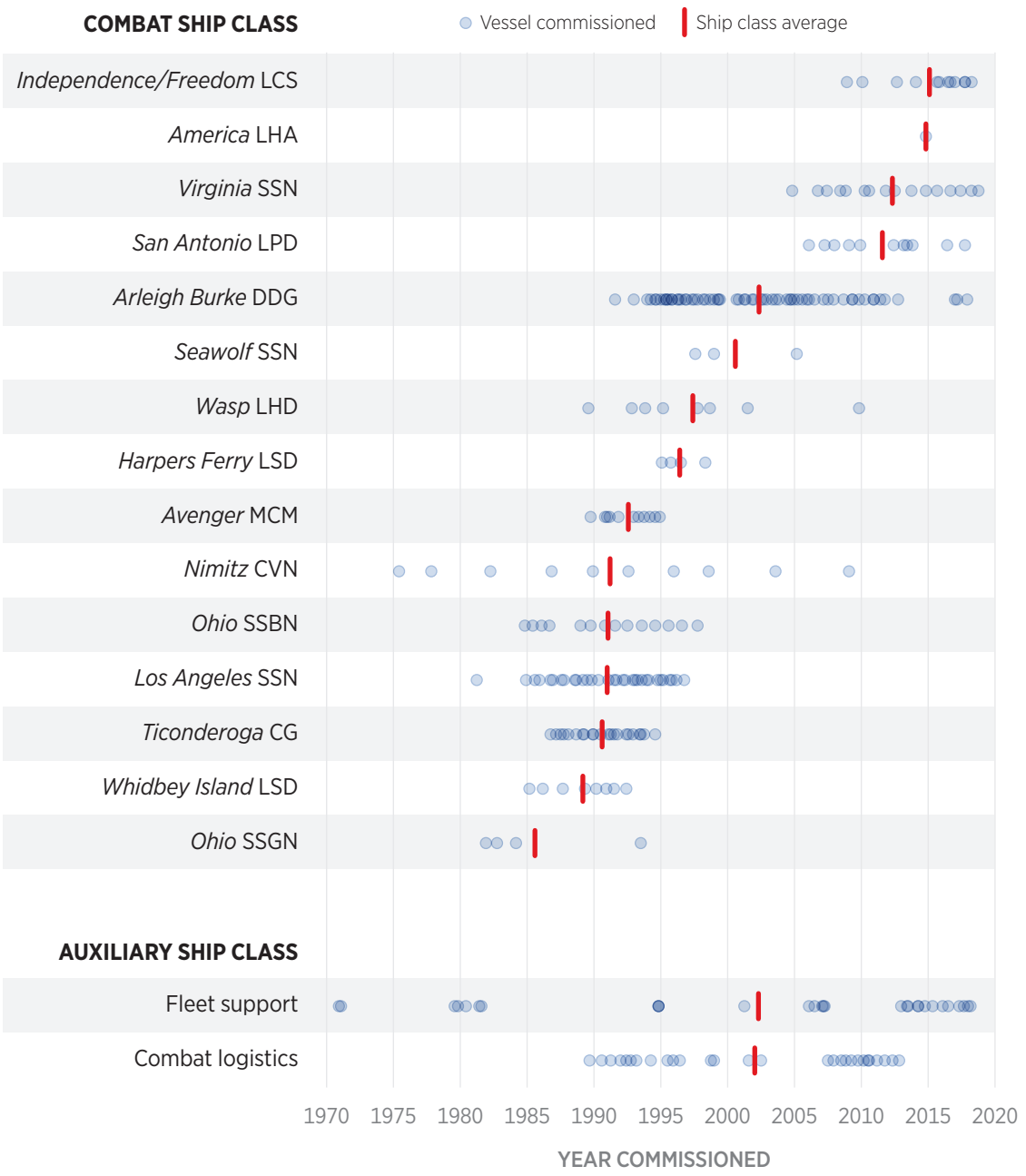
Taken alone, total fleet size can be a misleading statistic; related factors must also be taken into account when considering numbers of ships. One such important factor is the number of ships that are forward deployed to meet operational demands. On average, the Navy maintains approximately one-third of the total fleet deployed at any given time (90–100 ships). 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

CHART 11

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 has resulted in a fleet of increasing age.



NOTE: Data are current as of July 30, 2018.
SOURCE: Naval Sea Systems Command, Naval Vessel Register, "Fleet Size," http://www.nvr.navy.mil/NVRSHIPS/ FLEETSIZE.HTML (accessed August 6, 2018).

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based in the continental United States (CONUS) to undergo routine maintenance and training, as well as to limit deployment time for sailors. However, given the COCOMs' requirements for naval power presence in each of their regions, there is 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."[48] The plan incorporates four phases of ship availability/maintenance, resulting in a basic ratio of 4:1 for CONUS-based force structure required for deployed platforms. The OFRP is on track to achieve the Navy's goal of "2 deployed and 3 surge ready" carrier strike groups just beyond 2021.[49]

In 2017, the Navy had 104 ships deployed globally (including submarines): 38 percent of the total battle force fleet and an increase from the 94 deployed in 2016.[50] As of August 17, 2018, the Navy had 89 "Deployed Battle Force Across the Fleet Including Forward Deployed Submarines."[51] A primary factor in this decrease is the Navy's improved focus on restoring surface fleet material and mission proficiency readiness following the deadly Seventh Fleet collisions of 2017. 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 both 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):[52]

- **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.[53] 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. However, these options allow one ship to provide a greater level of presence than four ships based in CONUS and in rotational deployment because they offset the time needed to deploy ships to distant theaters.[54] 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.[55]

Capability

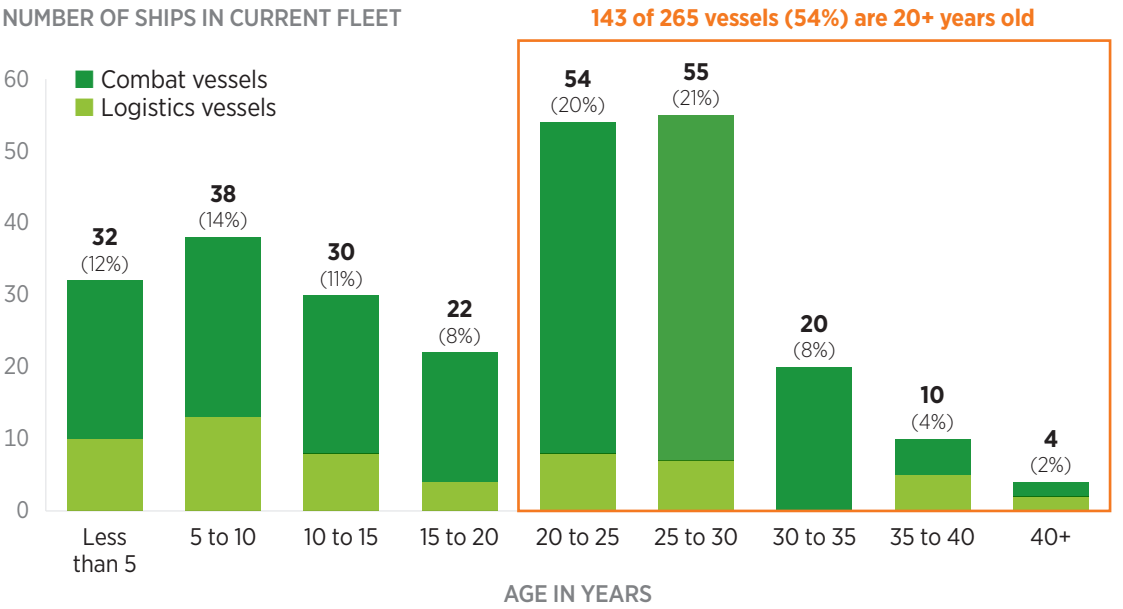
Scoring the U.S. Navy's overall ability to protect U.S. interests globally is not simply a matter of counting the fleet. The quality of the battle force is also important in determining naval strength.

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 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

CHART 12

An Aging U.S. Navy



NOTE: Data are current as of August 15, 2018.
SOURCE: Naval Sea Systems Command, Naval Vessel Register, "Fleet Size," http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML (accessed August 15, 2018).

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ships, and 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.

The Navy retired the last of its *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.[56] The LCS concept of operations 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 ships dedicated to a specific mission: ASW, SuW, or MCM.[57]

Planned capability upgrades to give the LCS fleet frigate-like capabilities include "[o]ver-the-horizon surface to surface missile and additional weapon systems and combat system upgrades" and "increased survivability... achieved by incorporating additional self-defense capabilities and increased hardening of vital systems and vital spaces."[58] 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.[59] 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.[60]

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."[61] 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.[62]

The Administration's FY 2019 budget request includes funding for one LCS. Congress authorized the procurement of three LCSs in the FY 2018 NDAA, meeting the LCS requirement for 32 ships. The Navy has stated that the one additional LCS requested in FY 2019 provides sufficient workload, coupled with the 21 LCSs currently under construction or planned, to "allow [two] shipbuilders to maintain stability and be competitive for the FFG(X) award in FY 2020."[63] Both Austal USA and Lockheed Martin disagreed with the Navy's assessment. Austal responded that "funding one LCS in the FY19 budget is not sufficient to support the Shipbuilding Industrial Base" and that "[a]ny reduction in [production] volume would negatively impact the shipbuilding industrial base, including our suppliers (local and national), as well as the ability to efficiently transition to Frigate."[64] Lockheed Martin countered that with its production rate of two LCS per year, "our current production backlog is insufficient to maintain the employment and efficiency levels required for our team to remain competitive for Frigate."[65]

The Navy projects that the LCS deployable force will reach 16 LCSs by the end of FY 2018 and reach 20 ships by the end of FY 2019.[66] This is still well below the fleet size of 71 small surface combatants necessary to fulfill the Navy's global responsibilities, even when combined with the 11 remaining mine countermeasure vessels in the fleet.

In July 2017, the Navy released a Request for Information 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.[67] 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.[68]

The notional FFG(X) procurement plan would purchase 20 ships over 11 years.[69] 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 an existing SSC ship design that can be modified to meet the FFG(X)'s specific capability requirements.[70] 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; Fincantieri/Marinette Marine (F/MM); and General Dynamics/Bath Iron Works (GD/BIW).[71] The Navy will select one shipbuilder in FY 2020.[72]

The Navy possesses 22 *Ticonderoga*-class cruisers.[73] 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 a 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….[74]

In FY 2019, the Navy will continue to execute the "2-4-6" plan on seven of 11 cruisers, with the remaining four BMD-capable cruisers to receive scheduled modernization to their hull and support systems throughout their service life.[75] The Navy currently has six cruisers inducted in the modernization program. Along with the USS *Anzio*, inducted in May 2017, the program includes USS *Cape St. George*, inducted in March 2017; USS *Chosin* and USS *Vicksburg*, inducted in FY 2016; and USS *Cowpens* and USS *Gettysburg*, inducted in FY 2015.[76]

The Navy's FY 2019 budget request includes "$276 million for guided missile cruiser modernization and $79 million to upgrade eight cruisers to AEGIS Baseline 9, enabling them to perform critical Integrated Air and Missile Defense (IAMD) and Ballistic Missile Defense (BMD) operations simultaneously."[77] It also requests $5.6 billion for three DDG 51 Flight III destroyers as part of a 10-ship Multi-Year Procurement (MYP), bringing the class size to 82 ships.[78] 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.

The DDG-1000 *Zumwalt*-class is a "multi-mission destroyer designed with a primary mission of naval surface fire support (NSFS) and operations in littoral (i.e., nearshore) waters."[79] 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."[80] The stealthy DDG-1000 hull design cannot support the required ballistic defense capabilities without significant modifications.

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 better 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).[81] The Navy's FY 2019 budget requests $89.7 million to convert the *Zumwalt*-class destroyers by integrating Raytheon's multi-mission SM-6 anti-air and anti-surface missile, as well as the Maritime Strike variant of the Tomahawk missile.[82]

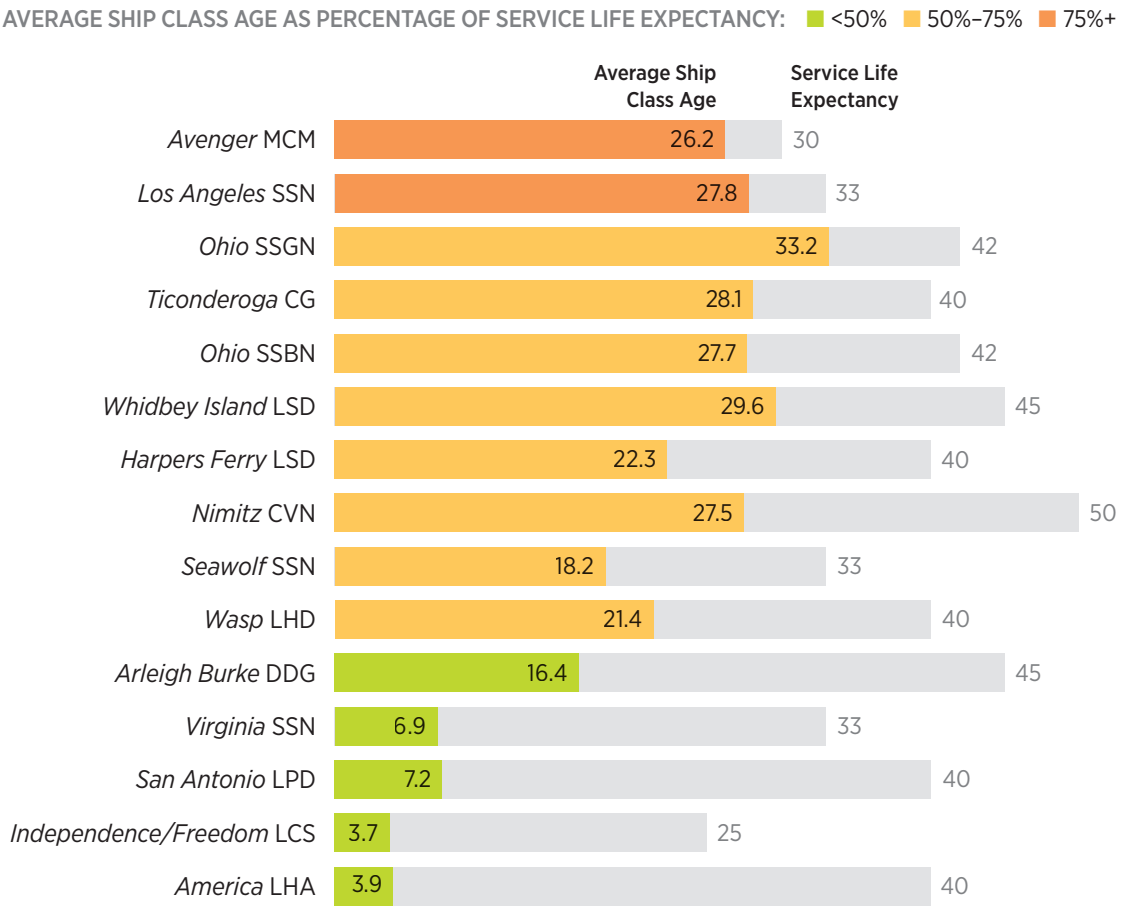
The Navy's 12 landing ships (LSDs), the *Whidbey Island*-class and *Harpers Ferry*-class amphibious vessels, are currently scheduled to reach the end of their 40-year service lives in 2025. The 13-ship LPD-17 Flight II program, previously known as the LX(R) program, will replace these legacy landing 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.[83] Although the first Flight II ship was planned for FY 2020, Congress directed the Navy to accelerate it to FY 2018.[84]

Most of the Navy's battle force fleet consists of legacy platforms. Of the 20 classes of ships in the Navy, only eight are currently in production. For example, 64 percent of the Navy's attack submarines are *Los Angeles*-class submarines, an older platform that is being replaced with a more modern and capable *Virginia*-class.[85]

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 proven to be substantially more expensive to build than the Navy originally estimated.[86] The first ship of any class is typically more expensive than early estimates project, which is

CHART 13

Combat Fleets Pushing Limits of Life Expectancy



NOTE: Average Ship Class Age is as of October 2018.
SOURCE: Heritage Foundation research based on data from the U.S. Department of the Navy, U.S. Department of Defense, U.S. Government Publishing Office, and other sources.

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not entirely surprising given the technology assumptions and cost estimates that must be made several years before actual construction begins. Although the CBO has reported that only two of the last 11 lead ships have been delivered over budget, the trend has been downward for the most recent classes.[87] 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.[88]

Many consider the 30-year shipbuilding plan to be optimistic based on recent history. For example, the Navy received $24 billion more in shipbuilding funding than planned yet purchased 50 fewer ships than outlined in the 2007 long-range shipbuilding plan.[89]

The goal of 355 ships stated in the Navy's most recent 30-year plan includes an objective for 12 *Columbia*-class nuclear ballistic missile submarines (SSBNs) to replace the

legacy *Ohio*-class SSBN. Production of these 12 *Columbia*-class submarines will require a significant portion of the Navy's shipbuilding funding if the overall budget is not increased.

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 FY2029–FY2041."[90] This is something that the Navy will continue to have difficulty maintaining as it struggles to sustain, overhaul, modernize, and eventually retire the remainder of its legacy SSBN fleet. The *Columbia*-class SSBN is "the Navy's top priority program"[91] and has been allocated $3 billion—almost 15 percent of its total shipbuilding budget—in the Navy's FY 2019 request for "detail design efforts, continuous missile tube production, and Advanced Construction of major hull components and propulsion systems."[92]

The Navy's long-range strike capability derives from its ability to launch various missiles and combat aircraft. Naval aircraft are much more expensive and difficult to modernize as a class 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.[93] By the end of 2018, all Navy squadrons will have transitioned to more capable and modern F/A-18E/F Super Hornets.[94]

The F/A-18E/F Super Hornet has better range, greater weapons payload, and increased survivability than the F/A-18A-D Legacy Hornet.[95] The Navy is implementing efforts to extend the life of some of the older Super Hornet variants until the F-35C is fully fielded in the mid-2030s, ensuring that the F/A-18E/F "will be the numerically predominant aircraft in CVWs into the mid-late 2030s."[96] The Navy's FY 2019 budget request includes $1.99 billion for 24 F/A-18E/F Super Hornets, and it plans to buy 110 Block III Super Hornets over the next five years in an attempt to mitigate shortfalls in its strike aircraft inventory.[97]

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 will be 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."[98] The FY 2019 budget requests "$147.4 million for research, development, testing, and evaluation (RDT&E) for additional modernization" to ensure that the EA-18G maintains its technical advantage over adversary electronic warfare and air defense systems.[99]

The Navy has been addressing numerous incidents, or physiological episodes (PEs), of dizziness and blackouts by F/A-18 aircrews over the past five years. There were 57 such incidents in 2012 and 114 in 2016, and 52 were reported during the first half of 2017.[100] Of the 588 F/A-18 PE incidents analyzed to date:

> 212 involved ECS [Environmental Control System] component failures, 194 were attributed to breathing gas issues, including 51 OBOGS [Onboard Oxygen Generation System] component failures and 13 breathing gas delivery component failures, 92 involved human factors, and 87 were inconclusive or involved another aircraft system failure.[101]

Only six T-45 training aircraft PEs were reported after the planes returned from an operational pause and modifications to their OBOG system in July 2017, and only one of these PEs has been attributed to the aircraft's breathing systems. The remaining five events "have all been linked to other human factors."[102]

The Navy's Physiological Episode Action Team (PEAT) "considers hypoxia and decompression events [to be] the two most likely causes of recent physiological episodes in aviators," but as physical symptoms related to "pressure fluctuations, hypoxia and contamination overlap, discerning of a root cause is a complex process."[103]

The Navy has implemented numerous corrective actions to address PEs in F/A-18F/F and EA-18G aircraft. These include "new maintenance rules for handling the occurrence of specific ECS built-in test faults;" "revised and expanded emergency procedures;" "forward deployment of transportable recompression systems to immediately treat aircrew in the event they experience pressure related symptoms"; and "annual hypoxia awareness and biennial dynamic training using a Reduced Oxygen Breathing Device (ROBD) to experience and recognize hypoxia symptoms while operating an aircraft simulator."[104] 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 its 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.[105] The F-35 is supposed to be a more capable aircraft relative to the F/A-18, but at planned procurement levels of 260 aircraft, it will not be enough to make up for the Hornets that the Navy will need to replace. The Navy now plans for future carrier air wings to include a combination of both F/A-18E/Fs and F-35Cs. In addition, like the other F-35 variants, the F-35C has faced development problems. The system has been grounded because of engine problems, and software development issues have threatened further delay. The aircraft also has grown more expensive through the development process.

As evidence of continued program issues, in March 2018, the Department of Defense stopped accepting new F-35s "pending resolution of a dispute with [the builder], Lockheed Martin, over who should pay to repair identified issues with corrosion on F-35s." As of April 12, 2018, the delivery of "five aircraft had been deferred."[106] The F-35 program's delay of the Initial Operations Test and Evaluation (IOT&E) until September 2018 appears to be jeopardizing the F-35C's scheduled initial operational capability of February 2018. According to Rear Admiral Dale Horan, Director of Joint Strike Fighter Fleet Integration:

> The whole F-35 enterprise's IOT&E starts in September, so it's not Navy F-35C that's holding up IOC, it's that we're tied to IOT&E and need to see the demonstration and capabilities. We need to really see the 3F capability demonstrated in IOT&E and there's just not going to be enough time to see enough of that before Feb. 2019.[107]

This delay in the F-35C's IOC is not expected to affect the first F-35C operational deployment in 2021.[108]

The Navy is investing in cruise missile modernization and new missile programs to provide increased range, survivability, and effectiveness in modern Anti-Access/Area Denial (A2/AD) environments. The Navy's FY 2019 budget requests $282.4 million in RDT&E and $98.6 million in weapons procurement to develop and procure 112 A2/AD capability upgrades as well as to develop an improved warhead and an anti-ship maritime strike version of the Tactical Tomahawk (TACTOM) Block IV cruise missile.[109] It also requests $143.1 million for development and testing of the Long Range Anti-Ship Missile (LRASM) and $81.2 million to purchase 25 LRASM weapons that will provide the "ability to conduct anti-surface warfare (ASuW) operations against high-value surface combatants protected by Integrated Air Defense Systems with long-range

Surface-to-Air-Missiles and deny adversaries sanctuary of maneuver against 2018–2020 threats."[110] The LRASM is "scheduled to achieve Early Operational Capability on the... Navy F/A-18E/F by the end of FY 2019."[111]

Readiness

Although the Navy states that it can still deploy forces in accordance with GFMAP requirements, various factors indicate a continued decline in readiness over the past year. Admiral William Moran, Vice Chief of Naval Operations, testified before the Senate Armed Services Readiness Subcommittee in February 2018 that:

> At the height of the Cold War, approximately one in six ships were deployed on any given day, today almost one in three are deployed on any given day.... [N]ational demands for your Navy far exceed its capacity, driving operational tempo [OPTEMPO] to unsustainable levels....
>
> 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.[112]

Over the past nine years, "Continuing Resolutions have averaged 106 days per fiscal year," forcing the Navy to operate under reduced spending levels and severely limiting the ability to complete required ship and aircraft maintenance and training.[113] The FY 2018 Appropriations Act did not become law until March 23, 2018, effectively forcing the Navy to plan and execute 12 months of maintenance and training within the final six months of the fiscal year. "In a six month Continuing Resolution," according to Admiral Moran, "we will delay up to six ship maintenance periods, suffer delays in aircraft maintenance and repair parts, delay our munitions contracts, and...will not award three ship contracts."[114] The cycle of annual continuing resolutions continues to hamper and delay the ability of the U.S. Navy to restore readiness. Admiral John Richardson, Chief of Naval Operations, 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.[115]

The $1.7 billion provided by Congress as part of the FY 2017 Request for Additional Appropriations did help to reverse some of the Navy's "most critical readiness problems by executing 13 more ship maintenance availabilities, restoring 35 additional air frames to flight, and providing 18,000 flying hours to train 900 pilots," all of which "gained back two ship deployments and a combined one year of carrier operations and surge capability."[116]

Like the other services, the Navy has had to dedicate readiness funding to the immediate needs of various engagements around the globe, which means that the maintenance and training for non-deployed ships and sailors are not prioritized. Deferral of ship and aircraft depot maintenance because of inadequate funding or because public shipyards do not have 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 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. Even with the hiring of additional shipyard workers over the

past two years, the public (government-owned) shipyards are still undermanned for the amount of work they need to do.

Correcting these maintenance backlogs will require sufficient and stable funding to defray the costs of ship maintenance and further expand the workforce of 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 2011 and 2016, ship maintenance overruns resulted in the loss of 1,103 aircraft carrier; 6,603 large surface combatant (cruiser and destroyers); and 6,220 submarine operational days.[117] This is the equivalent of losing 0.5 aircraft carriers, 3.0 large surface combatants, and 2.8 submarines from fleet operations for a year.

The FY 2019 budget seeks to increase the public shipyard workforce by 3,187 workers and to provide additional funding to private yards for submarine maintenance in order to lessen the workload on government shipyards.[118] In FY 2019, funding ship maintenance at the maximum executable capacity of both public and private shipyards can address only 96 percent of the required maintenance, and funding aviation maintenance at the maximum executable level of the depots can meet only 92 percent of the requirement.[119] The Navy has commenced a $21 billion, 20-year public shipyard optimization plan to increase shipyard capacity by updating equipment, improving workflow, and modernizing dry docks to accommodate new ship and submarine classes.[120]

Ship and aircraft operations and training are just as critical to fleet readiness as maintenance is. The Navy's FY 2019 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.[121] In addition, flight hours are funded to achieve a T-rating of 2.0 for nine Navy carrier air wings.[122] 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."[123]

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 naval aviation mishaps for F/A-18E/F Super Hornets had increased 108 percent over the past five years, while across the entire aviation fleet, mishaps rose 82 percent. While 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."[124]

The naval aviation community has 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 deploying squadrons had sufficient operational aircraft and personnel operate safely and effectively.[125] 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."[126]

Vice Admiral Troy Shoemaker, Commander, Naval Air Forces, made the operational impact of this aviation readiness decline starkly clear when he testified in November 2017 that "in our Super Hornet community alone, only half of our total inventory of 542 aircraft were flyable, or mission capable, and only 170 or 31% of the total inventory were fully mission capable and ready to 'fight tonight.'"[127]

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.[128] 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. The *Comprehensive 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."[129] The report recommended 58 actions to correct deficiencies across the "Doctrine, Organization, Training, Material, Leadership and Education, Personnel, and Facilities (DOTMLPF)" spectrum.[130]

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 performance and readiness of the fleet.[131] 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."[132]

In short, Navy readiness levels are problematic and will take several years to correct. 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 and fast attack submarines to the extent that they contribute to the overall size of the battle fleet and with 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.

The role of SSBNs (fleet ballistic missile submarines) as one leg of America's nuclear triad capability is well known; perhaps less well known are the day-to-day tasks undertaken by the SSN force, whose operations, which can include collection, surveillance, and support to the special operations community, often take place far from the operations of the surface Navy.

Two-MRC Requirement. This *Index* uses the Navy's fleet size required "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." 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 Deployable Carrier Strike Groups. The average number of aircraft carriers deployed in major U.S. military operations since the end of the Cold War, such as the conflicts in Kuwait in 1991,[133] Afghanistan in 2001,[134] and Iraq in 2003,[135] was between five and seven. An operational fleet of 11 carriers would ensure that five are available to deploy within 30 days for a crisis or conflict. (The rest would be undergoing scheduled maintenance or taking part in training exercises and would not be ready for combat.) Within 90 days, the Navy would generally have seven carriers available.[136] This correlates with the recommendations of numerous force-sizing assessments, from the 1993 Bottom-Up Review (BUR)[137] to the Navy's 2016 Force Structure Assessment,[138] 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 carrier groups and 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.[139]

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:

- "[F]ive to seven air and missile defense–capable large surface combatant ships (guided missile cruiser (CG) or guided missile destroyer (DDG)) to combat the advent of highly capable anti-ship ballistic missiles and anti-ship cruise missiles" and conduct "simultaneous ballistic missile defense and anti-air warfare" operations.

- "A naval integrated fire control-counter air capable cruiser," which "is the preferred ship for the [air and missile defense commander]."

- "No less than three cruise missile land attack capable (e.g. Tomahawk land attack missile or follow on weapon) capable large surface combatant ships."

- "No less than three [surface warfare] cruise missile (e.g. Harpoon or follow-on weapon) capable large surface combatant ships."

- "No less than four multi-functional tactical towed array systems."

- "One fast combat support (T-AOE) or equivalent dry cargo and ammunition (T-AKE) or fleet replenishment oiler (T-AO) pair combat logistics force ship(s)," which, "while not a part of the CSG, are usually assigned to support CSG operations."[140]

Although not mentioned in this instruction, at least one SSN is typically assigned to a CSG.[141]

Therefore, this *Index* defines the nominal CSG engaged in an MRC as follows: one nuclear-powered aircraft carrier (CVN); one carrier air wing (CVW); one CG; four DDGs; two FFGs; two SSNs; and one T-AOE or one T-AO and one T-AKE. Until the new FFG(X) becomes operational, this nominal CSG will consist of six in place of four DDGs.

Thirteen Carrier Air Wings. Each carrier deployed for combat operations was equipped with a carrier air wing, meaning that five to six air wings were necessary for each of those four major contingencies listed. The strategic documents differ slightly in this regard because each document suggests one less carrier air wing than the number of aircraft carriers.

A carrier air wing customarily includes four strike fighter squadrons.[142] 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.[143]

Forty-Five Amphibious Ships. The 1993 BUR recommended a fleet of 41 large amphibious vessels to support the operations of 2.5 Marine Expeditionary Brigades (MEBs).[144] 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.[145] The number of amphibious vessels required in combat operations has declined since the Korean War, which employed 34 amphibious vessels; 26 were deployed in Vietnam, 21 in the Persian Gulf War, and only seven supported Operation Iraqi Freedom (which did not require as large a sea-based expeditionary force).[146] The Persian Gulf War is the most pertinent example for today because similar vessels were employed, and the modern requirements for an MEB most closely resemble this engagement.[147]

The Marine Corps' *Expeditionary Force 21, Marine Expeditionary Brigade Informational Overview* 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).[148] In conjunction with the Navy's Expeditionary

TABLE 6

Navy Force Structure Assessment

Ship Type/Class	Current Fleet	2016 Force Structure Assessment	*2019 Index* Recommendation
Ballistic Missile Submarines	14	12	12
Aircraft Carriers	11	12	13
Large Surface Combatants	90	104	105
Small Surface Combatants	24	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	30	39	35
Total	**284**	**355**	**400**

SOURCE: U.S. Department of Defense, U.S. Navy, Naval Vessel Register, "Fleet Size," http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML (accessed August 8, 2018). For more information, see footnote 169.

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Strike Group definition, five ESGs compose one MEB AATF.[149] Based on these requirements and definitions, this *Index* defines the nominal ESG engaged in an MRC as follows: one LHA or LHD; one LPD/LX(R); one LSD; two DDGs; two FFGs; and one T-AOE or one T-AO and one T-AKE. 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,[150] 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 as well as ensuring a strategic reserve of 20 percent.

Total Ship Requirement. 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. This analysis did not consider unmanned systems or ship classes that are not current programs of record. While unmanned systems offer the promise to improve the effectiveness and reach of ships and submarines, they have not matured sufficiently to replace a manned ship or submarine in the battle force.

The most significant differences in this updated total ship requirement compared to the Navy's 2016 FSA are in SSC and CLF ships. The

increase in SSC 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 plus the continued requirement for a combination of least 15 MCM ships and MIW LCS. 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."[151] 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 for Navy to assume we would have the resources to aspire to a force of this size with this mix of ships."[152] Finally, this FSA has not been updated to address the 2018 National Defense Strategy, which reestablished long-term strategic competition with China and long-term strategic competition with Russia as the principal Department of Defense priorities.[153]

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 284 ships, planned fleet of 289 ships by the end of FY 2018, 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," down from its *2017 Index* score of "marginal." Depending on the Navy's ability to fund more aggressive growth options and service life extensions as identified in the FY 2019 30-year shipbuilding plan, and in view of the *Columbia*-class ballistic missile submarine program that could cost nearly half of the current shipbuilding budget per hull, the Navy's capacity score could fall further in the "weak" category in the near future.

Capability Score: Marginal

The overall capability score for the Navy is "marginal," an increase over its score of "weak" in the *2018 Index*. 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 more easily presented in a tabular format as shown in the Appendix.

Readiness Score: Marginal

The Navy's readiness score remained "marginal." This assessment combines two major elements of naval readiness: the ability to provide 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 it has prioritized restoring readiness through increased maintenance and training in 2017 and 2018, as Admiral Richardson has stated, it will take at least until 2022 for the Navy to restore its readiness to required levels.[154] To improve personnel readiness, the Navy is adding 7,500 sailors in FY 2019 "to address [manpower] gaps at sea."[155]

The Navy has reported that it continues to meet GFMAP goals but at the cost of future readiness. The U.S. Government Accountability Office (GAO) reported in May 2016

that "[t]o meet heavy operational demands over the past decade, the Navy has increased ship deployment lengths and has reduced or deferred ship maintenance"[156] The GAO further found that the Navy's efforts to provide the same amount of forward presence with an undersized fleet have "resulted in declining ship conditions across the fleet" and have "increased the amount of time that ships require to complete maintenance in the shipyards."[157]

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 requirements 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.[158]

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. Navy leadership responded quickly. The Chief of Naval Operations, Admiral Richardson, directed 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."[159]

The Government Accountability Office 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.[160] 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.[161]

Another critical find 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. Recently completed Surface Warfare Officer School seamanship competency checks of 196 first sea tour Officer of the Deck–qualified junior officers revealed that evaluations of almost 84 percent of these officers revealed "some concerns" or "significant concerns."[162]

The readiness reviews presented numerous corrective actions to improve the material condition of its ships as well as the professional training and operational proficiency of its crews. For example:

- Cancellation of all risk-assessment mitigation plans and waivers for expired mission certifications.[163]
- 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.[164]
- Ready for Sea Assessments on Japan-based cruisers and destroyers, with the exception of those completing or in maintenance, in order to rebaseline mission certifications.[165]
- A redesigned Surface Warfare Officer (SWO) career path that increases

professional and seamanship training, adds individual proficiency assessments, and increases at-sea time.[166]

A Readiness Reform Oversight Council to oversee not only implementation of the recommended actions, but also the ongoing impact of these actions to ensure that they achieve their desired results now and in the future.[167]

The Navy's FY 2019 budget request includes $79 million for FY 2019 and $600 million across the FY 2019–FY 2023 Future Years Defense Program "to address training, manning and equipment issues and recommendations identified in the [Comprehensive and Strategic Readiness Reviews]."[168] The Navy's readiness as it pertains to providing global presence is rated as "marginal." The level of COCOM demand for naval presence and the fleet's ability to meet that demand is similar to that found in the *2018 Index* but is 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.

However, the Navy's readiness corrective actions, coupled with an inadequate fleet size, have resulted in a reduction in its ability to respond to COCOM requirements for sustained presence, crisis support, and surge response in the event of a major conflict. Since COCOM demand signals have been 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 OPTEMPO for missions short of major conflict. While 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 ship-driving skills, it will be several years before they can fully change the culture and raise the fleet's overall professional knowledge and experience.

Even with prioritized investments for 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 2019.

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 over one year ago, the gains have not been sufficient to assume that his concerns do not still hold true today.

Overall U.S. Navy Score: Marginal

The Navy's overall score for the *2018 Index* is "marginal," the same as it was in the *2018 Index*. This was derived by aggregating the scores for capacity ("weak"); capability ("marginal"); and readiness ("marginal"). The Navy's prioritization of restoring readiness and increasing its capacity, matched by increased funding in 2017 and 2018, suggests that its overall score could improve in the near future. Continuation of unstable funding as the result of future continuing resolutions and a return to BCA sequestration-level funding will negate these improvements and instead cause future degradation in the Navy's score.

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 2018 ■ Pending

Aircraft Carrier

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***Nimitz*-Class Aircraft Carrier (CVN-68)** Inventory: **10** Fleet age: **27.5** Date: **1975** The expected life of the *Nimitz*-class nuclear aircraft carrier is 50 years. The class will start retiring in the mid-2020s and will be replaced by the *Ford*-class carriers.	3	3	***Ford*-Class Aircraft Carrier (CVN-78)** Timeline: **2008–2018** Currently in production, the *Ford*-class will replace the current Nimitz-class aircraft carriers. The *Ford*-class will increase aircraft sorties by 25 percent, require a crew of several hundred fewer sailors, and be able to handle more advanced weapon systems. Program cost increases reflect an increased acquisition objective from 3 to 4 ships. **PROCUREMENT** 3 1 **SPENDING** *($ millions)* $32,707 $25,932	1	2
***Ford*-Class Aircraft Carrier (CVN-21)** Inventory: **1** Fleet age: **1** Date: **2017** The expected life of the *Ford*-class nuclear aircraft carrier is 50 years.	5				

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Large Surface Combatant

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***Ticonderoga*-Class Cruiser (CG-47)** Inventory: **22** Fleet age: **28** Date: **1983** The *Ticonderoga*-class guided missile cruiser has a life expectancy of 40 years. There are plans to lay up half of the cruiser fleet to modernize it and extend its life into the 2030s. There are no replacements currently planned.	2	4	***Zumwalt*-Class Destroyer (DDG-1000)** Timeline: **2007–2009** 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. The DDG-1000 program was intended to produce a total of 32 ships, but this number has been reduced to 3. The first DDG-1000 was commissioned in October 2016. **PROCUREMENT** 3 **SPENDING** *($ millions)* $22,292 $1,200	1	1
***Zumwalt*-Class Destroyer** Inventory: **1** Fleet age: **2** Date: **2016** Although the ship has passed sea trials, it continues to experience problems with its combat systems. The second ship of the Zumwalt class is expected to commission in January 2019.	5				
***Arleigh Burke*-Class Destroyer (DDG-51)** Inventory: **66** Fleet age: **16.3** Date: **1991** The *Arleigh Burke*-class guided missile destroyer is the only operating class of large surface combatant currently in production. The Navy plans to extend the service life of the entire class to 45 years from its original life expectancy of 35 years.	3		***Arleigh Burke*-Class Destroyer (DDG-51)** Timeline: **1985–2024** The DDG-51 was restarted in FY 2013 to make up for the reduction in DDG-1000 acquisitions. Future DDG-51s will be upgraded to a Flight III design, which will include the Advanced Missile Defense Radar (AMDR), a more capable missile defense radar. Cost growth reflects a procurement increase to 95 ships. **PROCUREMENT** 80 15 **SPENDING** *($ millions)* $90,566 $31,182	4	4

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Small Surface Combatant

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
Littoral Combat Ship (LCS) Inventory: **12** Fleet age: **3.6** Date: **2008** The Littoral Combat Ship includes two classes: the *Independence*-class and the *Freedom*-class, both of which are in the early phases of production. The ship is expected to have a service life of 25 years. The LCS is designed to meet multiple missions and make up the entirety of the small surface combatant requirement. LCS 14 was commissioned in May 2018.	5	2	**Littoral Combat Ship (LCS)** Timeline: **2009–2025** 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. Procurement of 3 additional LCSs in FY2019 will exceed the planned procurement of 32. A new program called the FFG(x) will fill out the remaining 20-ship small surface combatant requirement. **PROCUREMENT** 32 **SPENDING** *($ millions)* $21,953	2	1
***Avenger*-Class Mine Counter Measure (MCM-1)** Inventory: **11** Fleet age: **26.1** Date: **1987** Designed for mine sweeping and hunting/killing, 11 of the 14 *Avenger*-class ships built are still active. The class has a 30-year life span. The remaining MCMs are expected to be decommissioned throughout the 2020s. There is no replacement in production for this class of ship, but the Navy plans to fill its mine countermeasure role with the LCS.	1				

SSGN Cruise Missile Submarine

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***Ohio*-Class (SSGN-726)** Inventory: **4** Fleet age: **33.1** Date: **1981** Rather than retiring the four oldest *Ohio*-class ballistic missile submarines early, the Navy converted them to SSGN-726 guided missile submarines, equipping them with conventional Tomahawk cruise missiles rather than Trident ballistic missiles tipped with nuclear warheads. The SSGNs provide the Navy with a large stealthy strike capability. The conversion began in 2002 and was completed in 2007. Since the conversion, they are expected to be retired in the late 2020s. The Navy has no planned replacement for the SSGNs once they retire.	2	4	None		

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

Attack Submarines

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***Seawolf*-Class (SSN-21)** Inventory: **3** Fleet age: **18.1** Date: **1997** Larger and equipped with more torpedo tubes than the U.S. Navy's other current nuclear-powered attack submarines, the class was cancelled after three submarines were purchased due to budget constraints in the 1990s. The *Seawolf*-class submarines are expected to be retired by 2030. Meant to replace the *Los Angeles*-class, the *Seawolf* has been replaced by the *Virginia*-class attack submarine.	3		***Virginia*-Class (SSN-774)** Timeline: **1998–2021** In 2017, the Navy increased the official acquistion objective from 30 to 48. **PROCUREMENT** 28 / 20 **SPENDING** *($ millions)* $84,133 / $80,073	5	4
***Los Angeles*-Class (SSN-688)** Inventory: **31** Fleet age: **27.2** Date: **1976** The *Los Angeles*-class comprises the largest portion of the Navy's attack submarine fleet. The class has a 33 year service life. Of the 62 built, 28 have been decommissioned and three have been inactivated awaiting decommissioning. The last *Los Angeles*-class submarine is expected to retire in the late 2020s. The *Virginia*-class is replacing this submarine class.	1	4			
***Virginia*-Class (SSN-774)** Inventory: **15** Fleet age: **6.8** Date: **2004** The *Virginia*-class is the U.S. Navy's next-generation attack submarine. The life expectancy of the *Virginia*-class is 33 years. The *Virginia*-class is in production and will replace the *Los Angeles*-class and *Seawolf*-class attack submarines as they are decommissioned.	4				

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

SSBN Ballistic Missile Submarine

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***Ohio*-Class (SSBN)** Inventory: **14** Fleet age: **27.6** Date: **1984** The SSBN *Ohio*-class is one of the three legs of the U.S. military's nuclear triad. The *Ohio*-class's expected service life is 42 years. The *Ohio*-class fleet will begin retiring in 2027 at an estimated rate of one submarine per year until 2039. The Navy plans to replace the *Ohio*-class with the SSBN(X) or next-generation "Ohio replacement program."	2	4	***Columbia*-Class (SSBN-826)** Inventory: **n/a** Fleet age: **26.7** Date: **1984** In January 2017, the SSBN *Columbia*-class was designated a major defense acquisition program. This also marks the entry of the program into the engineering and manufacturing development phase. The ships will begin construction in FY 2021, and are expected to remain in service until 2080. **PROCUREMENT** 12 **SPENDING** *($ millions)* $9,534 $117,340	5	5

Amphibious Warfare Ship

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***Wasp*-Class Amphibious Assault Ship (LHD-1)** Inventory: **8** Fleet age: **21.3** Date: **1989** The *Wasp*-class is the Navy's current amphibious landing helicopter deck, meant to replace the *Tarawa*-class LHA. This ship has a 40-year life span. This class is no longer in production and will be replaced by the new *America*-class.	3	3	***America*-class (LHA-6)** Timeline: **2007–2017** The *America*-class is in production with all three LHA-6s already procured. There has been significant cost growth in this program resulting in a Nunn–McCurdy cost breach. The program is also experiencing a 19-month delay because of design problems. One problem was caused by the level of heat from the F-35B STOVL's exhaust. The LHA-7 will follow designs from the LHA-6; FY2017 funded the procurement of the third and final *America*-Class LHA. **PROCUREMENT** 3 **SPENDING** *($ millions)* $10,748 $509	1	1
***America*-Class Amphibious Assault Ship (LHA-6)** Inventory: **1** Fleet age: **3.8** Date: **2014** The *America*-class, the Navy's new class of large-deck amphibious assault ships, is meant to replace the retiring *Wasp*-class LHDs. The lead ship was delivered in April 2014. The *America*-class is designed to accommodate the Marine Corps's F-35Bs.	5				

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Amphibious Warfare Ship

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***San Antonio*-Class Amphibious Transport Dock (LPD-17)** Inventory: **11** Fleet age: **7.1** Date: **2006** The *San Antonio*-class is the replacement for the *Austin*-class LPD and makes up most of the LPD inventory. The LPDs have well decks that allow the USMC to transfer the vehicles and supplies carried by the ship to the shore via landing craft. The LPD can also carry 4 CH-46s or 2 MV-22s. The class has a 40-year life expectancy.	5	3	***San Antonio*-Class Amphibious Transport Dock (LPD-17)** Timeline: **1996–2016** The LPD-17s are replacements for the *San Antonio*-class LPDs. All 13 LPD-17s have been procured. **PROCUREMENT** 13 **SPENDING** *($ millions)* $22,464 $195	5	4
***Whidbey Island*-Class Dock Landing Ship (LSD-41)** Inventory: **8** Fleet age: **29.5** Date: **1985** The *Whidbey Island*-class is a dock landing ship that transports Marine Corps units, equipment, and supplies for amphibious operations through use of its large stowage and well decks. The *Whidbey Island*-class and *Harpers Ferry*-class ships are to be replaced by LPD–117 Flight II program, which began procurement in FY2018.	3				
***Harpers Ferry*-Class Dock Landing Ships (LSD-49)** Inventory: **4** Fleet age: **22.2** Date: **1995** A follow-on to the *Whidbey Island*-class, the *Harpers Ferry*-class LSDs have a larger well deck with more space for vehicle stowage and landing craft. Like the *Whidbey Island*-class, these ships should remain in service until 2038. The *Whidbey Island*-class and *Harpers Ferry*-class ships are planned to be replaced by the LPD–17 Flight II, which began procurement in FY2018.	3		**LPD-17 Flight II** Timeline: **2018–TBD** Previously known as LX(R), the LPD–17 Flight II program will procure 13 ships to replace the Navy's LSD-type ships. The Navy originally planned to procure the first Flight II ships in 2020, however accelerated procurement funding enabled procurement of the first LPD-17 Flight II in 2018. A procurement timeline remains in development. **PROCUREMENT** 1 12 **SPENDING** *($ millions)* $1,800	5	5

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Airborne Early Warning

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
E-2C Hawkeye Inventory: **50** Fleet age: **32** Date: **1964** The E-2C Hawkeye is a battle management and airborne early warning aircraft. While still operational, the E-2C is nearing the end of its service life and is being replaced by the E-2D Advanced Hawkeye. The E-2C fleet received a series of upgrades to mechanical and computer systems around the year 2000.	1	4	**E-2D Advanced Hawkeye** Timeline: **2009–2024** Meant to replace the E-2C, the E-2D Hawkeye is in production. The original plan was to purchase five per year until 2023. **PROCUREMENT** 51 / 24 **SPENDING** *($ millions)* $14,805 / $6,652	5	4
E-2D Advanced Hawkeye Inventory: **30** Fleet age: **3** Date: **2013** A more advanced version of the E-2C, the E-2D provides improved battle management capabilities.	5				

Electronic Attack Aircraft

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
EA-18G Growler Inventory: **131** Fleet age: **4** Date: **2010** The EA-18G electronic warfare aircraft replaced the legacy EA-6B Prowlers. The platform is still in production and is relatively new.	5	5	**EA-18G Growler** Timeline: **2006–2016** The EA-18G Growler has been in production for several years, with few current acquisition problems. The program total of 160 is an increase from previous years, which estimated the Navy would purchase 88. All 160 have been procured. **PROCUREMENT** 160 **SPENDING** *($ millions)* $15,031 / $377	5	4

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Fighter/Attack Aircraft

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
F/A-18 A-D Hornet Inventory: **139** Fleet age: **25.5** Date: **1983** The F/A-18 is the Navy's older carrier-based fighter and strike attack aircraft. The Navy has been trying to extend the life of the later variants (C-D) from 6,000 flight hours to potentially 10,000. In 2019, the Navy plans to transfer its remaining F/A–18 A–Ds to the Marine Corps to help maintain its fleet through 2030.	1	3	**F-35C Joint Strike Fighter** Timeline: **2009–2033** The F-35C is the Navy's variant of the Joint Strike Fighter. The Joint Strike Fighter faced many issues during its developmental stages, including engine problems, software development delays, cost overruns incurring a Nunn–McCurdy breach, and structural problems. The F-35C variant was always scheduled to be the last one to reach IOC, which repeatedly has been and is currently planned for 2019. **PROCUREMENT** 75 185 **SPENDING** *($ millions)* $133,099 $273,122	1	1
F/A-18 E/F Super Hornet Inventory: **561** Fleet age: **15** Date: **2001** The F/A-18 E/F Super Hornet is a newer, more capable version of the Hornet. The Navy is aiming to have a combination of Super Hornets and F-35Cs make up their carrier-based strike capability. The F/A-18E-F has an expected service life of 20 years.	2				

NOTES: 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.
SOURCE: Heritage Foundation research using data from government documents and websites. See also Dakota L. Wood, ed., *2018 Index of U.S. Military Strength* (Washington, DC: The Heritage Foundation, 2018), http://index.heritage.org/militarystrength/.

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

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U.S. Air Force

The U.S. Air Force (USAF) is the youngest of the four branches of the U.S. military, having been born out of the Army Signal Corps to become its own service in 1947. The USAF's mission set has expanded significantly over the years, and this is reflected in the organizational changes in its 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 the "fly, fight, and win" nature of the service. Space's rise to prominence began in the early 1950s, and with it came a host of faculties that would help to expand the impact (and mission set) of this service.

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 an even greater squeeze on the resources available to the Air Force in an incredibly strained and competitive fiscal environment. Using the 2012 Defense Strategic Guidance (DSG) as its framework for determining investment priorities and posture, the Air Force intentionally traded size for quality by aiming to be a "smaller, but superb, force that maintains the agility, flexibility, and readiness to engage a full range of contingencies and threats."[1]

There can be no doubt that the Air Force has become smaller. Testifying before the Senate Armed Services Committee in 2017, Secretary of the Air Force Heather Wilson and Air Force Chief of Staff General David Goldfein stated flatly that the Air Force "is too small for the missions demanded of it." Even with its reduced size, the funding available through fiscal year (FY) 2017 did not allow the service to acquire enough aircraft to reverse the downward spiral of aircraft availability or the level of flying time that pilots need to sustain more than a marginal level of readiness.[2] Appearing before the same committee in 2018, Secretary Wilson and General Goldfein testified that "[t]he projected mismatch between demand and available resources has widened."[3]

Sequestration has forced General Goldfein to make strategic trades in capability, capacity, and readiness to meet the current operational demands of the war on terrorism and prepare for the future. Budgetary uncertainty over the five years of sequestration has had many detrimental effects on the USAF's ability to sustain the war on terrorism, remain ready for a full-spectrum war, and modernize its aging fleet of aircraft. Presidential budgets during the sequestration years of the Obama Administration always proved aspirational, and those trades among capability, capacity, and readiness failed to keep pace with the demands placed on the service. When funding did arrive, it was through continuing resolutions well into

the year of execution, which prevented any real form of strategic planning.[4]

The Obama Administration's FY 2017 budget would have continued that decline if Congress had not delivered a $5.6 billion topline increase through a request for additional appropriations that was approved in the spring of 2018. The additional appropriations allowed the Air Force to bring on an additional 4,000 active-duty personnel and fully fund its flying hour program, arresting the decline in people, equipment, and training.[5] The President's budget will increase the Air Force topline from $132.2 billion in FY 2017 to $146.3 billion in FY 2018 and $156.2 in FY 2019. Used prudently, these funding levels will enable the Air Force to reverse downward trends in capacity, capability, and readiness, all three of which are under stress.

Capacity

The tradeoff in capacity has seen near-term reductions in lift, command and control, and fourth-generation fighter aircraft to ensure that the Air Force's top three modernization programs—the F-35A, Long-Range Strike Bomber (LRS-B), and KC-46A—are preserved.[6] Unlike some of the other services, the Air Force did not expand in numbers during the post-9/11 buildup. Rather, it got smaller as programmed retirement dates for older aircraft were not offset by programmed retirements. Successive delays in F-35 and KC-46 development have carried over into production, leaving both fighter and tanker fleets short of the ready numbers required to train for and execute their respective missions.

Air Force capacity in terms of the number of aircraft had been on a constant downward slope since 1952.[7] The President's budget for FY 2018 had projected a decrease from 5,517 aircraft in 2017 to 5,416 in 2018,[8] but over the course of the year, the inventory slipped to 5,373. The President's budget for FY 2019 ends the slide and adds 53 aircraft to the roster for a projected total of 5,426 at the end of FY 2019.[9] Totals for specific platforms can be found in Table 7.

Adversaries are modernizing and innovating faster than the Air Force is, jeopardizing America's technological advantage in air and space. Before 1991, the Air Force bought approximately 510 aircraft per year. Over the past 20 years, it has acquired an average of only 96 new aircraft per year. Today, the average age of our aircraft is over 28 years, yet the Air Force—even with the budget increases for FY 2018 and FY 2019—has no plans to raise the acquisition rates for the F-35 or KC-46 to buy down that average.[10] The decades-long trend of steadily declining aircraft numbers, coupled with the fleet's ever-growing average age, may be lulling senior leaders into the belief that the service can be fixed sometime in the future, but the numbers tell a different story.

The combination of downsizing following the end of the Cold War and Budget Control Act of 2011 (BCA) spending caps has caused the Air Force to shrink from 70 combat-coded[11] active-duty fighter squadrons during Desert Storm[12] to just 55 across the whole of the active-duty, guard, and reserve force today. Only 32 of those squadrons are part of the active-duty Air Force.[13]

For the purpose of assessing capacity and readiness, this *Index* refers to combat-coded aircraft and units maintained within the Active component of the U.S. Air Force. "Combat-coded" aircraft and related squadrons are aircraft and units assigned a wartime mission. The numbers exclude units and aircraft assigned to training, operational test and evaluation, and other missions. The software and munitions carriage/delivery capability of aircraft in these 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 limit their utility in combat. While those jets may be slated for upgrades, hardware updates sideline jets for several months to manifest, and training wings and certain test organizations will be the last to receive those upgrades.

TABLE 7

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

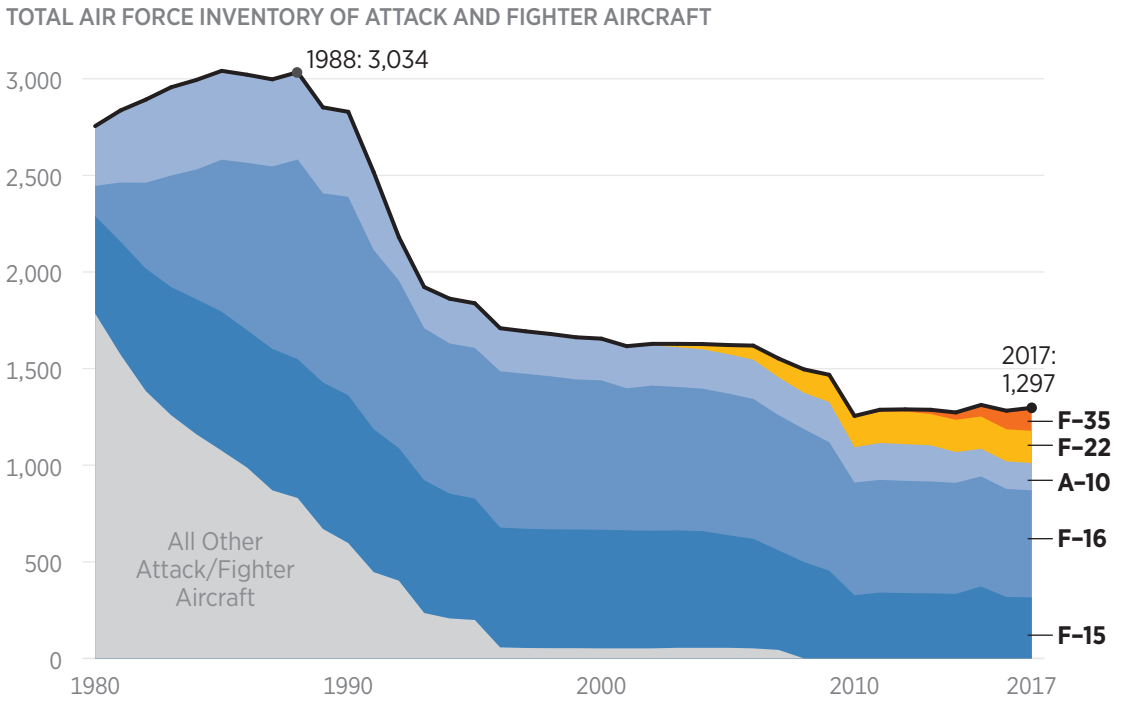
* FY 2019 total numbers are contingent upon acquisition of six KC-46 aircraft.
SOURCE: Headquarters U.S. Air Force response to query by The Heritage Foundation.

heritage.org

CHART 14

Air Force Attack and Fighter Aircraft

Total aircraft inventory (including training and replacement aircraft) has declined by 57 percent over 30 years. Although two new aircraft have been added to the inventory in the past two decades, their procurement rates have barely offset the retirement of legacy systems.



NOTE: These figures differ slightly from figures found elsewhere in this *Index*. The *Index* only assesses combat-coded aircraft (capable of executing operational missions).

SOURCES:

- Pre–1996: James C. Ruehrmund Jr. and Christopher J. Bowie, "Arsenal of Airpower: USAF Aircraft Inventory 1950–2009," The Mitchell Institute, November 2010, https://higherlogicdownload.s3.amazonaws.com/AFA/6379b747-7730-4f82-9b45-a1c80d6c8fdb/UploadedImages/Mitchell%20Publications/Arsenal%20of%20Airpower.pdf (accessed August 6, 2018).
- 1996–current: *Air Force Magazine*, "Air Force Magazine Almanacs Archive," 1997–2018, http://www.airforcemag.com/Almanacs/Pages/default.aspx (accessed August 6, 2018).

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The Heritage *Index of U.S. Military Strength* assesses that a force of 1,200 fighter aircraft is required to execute a two–major regional contingency (two-MRC) strategy, a number that is also reflected in a 2011 study conducted by the Air Force.[14] In 2015, pressured by a third year of budget caps dictated by the BCA, the service acknowledged that it could reduce the 1,200 fighter requirement by 100 jets by assuming more risk.[15]

Of the 5,426 manned and unmanned aircraft projected to be in the USAF's inventory at the end of FY 2019, 1,385 are active-duty fighters, and 924 of these are combat-coded aircraft.[16] This number includes all active-duty backup inventory aircraft as well as attrition reserve spares.[17]

The number of fighters and fighter squadrons available to deploy to contingency

TABLE 8

Precision Munitions Expenditures and Acquisitions

NUMBER OF MUNITIONS

	Expended FY 2017	Expended FY 2018 (est.)	FY 2019 Acquisitions
JDAM	21,628	5,462	36,000
HELLFIRE	2,990	2,110	4,354
SDB-I	2,871*	749*	6,853
SDB-II			510
APKWS	0	0	7,279
JASSM-ER	0	19*	360
LGB	1,660	276	0
TOTAL	**29,149**	**8,597**	**56,105**

* Figures not broken out.
SOURCE: Headquarters U.S. Air Force response to query by The Heritage Foundation.

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operations does not just affect 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. The only two ways to solve that problem are to decrease operational tempo and/or increase 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 that option has not been brought up as a possibility by the Chief of Staff, much less through actual Air Force budgetary commitment.

The funding that facilitated the Reagan build-up 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 forecasting an end to the current defense plus-up in FY 2020, and unless Congress intervenes, the opportunity to increase 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 render an assessment of the overall health of this vital area. The inventory for precision-guided munitions (PGM) has been severely stressed by nearly 17 years of sustained combat operations and budget actions that limited the service's ability to procure replacements and increase stockpiles. In 2017, the Air Force alone expended 29,149 precision-guided munitions. While Overseas Contingency Operations (OCO) funding has provided some relief, there is typically a delay of 24–36 months between conclusion of a contract and delivery of these weapons, which means that munitions are often replaced three years after they were expended.

During the past three years, however, funding has improved significantly, and the preferred munitions are starting to recover to pre-war levels.[18] Table 8 depicts recent expenditures as well as inventory replenishments.

Capability

The risk assumed with a marginal level of capacity has placed an ever-growing burden on the capability of the assets within the Air Force portfolio. The ensuing capability-over-capacity

strategy centers on the idea of developing and maintaining a *more*-capable force that can win against advanced fighters and surface-to-air missile systems now being developed by top-tier potential adversaries like China and Russia that 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 metal fatigue. The average age of Air Force aircraft is 28 years, and some fleets, such as the B-52 bomber, average 56 years. In addition, KC-135s comprise 87 percent of the Air Force's tankers and are over 56 years old on average, and the average age of the F-15C fleet is over 34 years, leaving less than 8 percent of its useful service life remaining.[19] That same fleet comprises 44 percent of USAF air superiority platforms.[20] An unknown number of F-15s will likely receive airframe modifications through service life extension programs (SLEPs) that will keep them in service at least through 2030.

The fleet of F-16Cs are 27 years old on average,[21] and the service has used up nearly 82 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.[22] Although SLEPs can lengthen the useful life of airframes, the dated avionics of those airframes become increasingly expensive to maintain. Those modifications are costly, and the added expense consumes available funding and reduces the amount the services have to invest in modernization, which is critical to ensuring future capability.

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),[23] but even here the numbers fell in 2018 from 371[24] to 220 with the complete retirement of the MQ-1 Predator weapons system.[25] 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, which is now 35 years old on average with no scheduled retirement currently on the books.[26]

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 was constructed in 1979. The reliability of the Air Force fleet is at risk because of the challenges linked to aircraft age and flight hours, and the fleet needs to be modernized. In the 2019 NDAA, Congress elected not to recapitalize the J-STARS fleet, in line with the service's belief that that 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, along with enhanced and hardened communications links. The Air Force refers to this solution as the Advanced Battle Management System, envisioned as an all-encompassing approach to both airborne and ground Battle Management Command and Control (BMC2) that is designed to allow the Air Force to fight and support joint and coalition partners in the high-end fight of tomorrow.[27]

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 Air Force's number one priority remains the F-35A. It is the next-generation fighter scheduled to replace all legacy multirole and close air support aircraft. The rationale for the Air Force's program of record of 1,763 aircraft is to replace every F-117, F-16, and A-10 aircraft on a one for one basis.[28] The Defense Department made draconian cuts in the original plan to purchase 750 F-22A program of record aircraft,[29] reducing it to a final program of record of just 183 total active, guard, and reserve fighters.[30] Even so,

Heritage Foundation experts find a requirement for 1,200 combat-coded fighters, and given the service's intent to retain hundreds of fourth-generation fighters in its fleet for the foreseeable future, the programmed purchase of F-35As should be reduced to 1,260 aircraft.[31]

The Active Air Force currently has just 96 F-15Cs left in its fleet, and the concerns about what platform will fill this role when the F-15C is retired have now manifested into a significant gap. Even with their superior technology, 166 combat-coded F-22As from the active and guard inventory would be unable to fulfill the wartime requirement for air superiority fighters for even a single major regional contingency.[32] The F-35A's multirole design favors the air-to-ground mission, but its fifth-generation faculties will allow it also to be dominant in an air-to-air role,[33] which will allow it to augment the F-22A in many scenarios.[34]

Fulfilling the operational need for air superiority fighters will be further strained in the near term because the F-22 retrofit—a mix of structural alterations to the fleet of aircraft needed for the airframe to reach its promised service life—has been forecasted to run through 2021. As a result of the retrofit, only 62 percent (103 of 166) of the active duty mission fleet of F-22As are currently available.[35]

As with the other Joint Strike Fighter variants, the F-35A has experienced a host of developmental problems that resulted in its initial operating capability (IOC) date being pushed from 2013 to 2016. This system of systems relies heavily on software, and the 3F software that enables full operating capability (FOC) is currently being fielded.[36] The updated software and required hardware modifications are already incorporated in jets coming off the production line.[37] The F-35 has endured several delays and controversies, but experienced fighter pilots now flying the jet have a great deal of confidence in their new fighter.[38]

A second top priority for the USAF is the KC-46A air refueling tanker aircraft. Although the KC-46 has experienced a series of delays, it reached a milestone in August 2016 that enabled low-rate initial production.[39] The Air Force awarded the contract for 19 initial aircraft in August 2016 and has programmed delivery of 70 aircraft by FY 2020.[40] It expects to have all 179 of these new tankers in service by 2028. The Pegasus "will replace less than half of the current tanker fleet and will leave the Air Force with over 200 aging KC-135s awaiting recapitalization."[41]

The third major priority for the USAF from an acquisition perspective is the B-21 Raider, formerly called the Long-Range Strike Bomber (LSRB). As of May 2017, the capacity of the Air Force bomber fleet had fallen from 290 aircraft in 1991 to 156 B-1s, B-2s, and B-52s, and "[t]he current number [was] insufficient to meet Defense Planning Guidance and nuclear guidance while sustaining current operational demands and maintaining sufficient training and readiness capacity."[42]

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.[43]

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.[44]

The B-21 is programmed to begin replacing portions of the B-52 and B-1B fleets by the mid-2020s.[45] 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 viable until it is replaced by the B-21.

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

The Air Force's strategy of capability over capacity is encumbered by the requirement to sustain ongoing combat operations in Afghanistan, Iraq, and Syria. While operations are down in Syria and Iraq, they are likely to accelerate in Afghanistan during the next two years.

Readiness

During testimony before the Senate Armed Services Committee 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."[46] While the Department of Defense has seemingly stifled open conversations or testimony about readiness, there are plenty of facts and ancillary evidence to support a conclusion that their statement and other 2017 general officer testimony still apply in 2018.

Full-spectrum operations include the seamless conduct of nuclear deterrence operations, continued support of counterterrorism (CT) operations, and readiness for potential conflict with a near-peer competitor. During testimony before the House Armed Services Committee Subcommittee on Readiness, Major General Scott West informed Congress that the Air Force was "able 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."[47]

The Air Force used five areas or "levers" of readiness to inform the FY 2018 budget request:

- Flying Hour Program (FHP), which includes funding sortie production;
- Critical Skills Availability (Pilot/Maintenance specialty level training);
- Weapons System Sustainment (Aircraft availability production);
- Training Resource Availability (Funding for Ranges, Live/Virtual Construct);
- Deploy to Dwell (Funding for force capacity to meet current taskings).

Flying Hour Program and Critical Skills Availability. A shortage of aircraft maintenance personnel (maintainers) limited the ability of the Air Force to generate sorties through 2017. The Air Force was short 3,400 aircraft maintainers at the close of 2016,[48] and senior leaders cited this shortfall as the principal reason why fighter pilots who once averaged over 200 hours per year were fortunate to fly 120 hours in 2014.[49] The average was said to have risen above 150 hours a year in 2017,[50] but data provided by the Air Force organization charged with tracking these details revealed that fighter pilots received an average of 11.8 hours per month in 2017, and the average has fallen to just 11.6 hours per month for the first five months of 2018. Pilots are flying less than seven sorties per month, less than two times a week on average. If that rate holds for the rest of the year, pilots will receive just 139 hours in 2018.

F-35A pilots received the lowest number of hours and sorties of any other major weapons system in the fighter community, averaging just 6.3 hours and 6.3 sorties per month—an annualized rate of just 76 hours and 76 sorties per year.[51] These low sortie rates are happening in spite of the fact that maintenance manning levels have almost fully recovered from the shortfalls suffered in previous years.

In June 2016, responding to written questions posed as part of the hearing on his confirmation as Chief of Staff of the Air Force, General David Goldfein stated that his service could not surge enough combat-ready forces to execute a single MRC and still meet the remaining demand for global combat-ready forces. He went on to say that less than 50 percent of combat units are ready for "full spectrum"

TABLE 9

Maintenance Skill Level Manning

Skill Level	Authorized Level	Actual Manning	Manning Percentage
3–Level (Apprentice)	14,525	17,331	119%
5–Level (Journeyman)	16,857	16,225	91%
7–Level (Craftsman)	33,492	32,152	96%

NOTE: Figures are current as of June 2018.
SOURCE: Headquarters U.S. Air Force response to query by The Heritage Foundation.

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(high-threat, high-intensity) combat.[52] Nearly a year later, on March 29, 2017, Lieutenant General Mark Nowland, Air Force Deputy Chief of Staff for Operations, testified that only four of the Air Force's 55 total (Active, Reserve, and National Guard) fighter squadrons were at the very highest levels of readiness and that fewer than half were in the top two readiness tiers.[53] There is no evidence of any real improvement since then.

The current state of Air Force fighter readiness has many intangibles, but the things that can be measured such as average sortie per aircraft/month and total flying time point to a readiness level that has not improved over 2017. These sortie/hour rates remain below those of the hollow force experienced during the Carter Administration in the late 1970s.

Weapons System Sustainment. Nearly constant deployments and a shortage of maintenance personnel have severely limited aircraft availability and sortie production. Maintenance manning shortfalls have almost fully recovered from the previous year, but manning for pilots has continued to fall.

On March 29, 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, 294 reserve). Of this amount, the total force was short 1,211 fighter pilots (873 active, 272 guard, 66 reserve).[54] The numbers continued to fall, and at the end of FY 2017, the Air Force was short more than 2,000 pilots, of which 1,300 are empty fighter pilot billets across the Total Force (All Active/Guard/Reserve requirements). Although the Air Force no longer breaks these numbers out by Active Guard and Reserve, the total pilot shortfall has grown by 29 percent, and 9 percent for the fighter community over the previous year.[55]

The pipeline for pilots is also suffering. After a rash of hypoxia incidents, the Air Force grounded its fleet of T-6 trainers, effectively shutting down the pilot training pipeline for a month in February 2018.[56] The Air Force had projected that it would graduate 1,200 pilots in 2018, but the grounding will reduce that number by at least 82 for a total of 1,118 pilots in 2018.[57] The projections for 2019 increase pilot production to 1,300. However, both numbers rely on a 100 percent graduation rate for every pilot training class. In 2016, the rate was 93 percent, and in 2017, the rate was 98 percent,[58] but the expectation for 100 percent graduation means that the quality of those respective year groups will be even lower.

Training Resource Availability (Funding for Ranges, Live/Virtual Construct). To prepare for full-spectrum combat in peacetime, pilots require the opportunity to engage high-end air-to-air and surface-to-air missile platforms and simulators on a regular basis. The two effective methods for giving aircrew the repetitions they need to sharpen these perishable skills are live, large force exercises (LFEs) over well-equipped ranges or a live/virtual construct.

The three exercises/ranges that have the airspace and assets required for a live high-threat training are the Red Flag exercises at Nellis Air Force Base, Nevada, and Elmendorf Air Force Base, Alaska. The Air Force funded seven of these large force exercises in 2018,[59] and the same number will be executed in FY 2019.[60]

The live/virtual construct attempts to fill the gaps between deployments to Nellis and Elmendorf through networked simulators as well as plug-and-play simulations that feed a virtual scenario and the accompanying threats into the software/cockpit displays of fighters flying "local" missions out of their home airfields. While these systems show genuine progress, the number of opportunities offered does not offset the drought in sorties, and the pilots themselves do not regard them as replacements for actual flying time.[61]

Deploy to Dwell. The last of the five Air Force levers or areas of readiness is the deploy-to-dwell ratio. The projected dwell time for active-duty personnel in the FY 2019 President's budget request is 1:2 dwell (or better) for active-duty members and a 1:5 dwell (or better) for Guard and Reserve personnel. On paper, these look healthy enough, but the major deployments do not include shorter-term dispatch to schools, exercises, and other non-elective temporary duty assignments, and those career specialties that find themselves in the 3 percent to 4 percent that do not meet the established goals for dwell are in such great demand that they generally do not even come close to the target dwell.

Wartime Readiness Materials. An additional consideration in assessing Air Force readiness is the availability of wartime readiness materials (WRM) like munitions. Funding limitations have not allowed restocking of all WRM accounts. Munitions have been used faster than they have been replaced. While programmed purchases for 2019 will begin to reverse that trend, the air-to-surface weapons that offer stand-off, direct attack, and penetrators are short of current inventory objectives.[62] The concurrent shortage of air-to-air weapons could lead to an increase in the time needed to gain and maintain air superiority in future environments,[63] particularly highly contested ones.

The Air Force has rapidly been depleting its wartime inventory levels of precision-guided munitions. Over 87,000 missiles and bomb-related munitions have been used since August 2014,[64] significantly drawing down stockpiles, and the rate of expenditure has only grown with time. Even with the current buy plan for 2018 and 2019, absent sustained and increased funding, the ongoing depletion of our munition stockpiles will continue to reduce Air Force readiness and jeopardize America's ability to meet its national security objectives.[65]

Space. The classified nature of deployed space assets and their capabilities makes any assessment of this mission area challenging. That said, 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, the United States' historically unchecked dominance in space has facilitated an environment of overreliance on the domain and an underappreciation of the vulnerabilities of its capabilities.[66] Some space assets represent nearly single-point failures in which a loss caused by either 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.[67]

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.[68]

China and Russia are investing heavily in ground-based anti-satellite (ASAT) missiles;[69] orbital ASAT programs that can deliver a kinetic blow;[70] or co-orbital robotic interference to alter signals, mask denial efforts, or even pull adversary satellites out of orbit.[71] 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 is in its design.[72] Every satellite we currently rely on 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 precisely find, fix, and destroy targets, space will remain both a dominant and an incredibly vulnerable domain for the U.S. Air Force.

The omnibus appropriations deal reached in March 2018 included funding for the Air Force to increase the unclassified budget for space combat operations and space procurement over FY 2017 levels[73] by a total of 34 percent in FY 2018 and 23 percent for FY 2019.[74] While there certainly are increases for Air Force space assets in the classified funding streams, these are substantial increases that will allow this service to increase both the capability and survivability of U.S. Air Force satellite constellations.

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 two-MRC–capable force (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 and the risk of employing 100 percent of fighters at any one time.

- **Two-MRC Level:** 1,200 fighter aircraft.
- **Actual 2018 Level:** 924 fighter aircraft.

Based on a pure count of combat-coded fighter/attack platforms that have achieved IOC, the USAF currently is at 77 percent of the two-MRC benchmark, and even that low number should be taken with a few caveats. The F-35 will become a highly advanced and capable multirole platform, but the 210 aircraft that have entered the USAF inventory to date[75] are only IOC and do not yet field many of the capabilities that would constitute full-spectrum readiness.

The 924 figure yields a capacity level well within the methodology's range of "marginal." Aircraft require pilots to fly them and maintainers to launch, recover, and fix them. With a fighter pilot shortage of over 1,200, the ability of the Air Force to meet the wartime manning requirements for fighter cockpits continues to wane. Those factors, coupled with the dismally low flying hours that those pilots are receiving, has kept the rating at "marginal." As noted, given shortfalls in personnel and flying time, the Air Force capacity score continues to trend toward "weak."

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 *2018 Index*'s assessment. However, with new F-35 and KC-46 aircraft continuing to roll off their respective production lines, the Air Force should slowly begin to turn this corner.

Readiness Score: Weak

The Air Force scores "weak" in readiness in the *2019 Index*, a grade lower than it received in the *2018 Index*. The Air Force's growing deficit of pilots and a systemic drought of sorties and flying hours for those pilots since 2012 are the principal reasons for the drop in this assessment.[76] The Air Force should be prepared to respond quickly to an emergent crisis and retain full readiness of its combat airpower, but it has been suffering from degraded high-end combat readiness since 2003, and implementation of BCA-imposed budget cuts in FY 2012 cut flying hours and sortie rates to the bone.

Fighter pilots should receive an average of three sorties a week and 200 hours a year to have the skill sets to survive in combat but have averaged less than two sorties a week and 150 hours of flight time a year for the past five years. Even with the greatly improved maintenance manning/experience levels and the increased funding for FY 2018, there has been no improvement. This fact and the ever-growing exodus of experienced pilots from the ranks of the active-duty force are very troubling indicators. Both factors have already strained the service and, unless reversed in the near term, will lead to a death spiral for both retention and readiness challenges in the very near future.

Overall U.S. Air Force Score: Marginal

The Air Force is scored as "marginal" overall. This is an unweighted average of its capacity score of "marginal," capability score of "marginal," and readiness score of "weak." This score has trended downward since the *2018 Index* largely because of two factors: a drop in "capacity" that has not effectively changed and a readiness score of "weak." 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. While the Air Force could eventually win a single major regional contingency in any theater, the 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			✓		

Strategic Bomber

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
B-52 Inventory: **58** Fleet age: **56** Date: **1955** The B-52, the oldest of the bombers, can provide global strike capabilities with conventional or nuclear payloads, although it largely has made up the core of the strategic bomber force. The aircraft entered service in 1955 and was in production until 1962.	1		The B-21 is intended to replace the Air Force bomber fleet. Initial conventional capability is enhanced for the mid-2020s. The program completed primary design review in early 2017.		
B-1 Inventory: **61** Fleet age: **30** Date: **1986** The B-1, originally designed to carry nuclear weapons, was reconfigured for conventional weapons in the early 1990s. The program entered service in 1986 and completed production in 1988. The B-1B will remain in service until 2040.	3	1			
B-2 Inventory: **20** Fleet age: **23** Date: **1997** The B-2 bomber provides the USAF with global strike capabilities. It can carry both nuclear and conventional payloads. Initially deployed in 1997, the aircraft communication modules are being upgraded. It is expected to remain in service until 2058.	4				

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Ground Attack/Multi-Role Aircraft

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
A-10 Thunderbolt II Inventory: **141** Fleet age: **36** Date: **1977** The A-10 is the only USAF platform designed primarily for close air support, which it provides usng a variety of conventional munitions. The USAF has proposed retiring the aircraft earlier than the planned 2028 date for budget reasons.	2	1	**F-35A** Timeline: **2007–2038** The F-35A is the Air Force variant of the Joint Strike Fighter program, a multirole fixed-wing aircraft. It is currently in early stages of production. The program has faced many issues including a Nunn–McCurdy cost breach during development, grounding due to engine problems, and software development problems. The F-35A achieved IOC on August 2, 2016. **PROCUREMENT** 234 1,529 **SPENDING** *($ millions)* $132,461 $273,670	5	1
F-16 Inventory: **570** Fleet age: **27** Date: **1978** The F-16 is a multirole aircraft that was built between 1976 and 1999. It has received various upgrade blocks over that time. The aircraft was expected to last about 30 years.	2	1			
F-35A Inventory: **122** Fleet age: **2.6** Date: **2016** See Ground Attack Modernization Program entry. The USAF has received a small portion of a projected 1,763 total aircraft for the program.	5				

Fighter Aircraft

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
F-15 Inventory: **317** Fleet age: **30** Date: **1979** The F-15 is a legacy fighter that performs air superiority missions. It is no longer in production. The newer F-15E Strike Eagle variant is to operate until 2025 to supplement the F-22.	1	2	None		
F-22 Inventory: **166** Fleet age: **10** Date: **2005** The F-22 is the preeminent air superiority fighter aircraft. The stealth aircraft completed production in 2009 after a dramatic cut of its overall order from 750 to 187. It is currently being modified.	5				

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Tanker

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
KC-10 Inventory: **59** Fleet age: **33** Date: **1981** An aerial refueling tanker supporting the USAF's Mobility and Lift mission, the KC-10 was deployed in 1981. The aircraft was purchased to increase the number of tankers available, which the Air Force posited did not meet current requirements. The aircraft is no longer in production, but is planned to remain in inventory until 2040.	3		**KC-46** Timeline: **2015–2027** The KC-46 is meant to replace the KC-135. The program entered low rate initial production in August 2016 after having been delayed by a year due to "design changes and late parts." The first delivery is anticipated in October 2018. **PROCUREMENT** 55 124 **SPENDING** *($ millions)* $15,712 $28,106	1	3
KC-135 Inventory: **156** Fleet age: **57** Date: **1956** The KC-135 supports the mobility and lift mission by providing the joint force aerial refueling capability. The KC-135 makes up the bulk of the aerial refueling capability. The aircraft was initially deployed in 1956, completing production in 1965. The aircraft has undergone several modifications, mainly engine upgrades to improve reliability. It is expected to be in service until 2040, but excessive usage has created many reliability issues due to problems from wear and tear, such as corrosion and fuel bladder leaks.	1	1			

Heavy Lift

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
C–5M Inventory: **35** Fleet age: **30** Date: **1970** The C-5 is the USAF's largest mobility and lift aircraft, enabling it to transport a greater amount of cargo (270,000 pounds) compared with other transport aircraft. Originally deployed in 1970, the aircraft has undergone three modification cycles. The latest started in 2009 to upgrade the platform to a C-5M. Funding is now completed for the modernization program.	2	5	None		

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Heavy Lift

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
C-17 Inventory: **162** Fleet age: **14** Date: **1993** The C-17 is a large fixed-wing transport aircraft in support of USAF's mobility and lift mission. The aircraft can lift 170,900 pounds and land on short runways. The aircraft entered service in 1995. The program was expanded from 120 aircraft to 223 aircraft. The procurement program for the C-17 was recently completed. The aircraft was originally planned to last 30 years, but more frequent usage may shorten that life span.	3	5	None		

Medium Lift

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
C-130J Inventory: **87** Fleet age: **8.8** Date: **1956** The C-130J aircraft supports the USAF's tactical mobility and lift capability. Unlike the other transport aircraft, the C-130s can land on rough dirt strips. It can carry about 42,000 pounds and is expected to last 25 years. The air force active component completed transition to the C-130J in October 2017.	5	5	**C-130J** Timeline: **1994–2023** The program provides the Air Force with an upgraded medium-lift capability. The C-130J can lift over 40,000 pounds of cargo. The frame supports various other types of aircraft, such as the USMC tanker KC-130J. There are few issues with the current acquisition of C-130Js. **PROCUREMENT** 168 2 **SPENDING** *($ millions)* $14,124 $110	4	4

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Intelligence, Surveillance, and Reconnaissance (ISR)

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
RQ-4 Global Hawk Inventory: **29** Fleet age: **6.6** Date: **2011** The RQ-4 is an unmanned aerial vehicle (UAV) that supports the USAF's ISR mission. 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.	4	4	None		
MQ-9 A/B Inventory: **200** Fleet age: **4.4** Date: **2007** The MQ-9 Reaper replaced the MQ-1 Predator to fulfill the USAF's ISR mission. The UAV is in production. The expected life span of the MQ-9 is 20 years.	4		**MQ-9** Timeline: **2002–2017** The MQ-9 is in production. It has experienced delays due to manufacturing and testing problems. The Air Force continues to increase planned acquistion objectives for the MQ-9. **PROCUREMENT** 363 / 73 **SPENDING** *($ millions)* $8,947 / $4,215	5	3
RC-135 Rivet Joint Inventory: **22** Fleet age: **54** Date: **1964** The RC-135 is a manned ISR aircraft. It was originally fielded in 1964. The Air Force plans to keep the system in service through 2018.	1		None		
U-2 Inventory: **27** Fleet age: **34** Date: **1956** Initially deployed in 1956, this manned ISR aircraft can operate at high altitudes and long ranges. The U-2 has undergone a series of modification programs since 1967 to extend the life of the aircraft.	3				

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Command and Control

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
E-3 AWACS Inventory: **31** Fleet age: **39** Date: **1978** The E-3 is an airborne warning and control system (AWACS) that provides USAF with command and control and battle management capabilities. The aircraft entered service in 1978. No longer in production, the current inventory is undergoing modifications to upgrade computing systems. The fleet is currently intended to remain in service until 2025.	1	2	None		
E-8 JSTARS Inventory: **16** Fleet age: **17** Date: **1997** The E-8 is a newer command and control aircraft that provides battle management and C4ISR capabilities, mainly by providing ground surveillance to various air and ground commanders in theater. The aircraft first entered service in 1997 and is not currently in production. The Air Force plans to retire the JSTARs in the early 2030s.	2				

SOURCE: Heritage Foundation research using data from government documents and websites. See also Dakota L. Wood, ed., *2018 Index of U.S. Military Strength* (Washington, DC: The Heritage Foundation, 2018), http://index.heritage.org/militarystrength/.

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

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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 February 2018, 35,200 Marines (roughly one-third of Marine Corps operating forces)[1] were deployed around the world "to assure our allies and partners, to deter our adversaries, and to respond when our...citizens and interests are threatened."[2] In 2017, "Marines executed approximately 104 operations, 87 security cooperation events with partners and allies, and participated in 61 major exercises" in addition to providing substantial support to civil authorities in "Texas, Florida, Puerto Rico and the U.S. Virgin Islands after recent Hurricanes Harvey, Irma and Maria wreaked havoc on the homeland."[3]

Pursuant to the Defense Strategic Guidance (DSG), maintaining the Corps' crisis response capability is critical. Thus, given the fiscal constraints imposed, the Marines have prioritized "near-term readiness" at the expense of other areas such as capacity, capability, modernization, home station readiness, and infrastructure.[4] However, the President's fiscal year (FY) 2019 budget request states that the service will now "prioritize modernization."[5] 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. According to General Glenn Walters, Assistant Commandant of the Marine Corps:

> After years of prioritizing readiness to meet steady-state requirements, our strategy now defines readiness as our ability to compete, deter and win against the rising peer threats we face. We define readiness by whether we possess the required capabilities and capacity we need to face the threats outlined in the NDS.[6]

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). 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.

In 2011, the Marine Corps maintained 27 infantry battalions in its active component at an authorized end strength of 202,100.[7] 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,[8] Congress began to fund gradual increases in end strength, returning the Marine Corps to 24 infantry battalions.

President Donald Trump's FY 2019 budget request would increase the size of the active component Marine Corps by only 1,500 over the congressionally authorized level of 185,000 in FY 2018.[9] Despite increases in active component end strength, the President's FY 2019 budget provides enough support for only 24 infantry battalions. Additional manpower will backfill existing units and help the Marine Corps to recruit and retain individuals with critical skillsets 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 unsustainable deployment rates.[10] For example, as a result of sustained engagement in the Middle East, diminished capacity, and increased operational tempo (OPTEMPO), Marine Corps tactical aviation units have been operating under a surge condition (in excess of a 1:2 deployment-to-dwell ratio) "for more than fifteen years."[11] This increased deployment frequency has exacerbated 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).[12] This leaves more time available for training and recovery and provides support for a "ready bench," without which readiness investments are immediately consumed. Current budget constraints support only "an approximate 1:2 D2D ratio in the aggregate."[13] A return to BCA-level budget caps could reduce capacity even further, and the dwell ratio for the Marine Corps could fall to 1:1.[14] The same problems are present across the Marine Corps' aviation units and amphibious assets.

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 are available for tasking or training. For example, according to its *2018 Marine Aviation Plan*, the USMC currently fields 18 tactical fighter squadrons,[15] compared to 19 in 2017[16] and around 28 during Desert Storm.[17] This is a decrease from 2017, but the Marine Corps has begun to increase quantities of aircraft in some of its legacy squadrons. In 2016, "shortages in aircraft availability due to increased wear on aging aircraft and modernization delays" led the Corps to reduce the requirement of aircraft per squadron for the F/A-18, CH-53E, and AV-8B temporarily in order to provide additional aircraft for home station training.[18] As 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 has increased unit "flight line entitlements for F/A-18s and AV-8Bs back to 12 and 16, respectively."[19]

Although budget increases have yielded incremental improvements, however, the Marine Corps remains "20% short of the required aircraft to meet Congress' [readiness requirements]."[20] The transfer of legacy Hornets from

the Navy will contribute to existing inventory, and increased funding for spare parts will increase availability within the current inventory, but meaningful capacity increases in Marine aviation will depend on procurement of new systems. For example, the Corps' heavy-lift capability is filled by the CH-53E, of which it maintains only 143 airframes, only 37 percent of which are considered flyable. [21] The Corps began a reset of the CH-53E in 2016 to bridge the procurement gap and aims to "reset...the entire 143-aircraft fleet by FY20,"[22] but this will still leave the service 57 aircraft short of the stated heavy-lift requirements 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.[23]

According to the *2018 Marine Aviation Plan*, the transition to the Osprey is 80 percent complete, with 15 fully operational squadrons in the active component and the 18th (and final) squadron planned for activation in FY 2019.[24] However, the procurement objective could increase to 380 aircraft pending the results of an ongoing requirements-based analysis.[25] The Osprey has been called "our most in-demand aircraft,"[26] and with only a year of planned procurement remaining, the Marine Corps will have to reconcile high OPTEMPOs with the objective of maintaining the platform in inventory "for at least the next 40 years."[27]

Shallow acquisition ramps for the F-35 pose similar problems for the service's fighter fleet. As the F-35 enters into service and legacy platforms reach the end of their service lives, the Marine Corps expects a near-term inventory challenge due to a combination of reduced Joint Strike Fighter (JSF) procurement, increasing tactical aircraft utilization rates, and shortfalls in F/A-18A-D and AV-8B depot facility production.[28] Any reduction in Marine aviation capability has a direct effect on overall combat capability, as the Corps usually fights with its ground and aviation forces integrated as Marine Air-Ground Task Forces (MAGTFs).

Although amphibious ships are assessed as part of the Navy's fleet capacity, Marines operate and train aboard naval vessels, making "the shortage of amphibious ships...the quintessential challenge to amphibious training."[29] The Navy currently operates only 32 ships 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.[30] Because of this chronic shortfall in amphibious ships, the USMC has relied partially on land-based Special Purpose Marine Air-Ground Task Forces (SPMAGTFs). While SPMAGTFs have enabled the Corps to meet Joint Force requirements, land-based locations "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."[31]

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 is 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.[32] However, modernization spending still accounts for only 14 percent of the Marine Corps' proposed FY 2019 budget,[33] compared to 21 percent for the Army, 47 percent for the Air Force, and 45 percent for the Navy.[34] The Corps' aircraft, tanks, and ground combat vehicles are some of the oldest in the entire U.S. inventory.

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.[35] The AAV-7A1 is undergoing survivability upgrades. Following the successful test and evaluation of 10 initial prototype vehicles in 2016, the DOD awarded Science Applications International Corporation (SAIC) a low-rate initial production contract for the AAV Survivability Upgrade (AAV SU) in August 2017.[36] The AAV SU is slated to reach full-rate production in FY 2019.[37] The Marine Corps has procured 48 vehicles to-date.[38] These upgrades will help to bridge the capability gap until the fielding of the ACV and keep the AAV SU in service until 2035.[39] In the meantime, the Marine Corps will "continue to spend limited fiscal resources to sustain legacy systems as a result of deferred modernization" and "risk steadily losing our capability advantage against potential adversaries."[40]

Though not yet in development, 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."[41] 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,[42] while the newest HMMWV variant has already consumed half of a projected 15-year service life.[43]

All of the Corps' main combat vehicles entered service in the 1970s and 1980s, and while service life extensions, upgrades, and new generations of designs have allowed the platforms to remain in service, these vehicles are quickly becoming poorly suited to the changing threat environment. The President's FY 2019 budget seeks to provide "a balanced level of attainment and maintenance of inventory in order to meet mission requirements"[44] and plans to invest "approximately 29 percent of its modernization resources into GCTV [ground combat tactical vehicle] systems within the FYDP."[45]

The age profiles of the Corps' aircraft are similar to those of the Navy's. As of 2018, the USMC had 251 F/A-18A-Ds (including one reserve squadron)[46] and six EA-6Bs in its primary mission aircraft inventory,[47] and both aircraft have already surpassed their originally intended life spans. The Marine Corps began to retire its EA-6B squadrons in FY 2016 with the decommissioning of Marine Tactical Electronic Warfare Squadron 1, followed by deactivation of a second squadron in May 2018.[48] The last remaining EA-6B squadron will begin deactivation in October 2018.[49]

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.[50] This was intended to bridge the gap until the F-35Bs and F-35Cs enter service to replace the Harriers and most of the Hornets. However, delays in the service life extension program and "increased wear on aging aircraft" have further limited availability of the F/A-18A-D and AV-8B.[51]

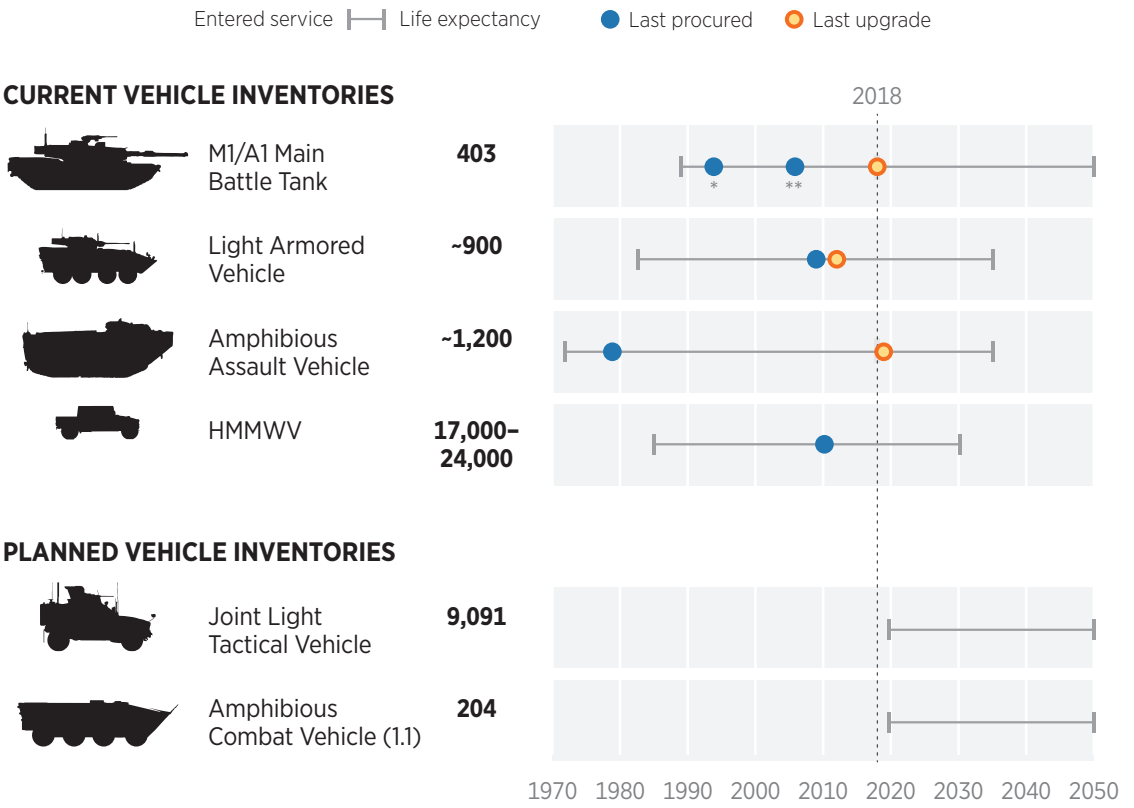
As the Navy accelerates its transition to the Super Hornet, it plans to transfer some of its "best of breed" aircraft from its F/A-18A-D inventory to the Marine Corps and scrap the remaining for parts to help maintain the Corps' legacy fleet through FY 2030.[52] The AV-8B Harrier, designed to take off from the LHA and LHD amphibious assault ships, will be retired from Marine Corps service by 2026.[53] The AV-8B received near-term capability upgrades in 2015, which continued in 2017 in order to maintain its lethality and interoperability[54] until the F-35 transition is completed in FY 2022.[55] The Corps declared its first F-35B squadron operationally capable on July 31, 2015, after it passed an "Operational Readiness Inspection" test.[56] To date, three F-35B squadrons have been delivered to the Marine Corps, including two operational squadrons and one fleet replacement squadron, totaling 57 aircraft.[57]

The Marine Corps has two Major Defense Acquisition (MDAP) vehicle programs: the

FIGURE 5

Marine Corps Combat Vehicles

All of the Marine Corps' current combat vehicle fleets first entered service before 1990. Upgrades have extended the fleets, and two new vehicles are expected to enter service around 2020.



SOURCE: Heritage Foundation research. * New ** From Army

heritage.org

Joint Light Tactical Vehicle (JLTV) and Amphibious Combat Vehicle.[58] The JLTV is a joint program with the Army to acquire a more survivable light tactical vehicle to replace a percentage of the older HMMWV fleet, originally introduced in 1985. The Army retains overall responsibility for JLTV development through its Joint Program Office.[59]

Following FY 2015 plans for the JLTV, the program awarded a low-rate initial production contract, which includes a future option of producing JLTVs for the Marine Corps, to defense contractor Oshkosh.[60] Congressional testimony indicates that if its budget permits it to do so, the USMC may be interested in procuring a larger quantity in the long term than originally intended. Despite a delay in the program's full-rate production decision and reduced procurement quantities in FY 2016 and FY 2017, in June 2017, the Corps had still expected to complete its prior acquisition objective of 5,500 by FY 2023.[61] Reductions in annual procurement quantities reflect prioritization of the ACV within the USMC's ground force.[62]

The President's budget request for FY 2018 would fund the final year of low-rate initial production for the JLTV, including 1,642 vehicles for the Marine Corps and limited

procurement quantities for the Air Force.[63] Because the JLTV will not be a one-for-one replacement of the HMMWV, there are concerns that limited procurement will create a battlefield mobility gap for some units.[64] Although the Marine Corps reached a decision to increase its acquisition objective from 7,241 to 9,091,[65] this will still only partially offset the inventory of 17,000 HMMWVs.[66] The service is considering what percent of the fleet should be replaced by the JLTV and what percent of the requirement might be filled by lighter wheeled vehicles.[67] As end strength and combat units return to each of the services, this could further affect JLTV requirements and result in additional procurement demand.

The Corps has procured 844 JLTVs through FY 2018.[68] The lack of operational detail in the Army's Tactical Wheeled Vehicle Strategy could affect future USMC JLTV procurement and modernization plans.[69] The USMC expected the program to reach initial operational capability (IOC) in the fourth quarter of 2018, but this has been delayed to the first quarter of 2020 because of program disruption caused by bid protests and scheduled testing delays.[70] "Marines are expected to start receiving JLTVs for operational use in FY 2019," along with a full-rate production decision.[71] The increased acquisition objective will extend the program's procurement timeline through FY 2023.[72]

The Marine Corps intends to replace the AAV-7A1 with the ACV, planned "to enter the acquisition cycle at Milestone B (Engineering and Manufacturing Development) in FY2016, award prototype contracts leading to a down select to one vendor in FY2018, and [then] enter low-rate initial production."[73] The ACV, which took the place of the Expeditionary Fighting Vehicle (EFV), "has been structured to provide a phased, incremental capability."[74] 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.[75] 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 the upgraded AAVs.[76] This would help the Corps to meet its requirement of armored lift for 10 battalions of infantry.[77] In June 2018, BAE Systems won the contract award to build the ACV 1.1, and it is expected to deliver the first 30 vehicles by the fall of 2019.[78] The Marine Corps plans to field 204 vehicles in the first increment—enough to support lift requirements for two infantry battalions.[79]

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.[80] Plans call for a program of record of 694 vehicles (a combination of upgraded AAVs and ACVs), with the first battalion to reach 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 AAV survivability upgrade program will modernize the remaining four battalions, allowing the Corps to meet its armored lift requirement for 10 battalions.[81]

Regarding aviation, Lieutenant General Brian Beaudreault, Marine Corps Deputy Commandant for Plans, Policies, and Operations, has testified 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."[82] The F-35B remains the Marine Corps' largest investment program in FY 2019. The Corps announced IOC of the F-35B variant in July 2015.[83] Total procurement will consist of 420 F-35s (353 F-35Bs and 67 F-35Cs). 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, and the Corps continues to seek opportunities to accelerate procurement.[84]

Today, the USMC MV-22 Osprey program is operating with few problems and nearing completion of the full acquisition objective of 360 aircraft.[85] The Marine Corps added one squadron to its active component over the past year, bringing the total to 15 fully operational squadrons in the active component.[86] Two additional squadrons are expected to stand up in FY 2018, followed by the final active component squadron in FY 2019.[87] The MV-22's capabilities are in high demand from the Combatant Commanders (COCOMS), 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 COCOMs.

The Corps continues to struggle with sustainment challenges in the Osprey fleet. Since the first MV-22 was procured in 1999, the fleet has developed more than 70 different configurations.[88] 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 has developed a plan to consolidate the inventory to a common configuration at a rate of "2–23 aircraft installs per year" beginning in FY 2018.[89]

The USMC's heavy-lift replacement program, the CH-53K, conducted its first flight on October 27, 2015.[90] The CH-53K will replace the Corps' CH-53E, which is now 28 years old. Although "unexpected redesigns to critical components" delayed a low-rate initial production decision,[91] the program achieved Milestone C in April 2017, and the President's FY 2019 budget requests $1,601.8 million for the procurement of eight aircraft in its second year of low-rate initial production.[92] The helicopter is predicted to reach IOC in 2019, almost four years later than initially anticipated.[93] This is of increasing concern as the Marine Corps maintains only 139 CH-53Es[94] and will not have enough helicopters to meet its heavy-lift requirement of 200 aircraft without the transition to the CH-53K.[95]

The Corps began a reset of the CH-53E in 2016 to bridge the procurement gap, but as of November 2017, it had completed the reset of only 13 CH-53Es.[96] The DOD plans to complete fielding of the CH-53K by FY28, but continuing resolutions "have resulted in shallow acquisition ramps" and could further delay this transition.[97] The FY 2019 request would continue to fund procurement totals of 194 CH-53K aircraft.[98]

Readiness

The Marine Corps' first priority is to be the crisis response force for the military, which is why investment in immediate readiness has been prioritized over capacity and capability. Although this is sustainable for a short time, future concerns when the Budget Control Act was passed are rapidly becoming impediments in the present. Modernization is now a primary inhibitor of readiness as keeping aging platforms in working order becomes increasing 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 two-to-one deployment-to-dwell ratio.[99] At this pace, readiness is consumed as quickly as it is built, leaving minimal flexibility to respond to contingencies. As a result, the USMC has maintained support for current operations but "may not have the required capacity—the 'ready bench'—to respond to larger crises at the readiness levels and timeliness required" or to support sustained conflict.[100]

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.[101]

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."[102]

In December 2017, a U.S. Government Accountability Office (GAO) official testified that while 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."[103] A shortage of available amphibious ships was identified as the primary factor in training limitations. Of the 32 amphibious ships currently in the U.S. fleet, only 16 are considered "available to support current or contingency operations."[104] 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. The *2018 Marine Aviation Plan* found that "[a]cross all of Marine aviation, readiness is below steady state requirements."[105] With a smaller force structure and fewer aircraft available for training, aviation units are having difficulty keeping up with demanding operational requirements. According to Lieutenant General Stephen Rudder, Marine Corps Deputy Commandant for Aviation, most Marine aviation squadrons "still lack the required number of ready aircraft required to 'fight tonight.'"[106]

As of November 2017, approximately half of the Marine Corps' tactical aircraft were considered flyable.[107] This is a slight increase over FY 2018 readiness figures and has helped to improve the D2D ratio from 1:2 to 1:2.6 across the TACAIR fleet. Through investments in modernization and adequate funding for spare parts, the Marine Corps has managed to increase readiness by roughly 15 percent in the modern fleet and 10 percent in the legacy fleet.[108]

However, readiness gains have begun to plateau.[109] The Marine Corps received funding for spare parts at the "maximum executable levels" in FY 2017 and even higher levels in FY 2018.[110] In FY 2017, the Corps added only six ready basic aircraft to the fleet, compared to 44 in FY 2016,[111] yielding only modest increases in flight hours of two per crew per month in 2017. Although the Marine Corps is working to maximize their utilization, as long as it continues to rely on legacy systems, the amount of time committed to maintenance and access to spare parts will constrain aircraft availability.

Readiness rates remain particularly stressed within certain high-demand communities (including the MV-22, F/A-18, and F-35) that lack necessary numbers of available aircraft, pilots, and maintainers.[112] Although the MV-22 is a relatively new platform and is operating with few problems, high demand has held its readiness rates at 48 percent and forced the Marine Corps to put these aircraft "into operation as fast as they were coming off the line."[113] As is the case with the Corps' infantry battalions, this leaves little capacity available to support a "ready bench," and immediate demand

challenges efforts to reduce the platform to a common configuration.

Availability of spare parts remains "the primary degrader of Marine aviation readiness."[114] Although adequate funding for spare parts and maintenance will help to maintain current numbers of ready basic aircraft, the Marine Corps recognizes that "modernization of [its] legacy fleet is the true key to regaining readiness."[115] The transition to modern systems will increase capacity, dispersing some of the strain from high utilization rates and offsetting costs from legacy platforms, which require more time and money to maintain.

For FY 2018, the Department of the Navy chose to prioritize immediate readiness by accepting "risk in facilities [and] weapons capacity," "delay[ing] certain modernization programs,"[116] and "protect[ing] near-term operational readiness of its deployed and next-to-deploy units" while struggling to maintain a "ready bench."[117] According to former Marine Corps Assistant Commandant General John M. Paxton, "[b]y degrading the readiness of these bench forces to support those forward deployed, we are forced to accept increased risk in our ability to respond to further contingencies, our ability to assure we are the most ready when the nation is least ready."[118] In looking beyond immediate readiness, the USMC FY 2019 budget request aims to support a "comprehensive aviation recovery plan that, *if sufficiently resourced and supported by our industrial base*, recovers the force to an acceptable readiness level by FY20 with a ready bench by FY22."[119]

The Marines Corps' Ground Equipment Reset Strategy, developed to recover from the strain of years of sustained operations in Iraq and Afghanistan, is nearing completion after being delayed from the end of FY 2017 to FY 2019. As of March 2018, the Marine Corps had reset approximately 99 percent of its ground equipment, compared to 90 percent in the prior year.[120] 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.[121] 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.

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 scored as "weak" again in 2018.

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." Excluded from the scoring are various ground vehicle programs that have been cancelled and are now being reprogrammed.

Readiness Score: Weak

In FY 2018, the Marine Corps again prioritized next-to-deploy units. As the nation's crisis response force, the Corps requires that all units, whether deployed or non-deployed, 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, as of November 2017, the USMC reported that only half of its tactical aircraft were considered flyable.

Marine Corps officials have not been clear as to the status of ground component readiness during FY 2018, but in testimony to Congress during the year, as noted, they have highlighted concerns about shortfalls in service readiness to mobilize for larger-scale operational commitments. Due to the lack of a "ready bench" and a further decline in readiness levels among the USMC aircraft fleet, the *2019 Index* assesses Marine Corps readiness levels as "weak."

Overall U.S. Marine Corps Score: Weak

Although 2018 congressional testimony strikes an optimistic note and increased funding for readiness and an emphasis on modernization give strong support to the Corps' readiness-recovery efforts, the effects will take time to materialize. As a result, the Marine Corps maintains an overall score of "weak" in the *2019 Index*.

U.S. Military Power: Marine Corps

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

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Main Battle Tank

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
M1A1 Abrams Inventory: **447** Fleet age: **28** Date: **1989** The M1A1 Abrams Main Battle Tank 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	MODERNIZATION PROGRAM	Size Score	Health Score
HMMWV Inventory: **17,000** Fleet age: **10** Date: **1985** 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	**Joint Light Tactical Vehicle (JLTV)** Timeline: **2015–2023** Currently in development, the JLTV is a vehicle program meant to replace some of the HMMWVs and improve reliability, survivability, and strategic and operational transportability. So far the program has experienced a one-year delay due to changes in vehicle requirements. This is a joint program with Army. The Marine Corps has increased its acquistion objective by 1,850 vehicles, bringing the total planned procurement to 9,091 and extending the timeline procurement through 2023. **PROCUREMENT** 850 8,511 **SPENDING** *($ millions)* $3,001 $25,028	2	5

NOTE: JLTV spending figures reflect the full joint program spending.

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Amphibious Assault Vehicle

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
AAV Inventory: **~1,200** Fleet age: **40** Date: **1972** The Amphibious Assault Vehicle transports troops and cargo from ship to shore. The AAV is undergoing a survivability upgrade to extend its life through 2035. The Marine Corps has procured 48 upgraded vehicles to-date. It will upgrade 392 in total.	1	1	**Amphibious Combat Vehicle (ACV) 1.1** Timeline: **2014–2021** The Amphibious Combat Vehicle is now a major defense acquisition program. The ACV is intended to replace the aging AAV. ACV 1.1 will procure 204 vehicles. Delivery of the first 30 vehicles are anticipated for 2019. **PROCUREMENT** 26 178 **SPENDING** *($ millions)* $619 $1,271	3	5
LAV-25 Inventory: **~900** Fleet age: **26** Date: **1983** 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.	2	1			

Attack Helicopters

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
AH-1W Cobra Inventory: **77** Fleet age: **26** Date: **1986** 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, when it will be replaced with the AH-1Z.	1	2	**AH-1Z** Timeline: **2004–2020** The new AH-1Z Viper program is part of a larger modification program to the H-1 platform. The new H-1 rotorcraft will have upgraded avionics, rotor blades, transmissions, landing gear, and structural modifications to enhance speed, maneuverability, and payload. The AH-1Z started out as a remanufacture program, but that was later changed to a New Build program because of concerns over existing airframes. While costs have increased, the program has not met the APB breach threshold. **PROCUREMENT** 148 41 **SPENDING** *($ millions)* $11,554 $731	5	3
AH-1Z Viper Inventory: **76** Fleet age: **4** Date: **2010** The AH-1Z Viper is the follow on to the AH-1W Cobra attack helicopter. The Viper will have greater speed, payload, and range, as well as a more advanced cockpit. It is expected that the AH-1Z will fully replace the AH-1W Cobra in 2021. The expected operational life span of the Viper is 30 years.	5				

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

Airborne Electronic Attack Aircraft/ Ground Attack Aircraft

PLATFORM	Age Score	Capability Score
EA-6B Inventory: **6** Fleet age: **29** Date: **1971** The Prowler provides the USMC with an electronic warfare capability. The last squadron will be retired in October 2018.	1	1
AV-8B Inventory: **130** Fleet age: **21** Date: **1985** The Harrier is a vertical/short takeoff and landing aircraft designed to fly from LHA/LHDs. It provides strike and reconnaissance capabilities. The aircraft will be retired around 2024.	5	
F-35B Inventory: **50** Fleet age: **3** Date: **2015** The F-35B is the Marine Corps's short takeoff and vertical landing variant meant to replace the AV-8B Harrier. Despite some development problems, the F-35B achieved IOC in July 2015.	5	
F/A-18 A-D Inventory: **251** Fleet age: **26** Date: **1978** Many aircraft in the F/A-18 fleet have logged about 8,000 hours compared with the originally intended 6,000. 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.	3	

MODERNIZATION PROGRAM	Size Score	Health Score
F-35B/C Timeline: **2008–2033** The Corps is purchasing 353 F-35Bs and 67 F-35Cs. The F-35B is the USMC version of the Joint Strike Fighter program. It is meant to replace the AV-8B Harrier, completing transition by 2030. The Joint Strike Fighter has had many development issues, including a Nunn–McCurdy cost breach and major development issues. The F-35B in particular has had software development problems and engine problems that led to grounding. The Marine Corps announced IOC of its second F-35B squadron in June 2016. The F-35C is not anticipated to achieve IOC until 2019. **PROCUREMENT** 131 289 **SPENDING** *($ millions)* $127,534 $278,597	3	1

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2018 ■ Pending

Medium Lift

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
MV-22 Inventory: **277** Fleet age: **6** Date: **2007** 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.	4	5	**MV-22B** Timeline: **1997–2031** The Osprey is in production, and the platform is meeting performance requirements. The modernization program is not facing any serious issues. Procurement figures include 48 Navy MV-22s and 50 of the carrier variant CV-22s. **PROCUREMENT** 403 / 59 **SPENDING** *($ millions)* $47,898 / $8,341	4	5

Heavy Lift

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
CH-53E Super Stallion Inventory: **139** Fleet age: **29** Date: **1981** 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.	2	1	**CH-53K** Timeline: **2017–2028** 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 has experienced delays and cost growth. **PROCUREMENT** 6 / 194 **SPENDING** *($ millions)* $6,969 / $24,196	5	3

Tanker

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
KC-130J Inventory: **45** Fleet age: **10** Date: **2004** 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.	4	5	**KC-130J** Timeline: **1997–2028** The KC-130J is both a tanker and transport aircraft. The procurement program for the KC-130J is not facing acquisition problems. **PROCUREMENT** 63 / 41 **SPENDING** *($ millions)* $4,992 / $4,904	4	4

NOTES: 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.
SOURCE: Heritage Foundation research using data from government documents and websites. See also Dakota L. Wood, ed., *2018 Index of U.S. Military Strength* (Washington, DC: The Heritage Foundation, 2018), http://index.heritage.org/militarystrength/.

See Methodology for descriptions of scores. Fleet age—Average age of fleet Date—Year fleet first entered service

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U.S. Nuclear Weapons Capability

Assessing the state of U.S. nuclear weapons capabilities presents several challenges.

First, instead of taking advantage of technological developments to field new warheads that could be designed to be safer and more secure and could give the United States improved options for guaranteeing a credible deterrent, the U.S. has elected to maintain (extend the service life of) 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 conventional missions. For example, dual-capable bombers do not fly airborne alert with nuclear weapons today, although they did so routinely during the 1960s (and are capable of doing so again should the decision ever be made to resume this practice). Additionally, the national security laboratories do not focus solely on the nuclear weapons mission; as they did during the Cold War, they also perform a variety of functions related to nuclear nonproliferation, medical research, threat reduction, and countering nuclear terrorism, including nuclear detection. The National Command and Control System performs nuclear command and control in addition to supporting ongoing conventional operations.

Thus, assessing the extent to which any one piece of the nuclear enterprise is sufficiently funded, focused, and effective with regard to the nuclear mission is problematic.

In today's rapidly changing world, the U.S. nuclear weapons enterprise must be flexible and resilient to underpin the U.S. nuclear deterrent. If the U.S. detects a game-changing nuclear weapons development in another country or experiences a technical problem with a warhead or delivery system, its nuclear weapons complex must be able to provide a timely response.

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 are said to be ready within 24 to 60 months.[1] The U.S. also preserves significant upload capability on its strategic delivery vehicles so that the nation can 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.[2]

Presidential Decision Directive-15 (PDD-15) requires that the U.S. maintain the ability to conduct a nuclear test within 24 to 36 months of a presidential decision to do so.[3] However, successive government reports have noted the continued deterioration of technical and diagnostics equipment and the inability to fill technical positions that support nuclear testing readiness.[4] A lack of congressional support for improving technical readiness further undermines efforts by the National Nuclear Security Administration (NNSA) to comply with the directive.

The weapons labs face demographic challenges of their own. Most scientists and

engineers with practical nuclear weapon design and testing experience are retired. This means that for the first time since the dawn of the nuclear age, the U.S. will have to rely on the scientific judgment of people who were not directly involved in underground nuclear explosive tests of weapons that they designed, developed, and are certifying.

The shift of focus away from the nuclear mission after the end of the Cold War caused the NNSA laboratories to lose their sense of purpose and to feel compelled to reorient and broaden their mission focus. According to a number of studies, their relationship with the government also evolved in ways that reduce output and increase costs.

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 enterprise's culture, business practices, project management, and organization. Others proposed moving the NNSA to the Department of Defense.[5]

Another important indication of the health of the overall force is the readiness of forces that operate U.S. nuclear systems. In 2006, the Air Force mistakenly shipped non-nuclear warhead components to Taiwan.[6] A year later, it transported nuclear-armed cruise missiles across the U.S. without authorization (or apparently even awareness that it was doing so, mistaking them for conventional cruise missiles).[7] These serious incidents led to the establishment of a Task Force on DOD Nuclear Weapons Management, which found that "there has been an unambiguous, dramatic, and unacceptable decline in the Air Force's commitment to perform the nuclear mission"; that "until very recently, little has been done to reverse it"; and that "the readiness of forces assigned the nuclear mission has seriously eroded."[8]

Following these incidents, the Air Force instituted broad changes to improve oversight and management of the nuclear mission and the inventory of nuclear weapons, including creating the Air Force Global Strike Command to organize, train, and equip intercontinental-range ballistic missile and nuclear-capable bomber crews as well as other personnel to fulfill the nuclear mission and implement a stringent inspection regime. Then, in January 2014, 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.[9]

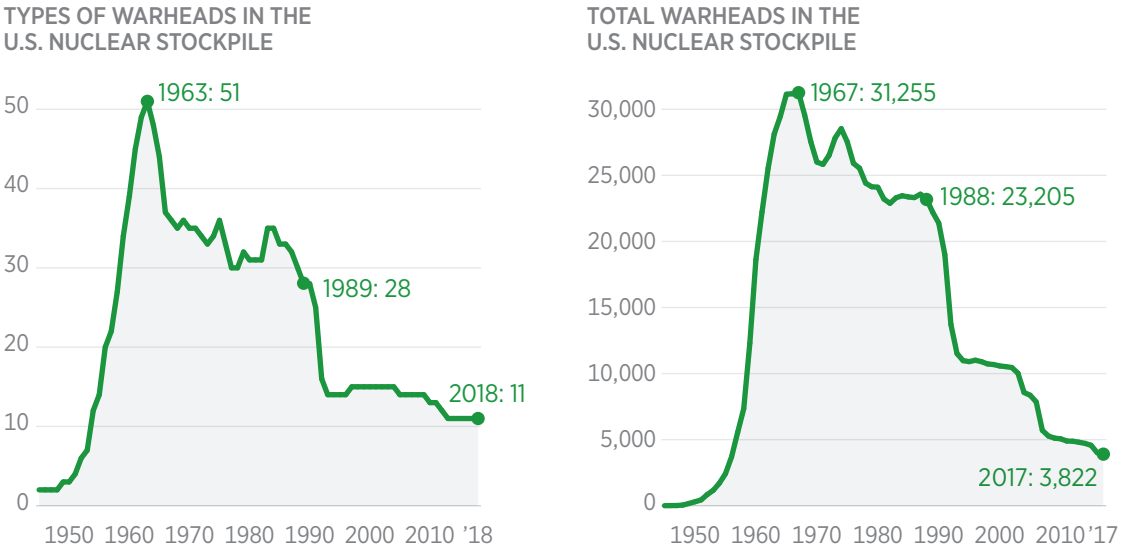
The Department of Defense conducted two nuclear enterprise reviews, one internal and one external. Both reviews identified a lack of leadership attention, a lack of resources to modernize the atrophied infrastructure, and unduly burdensome implementation of the personnel reliability program as some of the core challenges preventing a sole focus on accomplishing the nuclear mission.[10] The Navy and Air Force took steps to address these concerns, but if changes in the nuclear enterprise are to be effective, leaders across the executive and legislative branches will have to continue to provide sufficient resources to mitigate readiness and morale issues within the force.

Fiscal uncertainty and a steady decline in resources for the nuclear weapons enterprise (trends that have begun to reverse in recent years) have negatively affected the nuclear deterrence mission. Under Secretary of Defense for Policy John Rood testified in March 2018 that:

> The U.S. military remains the strongest in the world. However, our advantages are eroding as potential adversaries modernize and build up their conventional and nuclear forces. They now field a broad arsenal of advanced missiles, including variants that can reach the American homeland....
>
> While this picture is unsettling and clearly not what we desire, as Secretary of Defense [James] Mattis has pointed out, "We must look reality in the eye and see the world as it is, not as we wish it to be."[11]

CHART 15

A Smaller and Less Diverse Nuclear Arsenal



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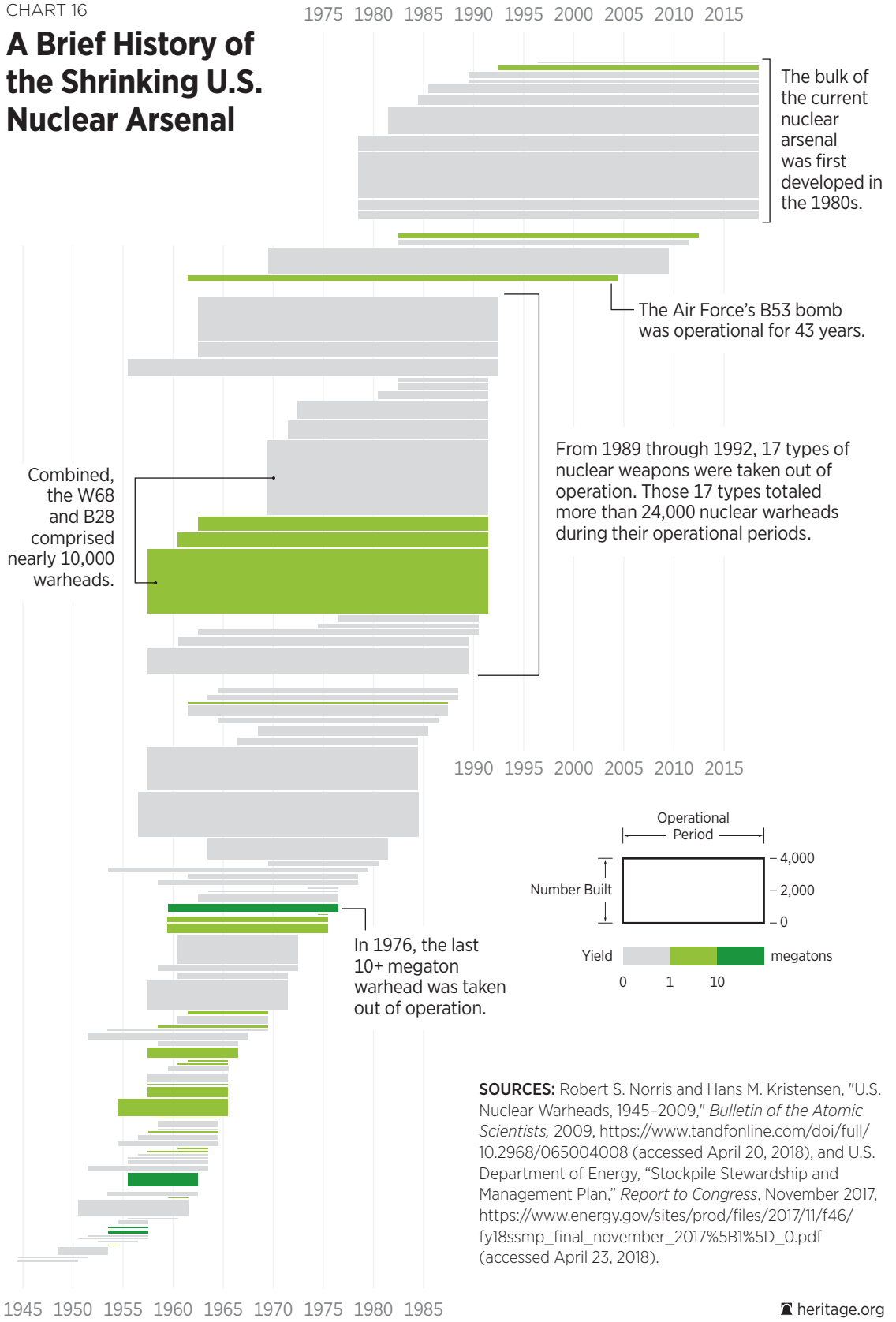
The Trump Administration has inherited a comprehensive modernization program for nuclear forces: warheads, delivery systems, and command and control. The Obama Administration included this program in its budget requests, and Congress to a significant extent has funded it. Because such modernization activities require long-term funding commitments, it is important that this commitment continue.

The Trump Administration's reassessment of the U.S. nuclear force posture has included correcting some of the more questionable elements of the 2010 Nuclear Posture Review (NPR). Most specifically, the 2018 NPR recognizes that Russia's aggressive international policies and both Russia's and China's robust nuclear weapon modernization programs should inform the U.S. nuclear posture.[12] The 2018 NPR calls for tailoring U.S. nuclear deterrence strategies and restores deterring a large-scale attack against the U.S. homeland and its allies as the first priority of U.S. nuclear weapons policy. To that end, the 2018 NPR supports modernization of nuclear weapons and the nuclear weapons complex, as well as the sustainment of a nuclear triad, and proposes two low-yield options: a submarine-launched low-yield warhead in the short term and a nuclear-armed sea-launched cruise missile in the long term.

It is not clear how the additional workload created by these capabilities will affect the NNSA complex. Despite these departures from the 2010 NPR, however, the 2018 NPR is "clearly in the mainstream of U.S. nuclear policy as it has evolved through nearly eight decades of the nuclear age."[13]

CHART 16

A Brief History of the Shrinking U.S. Nuclear Arsenal



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), and U.S. Department of Energy, "Stockpile Stewardship and Management Plan," *Report to Congress*, November 2017, https://www.energy.gov/sites/prod/files/2017/11/f46/fy18ssmp_final_november_2017%5B1%5D_0.pdf (accessed April 23, 2018).

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Implications for U.S. National Security

U.S. nuclear forces and U.S. military forces in general are not designed to shield the nation from all types of attacks from all adversaries. They are designed to deter large-scale conventional and nuclear attacks that threaten America's sovereignty, forward-deployed troops, and allies.

U.S. nuclear forces play an important role in the global nonproliferation regime by providing U.S. security guarantees and assurances to NATO, Japan, and South Korea that lead these allies either to keep the number of their nuclear weapons lower than might otherwise be the case (France and the United Kingdom) or to forgo their development and deployment altogether. North Korea has proven that a country with very limited intellectual and financial resources can develop a nuclear weapon if it decides to do so. Iran continues on the path to obtaining a nuclear weapon.

This makes U.S. nuclear guarantees and assurances to allies and partners ever more important. Should the credibility of American nuclear forces continue to degrade, countries like South Korea could pursue an independent nuclear option, which would raise several thorny issues including possible additional instability across the region.

Certain negative trends could undermine U.S. nuclear deterrence if problems are not addressed. There is no shortage of challenges on the horizon, from an aging nuclear weapons infrastructure and unchallenged workforce to the need to recapitalize all three legs (land, air, and sea) of the nuclear triad, and from the need to conduct life-extension programs while maintaining a self-imposed nuclear weapons test moratorium to limiting the spread of nuclear know-how and the means to deliver nuclear weapons. Additionally, the United States must take account of adversaries that are modernizing their nuclear forces, particularly Russia and China.

The 2018 NPR observes that the global strategic security environment has become increasingly dangerous. Russia is now engaged in an aggressive nuclear buildup. Concurrently, Moscow is using its capabilities to threaten the sovereignty of U.S. allies in Eastern Europe and the Baltics. China is engaging in a similar nuclear buildup as it projects power into the South China Sea. North Korea and Iran have taken an aggressive posture toward the West as they attempt to shift from being nuclear proliferators to being nuclear-armed states.

Deterrence is an intricate interaction between U.S. conventional and nuclear forces and the psychology of both allies and adversaries that the U.S. uses these forces to defend the interests of the U.S. and its allies. Nuclear deterrence must reflect the mindset of the adversary 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 even if U.S. leaders think it is not possible to control escalation. The U.S. nuclear portfolio must be structured in terms of capacity, capability, variety, flexibility, and readiness to achieve this objective. In addition, military requirements and specifications for nuclear weapons will be different depending on who is being deterred, what he values, and what the U.S. seeks to deter him from doing.

Due to the complex interplay among strategy, policy, actions that states take in international relations, and other actors' perceptions of the world around them, one might never know precisely if and when a nuclear or conventional deterrent provided by U.S. forces loses credibility. Nuclear weapons 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 modern nuclear enterprise is more likely to sustain its deterrent value than is an outdated one with questionable capabilities.

The U.S. is capable of incredible mobilization when danger materializes. The nuclear threat environment is dynamic and proliferating, with old and new actors developing advanced capabilities while the U.S. enterprise is relatively static, potentially leaving the United

States at a technological disadvantage. This is worrisome because of its implications both for the security of the United States and for the security of its allies and the free world.

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; aerial refueling; and the research and development and manufacturing infrastructure that designs, manufactures, and maintains U.S. nuclear weapons. The complex also includes the experienced people, from physicists to engineers, maintainers, and operators, without whom the continuous maintenance of the nuclear infrastructure would not be possible.

The factors selected below are the most important elements of the nuclear weapons complex. They are judged on a five-grade scale, where "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, which is very likely to damage vital national interests if the situation is not corrected.

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."[14] Since 1993, reliability has been determined through an intensive warhead surveillance program; non-nuclear experiments (that is, without the use of experiments producing nuclear explosive yield); sophisticated calculations using high-performance computing; and related evaluations.

The reliability of nuclear warheads and delivery systems becomes more important as the number and diversity of nuclear weapons in the stockpile decrease, because fewer types of nuclear weapons means a greater risk of a "common mode failure" that could affect one or more of the remaining warhead types, coupled with the absence of sufficient hedge warheads to replace operational warheads until they can be repaired. Americans, allies, and adversaries must be confident that U.S. nuclear warheads will perform as expected.[15]

As warheads age, aging components must be replaced before they begin to degrade warhead reliability. Otherwise, military planning and employment of these warheads become much more complex. Despite creating impressive amounts of knowledge about nuclear weapons physics and materials chemistry, the long-term effect of aging components that comprise a nuclear weapon, including plutonium pits, is uncertain. As General Kevin Chilton (Ret.), former Commander, U.S. Strategic Command, has stated, "We cannot life extend these [nuclear weapons] forever.... [W]e better know how to do it when we get there...and the only way to be assured of that is to exercise that muscle in the near term."[16]

The United States has the world's safest and most secure stockpile, but security of long-term domestic and overseas storage sites, potential problems introduced by improper handling, or unanticipated effects stemming from long-term handling could compromise the integrity of U.S. warheads. The nuclear warheads themselves contain security measures that are designed to make it difficult, if not impossible, to detonate a weapon absent a proper authorization.

Grade: The Department of Energy and Department of Defense are required to assess the reliability of the nuclear stockpile annually.

This assessment does not include delivery systems, although the U.S. Strategic Command assesses overall weapons system reliability, which includes both the warhead and delivery platforms.

Absent nuclear weapons testing, the assessment of weapons reliability becomes more subjective over time, albeit based on experience, non-nuclear experiments, and simulations. While certainly an educated opinion, some argue that it is not a substitute for the type of objective data that is obtained through nuclear testing. Testing was used to diagnose potential problems and to certify the effectiveness of fixes to those problems. A continuous cycle of replacement of aging components with modern versions will inevitably introduce changes that take weapons away from the designs that were tested in the 1960s through 1980s. This risk must be weighed against the downside risks entailed in a U.S. resumption of nuclear testing.

"[I]n the past," according to the late Major General Robert Smolen, some of the nuclear weapon problems that the U.S. now faces "would have [been] resolved with nuclear tests."[17] By 2005, a consensus emerged in the NNSA, informed by the nuclear weapons labs, that it would "be increasingly difficult and risky to attempt to replicate exactly existing warheads without nuclear testing and that creating a reliable replacement warhead should be explored."[18] 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 weapons with serious problems being introduced into the U.S. stockpile.[19]

In fiscal year (FY) 2018, the NNSA nuclear weapons lab directors and the Commander of U.S. Strategic Command, advised by his Strategic Advisory Group, assessed that the stockpile "remains safe, secure, and reliable."[20]

The lack of nuclear weapons testing creates some uncertainty concerning the adequacy of fixes to the stockpile when problems are found. This includes updates that are made in order to correct problems 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 former Defense Threat Reduction Agency Director Dr. Stephen Younger, we have had to fix "a number of problems that were never anticipated" by using "similar but not quite identical parts."[21] Political decisions made by successive Administrations have resulted in fewer types of weapons and, consequently, the potential for a greater impact across the inventory if an error is found during the certification process.

"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."[22] The U.S. is pursuing warhead life-extension programs that replace aging components before they can cause reliability problems, but the national commitment to this modernization program, including the necessary long-term funding, continues to be uncertain.

In light of our overall assessment, we grade the U.S. stockpile as "strong." We are concerned that this rating may be revised downward in future years if the nation lags further in providing challenging nuclear weapons design and development opportunities as means to hone the skills of a next generation of weapons scientists and engineers.

Reliability of U.S. Delivery Platforms Score: Marginal

Reliability encompasses not only the warhead, but strategic delivery vehicles as well. In addition to a successful missile launch, this includes the separation of missile boost stages, performance of the missile guidance system, separation of the multiple re-entry vehicle warheads from the missile post-boost vehicle, and accuracy of the final re-entry vehicle in reaching its target.[23]

The U.S. tries to conduct flight tests of ICBMs and submarine-launched ballistic missiles (SLBMs) every year to ensure the

reliability of its systems. Anything from electrical wiring to faulty booster separations could degrade the efficiency and safety of the U.S. strategic deterrent if it were to malfunction. U.S. strategic, long-range bombers regularly conduct intercontinental training and receive upgrades in order to sustain a high level of combat readiness, but potential challenges are on the horizon.

Grade: There was one U.S. ICBM test during the time period covered, and that test was successful. However, another test scheduled for February 2018 was cancelled with no explanation.[24] The ICBM test force has also been struggling with test kit supply. SLBM tests were successful in 2017 and 2018. 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. adversaries that the system works. The aged systems, however, occasionally have reliability problems.[25] Overall, this factor earns a grade of "marginal," which is lower than the previous year's score, because of emerging problems with the ICBM test program and a lower number of overall launches. Additional future concerns stem from advanced networked air defense systems and their potential to increase risk to manned bombers.

Nuclear Warhead Modernization Score: Weak

During the Cold War, the United States maintained a strong focus on designing and developing new nuclear warhead designs in order to counter Soviet advances and modernization efforts and to leverage advances in understanding the physics, chemistry, and design of nuclear weapons. Today, the United States is focused on sustaining the existing stockpile, not on developing new warheads, even though all of its nuclear-armed adversaries are developing new nuclear warheads and capabilities and accruing new knowledge in areas in which the U.S. used to lead.

Since the collapse of the Soviet Union, nuclear warheads and delivery vehicles have not been replaced despite being well beyond their designed service lives. 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.

New warhead designs could allow American engineers and scientists to improve previous designs and devise more effective means to address existing military requirements (for example, the need to destroy deeply buried and hardened targets) that have emerged in recent years. New warheads could also enhance the safety and security of American weapons.

An ability to work on new warhead designs would also help American experts to remain engaged and knowledgeable, would help to attract the best talent to the nuclear enterprise and retain that talent, and could help the nation to gain additional insights into foreign nations' nuclear weapon programs. 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."[26]

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. At the urging of Congress, the NNSA is increasing its focus on programs to exercise skills that are needed to develop and potentially build new nuclear warheads through the Stockpile Responsiveness Program. These efforts ought to be expanded and sustained in the future.

Grade: The lack of plans to modernize nuclear warheads—life-extension programs are not modernization—and restrictions on thinking about new weapon designs that might accomplish the deterrence mission in the 21st century more effectively earn nuclear warhead modernization a grade of "weak."

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, there is increased risk of a significantly negative impact on operational capabilities. The older weapons are, the more at risk they are that faulty components, malfunctioning equipment, or technological developments will limit their reliability in the operating environment. Age can degrade reliability by increasing the potential for systems to break down or fail to respond correctly. 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. If it cannot be assumed that a strategic delivery vehicle will operate reliably at all times, that vehicle's deterrence and assurance value is significantly reduced.

The U.S. Air Force and Navy plan to modernize or replace each leg of the nuclear triad in the next several decades, but fiscal constraints are likely to make such efforts difficult. The Navy is fully funding its programs to replace the *Ohio*-class submarine with the *Columbia*-class submarine and to extend the life of and eventually replace the Trident SLBM. Existing ICBMs and SLBMs are expected to remain in service until 2032 and 2042, respectively, and new bombers are not planned to enter into service until 2023 at the earliest. Budgetary shortfalls are leading to uncertainty as to whether the nation will be able to modernize all three legs of the nuclear triad. The U.S. Strategic Command says that a triad is a "requirement."[27] This requirement, validated by all U.S. NPRs since the end of the Cold War, gives U.S. leadership credibility and flexibility, attributes that are necessary for any future deterrence scenarios.

Maintenance issues caused by the aging of American SSBNs and long-range bombers could make it difficult to deploy units overseas for long periods or remain stealthy in enemy hot spots. At present, the United States can send only a limited number of bombers on missions at any one time. Remanufacturing some weapon parts is difficult and expensive either because some of the manufacturers are no longer in business or because the materials that constituted the original weapons are no longer available (for example, due to environmental restrictions). The ability of the U.S. to produce solid-fuel rocket engines and continued U.S. dependence on Russia as a source of such engines are other long-range concerns.[28]

Grade: U.S. nuclear platforms are in dire need of recapitalization. Plans for modernization of the U.S. nuclear triad are in place, and funding for these programs has been sustained so far by Congress and by the services, notwithstanding difficulties caused by sequestration. This demonstration of commitment to nuclear weapons modernization earns this indicator a grade of "strong."

Nuclear Weapons Complex Score: Weak

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 Laboratories,
- Lawrence Livermore National Laboratory,
- Sandia National Laboratory,
- 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.[29]

A flexible and resilient infrastructure is an essential hedge in the event that components fail or the U.S. is surprised by the nuclear weapon capabilities of potential adversaries. U.S. research and development efforts and the industrial base that supports modernization of delivery systems and warheads are important parts of this indicator.

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. The existing nuclear weapons complex, however, is not fully functional. The U.S. cannot produce more than a few new plutonium pits (one of the core components of nuclear warheads) per year; there are limits on the ability to conduct life-extension programs; and Dr. John S. Foster, Jr., former director of the Lawrence Livermore National Laboratory, has reported that the U.S. no longer can "serially produce many crucial components of our nuclear weapons."[30]

If the facilities are not properly funded, the U.S. will gradually lose the ability to conduct high-quality experiments. In addition to demoralizing the workforce and hampering further recruitment, obsolete facilities and poor working environments make maintaining a safe, secure, reliable, and militarily effective nuclear stockpile exceedingly difficult. NNSA facilities are old: In 2016, the agency reported that "[m]ore than 50 percent of its facilities are over 40 years old, nearly 30 percent date to the Manhattan Project era, and 12 percent are currently excess and no longer needed."[31] Deferred maintenance can indicate "aging infrastructure and associated challenges, such as those relating to reliability, mission readiness, and health and safety."[32] The state of the NNSA's infrastructure did not change during the covered period, although the agency did manage to halt growth in deferred maintenance.[33]

Since 1993, the DOE has not had a facility dedicated to production of plutonium pits. The U.S. currently keeps about 5,000 plutonium pits in strategic reserve. There are significant disagreements as to the effect of aging on pits and whether the U.S. will be able to maintain them indefinitely without nuclear weapons testing. Currently, the U.S. can produce no more than about 10 plutonium pits a year at the Los Alamos PF-4 facility. Infrastructure modernization plans for PF-4, if funded, will boost that number to about 30 by the middle of the next decade and to between 50 and 80 by the end of the following decade. Russia reportedly can produce approximately 1,000 pits a year.[34]

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—most importantly, parts of the plutonium and highly enriched uranium component manufacturing infrastructure—have not been modernized since the 1950s, and plans for long-term infrastructure recapitalization remain uncertain. The infrastructure therefore receives a grade of "weak."

Personnel Challenges Within the National Nuclear Laboratories Score: Marginal[35]

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, 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.[36]

The ability to maintain and attract a high-quality workforce is critical to assuring the future of the American nuclear deterrent. 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 that will take on this mission. This means that young designers need challenging warhead design and development programs to hone their skills, but only a very limited number of such challenging programs are in place today. The next generation must be given opportunities to develop and maintain the skills that the future nuclear enterprise needs. The NNSA and its weapons labs understand this problem and, with the support of Congress and despite significant challenges, including a fiscally constrained environment, are taking initial steps to mentor and train the next generation.

The U.S. currently relies on non-yield-producing laboratory experiments, flight tests, and the judgment of experienced nuclear scientists and engineers 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.

A basic problem is that few 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, and production. The complex must attract and retain the best and brightest. The average age of the NNSA's workforce remained 48.1 years as of August 2017.[37] Even more worrisome is that over a third of the NNSA 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.[38]

Grade: In addition to employing world-class experts, the NNSA labs have had recent success in attracting and retaining talent. However, because many scientists and engineers with practical nuclear weapon design and testing experience are retired or retiring very soon, nuclear warhead certifications will rely largely on the judgments of people who have never tested or designed a nuclear warhead. Management challenges and a lack of focus on the nuclear weapon mission contribute to the lowering of morale in the NNSA complex. In light of these issues, which have to do more with policy than with the quality of people, the complex earns a score of "marginal."

Readiness of Forces Score: Marginal

The readiness of forces is a vital component of America's strategic forces. The military personnel operating the three legs of the nuclear triad must be properly trained and equipped. It is also essential that these systems are maintained in a high state of readiness.

During FY 2017, the services have continued to align resources in order to preserve strategic capabilities in the short term, but long-term impacts remain uncertain. Continued decline in U.S. general-purpose forces eventually could affect nuclear forces, especially the bomber leg of the nuclear triad. Changes prompted by the 2014 Navy and Air Force cheating scandals have begun to address some of the morale issues. A sustained attention to the situation in the nuclear enterprise is critical.

Grade: Uncertainty regarding the further potential impacts of budgetary shortfalls, as part of the overall assessment, earns this indicator a grade of "marginal."

Allied Assurance Score: Strong

The number of weapons held by U.S. allies is an important element when speaking about the credibility of America's extended deterrence. Allies that already have nuclear weapons can

coordinate action with other powers or act independently. During the Cold War, the U.S. and the U.K. cooperated to the point where joint targeting was included.[39] France maintains its own independent nuclear arsenal, partly as a hedge against the uncertainty of American credibility. The U.S. also deploys nuclear gravity bombs in Europe as a visible manifestation of its commitment to its NATO allies.

The U.S., however, must also concern itself with its Asian allies. The United States provides nuclear assurances to Japan and South Korea, both of which are technologically advanced industrial economies facing nuclear-armed adversaries and potential adversaries. If they do not perceive U.S. assurances and guarantees as credible, they have the capability and know-how to build their own nuclear weapons and to do so quickly. That would be a major setback for U.S. nonproliferation policies.

The 2018 NPR takes a step in a good direction when it places "[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 proposes two supplements to existing capabilities—a low-yield SLBM warhead and a new nuclear sea-launched cruise missile—as important initiatives that act to strengthen assurance along with the Obama and Trump Administrations' initiatives to bolster conventional forces in NATO.[40]

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. Doubts about the modernization of dual-capable aircraft and even about the weapons themselves, as well as NATO's lack of attention to the nuclear mission and its intellectual underpinning, preclude assigning a score of "very strong." An unequivocal articulation of U.S. commitment to extended deterrence leads to an improvement in this year's score, raising it to "strong."

Nuclear Test Readiness Score: Weak

In the past, underground nuclear testing was one of the key elements of a safe, secure, effective, and reliable nuclear deterrent. For three decades, however, the U.S. has been under a self-imposed nuclear testing moratorium but with a commitment to return to nuclear testing if required to identify a problem, or confirm the fix to a problem, for a warhead critical to the nation's deterrent. Among other potential reasons to resume nuclear testing, the U.S. might need to test to develop a weapon with new characteristics that can be validated only by testing or to verify render-safe procedures. Nuclear tests and yield-producing experiments can also play an important role if the U.S. needs to react strongly to other nations' nuclear weapons tests and communicate its resolve or to understand other countries' new nuclear weapons.

To ensure a capability to resume testing if required, the U.S. maintains a low level of nuclear test readiness at the Nevada National Security Site (formerly Nevada Test Site). Current law requires that the U.S. be prepared to conduct a nuclear weapons test within a maximum of 36 months after a presidential decision to do so. The current state of test readiness is intended to be between 24 and 36 months, although it is doubtful that NNSA has achieved that goal. In the past, the requirement was 18 months.[41] The U.S. could meet the 18-month requirement only if certain domestic regulations, agreements, and laws were waived.[42] Because the United States is rapidly losing its remaining practical nuclear testing experience, including instrumentation of very sensitive equipment, the process would likely have to be reinvented from scratch.[43]

"Test readiness" seeks to facilitate a single test or a very short series of tests, not a sustained nuclear testing program. Because of a shortage of resources, the NNSA has been unable to achieve the goal of 24 to 36 months. The test readiness program is supported by experimental programs at the Nevada National Security Site, nuclear laboratory experiments, and advanced diagnostics development.[44]

Grade: As noted, the U.S. can meet the readiness requirement mandated by the law 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, which certain scenarios might require. 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 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 U.S. nuclear forces modernization and warhead sustainment, these programs remain threatened by potential future fiscal uncertainties. The infrastructure that supports nuclear programs is aged, and nuclear test readiness has revealed troubling problems within the forces. Additionally, the United States has conducted fewer test launches than in previous years.

On the plus side, the 2018 NPR articulates nuclear weapons policy grounded in realities of international developments and clearly articulates 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, and the modernization of nuclear delivery platforms represent a positive trend that should 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		✓			
OVERALL			✓		

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Ballistic Missile Defense

Missile defense is a critical component of the U.S. national security architecture that enables U.S. military efforts and can protect national critical infrastructure, from population and industrial centers to politically and historically important sites. It can strengthen U.S. diplomatic and deterrence efforts and provide both time and options to senior decision-makers.

Ballistic missiles remain a weapon of choice for many U.S. adversaries because they possess important attributes like extraordinarily high speed (against which the U.S. has a very limited ability to defend) and relative cost-effectiveness compared to other types of conventional attacks.[1] The number of states that possess ballistic missiles will continue to increase, and so will the sophistication of these weapons as modern technologies become cheaper and more widely available. An additional concern is ballistic missile cooperation between state and non-state actors, which furthers the spread of sophisticated technologies and compounds challenges to U.S. defense planning.[2]

The ability to deter an enemy from attacking depends on convincing 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 the perceived benefit of attacking. A U.S. missile defense system strengthens deterrence by offering a degree of protection to the American people and the economic base on which their well-being depends, as well as forward-deployed troops and allies, making it harder for an adversary to threaten them with ballistic missiles. A missile defense system also provides a decision-maker with 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.

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 U.S. 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. A robust missile defense system would change 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.

Ballistic missile defense is also 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 the United States' 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 adversarial missile in the boost, ascent, midcourse, or terminal phase of its flight.

Another way to consider missile defense 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, since 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 timeframe 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.[3] There is renewed interest in airborne missile defense concepts within the Trump Administration, particularly for boost-phase intercepts.

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.[4] These layers would include boost, ascent, midcourse, and terminal 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, despite tremendous technological advances and benefits that came out of the Strategic Defense Initiative (SDI) program.[5] 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.[6] The 2017 NDAA dropped the word "limited" that had been a fixture of policy since the National Missile Defense Act of 1999. 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 fiscal year (FY) 2018, the Trump Administration requested $7.9 billion for the Missile Defense Agency (MDA), the primary government agency responsible for developing, testing, fielding, and integrating a layered ballistic missile defense system. The request was not that different from the Obama Administration's FY 2017 request for $7.5 billion but below the Bush Administration's budget requests.[7] Additionally, the Administration requested permission to reprogram about $440 million of unspent FY 2017 funds from different accounts toward missile defense technologies, to be divided among different parts of the missile defense system based on policy priorities set by the President and Congress.

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 these choices are reflected in the composition of today's U.S. missile defense.

Ballistic missile defense interceptors are designed to intercept ballistic missiles in three different phases of their flight.

- The boost phase is 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 should the first intercept attempt fail.

- 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 timeframe 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.[8] 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.

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. The current budget environment also presents a challenge as it does not adequately fund research into future missile defense technologies and is barely enough to keep the existing missile defense programs going or enable 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 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. In June 2017, Vice Admiral James Syring, then Director of the Missile Defense Agency, testified before the House Armed Services Subcommittee on Strategic Forces that:

> I would not say we are comfortably ahead of the threat. I would say we are addressing the threat that we know today. And the advancements in the last six months have caused great concern to me and others in the advancement of and demonstration of technology, ballistic missiles from North Korea.[9]

The United States currently deploys 40 interceptors in Alaska and four in California and is planning to increase the number of deployed interceptors in the coming years. At about $70 million apiece, the GMD interceptors are rather expensive–but a lot cheaper than a successful ballistic missile attack. The system has struggled with reliability issues during its tests and is unsuited to addressing larger-scale ballistic missile threats.

The Aegis ballistic missile 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 the ship location and the quality of tracking data. The U.S. Navy was scheduled to operate 36 Aegis missile defense–capable ships by the end of FY 2018, but temporary loss of two missile defense destroyers, the USS *Fitzgerald* and USS *John S McCain*, involved in separate ship collisions during 2017, will make this goal harder to achieve.[10]

The Aegis-Ashore system being deployed to Poland and Romania 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.[11] It consists of a launcher, interceptors, AN/TPY-2 radar, and fire control. The system is transportable and rapidly deployable. DOD's FY 2018 program "[c]ontinues fielding and sustainment activities for seven THAAD Batteries."[12] THAAD batteries have been deployed to such countries and regions as Japan, South Korea, and the Middle East.

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, engagement control station, and diesel-powered generator units. The system is transportable, and the United States currently deploys 15 battalions in several theaters around the world.[13] 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. In so doing, 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 ballistic missile defense system also provides terminal capability against short-range and medium-range ballistic missiles.[14]

Sensors

The space sensor component of the U.S. ballistic 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. The 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.[15] 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."[16]

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.[17]

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' 11 AN/TPY-2 systems, five are forward-deployed with U.S. allies (one to the Central Command area of operations, two in Japan, and one apiece in Turkey and Israel); two are deployed with THAAD in Guam and the Republic of Korea; and four are in the United States.[18]

In March 2017, in cooperation with the Republic of Korea, the United States deployed a THAAD missile system to the Korean peninsula that was 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.[19] 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.[20]

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.[21] SBX is used primarily in the Pacific. The second radar 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, 34 are BMD-capable vessels that carry missile defense interceptors.[22]

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."[23] Control of the space BMD system is divided between the MDA and the U.S. Air Force.

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.[24] 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.[25] However, congressional funding delays have left SBIRS underfunded and hampered the system's full development and deployment.[26]

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.[27] 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.[28]

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 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.[29]

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.[30] More than 70 C2BMC workstations are distributed throughout the world at U.S. military bases.[31] C2BMC has undergone multiple technical

upgrades since 2004, and a major update is scheduled for completion in 2018.

Conclusion

By successive choices of post–Cold War Administrations and Congresses, the United States does not have in place a comprehensive ballistic missile defense system 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 ballistic missile threats, both qualitative and quantitative, outpaces the speed of ballistic 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.

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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 returned to "marginal" in the 2019 *Index*, primarily due to an increase in readiness. The Army continues to struggle to rebuild end strength and modernization for improved readiness in some units for current operations, accepting risks in these areas to keep roughly half of its force at acceptable levels of readiness.

- **Navy as "Marginal."** The Navy's overall score is the same as in the *2018 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. The Navy's decision to defer maintenance has kept ships at sea but also has affected the Navy's ability to deploy, and the service has little ability to surge to meet wartime demands. The Navy remained just able to meet operational requirements in 2018.

- **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 "Weak."** The Corps continues to deal with readiness challenges driven by the combination of high operational tempo and the lingering effects of procurement delays. The Marine Corps has cited modernization of its aviation platforms as the single most effective means to increase readiness within the service. Marine operating forces as a whole continue to average a two-to-one deployment-to-dwell ratio, consuming readiness as quickly as it is built and leaving minimal flexibility to respond to contingencies.

- **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 a bipartisan commitment has led to continued progress on U.S. nuclear forces modernization and warhead sustainment, these programs remain threatened by potential future fiscal uncertainties, as are 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 *2019 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.

The military services have continued to prioritize readiness for current operations by shifting funding to deployed or soon-to-deploy units while sacrificing the ability to keep non-deployed units in "ready" condition; delaying, reducing, extending, or canceling modernization programs; and sustaining the reduction in size and number of military units. While Congress and the new Administration took positive steps to stabilize funding for 2018 and 2019 through the Bipartisan Budget Agreement of 2018, they have not overturned the Budget Control Act that otherwise caps defense spending and that, absent additional legislative action, will reassert its damaging effects in 2020. Without a real commitment to increases in modernization, capacity, and readiness accounts over the next few years, a significant positive turn in the threat environment, or a reassessment of core U.S. security interests, America's military branches will continue to be strained to meet the missions they are called upon to fulfill.

U.S. Military Power: Army

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

U.S. Military Power: Navy

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

U.S. Military Power: Air Force

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

U.S. Military Power: Marine Corps

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

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		✓			
OVERALL			✓		

U.S. Military Power

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Army			✓		
Navy			✓		
Air Force			✓		
Marine Corps		✓			
Nuclear			✓		
OVERALL			✓		