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 three preceding editions of the *Index*, however, the U.S. does not have the right 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 tanks 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, competency, 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 hard, 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 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 invest. Although that investment 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 an 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,[4] 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.

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, have 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, while the increased precision of weapons makes it possible for fewer platforms to hit many more

targets. Additionally, 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 smaller forces can have far greater effect in battle than at any other time in history. But these same advances also enable enemy forces, and 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.

With smaller forces, each individual element of the force represents a greater percentage of its combat power. Each casualty or equipment loss 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 nonstate. Consequently, it may be that the outcomes of future wars will depend to a much greater degree on the skill of the forces and their capacity to sustain operations over time than they will on some great disparity in technology. If so, readiness and capacity will take on greater importance than absolute advances in capability.

All of this illustrates the difficulties of and need for exercising judgment in assessing the adequacy of America's military power. Yet without such an assessment, all that remains are the quadrennial strategic 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.

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 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 sub-types 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 anywhere 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 account for the Reserve and Guard components of the services; it focuses only on the Active component. Again, the element of proportion or ratio figures prominently. Each service determines the balance among its Active, Reserve, and National Guard elements (only the Army and Air Force have Guard elements; the Navy and Marine Corps do not) 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.[6] This assessment 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.

The Defense Budget and Strategic Guidance

When it comes to the defense budget, how much we spend does not 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 but not by itself sufficient condition for a capable, modern, and ready force. 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 decision to fund national defense commensurate with interests and prevailing threats is a reflection of 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) 2017 base discretionary budget for defense was $521.8 billion.[7] 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).

In 2017, the debate about how much funding to allocate to defense was framed by the incoming Administration's campaign promise to rebuild the military. 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.

The argument for significant increases in defense spending in 2017 was anchored by House Armed Services Committee Chairman Mac Thornberry (R–TX) and the Senate Armed Services Committee Chairman John McCain (R–AZ). Both released public documents early in the year that stressed the importance of rebuilding the military and set budgetary targets for the coming fiscal year that would start to do so.[8] The proposals established a spending objective of $640 billion, substantially higher than the caps imposed by the Budget Control Act (BCA) of 2011 and exceeding both the Trump Administration's recommended $603 billion[9] and The Heritage Foundation's recommended $632 billion.[10]

In testimony before the House Armed Services Committee, 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. "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."[11]

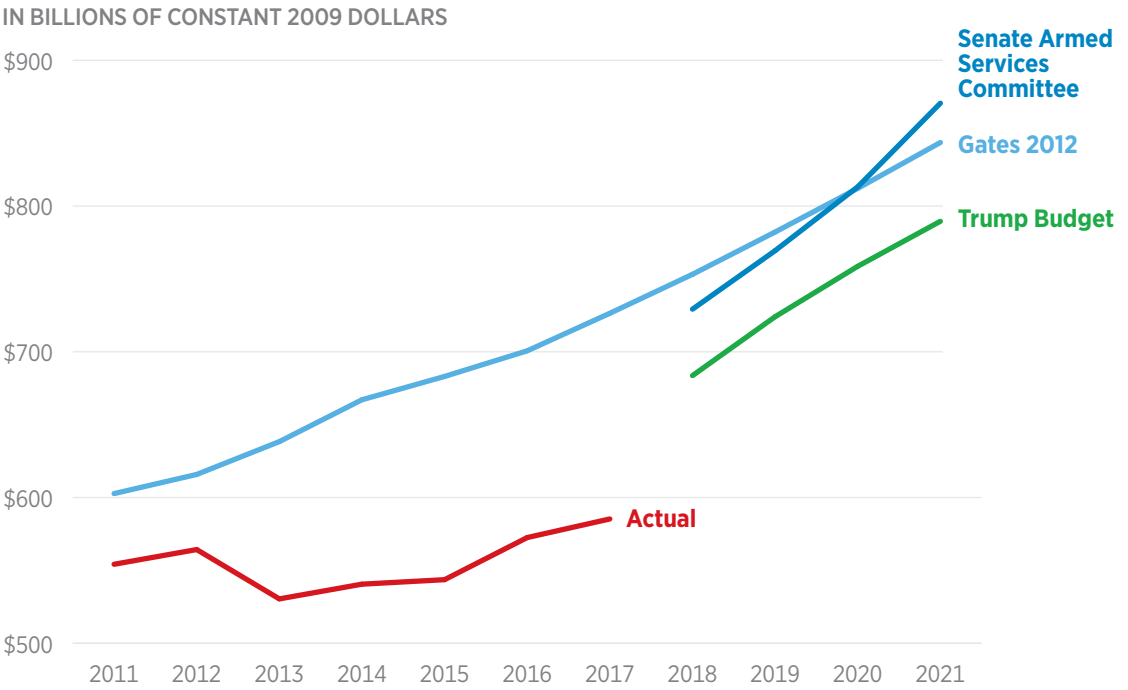
President Barack Obama's 2012 defense budget, the last sent to Congress before passage of the BCA, proposed $661 billion in defense spending for FY 2018. A bipartisan consensus, as seen in the National Defense Panel report in 2014, identified the so-called Gates budget (named after then-Secretary of Defense Robert Gates) as the minimum that the United States should be spending on national defense.[12] As seen in Chart 3, despite congressional pushes toward a higher topline, both the FY 2017 enacted budget and the FY 2018 budget proposal are below this minimum.

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. The funding

CHART 3

Defense Spending Heavily Constrained by Budget Control Act

Current defense spending is far below the levels requested by former Secretary of Defense Robert Gates in 2012 and President Trump in his FY 2018 budget.



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restrictions that have caused severe degradation in military readiness over the past five years have yet to be addressed adequately by Congress. The BCA remains a major obstacle to creating predictable levels of funding for defense and will continue to harm readiness and modernization until it is repealed and sufficient funding is provided on a consistent basis for at least the next decade.

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.[13] 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 Combatant Commands, or COCOMS (EUCOM, CENTCOM, PACOM, SOUTHCOM, and 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 establish working relationships with other countries, acquire a more detailed understanding of regional political–military dynamics and on-the-ground conditions in areas of interest, and signal U.S. security interests to friends and competitors.

To support such COCOM efforts, the services provide forces that are based permanently in respective regions or that operate in them temporarily on a rotational basis. To make these regional rotations possible, the services must maintain 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 with the amount of military power (typically measured in terms of combat units and major combat platforms, which informs 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 fills in for one of the other ships when it needs maintenance or training time.

This report 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"[14] 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 subsurface); 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.

In 2017, the military community continued to debate 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. 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. According to Acting Secretary of the Army Robert Speer and Army Chief of Staff General Mark Milley:

> In 2014, the United States Army began the transition from training for a decade-long counterinsurgency campaign to training for major combat operations. Over the next two years, the Army's challenge is to balance the requirements of remaining regionally engaged, while simultaneously preparing to meet the demands of a globally responsive contingency force.[15]

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, but 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 current funding for defense has the Corps at 24. In 2012, the Army was on a build toward 48 brigade combat teams, but funding reductions now have the number at 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 current debate within the total Army about the roles and contributions of the various Army components. A similar situation exists with the Air Force and Marine Corps.

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

We conducted a review of the major defense studies (1993 BUR, QDR reports, and independent panel critiques) that are publicly available,[16] 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 3. 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 346 ships and 624 strike aircraft.
- Air Force: 1,200 fighter/attack aircraft.
- Marine Corps: 36 battalions.

America's security interests require the services to 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.[17] To avoid this, the services have traded quantity/capacity and modernization to ensure that what they do have is "ready" for employment.

As was the case in 2016, the service chiefs have stated that current and projected levels of funding continue to take a toll on the ability of units to maintain sufficient levels of readiness across the force. Some units have reduced

TABLE 3

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

manning. Though progress has been made in some areas due to funding provided by Congress over the past few years, the return of further cuts under the Budget Control Act of 2011 threatens to undo these gains. For example:

- General Daniel Allyn, Vice Chief of Staff of the Army, testified in February 2017 that "[t]oday, only about 1/3 of our BCTs, 1/4 of our Combat Aviation Brigades and half of our Division Headquarters are ready. Of the BCTs that are ready, only three could be called upon to fight tonight in the event of a crisis."[18]

- Secretary of the Air Force Heather A. Wilson and Air Force Chief of Staff General David L. Goldfein warned in testimony before Congress in June 2017 that "the Air Force is too small for the missions demanded of it and it is unlikely that the need for air and space power will diminish significantly in the coming decade.... We are at our lowest state of full spectrum readiness in our history."[19]

- The U.S. Navy's force reductions without a commensurate reduction in mission demand have led to a readiness crisis as well. "Maintaining the readiness of our naval forces is key to maintaining the scope and scale of operations demanded of them," Acting Secretary of the Navy Sean Stackley testified in June 2017. "We have been increasingly challenged in our ability to do so, however, by the growing imbalance between the size of the force, the operational demand placed on the force, and the funding available to operate and sustain the force."[20]

- Top Marine Corps officials acknowledged similarly continued strains, testifying in April 2017 that "today's force is capable and our forward deployed forces are ready to fight," but that "we are fiscally stretched to maintain readiness across the breadth of the force in the near term, and to modernize for future readiness against threats we will face. The Marine Corps will require sufficient resources to remedy this situation."[21]

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.

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, Network-centric Operations, Global Strike, Multi-Domain Battle, 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 Managing Change in the Department of Defense* (Santa Monica, CA: RAND Corporation, National Defense Research Institute, 2003), http://www.rand.org/content/dam/rand/pubs/documented_briefings/2005/DB379.pdf (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 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. One example of balancing the forces was the Army's Aviation Restructure 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, p. 1, http://www.gao.gov/assets/670/669857.pdf (accessed August 2, 2017).
7. U.S. Department of Defense, Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2018*, June 2017, p. 1, http://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2018/FY18_Green_Book.pdf (accessed July 24, 2017).
8. For the House version, see House Committee on Armed Services, *Rebuilding National Security—The Price of Freedom*, 2017, https://armedservices.house.gov/sites/republicans.armedservices.house.gov/files/wysiwyg_uploaded/HASC%20Budget%20White%20Paper.pdf (accessed August 3, 2017). For the Senate version, see U.S. Senator John McCain, *Restoring American Power: Recommendations for the FY 2018–FY 2022 Defense Budget*, 2017, https://www.mccain.senate.gov/public/_cache/files/25bff0ec-481e-466a-843f-68ba5619e6d8/restoring-american-power-7.pdf (accessed August 3, 2017).
9. U.S. Office of Management and Budget, *Budget of the U.S. Government: A New Foundation for American Greatness*, *Fiscal Year 2018* (Washington: U.S. Government Printing Office, 2017), p. 201, https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/budget/fy2018/budget.pdf (accessed August 3, 2017).
10. Thomas Spoehr and Rachel Zissimos, "Preventing a Defense Crisis: The 2018 National Defense Authorization Act Must Begin to Restore U.S. Military Strength," Heritage Foundation *Backgrounder* No. 3205, March 29, 2017, http://www.heritage.org/defense/report/preventing-defense-crisis-the-2018-national-defense-authorization-act-must-begin.
11. 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).
12. See, for example, *Ensuring a Strong U.S. Defense for the Future: The National Defense Panel Review of the 2014 Quadrennial Defense Review*, July 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 1, 2017).
13. 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).

14. Defense references to war have varied over the past few decades from "major combat operations" (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.
15. The Honorable Robert M. Speer, Acting Secretary of the Army, and General Mark A. Milley, Chief of Staff, United States Army, statement "On the Posture of the United States Army" before the Committee on Armed Services, U.S. Senate, 115th Cong., 1st Sess., May 25, 2017, p. 6, https://www.armed-services.senate.gov/imo/media/doc/Speer-Milley_05-25-17.pdf (accessed August 3, 2017).
16. 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.
17. For more on the potential for a hollow force, see Association of the U.S. 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 July 31, 2017), 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).
18. General Daniel Allyn, Vice Chief of Staff, United States Army, statement on "State of the Military" before the Committee on Armed Services, U.S. House of Representatives, 115th Cong., 1st Sess., February 7, 2017, p. 4, http://docs.house.gov/meetings/AS/AS00/20170207/105530/HHRG-115-AS00-Wstate-AllynD-20170207.pdf (accessed August 3, 2017).
19. The Honorable Heather A. Wilson, Secretary of the Air Force, and General David L. Goldfein, Chief of Staff, United States Air Force, statement on "Air Force Budget Posture" before the Committee on Armed Services, U.S. Senate, June 6, 2017, pp. 2–3, https://www.armed-services.senate.gov/imo/media/doc/Wilson-Goldfein_06-06-17.pdf (accessed August 3, 2017).
20. The Honorable Sean J. Stackley, Acting Secretary of the Navy, statement before the Committee on Armed Services, U.S. Senate, June 15, 2017, p. 5, https://www.armed-services.senate.gov/imo/media/doc/Stackley_06-15-17.pdf (accessed August 3, 2017).
21. Lieutenant General Ronald L. Bailey, Deputy Commandant for Plans, Policies, and Operations; Lieutenant General Jon M. Davis, Deputy Commandant for Aviation; and Lieutenant General Michael G. Dana, Deputy Commandant for Installations and Logistics, statement on "The Current State of the Marine Corps" before the Subcommittee on Readiness Subcommittee, Committee on Armed Services, U.S. House of Representatives, April 5, 2017, p. 4, http://docs.house.gov/meetings/AS/AS03/20170405/105768/HHRG-115-AS03-Wstate-BaileyUSMCR-20170405.pdf (accessed August 1, 2017).

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.

Like the other services, the U.S. Army has been required "to take risk when meeting current operational requirements while maintaining a ready force for major combat operations."[1] Fiscal challenges have strained the Army's ability to meet the national security requirements outlined in the Defense Planning Guidance as it works to balance readiness, modernization, and end strength.

Army leaders have testified that Congress "stopped the bleeding" by including additional Army end strength in the 2017 National Defense Authorization Act (NDAA) and through supplemental funding in response to a May 2017 "Request for Additional Appropriations,"[2] but significant issues of size, readiness, modernization, and operational tempo still remain unaddressed. Chief of Staff General Mark Milley has testified that the Army is too small to accomplish the missions outlined in the National Security Strategy and Defense Planning Guidance, that "modernization has been sacrificed for current operations," and that only one-third of the Army's brigade combat teams (BCTs) are at an acceptable state of readiness.[3] Acting Secretary of the Army Robert M. Speer has testified that the Army's "pace of operations is as high as it has been in the past 16 years" despite ostensible reductions in troop deployments to Iraq and Afghanistan.[4]

In fiscal year (FY) 2017, the Army's active-duty end strength was 476,000, down from a height of 566,000 in FY 2011.[5] The Obama Administration had planned to cut active Army end strength even further to as low as 450,000 by 2018.[6] Although the Bipartisan Budget Act of 2015 provided a brief period of stability for the Department of Defense (DOD), current funding levels continue to force the Army to prioritize readiness. The trade-offs in that decision were "a smaller Army, smaller investments in modernization, and deferring installation maintenance. The principal negative impacts of these trade-offs have been stress on the force, eroded competitive advantage, and deteriorating installations."[7] Army leaders have testified that if Budget Control Act–mandated budget caps return in FY 2018, the result will be a "hollow Army."[8]

Operationally, the Army has approximately 186,000 soldiers forward stationed across 140 countries.[9] This is very similar to last year's level of 190,000, reinforcing the point that the Army continues to experience a historically high level of operational tempo,[10] but does not include a probable increase of as many as 3,900 soldiers in the number of U.S. forces in Afghanistan that is reportedly near approval by the Trump Administration.[11] Of the total number of U.S. forces deployed globally, "[t]he Army currently provides 48% of planned forces committed to global operations and over 70% of forces for emerging demands from Combatant Commanders," highlighting the key role that the Army plays in the nation's defense.[12]

Capacity

The 2017 NDAA increased Army authorized end strength to 1,018,000 soldiers: 476,000 Active soldiers, 199,000 in the Army Reserve, and 343,000 in the Army National Guard, reversing years of reductions.[13] Because the outgoing Obama Administration had not requested this funding, additional funding was requested by the Trump Administration and provided in the May 2017 supplemental funding package.[14] As noted, General Milley has testified that the Army is too small for the missions it has been assigned. He believes that the Active Army should number between 540,000 and 550,000, the Army National Guard from 350,000 to 355,000, and the Army Reserve between 205,000 and 209,000.[15]

The Army normally refers to its size 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 sufficiently equipped and organized so that they can conduct independent operations as circumstances demand.[16] 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 ground combat vehicle (GCV). Armored BCTs are the Army's principal armored units and employ the 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.[17] 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 force, 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."[18] 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[19]) 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 capacity. In preparation for the reduction of its end strength to 460,000, the planned level for FY 2017,[20] the Active Army underwent brigade restructuring that decreased the number of BCTs from 38 to 31. When Congress reversed that reduction in end strength and authorized an active-duty level of 476,000 for 2017, instead of "re-growing" BCTs, the Army chose primarily to "thicken" the force and is raising the manning levels within the individual BCTs and thereby increasing readiness.[21]

The 2015 NDAA established the 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.[22] The FY 2018 budget will support the conversion of one Infantry BCT into an Armored BCT, marking the creation of the Army's 15th Armored BCT.[23]

In 2017, in a major initiative personally shepherded by General Milley, the Army established the first of a planned six 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.[24] It plans to activate two SFABs in 2017, but further activations are on hold until final decisions on long-term Army end strength are made.[25]

Army aviation units also have been reduced in number. In May 2015, the Army deactivated one of its 12 Combat Aviation Brigades (though retaining a headquarters element),[26] leaving only 11 CABs in the active component.[27] This left U.S. Army Europe without a forward stationed CAB, forcing the Army to rely on rotational forces from the United States.

The reductions in end strength since 2011 have had a disproportionate effect on BCTs. The Active Army has been downsized from 45 BCTs (552,100 soldiers) in FY 2013 to 31 BCTs (476,000 soldiers) in FY 2017.[28] Put another way, a 14 percent reduction in troop numbers has resulted in 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 corresponding increase in operational tempo (OPTEMPO). The Army also uses the term "dwell time" to refer to the time soldiers and units are back at their home stations between deployments. The chief personnel officer for the Army has described the current situation:

> [M]any thought the dwell time had gone down because the troop levels have reduced in Afghanistan and Iraq, and that's really not the case. You know we're rotating forces right now into Korea. We're rotating forces into Kuwait. We're rotating forces into Europe along with Iraq and Afghanistan. So, the dwell time has not come down.[29]

As part of these rotations, the Army has begun to rotate Armored BCTs to Europe on a "heel-to-toe" basis, using the funding provided in the European Reassurance Initiative (ERI). The first of these rotational BCTs, the 3rd BCT of the 4th Infantry Division, arrived in January 2017 and is engaged in a series of exercises with NATO allies.[30]

To capture operational tempo, the Army uses a ratio referred to as "BOG/Dwell," which is the ratio of Boots on the Ground (BOG, or deployed) to Dwell (time back at home station). As of May 2017, Army BOG/Dwell rates were extraordinarily high.[31] For example, a 1:1 ratio for Division Headquarters means that for every year that Army division headquarters are deployed, they are at home station for a year. Primarily because of the stress on soldiers, these ratios are unsustainable.

Capability

The Army's main combat platforms are ground vehicles and rotorcraft. The upgraded M1A2 (M1A2SEP v.3) Abrams and M2/M3 Bradley vehicles are used primarily in active component Armored BCTs, while Army National Guard ABCTs still rely on variants.[32] Stryker BCTs are equipped with Stryker vehicles. In response to an Operational Needs Statement, Stryker vehicles in Europe are being fitted with a 30mm cannon to provide an improved anti-armor capability. Fielding will begin in 2018.[33] Infantry BCTs have fewer platforms and rely on lighter platforms such as trucks and High Mobility Multipurpose Wheeled Vehicles (HMMWVs) for mobility. 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. Some equipment has been worn down by usage in Afghanistan and Iraq, but the Army has undertaken a "reset" initiative that is discussed below in the readiness section. Most Army vehicles are relatively "young" because of recent remanufacture programs for the Abrams and Bradley that have extended the service life of

both vehicles beyond FY 2028.[34] While the current equipment is well maintained, however, "Army leadership notes for the first time since World War I, that the Army does not have a new ground combat vehicle under development and 'at current funding levels, the Bradley and Abrams will remain in the inventory for 50 to 70 more years.'"[35]

The Army has been methodically replacing the oldest variants of its rotorcraft and upgrading others that still have plenty of airframe service life. Today, the UH-60M, which is a newer version of the UH-60A, 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 extend the platform's service life at least through 2038.[36] However, at $3.1 billion, the 2018 budget request for aircraft procurement for Apache, Blackhawk, and Chinook helicopters stands at $1.3 billion less than the FY 2017 President's budget.[37] The proposed 2018 budget will further delay complete modernization of the Apache and Black Hawk fleets, respectively, from 2026 to 2028 and from 2028 to 2030.[38]

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 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.

The Army is currently undertaking several modernization programs to improve its ground combat vehicles and current rotorcraft fleet. However, cuts in research and development, acquisition, and procurement accounts because of budget reductions levied in previous years have significantly affected these efforts. As the Vice Chief of Staff of the Army recently testified, the modernization budget is "50 percent of what it was in 2009. In FY '17 it's $24.8 billion, it was $45.5 billion in 2009."[39] Summarizing the impact of these reductions at a November 2016 conference, 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, will have parity in three, and the United States will dominate in one."[40]

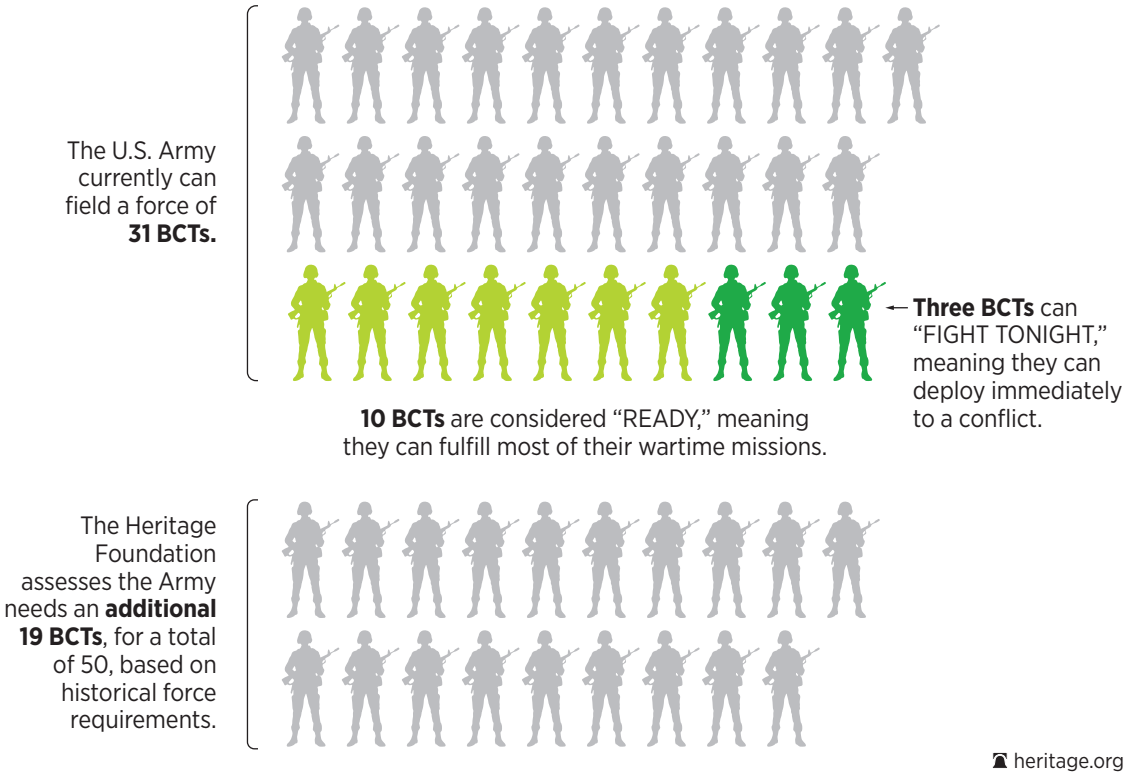
Army leaders have testified that they have "deferred many modernization investments which allowed our competitors to gain advantages in such areas as fires, air and missile defense, and armor."[41] As the Acting Secretary of the Army warned in June 2017, "a consequence of underfunding modernization for over a decade is *an Army potentially outgunned, outranged, and outdated* on a future battlefield with near-peer competitors."[42]

The anemic nature of the Army's modernization program is illustrated by the fact that its highest-profile joint service 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

FIGURE 6

Army Readiness: Brigade Combat Teams

In 2012, the Army fielded 45 active component Brigade Combat Teams (BCTs). Due to budget cuts, that number has been reduced to 31.



to the HMMWV, to include scouting and troop transport in adverse environments, guerrilla ambushes, and artillery bombardment.

Several issues, including changed requirements and some technical obstacles in the early development phases, delayed the JLTV program from its originally intended schedule by about one year. FY 2018 Base Procurement of $804.4 million supports 2,110 JLTVs of various configurations to fulfill the requirements of multiple mission roles and minimize ownership costs for the Army's Light Tactical Vehicle fleet.[43]

Other Army MDAPs of note in FY 2018 include the M1A2 Abrams Equipment Change Program (ECP); M2 Bradley modifications; M109A6 Paladin 155mm Howitzers (Paladin Integrated Management); and munitions including Guided Multiple Launcher Rocket System (GMLRS) and Hellfire missiles.[44]

The M1A2 is currently being enhanced with Vehicle Health Management and Power Train Improvement and Integration Optimization to upgrade the tank's reliability, durability, and fuel efficiency so that it can provide ground forces with superior battlefield firepower.[45] Similarly, the M109A6 is being outfitted with the Paladin Integrated Management (PIM) program, which consists of a new drivetrain and suspension components, to sustain the platform's utility in combat through 2050.[46]

The Armored Multi-Purpose Vehicle (AMPV), the program to replace the Army's 1960s-vintage M113 Armored Personnel Carrier, is a new start in FY 2018. The AMPV will

have five mission modules: General Purpose, Medical Treatment, Medical Evacuation, Mortar Carrier, and Mission Command. FY 2018 Base Procurement dollars of $193.715 million will procure 42 AMPVs. This represents the first year of Low Rate Initial Production (LRIP). The Army acquisition objective for AMPVs is 2,897 vehicles.[47]

Significantly, 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. In the words of an Army Deputy Chief of Staff, because of 15 years of sustained combat operations and limited resources, we have "forfeited the modernization of our weapons systems."[48]

Readiness

The combined effects of the Budget Control Act of 2011, an unrelenting global demand for forces, and reductions in end strength have caused Army readiness to decline to the point where only one-third of Army BCTs are now considered "ready" and only three are ready to "fight tonight."[49] The Chief of Staff of the Army recently testified that they "have much, much more work to do to achieve full-spectrum readiness and modernization."[50]

Congress provided much-needed relief in May 2017 by appropriating approximately $15 billion for the Pentagon in response to the Administration's request for additional appropriations, the bulk of which was targeted directly at increasing wartime readiness.[51] This, combined with the increase in Army end strength authorized in the 2017 NDAA, provided a desperately needed measure of relief. For FY 2018, 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 armor formations can drive their tanks and aviators can fly their helicopters. According to the Department of the Army's budget justification, "The FY 2018 base budget funds 1,188 Operating Tempo Full Spectrum Training Miles and 10.6 flying hours per crew, per month for an expected overall training proficiency of BCT(-)."[52] These are significantly higher than resourced levels of 839 miles and 9.5 hours in FY 2017.[53]

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 continues to "protect current readiness at the expense of future modernization and end strength."[54] In the words of Army Vice Chief of Staff General Daniel Allyn, "fifteen years of sustained counter-insurgency operations have degraded the Army's ability to conduct operations across the spectrum of conflict and narrowed the experience base of our leaders."[55]

Recognizing the risk that degraded readiness introduces into its ability to respond to an emergent threat, the Army continues to prioritize operational readiness over other expenditures for FY 2018. A return to "full spectrum combat readiness" will require sustained investment for a number of years. As a result of years of high operational tempos and sustained budget cuts, the Army now does not expect to return to "full spectrum readiness" until "best case 2021, worst case 2023."[56]

This tiered readiness strategy means that only a limited number of BCTs are available and ready for decisive action. Accordingly, the tiered readiness model employed by the Army has resulted in approximately one-third of the 31 Active BCTs being ready for contingency operations in FY 2017 compared to a desired readiness level of two-thirds.[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 mission of the CTC program 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 financing for 19 CTC rotations in FY 2018, 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, if the size of the Army remains the same and global demand does not diminish, "at today's end-strength, the Army risks consuming readiness as fast as we build it," which means that the date by which Army leaders hope to regain full spectrum readiness will continue to be pushed back, prolonging strategic risk for the nation.[62]

Another key factor in readiness is available quantities of munitions. The Army's chief logistician warned recently 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 are—continue to be emerging threats which we see around the world, I am very concerned with our current stockage of munitions."[63]

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, 42 BCTs would be needed to fight two MRCs.[64] Taking into account the need for a strategic reserve, the Active Army force should also include an additional 20 percent of the 42 BCTs.

- **Two-MRC Benchmark:** 50 brigade combat teams.
- **Actual 2017 Level:** 31 brigade combat teams.

The Army's current Active Component BCT capacity meets 64 percent of the two-MRC benchmark and thus is scored as "weak."

Capability Score: Marginal

The Army's aggregate capability score remains "marginal." While the Army will continue to pursue the aim of improving readiness levels in FY 2018 over the previous year, and while Congress increased end strength slightly and provided a modest amount of additional funding, the service's overall capability score remains static due to unrelenting global demands for Army forces with no additional BCTs, CABs, or Divisions to satisfy those demands. Additionally, in spite of modest progress with the JLTV and AMPV, research, development, and procurement budget levels remain well below the levels needed to begin even a minimal modernization program, thereby negatively affecting platform innovation

and modernization. These subsequent reductions continue to limit the Army's development of future capabilities needed to remain dominant in any operational environment.

This aggregate score is a result of "marginal" scores for "Age of Equipment," "Size of Modernization Programs," and "Health of Modernization Programs." The Army scored "weak" for "Capability of Equipment."

Readiness Score: Weak

Just over a third of Active BCTs were ready for action according to official Army testimony by the Chief of Staff in May 2017.[65] The Army had 31 BCTs; therefore, roughly 10 of the Active Army BCTs were considered ready for combat. For that reason, this *Index* assesses Army readiness as "weak." However, it should be noted that the Vice Chief of Staff also reported in February that of the BCTs fully trained for "decisive action operations," only three were ready to "fight tonight."[66] With this in mind, *actual* readiness is therefore likely dangerously close to nearing a state of "very weak."

Overall U.S. Army Score: Weak

The Army's overall score is calculated based on an unweighted average of its capacity, capability, and readiness scores. The average score was 2.3; thus, the overall Army score is "weak." This was derived from the aggregate score for capacity ("weak"); capability ("marginal"); and readiness ("weak"). This score is the same as the score in the *2017 Index* and indicates continued concerns for the Army, particularly when it comes to capacity in light of increased demand on the service around the globe.

U.S. Military Power: Army

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

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U.S. Navy

In *A Design for Maintaining Maritime Superiority*, 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 basis for understanding the key functions necessary to accomplish this mission was provided in the March 2015 update to *A Cooperative Strategy for 21st Century Seapower*.

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.[2]

As the military's primary maritime arm, the U.S. 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 requiring 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 routine 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 (SLOC) 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 2012 Defense Strategic Guidance (DSG);[3]
- The Global Force Management Allocation Plan (GFMAP);[4]
- The 2015 update to *A Cooperative Strategy for 21st Century Seapower*; and

- The *Design for Maintaining Maritime Superiority*.

The 2012 DSG issued by the Secretary of Defense describes 10 primary missions for the Navy and the other branches of the U.S. military. In addition, the U.S. Navy must meet forward presence requirements laid out in the fiscal year (FY) 2017 GFMAP, which states the force presence needed around the world as determined by the combatant commanders (COCOMs) and the Secretary of Defense.

Capacity

The Navy measures capacity by the number of ships rather than the number of sailors, and not all ships are counted 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.[5]

The Navy currently sails 276 vessels as part of its battle force fleet,[6] up from 274 in 2016[7] but still well below both the Navy's fleet goal and a level sufficient to uphold a two-MRC (major regional contingency) construct. The Navy requested procurement of nine ships in FY 2018,[8] 12 ships less than the number recommended for procurement in the Secretary of the Navy's February 2017 "United States Navy Accelerated Fleet Plan"[9] and in a Congressional Budget Office (CBO) assessment of the average annual ship procurement needed to achieve a 355-ship fleet by 2037.[10] The Accelerated Fleet Plan includes one additional guided missile destroyer (DDG 51), one Expeditionary Fast Transport (EPF), and one Expeditionary Mobile Base (ESB) in FY 2018.[11] The gap between actual and desired procurement is the result of a shortfall in funding.

The largest proportional shortfall in the Navy fleet assessed in the *2018 Index* is the same as in past editions: small surface combatants (SSC).[12] This includes Littoral Combat Ships (LCS) and mine countermeasure (MCM) ships and previously included frigates. All *Oliver Hazard Perry*-class frigates were decommissioned by the end of 2015.[13] The fleet currently includes 11 MCM vessels and nine LCS vessels for a total of 20 SSC,[14] 32 below the objective requirement of 52 established by the Navy.[15]

The aircraft carrier force suffers a capacity shortfall of two hulls: 11 are currently in the fleet, and the two-MRC construct requires 13.[16] Current U.S. law requires the Navy to maintain a force of "not less than 11 operational aircraft carriers."[17] H.R. 941, introduced by Representative K. Michael Conaway (R–TX) in February 2017, would amend the National Defense Authorization Act for Fiscal Year 2016 to require 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.[18] The Congressional Research Service (CRS) has assessed that "[i]ncreasing aircraft carrier procurement from the current rate of one ship every five years to one ship every three years would achieve a 12-carrier force on a sustained basis by about 2030."[19] The Navy has said it needs to have two carriers deployed at all times while three are ready to reinforce on short notice, which is very hard to do with a fleet of only 11 carriers.

The carrier force fell to 10 from December 2012 until July 2017. During the first week of January 2017, no U.S. aircraft carriers were deployed, the first time this has occurred since World War II.[20] The USS *Gerald R. Ford* (CVN-78) was commissioned on July 22, 2017, returning the Navy's carrier force to a total of 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 be operationally deployed until 2022.[21]

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."[22] 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

FIGURE 7

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, the Heritage Foundation recommends a fleet of 13 carriers.

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requirements but accept risk in providing continual presence missions.[23] The Navy's final force objective of 355 ships, recommended by the FSA, was 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."[24]

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.[25]

"[O]ver the next 30 years," according to the CBO, "meeting the 355-ship objective would cost the Navy an average of about $26.6 billion (in 2017 dollars) annually for ship construction." This "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."[26] The Navy's SCN (Shipbuilding and Conversion, Navy) request for FY 2018 totaled approximately $19.9 billion,[27] well below the level the CBO has assessed is necessary to reach fleet goals. As noted, however, this includes funding for procurement of only nine 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 large portion of this funding is dedicated to advanced procurement of the next-generation ballistic missile submarine program (SSBN(X) *Columbia*-class) as well as such non–battle force requirements as a training ship.[28] Also, the CRS has estimated that roughly 15,000 additional sailors would be needed to man the 47 additional ships.[29] Without significant funding increases to procure more vessels across ship types each year, it appears unlikely that the Navy will reach its 355-ship goal for the foreseeable future.[30]

The Navy has not updated its 30-year shipbuilding plan to reflect the revised 355-ship force objective. By definition, the current 30-year plan is structured to achieve a fleet of 308 ships. However, with major adjustments in annual funding, reactivation of decommissioned ships, and expansion of naval shipyard workforce and facilities, a fleet of 355 ships could be achieved by 2035.[31]

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, approximately one-third of the total fleet is deployed at any given time. The type or class of ship is also important. Operational commanders must have the proper mix of capabilities deployed to enable a timely and effective response to emergent crises. Not all ships in the battle force are at sea at the same time. The majority of the fleet is based in the continental U.S. (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."[32] The plan incorporates four phases of ship availability/maintenance as depicted in Chart 4. This results in a basic ratio of 4:1 for CONUS-based force structure required for deployed platforms. OFRP is on track to achieve the Navy's goal of "2 deployed and 3 surge ready" carrier strike groups (CSGs) just beyond 2021.[33]

As of this writing, the Navy had 104 ships deployed globally (including submarines): 38 percent of the total available fleet and an increase from the 94 ships deployed during 2016.[34] 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 both for the Navy's stated presence needs and for a fleet capable of projecting power at the two-MRC level. The Navy has tried to increase forward presence by emphasizing non-rotational deployments (having a ship "home-ported" overseas or keeping it forward stationed):[35]

- **Home-ported:** The ships, crew, and their families are stationed at the port or based abroad.

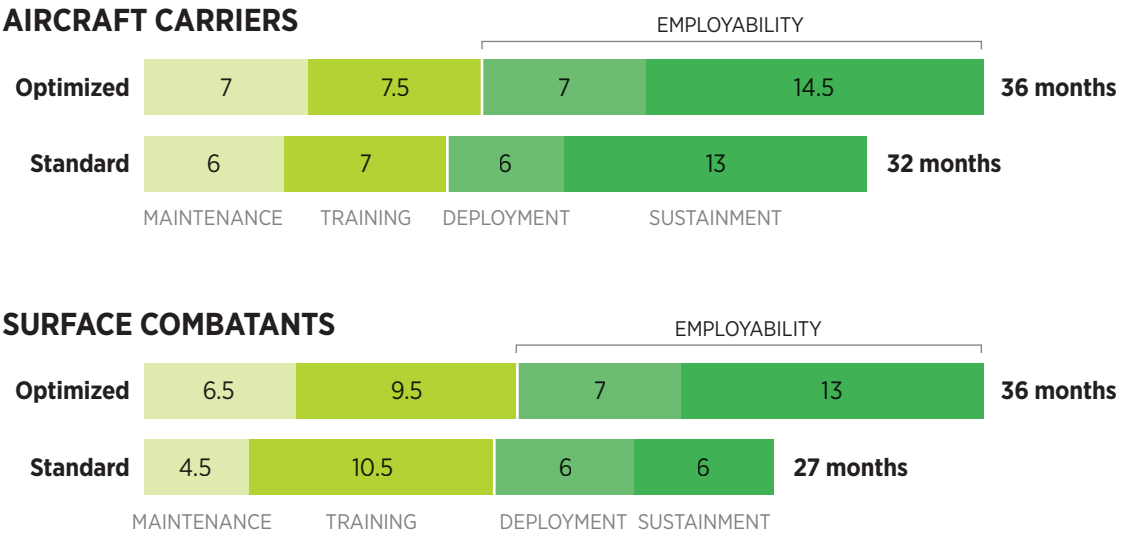
- **Forward Stationed:** Only the ships will be based abroad while crews are rotated out to the ship.[36]

Both of these non-rotational deployment options require cooperation from friends and allies to permit the Navy's use of their facilities, as well as 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 since they offset the time needed to deploy ships to distant theaters.[37] A key example of the use of this practice is the Navy's constant home-porting of an aircraft carrier at the U.S. naval base in Yokosuka, Japan. In May 2015, the USS *George Washington* (CVN-73) departed this base to return to CONUS,

CHART 4

Navy's Optimized Fleet Response Plan

The optimized fleet response plan extends the deployment cycle for carriers and surface combatants to 36 months.



SOURCE: U.S. Government Accountability Office, *Navy's Optimized Fleet Response Plan*, Updated Briefing for Congressional Committees, p. 12, attached to report, *Military Readiness: Progress and Challenges in Implementing the Navy's Optimized Fleet Response Plan*, GAO-16-466R, May 2, 2016, http://www.gao.gov/assets/680/676904.pdf (accessed August 16, 2017).

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with the USS *Ronald Reagan* sailing there to replace it.[38] The *George Washington*, stationed at Yokosuka since 2008, was withdrawn so that it could undergo its midlife refueling and complex overhaul (RCOH), the lengthy process of refueling its nuclear reactors and applying a variety of repairs and capability upgrades.

The Navy maintains that it currently will be able to meet GFMAP requirements and the 10 missions outlined in the DSG, but Admiral Richardson has indicated that the fleet will continue to be stretched to meet demand.

Capability

Scoring the U.S. Navy's overall ability to protect U.S. interests globally is not just 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, the modernity of the platform, the payloads and weapons systems carried by ships, and the ability of planned modernization

programs to maintain the fleet's technological edge. The Navy has several classes of ships that are nearing the end of their lifespans, and this will precipitate a consolidation of ship classes in the battle force.

As noted, the Navy retired its entire fleet of *Oliver Hazard Perry*-class guided missile frigates in 2015. The *Perry* class is being replaced by the Littoral Combat Ship.[39] 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."[40] However, critics of the LCS program have expressed 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."[41]

In July 2017, the Navy released a Request for Information to the shipbuilding industry with the goal of moving forward in FY 2020 with a new ship, currently referred to as the future Guided Missile Frigate (FFG(X)).[42] The Navy stated that a reevaluation of its frigate requirements as a result of evolving threats in the global maritime environment had led to a more robust SSC with better abilities to engage in undersea and surface warfare, operate independently in contested environments, extend the fleet's network of unmanned systems, and relieve large surface combatants from routine duties during operations other than war, thus freeing them for higher-end duties. The notional FFG(X) procurement plan would purchase 20 ships over 11 years.[43]

The Administration's FY 2018 budget request includes funding for two LCSs. While the Navy has not decided on the number to be procured in FY 2019, it has stated that it will maintain the LCS industrial base until the FFG(X) contract is awarded in 2020.[44] The Navy projects that the deployable force will include 11 LCSs by the end of FY 2017 and another four, for a total of 15, by the end of FY 2018. However, this is still well below the fleet size of small surface combatants necessary to fulfill the Navy's global responsibilities (52) even when combined with the remaining mine countermeasure vessels in the fleet (11).

The Navy possesses 22 *Ticonderoga*-class cruisers.[45] 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 (i.e., 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.[46]

In FY 2018, the Navy will continue to execute the "2-4-6" plan on seven of 11 cruisers.[47] By the end of FY 2017, the Navy will have inducted six cruisers into modernization.[48] Along with the USS *Anzio*, inducted in May 2017, the program includes *Cape St. George*, inducted in March 2017; *Cowpens* and *Gettysburg*, inducted in FY 2015; and *Chosin* and *Vicksburg*, inducted in FY 2016.[49]

In early 2016, Rear Admiral William Lescher, Deputy Assistant Secretary of the Navy for Budget, advanced an alternative to the current 2-4-6 model.[50] The alternative phased modernization plan in the FY 2017 budget request asked Congress to allow the Navy to put the remaining seven unmodernized cruisers into maintenance in FY 2017, arguing that doing so would save $3 billion in operating costs over the Future Years Defense Program. Congress had not agreed to this request as of the time this *Index* went to press.

The Navy's 12 landing ships (LSD), the *Whidbey Island*-class and *Harpers Ferry*-class amphibious vessels, will reach the end of their 40-year service lives in 2025 and are to be replaced by the next-generation LX(R) program, a ship that will be based on the *San Antonio* (LPD-17)-class amphibious ship.

Many of the other ships that the Navy sails are legacy platforms. Of the 18 classes of ships in the Navy, only seven are currently in production. For example, 66 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.[51]

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.[52] The first ship of any class is typically more expensive than early estimates project, which is not entirely surprising given the assumptions that must be made before actual construction begins. The Congressional Budget Office has reported that such estimates are off by 27 per cent, on average.[53] For that reason, the 30-year shipbuilding plan is often considered overly optimistic.

For example, the goal of 355 ships stated in the Navy's most recent 30-year plan includes an objective for 12 SSBN(X) *Columbia*-class submarines to replace the legacy *Ohio*-class submarine. Production of these 12 SSBN(X) submarines will require a significant portion of the SCN account if the overall budget is not increased.

The Navy's FY 2013 budget deferred the 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."[54] 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 ballistic missile submarine is "the Navy's top priority program"[55] and has been allocated almost $843 million in the Navy's FY 2018 request, or 4 percent of its total shipbuilding budget, for advanced procurement funding.[56]

The Navy's long-range strike capability derives from its ability to launch various missiles and combat aircraft. Of the two, naval aircraft are much more expensive and difficult to modernize as a class. 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 each of these aircraft were retired in 1997 (A-6); 2003 (A-4); and 2006 (F-14). 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, six Navy squadrons, the Naval Aviation Warfighting Development Center (NAWDC), and the Blue Angels.

The Navy is divesting itself of F/A-18 A-D variants and shifting to F/A-18 E/F Super Hornets, a newer and more capable version "that entered operational service with the U.S. Navy in 1999."[57] The F/A-18E/F Super Hornet has better range, greater weapons payload, and increased survivability over the F/A-18A-D Legacy Hornet.[58] The Navy is implementing efforts to extend the life of some of the older variants until the F-35C is fully fielded in the mid-2030s but plans to have a mix of the F-35C and F/A-18 E/F Super Hornets comprising its carrier-based strike aircraft capability.

The Navy's FY 2018 budget request includes $1.25 billion for 14 F/A-18E/F Super Hornets, and it plans to buy at least 80 more over the next five years in an attempt to mitigate shortfalls in its strike aircraft inventory.[59]

The Navy has been addressing numerous incidents, or physiological episodes (PE), 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.[60] The Navy report data show that "41 percent of the total

FA-18 PEs have been attributed to breathing air delivery system (27 percent possible contamination; 11 percent aircrew oxygen system; 3 percent breathing air delivery component) and 24 percent are adjudicated to be the result of ECS component failure."[61] The report concludes that:

> To date, finding a solution to the U.S. Navy and U.S. Marine Corps' high performance jet aircraft PE challenge has proved elusive. The complexity of aircraft human–machine interfaces and the unforgiving environment in which aircrew operate will continue to generate PEs whenever systems do not operate as intended or human physiology is a factor. The number and severity of PEs can and must be dramatically reduced with a unified, systematic approach.[62]

The F-35C is the Navy's largest aviation modernization program. It is a fifth-generation fighter (all F/A-18 variants are considered fourth-generation) that will have greater stealth capabilities and state-of-the-art electronic systems, allowing it to communicate with multiple other platforms. The Navy plans to purchase 260 F-35Cs[63] (along with 67 F-35Cs for the Marine Corps[64]) to replace "a portion of the existing inventory of 546 Navy and Marine Corps F/A-18 A-D aircraft [that] will be flown through the mid-2030 timeframe."[65] The F-35C, however, will not replace all of the A-Ds.

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. Transition to the F-35C is slated to begin in 2018, leading to the first operational deployment in 2021.[66]

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. The Navy's FY 2018 budget request indicates that the service plans to buy four additional F-35Cs before the end of 2017.[67]

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. According to Admiral William Moran, Vice Chief of Naval Operations:

> [W]hile our first team on deployment is ready, our bench—the depth of our forces at home—is thin. It has become clear to me that the Navy's overall readiness has reached its lowest level in many years.
>
> There are three main drivers of our readiness problems: 1) persistent, high operational demand for naval forces; 2) funding reductions; and 3) consistent uncertainty about when those reduced budgets will be approved.
>
> The operational demand for our Navy continues to be high, while the fleet has gotten smaller. Between 2001 and 2015, the Navy was able to keep an average of 100 ships at sea each day, despite a 14 percent decrease in the size of the battle force. The Navy is smaller today than it has been in the last 99 years. Maintaining these deployment levels as ships have been retired has taken a significant toll on our sailors and their families as well as on our equipment.
>
> The second factor degrading Navy readiness is the result of several years of constrained funding levels for our major readiness accounts, largely due to fiscal pressures imposed by the Budget Control Act of 2011. Although the Bipartisan Budget Act of 2015 provided temporary relief, in FY 2017 the Navy budget was $5 billion lower than in FY 2016. This major reduction drove very hard choices, including the difficult decision to reduce readiness accounts by over $2 billion this year.
>
> The third primary driver of reduced readiness is the inefficiency imposed by the uncertainty around when budgets will actually be approved. The inability to adjust funding levels as planned, or to commit to longer-term contracts, creates additional work and drives up costs. This results in even less capability for any given dollar we invest, and represents yet another tax on our readiness. We are paying more money and spending more time to maintain a less capable Navy.[68]

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 maintenance and training for ships and sailors that are not deployed is 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 due to 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. The public shipyards are undermanned for the amount of work they need to do.

Correcting this will require sufficient and stable funding both to defray the costs of ship maintenance and to expand the workforce of the public (government) 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.

The FY 2018 budget seeks to increase the public shipyard workforce by more than 1,100 workers and to provide additional funding to private yards for submarine maintenance in order to lessen the workload on government yards.[69]

A Government Accountability Office (GAO) analysis of OFRP's performance since its implementation in 2014 compared to naval readiness of the recent past yielded mixed results. The GAO found that during the period from 2011 to implementation of OFRP, the Navy's deployment and maintenance schedules were in poor condition. The three aircraft carriers that have implemented OFRP "have not completed maintenance tasks on time, a benchmark that is crucial to meeting the Navy's employability goals. Further, of the 83 cruisers and destroyers, only 15 have completed a maintenance availability under OFRP."[70] The GAO found that these rates were better than before OFRP was implemented, but only slightly.

The Navy's aviation readiness is also suffering as a consequence of deferred maintenance, delayed modernization, and high OPTEMPO. 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. As noted in Air Force testimony before the Tactical Air and Land Forces Subcommittee of the House Armed Services Committee in June 2017:

> Service life management efforts have extended the F-A-18 A-D beyond its original service life of 6,000 flight hours to 8,000 flight hours with select aircraft that may be extended up to 10,000 flight hours. Discovery of unanticipated corrosion on these legacy jets complicates depot throughput, and service life extensions for aircraft with more than 8,000 flight hours require High Flight Hour inspections, which furthers increases maintenance-man hours. These inspections assess the material condition of each aircraft and apply a unique combination of inspections and airframe modifications to maintain airworthiness certification. As of April 2017, 92 percent of the F/A-18 A-D fleet has over 6,000 flight hours and 24 percent have flown more than 8,000 flight hours; the highest flight hour airframe has attained over 9,799 hours.[71]

In short, Navy readiness levels are problematic. 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: Marginal

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. This enduring peacetime requirement to maintain a constant presence 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 apart from the operations of the surface Navy.

Two-MRC Requirement. The primary elements of naval combat power during a major regional contingency operation derive from carrier strike groups (which include squadrons of strike aircraft and support ships) and amphibious assault capacity. Since the Navy is constantly deployed around the globe during peacetime, 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 the Korean War, Vietnam War, Persian Gulf War, and Operation Iraqi Freedom was between five and six. This correlates with the figures recommended in the 1993 Bottom-Up Review (BUR) and subsequent government force-sizing documents, each of which recommended at least 11 aircraft carriers.[72] Assuming that 11 aircraft carriers are needed 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 have 13 CSGs.

The aircraft carrier is the centerpiece of a CSG, composed of one guided missile cruiser, two guided missile destroyers, one attack submarine, and a supply ship in addition to the carrier itself.[73] Therefore, based on the requirement for 13 aircraft carriers, the following numbers of ships are necessary for 13 deployable CSGs:

- 13 aircraft carriers,
- 13 cruisers,
- 26 destroyers, and
- 13 attack submarines.

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 usually includes four strike fighter squadrons.[74] Twelve aircraft typically comprise one Navy strike fighter squadron, so at least 48 strike fighter craft are required for each carrier air wing. To support 13 carrier air wings, the Navy therefore needs a minimum of 624 strike fighter aircraft.[75]

Fifty Amphibious Ships. The 1993 BUR recommended a fleet of 45 large amphibious vessels to support the operations of 2.5 Marine Expeditionary Brigades (MEBs). 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. The 1996 and 2001 QDRs each recommended 12 "amphibious ready groups" (ARGs). One ARG typically includes one amphibious assault ship (LHA/LHD); one amphibious transport dock ship (LPD); and one dock landing ship (LSD).[76] Therefore, the 12-ARG recommendation equates to 36 amphibious vessels.

The number of amphibious vessels required in combat operations has declined since the Korean War, in which 34 amphibious vessels were used; 26 were deployed in Vietnam, 21 in the Persian Gulf War, and only seven in Operation Iraqi Freedom (which did not require as large a sea-based expeditionary force).[77] The Persian Gulf War is the most pertinent example for today because similar vessels were used, and modern requirements for an MEB most closely resemble this engagement.[78]

While the Marine Corps has consistently advocated a fleet of 38 amphibious vessels to execute its two-MEB strategy,[79] it is more prudent to field a fleet of at least 42 such vessels based on the Persian Gulf engagement. Similarly, if the USMC is to have a strategic reserve of 20 percent, the ideal number of amphibious ships would be 50.

Total Ship Requirement. The bulk of the Navy's battle force ships are not directly tied to a carrier strike group. Some surface vessels and attack submarines are deployed 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* uses the benchmark set by previous government reports, especially the 1993 BUR, which was one of the most comprehensive reviews of military requirements. Similar Navy fleet size requirements have been echoed in follow-on reports.

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 full Navy requirement of ships as the benchmark, the Navy's current battle forces fleet capacity of 276 ships retains a score of "marginal," as was the case in the *2017 Index*. Given the fact that the Navy has not updated its 30-year shipbuilding plan to reflect its new force structure objective, and in view of the impending need for a ballistic missile submarine replacement that could cost nearly half of the current shipbuilding budget per hull, the Navy's capacity score could fall to "weak" in the near future.

Capability Score: Weak

The overall capability score for the Navy is "weak." 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 has returned to an assessment of "marginal," down from the *2017 Index*'s score of "strong." This assessment combines two major elements of naval readiness: the ability to consistently provide the required levels of presence around the globe and surge capacity. 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 is sacrificing long-term readiness to meet current demand.

The Navy has reported that it continues to meet GFMAP goals but at the cost of future readiness. The 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"[80] 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."[81] There was no compelling evidence in 2017 that this condition has improved.

Though the Navy has been able to maintain a third of its fleet globally deployed, and although the OFRP has preserved 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 ability of the Navy to meet the nation's needs in a time of conflict in this exchange with Senator Joni Ernst (R–IA):

> 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.[82]

As if to sharpen Admiral Moran's concerns, the Navy experienced a number of at-sea incidents—three ship collisions and one grounding—during 2017.[83] Admiral Richardson responded by ordering a "servicewide operational pause" to review practices throughout the fleet.[84] An investigation into the latest of these incidents was underway at the time of this writing, and observers have speculated that high operational tempo and lack of funding for adequate training have contributed to poor readiness across the Navy.[85]

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 of 2017 but is increasingly challenged by the range of funding problems noted in this section. The Navy maintains its ability to forward deploy a third of its fleet and has been able to stave off immediate readiness challenges through the OFRP. However, continued problems in ship maintenance and an inadequate number of hulls to relieve pressure on the maintenance cycle are jeopardizing the Navy's ability to respond effectively to COCOM requirements for sustained presence, crisis support, and surge response in the event of a major conflict.

Without increased funding for further fleet recapitalization and improvements in shipyard maintenance capacity, the readiness of the Navy's fleet will remain compromised. Admiral Moran's concerns about the Navy's ability to handle two major crises are therefore worrisome.

Overall U.S. Navy Score: Marginal

The Navy's overall score for the *2018 Index* is "marginal," the same as for the previous year. This was derived by aggregating the scores for capacity ("marginal"); capability ("weak"); and readiness ("marginal"). However, given the continued upward trends in OPTEMPO that have not been matched by similar increases in capacity or readiness funding, the Navy's overall score could degrade in the near future if the service does not recapitalize and maintain the health of its fleet more robustly than is now the case.

U.S. Military Power: Navy

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

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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's Signal Corps to become its own service in 1947. The Air Force mission set has expanded significantly over the years. Initially, there were four major components—Strategic Air Command (SAC); Tactical Air Command (TAC); Air Defense Command (ADC); and Air Mobility Command (AMC)—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 service's impact and mission set.

Today, the Air Force focuses on five primary missions:

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

These missions, while all necessary, put even greater stress on the resources for which the Air Force is forced to compete in an incredibly strained 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]

During testimony before the Senate Armed Services Committee in June 2017, Secretary of the Air Force Heather Wilson and Air Force Chief of Staff General David Goldfein stated that "the Air Force is too small for the mission demanded of it and it is unlikely that the need for air and space power will diminish significantly in the coming decade."[2] Unfortunately, the funding available has not allowed this "too small" service to execute an acquisition program to reverse the downward spiral of aircraft availability, nor has it supported enough time in the air for pilots to sustain much more than a marginal level of readiness.

Sequestration has forced the Air Force Chief of Staff 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. Five years of sequestration has had many detrimental effects on the ability of the service 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 the trades among capability, capacity, and readiness failed to keep pace with demands on the service. When funding did arrive, it was pursuant to continuing resolutions adopted well into the year of execution, making any real form of strategic planning impossible.[3]

The Trump Administration has proposed a budget for fiscal year (FY) 2018 that would begin to turn the corner in each of the three bins

with a budget of $183 billion (base budget plus overseas contingency operations or OCO).[4] If executed in its current form, it would allow the Air Force to bring on an additional 4,100 active-duty personnel, fund the flying hour program (FHP) to the maximum executable level of 91 percent, and increase full-spectrum training/operational readiness accounts to $1.5 billion.[5] While this Administration appears more willing to put pressure on Congress to execute the President's budget, it is by no means certain that Congress will do so.

If the House and Senate were able to meet or exceed the funding levels in the President's budget, they would enable the Air Force to reverse several trends in capacity, capability, and readiness, all three of which are under stress.

Capacity

The trade-off 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] The USAF is "the smallest and oldest it has ever been," and as the demand for air power continues to increase, capacity will continue to limit capability.[7] Unlike some of the other services, the Air Force did not expand in numbers during the post-9/11 buildup.[8] Rather, it became smaller as programmed retirement dates for older aircraft were not offset with 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.

The Air Force's capacity in terms of number of aircraft has been on a constant downward slope since 1952,[9] and the number will drop again from 5,517 aircraft in 2017 to 5,416 in 2018.[10] As Air Force officials testified in 2017:

> [A]dversaries are modernizing and innovating faster than we are, putting at risk America's technological advantage in air and space.... Before 1991, the Air Force bought approximately 510 aircraft per year. In the past 20 years, we have averaged only 96 per year. Today, the average age of our aircraft is over 27 years.[11]

This reduction in capacity is expected to continue because of ongoing budgetary pressure. Under spending caps mandated by the Budget Control Act of 2011 (BCA), the Air Force has shrunk from 70 combat-coded[12] active-duty fighter squadrons during Desert Storm[13] to just 55 across the whole of the active-duty, guard, and reserve force.[14] Only 32 of those are active duty.[15]

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.[16] More recently, the service acknowledged that it could reduce the requirement by 100 fighters by assuming more risk.[17] Of the 5,416 manned and unmanned aircraft in the USAF's inventory, 1,308 are active-duty fighters, 915 of which are combat-coded aircraft (aircraft not associated with operational testing, evaluation, or training of replacement pilots).[18] Constrained funding levels will continue to deepen the shortage of fighters and readiness levels, degrading vital air operations as well as operational testing and training expertise.

Capability

Reductions in funding brought about by the BCA and other budget constraints have forced the Air Force to prioritize future capability over capacity. This strategy centers on the idea of developing and maintaining a capable force that can win against advanced fighters and surface-to-air missile systems that are being developed by top-tier potential adversaries like China and Russia. The only way the Air Force can sustain that technological edge in the current budget environment is by reducing its fleet of aircraft that are moving toward obsolescence.

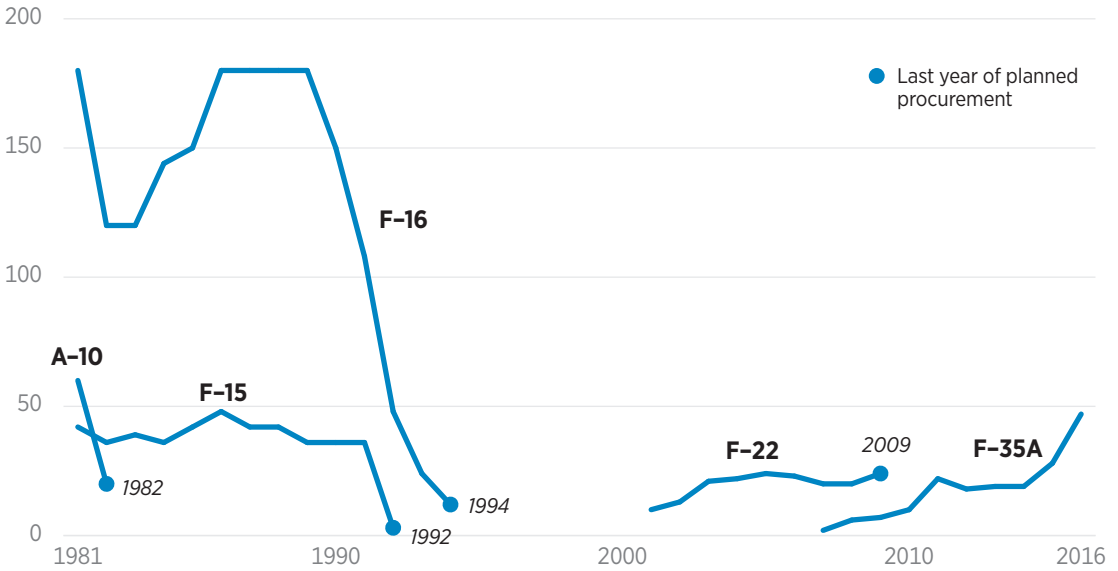
Any assessment of capability includes not only the incorporation of advanced technologies, but also the overall health of the inventory. Most aircraft have programmed life spans of

CHART 5

Lack of Procurement Has Led to Aging Aircraft Fleets

The U.S. military currently maintains several fighter aircraft fleets that were last purchased decades ago. In 1990, the average age of a fighter aircraft was 11 years. Today, it is 24 years.

NUMBER OF AIRCRAFT PROCURED ANNUALLY, BY AIR FORCE FLEET



SOURCES: Congressional Budget Office, "Total Quantities and Unit Procurement Cost Tables: 1974–1995," https://www.cbo.gov/sites/default/files/103rd-congress-1993-1994/reports/94doc02b.pdf (accessed June 27, 2017); U.S. Department of Defense, "Selected Acquisition Report: F–22," December 31, 2010, http://www.globalsecurity.org/military/library/budget/fy2010/sar/f-22_sar_25-dec-2010.pdf (accessed June 27, 2017); and U.S. Department of Defense, "Selected Acquisition Report: F–35 Joint Strike Fighter Aircraft (F–35)," December 2015, https://fas.org/man/eprint/F35-sar-2016.pdf (accessed June 27, 2017).

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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 27 years,[19] and some fleets, such as the B-52 bomber, average 55 years.[20] Although service life extension programs (SLEPs) can lengthen the useful life of airframes, their dated avionics become increasingly expensive to maintain. That added expense consumes funding and reduces the amount the services have available to invest in modernization, which is critical to ensuring future capability.

The average age of the F-15C fleet is over 33 years, leaving less than 10 percent of its useful service life remaining.[21] That same fleet comprises 57 percent of USAF air superiority platforms—a fleet reduced in size by 10 aircraft (8 percent) in 2017.[22] The fleet of F-16Cs are, on average, 26 years old,[23] and the service has used up nearly 80 percent of its expected life span. KC-135s comprise 63 percent of the Air Force's tankers and are over 55 years old on average.[24] Air Force officials have testified that "before 1991, the Air Force bought approximately 510 aircraft per year. In the past 20 years, we have averaged only 96 per year."[25]

The Air Force's ISR and lift capabilities face similar problems in specific areas that affect both capability and capacity. Of total ISR aircraft, 79 percent are now unmanned aerial vehicles (UAVs).[26] Even here, however, the numbers fell from 371 to 256[27] with the retirement of the MQ-1 Predator.[28] The RQ-4 Global Hawk is 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 34 years old on average.[29] The E-8 Joint Surveillance and Target Attack Radar System (Joint-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.

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 continued to structure its budget in FY 2017 to preserve funding for its three top acquisition priorities: the F-35A Joint Strike Fighter, the KC-46A Pegasus refueling aircraft, and the Long Range Strike-Bomber.[30]

The Air Force's number one priority continues to be the F-35A. It is the next-generation fighter scheduled to replace all legacy multirole and close air support aircraft. The rationale for a program of record of 1,763 aircraft to replace the 1,303 legacy fighters currently in the Air Force inventory has never been fully justified.[31] This has led to speculation that, at least in part, it may be an attempt to offset the Defense Department's draconian reduction of the original plan to purchase an F-22A program of record of 750 aircraft[32] to a final program of record of just 187.[33] Even so, The Heritage Foundation's analysis finds a requirement for 1,260 total F-35As.[34]

The Active Air Force currently has just 106 F-15Cs left in its fleet, and 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, 159 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.[35] 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,[36] enabling it to augment the F-22A in many scenarios.[37]

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 162 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 (99 of 169) of the mission fleet of F-22As are currently available.[38]

As with the other Joint Strike Fighter variants, the F-35A has experienced a host of developmental problems that have caused its initial operating capability (IOC) date to be pushed from 2013 to 2016. This system of systems relies heavily on software, and the currently fielded version (3I) delivers about 90 percent of the code required to deliver full warfighting capability. The "3F" version of the fighter's software that will enable full operating capability (FOC) will be fielded by the end of the third quarter of 2017, half a year later than planned.[39] Given the age of the aircraft that the F-35A will be replacing, every slip in the Lightning II's program will necessarily affect U.S. warfighting capability. Nevertheless, experienced fighter pilots now flying the jet have a great deal of confidence in their new fighter,[40] and this program appears to be gaining traction.

A second top priority for the USAF is the KC-46A air refueling tanker aircraft. Though the KC-46 has experienced a series of delays, it reached a milestone in August 2016 that enabled low-rate initial production.[41] The Air Force awarded the contract for 19 initial aircraft in August 2016 and has programmed delivery of 70 aircraft by FY 2020.[42] 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."[43]

The third major USAF priority from an acquisition perspective is the B-21 Raider, formerly called the Long-Range Strike Bomber. 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 a Preliminary Design Review. The Air Force is committed to a fleet size of 100 B-21s[44] at an average cost of $564 million per plane.[45]

The B-21 is programmed to begin replacing portions of the B-52 and B-1B fleets by the mid-2020s.[46] The Air Force has 62 B-1s in the inventory, 32 of which are undergoing an Integrated Battle Station upgrade that will provide enhanced situational awareness and precision engagement capabilities, and the entire fleet is undergoing a SLEP to restore all 289 B-1 engines to their original specifications. At least some of these bombers are programmed to remain in service through 2040.[47]

The Air Force also 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. These 20 stealth bombers will be in service for the foreseeable future.

Modernization efforts are also underway for the B-52. The jet entered service in the 1960s and will remain in the inventory through 2050.

The capacity of the Air Force's bomber fleet has fallen from 290 aircraft in 1991 to 156 B-1s, B-2s, and B-52s today. The current number is insufficient to meet Defense Planning Guidance and nuclear guidance while sustaining current operational demands and maintaining training and readiness capacity.[48]

The Air Force's strategy of capability over capacity is encumbered by the requirement to sustain ongoing combat operations in Afghanistan, Iraq, and Syria. In a budget-constrained environment, the need to sustain these ongoing efforts while modernizing an outdated fleet of aircraft for operations in contested environments means that funding has to be pulled from other areas, adversely affecting readiness.

Readiness

During testimony before the Senate Armed Services Committee in June 2017, the Secretary of the Air Force and the Air Force Chief of Staff warned that the USAF is at its "lowest state of full spectrum readiness in our history,"[49] and there is an abundance of ancillary evidence to support that statement.

Full-spectrum operations include the seamless conduct of nuclear deterrence operations, continued support of counterterrorist operations, and readiness for potential conflict with a near-peer competitor. During testimony before the House Armed Services Committee in July 2016, Major General Scott West, Director of Current Operations, Deputy Chief of Staff for Operations, stated that the Air Force was "able to conduct nuclear deterrence operations and support [counterterrorist] operations," but that operating "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."[50]

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

1. Flying Hour Program (FHP), which includes funding sortie production;
2. Critical Skills Availability (pilot/maintenance specialty level training);
3. Weapons System Sustainment (aircraft availability production);

TABLE 4

Air Force: Only Four of 32 Combat-Coded Fighter Squadrons Fully Mission Capable

SORTS Score	Resource/ Training Level	Mission Capability	Active Duty Units Meeting Capability Threshold
C1	90%–100%	Can execute **all** wartime missions	4 of 32
C2	70%–89%	Can execute **most** wartime missions	Less than 18 of 32
C3	55%–69%	Can execute **portions** of wartime missions	Up to 32 of 32
C4	0%–54%	**Needs more resources** before it can execute its mission	Up to 32 of 32

SOURCE: R. Derek Trunkey, "Implications of the Department of Defense Readiness Reporting System," Congressional Budget Office *Working Paper* No. 2013-03, May 2013, http://www.cbo.gov/sites/default/files/cbofiles/attachments/44127_DefenseReadiness.pdf (accessed April 11, 2017).

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4. Training Resource Availability (funding for ranges, live/virtual construct); and

5. 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) has limited the ability of the Air Force to generate sorties. The Air Force was short 3,400 aircraft maintainers at the close of 2016,[51] and this shortfall has reduced flying hours to the point where fighter pilots who once averaged over 200 hours per year were fortunate to fly 120 hours in 2014.[52] In 2015, the average rose to 150 hours through combat deployments to Iraq, Afghanistan, and Syria, but the air threat there is benign, the low-threat employment is relatively undemanding, and no high-threat training is allowed. When they return home, those same pilots have to rehone their primary mission skill sets, often averaging less than one sortie a week.[53]

During his confirmation hearing for the position of 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" high-threat, high-intensity combat.[54]

In testimony before the Senate Armed Services Committee on March 29, 2017, Lieutenant General Mark Nowland, Air Force Deputy Chief of Staff for Operations, told lawmakers that only four of the Air Force's 55 total (Active, Reserve, and National Guard) fighter squadrons are at the very highest levels of readiness. Fewer than half are in the top two readiness tiers.[55]

General Nowland's reference to levels of readiness is based on the formal Department of Defense grading system for readiness, known as the Status of Resources and Training System (SORTS). SORTS assesses personnel, supply, equipment, and training levels to make a comprehensive capability assessment of fighting units. A C1 designation is the highest level and is given to units that can fully carry out their wartime mission. C2 units can carry out "most" of their wartime missions, C3 units can carry out portions of their wartime missions, and C4 units need additional resources and/or training to execute their missions successfully. Organizations with a C1 or C2 score are the only ones that are considered to be combat-ready.[56]

When General Nowland said that only four squadrons are at the highest level of readiness, he presumably meant that those squadrons are C1. Taken in conjunction with the Chief of Staff's acknowledgement that less than 50 percent are ready for full-spectrum combat, this means that as many as 17 and as few as four fighter squadrons are ready to go to war with a near-peer competitor.

The current state of Air Force fighter readiness includes 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 not witnessed by the Air Force since the Carter Administration.

The flight hour program is limited by combat deployments and low sortie generation rates, but the Air Force has funded it to what it assesses to be the maximum executable level of 91 percent in the FY 2018 budget request.

Weapons System Sustainment. Near-constant deployments and a shortage of maintenance personnel have severely limited aircraft availability and sortie production. While maintenance manning shortfalls are expected to begin recovering during the coming year, it will take many years to develop the experience lost over the past five years. The shortage has driven and will continue to drive aircraft utilization rates (the number of times a jet is flown each month) well below those witnessed during the hollow force of the late 1970s.

Those numbers also affect retention of fighter pilots. Lieutenant General Gina M. Grosso, Air Force Deputy Chief of Staff for Manpower, Personnel, and Services, detailed this shortfall in testimony before a subcommittee of the House Armed Services Committee on March 29, 2017:

> At the end of FY 2016 the total force including active, reserve, and guard components was short 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). Unfortunately, our greatest concern is [that] the active fighter pilot shortage is projected [to] exceed 1,000 by the end of FY 2017.[57]

Training Resource Availability. In order to prepare for full-spectrum combat in peacetime, pilots require the opportunity to engage regularly in high-end air-to-air and surface-to-air missile platforms and simulators. The two effective methods for giving aircrew the repetitions they need to sharpen these perishable skills are through live, large-force exercises over well-equipped ranges or through a live/virtual construct.

The three exercises/ranges that have the airspace and assets required for live high-threat training are the Red and Green Flag exercises at Nellis Air Force Base, Nevada, and Elmendorf Air Force Base, Alaska. The Air Force funded 16 of these large-force exercises in 2016 and 2017 and has budgeted for the same number in FY 2018.[58]

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, nor are they considered replacements for actual flying time by the pilots themselves.[59] The FY 2018 budget requests a total increase of $1.5 billion to further each of these efforts.[60]

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 President's FY 2018 budget request is 1:2 dwell or better at home for 94 percent of the deployers; 96 percent of National Guard deployers achieve a 1:5 dwell or better, and Reservists average 97 percent. On paper, these look reasonably healthy, but several facts are not immediately evident from the numbers. The major deployments do not include shorter-term dispatch to schools, exercises, and other non-elective temporary duty (TDY) assignments. For some career specialties, personnel are in such high demand that they generally do not come close to the target dwell time.

One last 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 are being used faster than they can be replaced, and air-to-surface weapons that offer stand-off, direct attack, and penetrators are short of current inventory objectives.[61] 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,[62] particularly highly contested ones.

The Air Force has rapidly been depleting its wartime inventory levels of precision-guided munitions. Over 50,000 missiles and bomb-related munitions have been used since August 2014,[63] significantly drawing down stockpiles, and the rate of expenditure has only grown with time. 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.[64]

Space. Although the classified nature of deployed space assets and their capabilities makes any assessment of this mission area challenging, the constellation of ISR, navigation, and communication satellites available to the United States is arguably unrivaled by that of any other nation-state. It is an array that 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 also facilitated an environment of overreliance on the domain and underappreciation of the vulnerabilities of its capabilities.[65] Some space assets represent nearly single-point failures in which a loss caused by a system failure or an attack could cripple a linchpin capability. Because of U.S. dominance of space and nearly complete reliance on space-based assets for everything from targeting to weapons guidance, other state actors have every incentive to target those assets.[66]

An adversary will capture and hold the initiative by leveraging surprise and every asymmetric advantage it possesses while denying those warfighting elements to its opponents. Since Operation Desert Storm, the world, including every one of America's near-peer competitors, has 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-guide munitions (PGMs).[67]

China and Russia are now investing heavily in ground-based anti-satellite (ASAT) missiles,[68] orbital ASAT programs that can deliver a kinetic blow,[69] or co-orbital robotic interference to alter signals, mask denial efforts, or even pull adversary satellites out of orbit.[70] If a near-peer competitor were able to degrade regional GPS signals or blind GPS receivers, it could neutralize the PGMs the U.S. relies on to conduct virtually every aspect of its kinetic strike capability.

As General Thomas Hyten, head of Air Force Space Command, has clearly indicated, the vulnerability of the U.S. space constellation lies in its design.[71] 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 find, fix, and destroy targets precisely, space will remain a dominant but incredibly vulnerable domain for the U.S. Air Force.

Scoring the U.S. Air Force

Capacity Score: Marginal

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

component fighter aircraft to execute one MRC. Based on government force-sizing documents that count fighter aircraft, squadrons, or wings, an average of 55 squadrons (990 aircraft) is required to field a 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 2017 Level:** 915 fighter aircraft.

This number is 244 fighters below the *2017 Index* number of 1,159, which was based on total active-duty fighters minus Air Education and Training Command fighter numbers.[72] Several squadrons that should not have been included in the original total within Air Combat Command have been removed from the total.[73]

Based on a pure count of combat-coded fighter/attack platforms that have achieved IOC, the USAF currently is at 76 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 123 aircraft that have entered the USAF inventory to date[74] are only IOC and do not yet field many of the capabilities that would constitute full-spectrum readiness.

The 915 figure yields a capacity level well within the methodology's range of "marginal," but aircraft require pilots to fly them and maintainers to launch, recover, and fix them. With a fighter pilot shortage approaching 1,000 and a maintenance shortfall of over 3,000 personnel, the ability of the Air Force to meet wartime manning requirements for fighter cockpits, as well as enough maintenance personnel to repair, refuel, and rearm aircraft in line with wartime sortie requirements, continues to wane. These factors, coupled with the lack of funding for a sufficient supply of spare parts, have reduced the capacity for employment from a *2017 Index* assessment of "strong" to a *2018 Index* assessment of "marginal." As noted above, given personnel shortfalls, the Air Force capacity score is therefore trending toward "weak."

Capability Score: Marginal

The Air Force's capability score is "marginal," a 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 *2017 Index*'s assessment. However, the F-35 program has begun to show signs of strength, and the Air Force has made progress toward effective replacement of legacy aircraft.

Readiness Score: Marginal

The Air Force scores "marginal" trending downward in readiness in the *2018 Index*, the same overall grade that it received in the *2017 Index*. This assessment is based primarily on 47 fighter pilot interviews, testimony of senior leaders, and follow-on analysis of the Air Force's ability to meet full-spectrum readiness requirements in 2017.[75] 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 readiness since 2003, and implementation of BCA-imposed budget cuts in FY 2013 only exacerbated the problem. Similar to the other services, the Air Force was able to make up some of its readiness shortfalls under the FY 2016 budget, but given its poor readiness assessment, much more improvement is required.

The Air Force's current deficits in both pilot and maintainer manpower are also very troubling indicators for readiness. They will strain the service in the immediate term and, if not reversed, could lead to broader readiness challenges in the 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 "marginal."

While the overall score remains the same as its score in the *2017 Index*, it has trended downward, largely because of a drop in the USAF's "capacity" score for a second consecutive year. The shortage of pilots and maintainers also continues to affect the ability of the Air Force to generate the amount of combat air power that would be needed to meet wartime requirements.

U.S. Military Power: Air Force

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

Endnotes

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8. The Honorable Deborah Lee James, Secretary of the Air Force, and General Mark A. Welsh III, Chief of Staff of the Air Force, statement on "Air Force Posture" before the Committee on Armed Services, U.S. House of Representatives, March 16, 2016, pp. 7–8, http://docs.house.gov/meetings/AS/AS00/20160316/104662/HHRG-114-AS00-Bio-JamesD-20160316.pdf (accessed July 25, 2017).
9. Technological advances in aircraft materials and structure greatly extended the service life of USAF equipment. As a result, the USAF was able to sustain its force structure while procuring fewer aircraft. See Colonel James C. Ruehrmund Jr. and Christopher J. Bowie, *Arsenal of Airpower: USAF Aircraft Inventory 1950–2009*, Mitchell Institute for Airpower Studies, November 2010, p. 8, http://higherlogicdownload.s3.amazonaws.com/AFA/6379b747-7730-4f82-9b45-a1c80d6c8fdb/UploadedImages/Mitchell%20Publications/Arsenal%20of%20Airpower.pdf (accessed July 25, 2017).
10. U.S. Department of Defense, Secretary of the Air Force, Office of Financial Management and Budget (SAF/FMB), *United States Air Force Fiscal Year 2018 Budget Overview*, p. 15.
11. Wilson and Goldfein, statement on "Air Force Budget Posture," June 6, 2017, p. 2.
12. Combat-coded aircraft and related squadrons are aircraft and units assigned a wartime mission. 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. See Report No. 112–329, *National Defense Authorization Act for Fiscal Year 2012*, Conference Report to Accompany H.R. 1540, U.S. House of Representatives, 112th Cong, 1st Sess., December 12, 2011, p. 25, https://www.gpo.gov/fdsys/pkg/CRPT-112hrpt329/pdf/CRPT-112hrpt329-pt1.pdf (accessed August 6, 2017).
13. "The Air Force in Facts and Figures," U.S. Air Force Almanac 1996, *Air Force Magazine*, Vol. 79, No. 5 (May 1996), p. 59, http://www.airforcemag.com/MagazineArchive/Magazine%20Documents/1996/May%201996/0596facts_figures.pdf (accessed August 6, 2017). The Air Force uses a variety of categorizations to describe or refer to its inventory of aircraft and units. This can make assessing Air Force capacity a challenge.
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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. Today, "there are over 34,000 Marines deployed around the globe to assure our allies and partners, to deter our adversaries, and to respond when our...citizens and interests are threatened."[1] In 2016, despite the drawdown of forces, "the Marine Corps executed over 210 operations, 20 amphibious operations, [and] 160 Theater Security Cooperation (TSC) events, and participated in 75 exercises" in addition to providing embassy security and short-term reinforcement of posts.[2]

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.[3] This trade-off is a short-term fix to meet immediate needs: Over the longer term, the degradation of investment in equipment will lead to lowered readiness.

Capacity

The Marine Corps has continuously prioritized readiness through managed reductions in capacity, including a drawdown of forces, and delays or reductions in planned procurement. Its measures of capacity are similar to the Army's: end strength and units (battalions for the Marines and brigades for the Army). In February 2015, Marine Corps Commandant General Joseph Dunford testified that:

> Today, the Marine Corps continues to execute its end-strength reductions that began during FY12, reducing the Corps from a high of 202,000. The Marine Corps is adjusting its active duty end-strength to 182,000 Marines by 2017, emphasizing the enduring requirement to provide crisis response forces that meet today's demand. We can meet the DSG at this level, but with less than optimal time between deployments to train and allow Marines to be with their families.[4]

The Department of Defense (DOD) FY 2018 *Defense Budget Overview* reflects a slightly higher projected "Active Component End Strength" of 184,400 in 2017, a slight increase over previously projected levels due to President Trump's request for supplemental funding in FY 2017. President Trump's FY 2018 budget request would reverse planned drawdowns and support an end strength of 185,000 active personnel in FY 2018.[5]

The Marine Corps' basic combat unit is the infantry battalion. A battalion has about 900 Marines and includes three rifle companies, a weapons company, and a headquarters and service company. FY 2017 appropriations supported 24 infantry battalions,[6] an increase from 2016 levels but still down from 27 in FY 2012.[7] Although the President's FY 2018 budget request retains support for 24 battalions, under full sequestration, USMC end strength would be able to support only 21 infantry battalions,[8] which, according to General Dunford, would leave the Corps "with fewer active duty battalions and squadrons than would be required for a single major contingency."[9]

Additionally, the current population of noncommissioned officers and staff noncommissioned officers does not meet USMC force structure requirements. This will pose readiness challenges for the Corps as the shortage of "small unit leaders with the right grade, experience, technical skills and leadership qualifications" grows.[10]

In 2010, the USMC determined that its ideal force size would be 186,800 in light of the requirements of the President's National Security Strategy at that time.[11] However, given the budget pressures from the Budget Control Act (BCA) of 2011 and the newer 2012 DSG, the Corps determined that a force of "182,100 active component Marines could still be afforded with reduced modernization and infrastructure support."[12]

One impact of reduced capacity is a strain on Marines' dwell time. The stated ideal deployment-to-dwell (D2D) time ratio is 1:3 (seven months deployed for every 21 months at home), which, given current demands, can be achieved with 186,000 troops.[13] A force of 182,000, without a corresponding decrease in operational demand, would result in a lower D2D ratio of 1:2, which translates to roughly seven-month deployments separated by stretches of 14 months at home.[14]

Under current budget constraints, "Marine Corps operating forces are currently averaging less than a one-to-two deployment-to-dwell ratio."[15] A return to BCA-level budget caps in FY 2018 could reduce capacity even further, and the dwell ratio for the Marine Corps could fall to 1:1.[16] This increase in deployment frequency would exacerbate the degradation of readiness, because people and equipment would be used more frequently with less time to recover between deployments. The same problems are present across the Marine Corps' major weapons platforms, including its aviation and amphibious assets.

Marine aviation units have 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 the Marine Corps' *2017 Marine Aviation Plan*, the USMC currently fields 19 tactical fighter squadrons,[17] compared to 20 in 2016 and around 28 during Desert Storm.[18] This change reflects the retirement of one AV-8B squadron.[19] However, this does not adequately capture the capacity challenges the Marine Corps faces, as the service has decreased the number of aircraft per squadron in order to compensate for shortages in the number of aircraft available, whether because of maintenance or procurement delays.[20] Although supplemental appropriations in 2017 provided some relief from BCA caps, the capacity challenges facing the Marine Corps will be fixed only by stable and predictable increases in the funding of both procurement and maintenance accounts.

The number of available aircraft continues to decline as procurement of the F-35B and MV-22 struggles to keep pace with the decommissioning of aging aircraft squadrons, high operational tempos, and maintenance backlogs that have limited the number of Ready Basic Aircraft (RBA) for training and operational requirements.[21] According to the *2017 Marine Aviation Plan*, the transition to the Osprey is 75 percent complete, and it is expected that the active component transition will be completed in FY 2019. However, the procurement objective could increase to 380 aircraft pending the results of an ongoing requirements-based analysis.[22]

In 2016, "shortages in aircraft availability due to increased wear on aging aircraft and modernization delays" led the Marine 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.[23] Approximately 80 percent of Marine Corps aviation units are still experiencing shortages below the minimum number of RBA needed to account for training and wartime requirements.[24] 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).

Additionally, due to a chronic shortfall in the Navy's requirement for 38 amphibious ships, the USMC has relied heavily on land-based Special Purpose Marine Air-Ground Task Forces (SPMAGTFs). While SPMAGTFs have enabled the Marine 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."[25]

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 helping to maintain capacity, programs to extend service life do not provide the capability enhancements of modernization programs and ultimately result in higher costs to maintain an older, less-capable fleet of equipment.

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 the F-35 Joint Strike Fighter (JSF) programs its top two priorities.[26]

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.[27] The AAV-7A1 is currently undergoing survivability upgrades, with the first round of upgrades (AAV SU) delivered to U.S. Marine Corps Base Quantico in 2016.[28] These upgrades will help to bridge the capability gap until the fielding of the ACV and keep the AAV SU in service until 2035.[29] 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."[30] There is still no planned replacement for the LAV. Comparatively, the Corps' M1A1 Abrams inventory is 27 years old with an estimated 33-year life span,[31] while the newest HMMWV variant has already consumed half of a projected 15-year service life.[32]

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. For example, with the advent of improvised explosive devices (IEDs), the flat-bottom hulls found on most legacy vehicles are ineffective compared to the more blast-resistant V-shaped hulls incorporated in modern designs.

The age profiles of the Corps' aircraft are similar to those of the Navy's. As of 2017, the USMC had 273 F/A-18 A–Ds (including one reserve squadron) and 18 EA-6Bs in its primary mission aircraft inventory,[33] 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 and has stayed on track

in decommissioning one per year through FY 2019.[34] Unlike the Navy, the Corps did not acquire the newer F/A-18 E/F Super Hornets; thus, 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.[35] This was intended to bridge the gap to when 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-18 A-D and AV-8B.[36]

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.[37] The AV-8B received near-term capability upgrades in 2015, which continued in 2017 in order to maintain its lethality and interoperability until the F-35 transition is complete.[38] The Corps declared its first F-35B squadron operationally capable on July 31, 2015, after it passed an "Operational Readiness Inspection" test.[39] To date, three F-35B squadrons have been delivered to the Marine Corps, including two operational squadrons and one fleet replacement squadron, totaling 52 aircraft.[40]

The Marine Corps has two Major Defense Acquisition (MDAP) vehicle programs: the Joint Light Tactical Vehicle (JLTV) and Amphibious Combat Vehicle (ACV).[41] 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.[42]

Following FY 2015 plans for the JLTV, the program awarded a low-rate initial production (LRIP) contract, which includes a future option of producing JLTVs for the Marine Corps, to defense contractor Oshkosh.[43] 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, the Corps still expects to complete its initial acquisition objective of 5,500 by FY 2023.[44] Reductions in annual procurement quantities reflect prioritization of the ACV within the USMC's ground force.[45]

The President's budget request for FY 2018 would fund the final year of low-rate initial production for the JLTV, including 527 vehicles for the Marine Corps and limited procurement quantities for the Air Force.[46] Although the Marine Corps has indicated that the JLTV will not be a one-for-one replacement of the HMMWV, there are concerns that reduced procurement will create a battlefield mobility gap for some units.[47] Program officials have reportedly discussed increasing the acquisition objective to 9,091 for the Marine Corps.[48] While this will still only partially offset the inventory of 17,000 HMMWVs,[49] 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.[50]

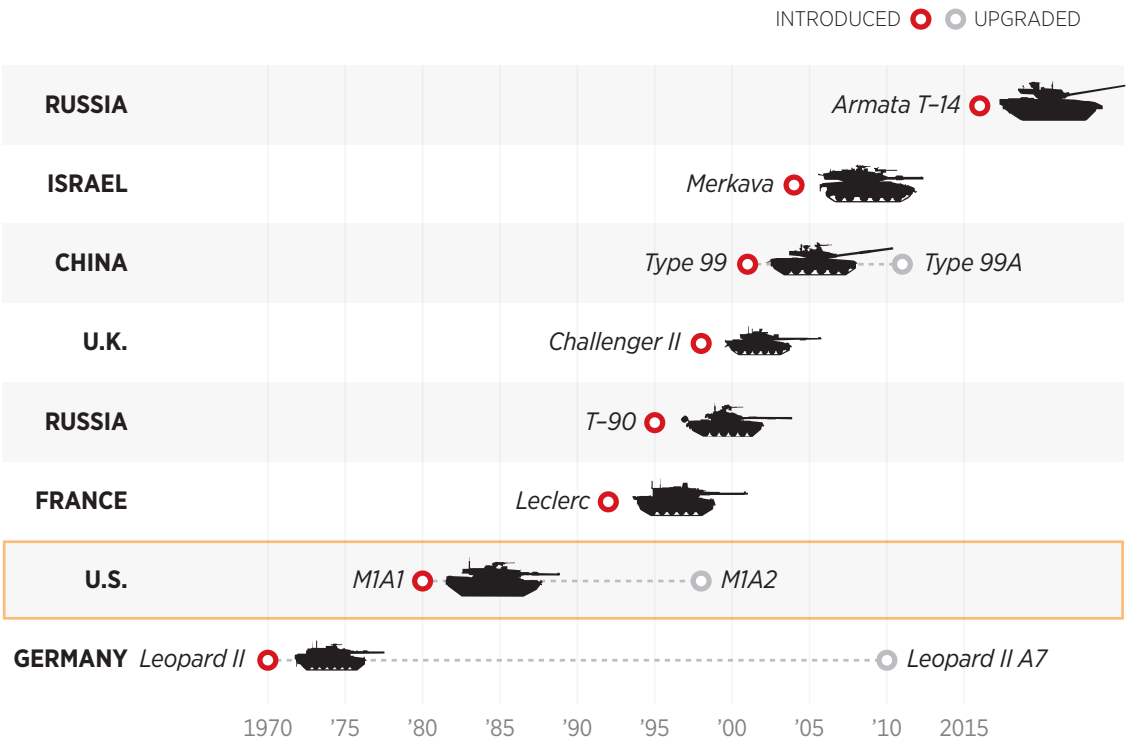
The Corps has procured 317 JLTVs through FY 2017.[51] The lack of operational detail in the Army's Tactical Wheeled Vehicle Strategy could affect future USMC JLTV procurement and modernization plans.[52] The USMC expected the program to reach initial operational capability (IOC) in the fourth quarter of 2018, but IOC has been delayed because of Lockheed Martin's bid protest following the award of a low-rate initial production decision to Oshkosh.[53]

The Marine Corps plans to replace the AAV-7A1 with the ACV, which completed its Milestone B requirements in November 2015 and will move into low-rate initial production in FY 2018.[54] The ACV, which took the place of the Expeditionary Fighting Vehicle (EFV), "has been structured to provide a phased, incremental capability."[55] 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 due to technical obstacles and cost overruns. Similarly, the Corps planned to replace the LAV inventory with

FIGURE 8

American Tank Loses Traction in Modernization

When it was first introduced in 1980, the M1A1 Abrams arguably became the world's most formidable battle tank. However, since then several nations have introduced new or upgraded tanks, including Russia and China.



SOURCE: Heritage Foundation research based on data from army-technology.com and nationalinterest.org.

heritage.org

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.[56] 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.[57] This would help the Corps to meet its requirement of armored lift for 10 battalions of infantry.[58] As of March 2015, the USMC's acquisition objective for the ACV 1.1 was 204 vehicles for the first increment.[59] However, ACV program officials have since informed the U.S. Government Accountability Office "that only 180 AAVs would be replaced by the incoming 204 ACV 1.1s."[60] Brigadier General Joseph Shrader confirmed that this ACV 1.1 increment would not entirely replace the AAV, but rather would serve to "enhance that capability."[61]

The ACV 1.1 platform is notable in that it will be 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). The ACV 1.2 platform is being planned as a fully amphibious, tracked version.[62] 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.[63] 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.[64] In addition, the Corps will purchase new vehicles based on the MPC concept.

The F-35B remains the Marine Corps' largest investment program in FY 2017. The Corps announced IOC of the F-35B variant in July 2015.[65] Total procurement will consist of 420 F-35s (353 F-35Bs and 67 F-35Cs). The slight change in the balance of short take-off and vertical landing vehicle and carrier variants from FY 2016 to FY 2017 reportedly reflects "evolving circumstances" and operational requirements within the service. The AV-8Bs and F/A-18A-Ds will 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.[66]

As the F-35 enters into service and legacy platforms reach the end of their service life, the Marine Corps expects a near-term inventory challenge due to a combination of reduced JSF procurement, increasing tactical aircraft utilization rates, and shortfalls in F/A-18A-D and AV-8B depot facility production.[67] In March 2016, Marine Corps Commandant General Robert Neller assessed that "[i]f these squadrons [in the F/A-18 community] were called on to fight today they would be forced to execute with 86 less jets than they need."[68] Like the F-35A, the F-35B and F-35C variants are subject to development delays, cost overruns, budget cuts, and production problems. The F-35B in particular was placed on probation in 2011 because of its technical challenges.[69] Probation has since been lifted, and the Corps declared IOC with its first F-35B squadron, VMFA-121, on July 31, 2015.[70]

Today, the USMC MV-22 program is operating with few problems and nearing completion of the full acquisition objective of 360 aircraft.[71] As of June 2017, the Corps had received 293 of the 360 aircraft included in the program of record.[72] Currently, there are 14 fully operational capability squadrons in the active component to meet these needs, and two additional squadrons are transitioning from the reserve component.[73] 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 is struggling to sustain the Osprey's capability rates because of a shortfall in its "ability to train enlisted maintainers in the numbers and with the qualifications necessary to sustain the high demand signal."[74]

The USMC's heavy-lift replacement program, the CH-53K, conducted its first flight on October 27, 2015.[75] The CH-53K will replace the Corps' CH-53E, which entered service in 1980. Although "unexpected redesigns to critical components" delayed a low-rate initial production decision,[76] the program achieved Milestone C in April 2017, and the FY 2018 President's budget request authorizes $756.4 million for the production of Lot 2 aircraft, "including Advanced Procurement and initial spares."[77] The helicopter is predicted to reach IOC in 2019, almost four years later than initially anticipated.[78] This is of increasing concern as the Marine Corps maintains only 146 CH-53Es.[79] Although the Corps began a reset of the CH-53E in 2016 to bridge the procurement gap, it will not have enough helicopters to meet its heavy-lift requirement without the transition to the CH-53K.[80] The FY 2018 request would continue to fund procurement totals of 194 aircraft.[81]

Readiness

The Marine Corps' first priority is to be the crisis response force for the military, which is why investment in readiness has been prioritized over capacity and capability. However, in order to invest in readiness in a time of downward fiscal pressure, the Corps has been forced to reduce end strength and delay investment in modernization.

Even though funding for near-term readiness has been relatively protected from cuts, future readiness is threatened by underinvestment in long-term modernization and infrastructure. As General Dunford has explained, extended or long-term imbalance among the USMC "pillars" of readiness, which address both operational and foundational readiness, "will hollow the force and create unacceptable risk for our national defense."[82]

Already, modernization delays have begun to affect readiness as it becomes increasingly challenging to keep aging platforms in working order, and aircraft are retired before they can be replaced—leaving a smaller force available to meet operational requirements that in turn further increases use of the platforms that remain. According to a 2017 joint statement before the Senate Armed Services Committee, "Marine Corps operating forces are currently averaging, in the aggregate, less than 1:2 deployment-to-dwell ratio," and "[i]ndividual unit deployment tempo remains on par with the height of our commitments in Iraq and Afghanistan.[83]

The DOD has prioritized funding for deployed and next-to-deploy units. 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.[84]

Marine aviation in particular is experiencing significant readiness shortfalls. With a smaller force structure and fewer aircraft available for training, aviation units are having difficulty keeping up with demanding operational requirements. All of the Marine Corps' fixed-wing and tiltrotor aircraft are operating in excess of a 1:2 D2D ratio; this stress is increased by reduced procurement and workforce cuts, which contribute to readiness problems and leave fewer aircraft available for training or operations.[85] More than 92 percent of the Department of the Navy's F/A 18 A-D fleet has already surpassed the aircraft's service life expectancy of 6,000 flight hours, and "a portion of the [USMC's] existing inventory...will be flown through the mid-2030 timeframe."[86]

As of December 31, 2016, only 41 percent of the Marine Corps' fixed-wing and rotary-wing aircraft were considered flyable. Readiness rates among the Hornet fleet are even more severe, with just over a quarter of the Corps' 280 aircraft considered flyable. As a result, the Corps is 150 airplanes short of the necessary requirement to meet its flight hour goals.[87] The combination of aging aircraft and flight hour reductions can raise the risk of flight accidents attributed to both human and mechanical error. However, according to a February 2017 statement by Lieutenant General Jon Davis, Deputy Commandant for Aviation, average flight hours for the Marine Corps is "about three hours per pilot per month better than we were" in May 2015.[88]

For FY 2018, the Department of the Navy continues to prioritize immediate readiness by accepting "risk in facilities [and] weapons capacity," "delay[ing] certain modernization programs,"[89] and "protect[ing] near-term operational readiness of its deployed and next-to-deploy units" while struggling to maintain a "ready bench."[90] According to 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."[91]

The Marines' Ground Equipment Reset Strategy has been progressing and is expected to be completed by the end of FY 2017. All of the equipment in Afghanistan was withdrawn by February 2015. As of April 2017, the Marine

Corps had reset approximately 90 percent of its ground equipment, compared to 78 percent in the prior year.[92] 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.[93] This translates to a force of around 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 recommendations 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, a 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.

- **Two-MRC Level:** 36 battalions.
- **Actual 2017 Level:** 24 battalions.

The Corps is operating with slightly less than 67 percent of the number of battalions relative to the two-MRC benchmark. This is a slight increase in the capacity level as measured in the *2017 Index* but insufficient to justify an increase in the Corps' capacity score. 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. This includes redesign of the MPC.

Readiness Score: Weak

In FY 2017, approximately half of USMC units experienced degraded readiness. 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 only sufficient to meet ongoing commitments 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 December 2016, the USMC reported more specifically that only 41 percent of its fixed-wing and rotary-wing aircraft were considered flyable. Due to the lack of a "ready bench" and a further decline in readiness levels among the USMC aircraft fleet, the *2018 Index* assesses Marine Corps readiness levels as "weak."

Overall U.S. Marine Corps Score: Weak

The Marine Corps is scored as "weak" overall in the *2018 Index*. This is a drop from "marginal" as assessed in the *2017 Index*. Absent a reduction in operational commitments and a significant increase in funding to clear backlogged maintenance and speed procurement of new platforms, the Corps will continue to struggle to improve its condition for the foreseeable future.

U.S. Military Power: Marine Corps

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

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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 nuclear warheads—based on designs from the 1960s and 1970s—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 if the decision should ever be made to resume this practice). Additionally, the national security laboratories do not focus solely on the nuclear weapons mission; 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, the U.S. 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. preserves significant upload capability on its strategic delivery vehicles, which means 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 the U.S. to maintain the ability to conduct a nuclear test within 24 to 36 months of a presidential decision to do so.[3] However, successive governmental reports have noted the continued deterioration of technical and diagnostics equipment and the inability to fill technical positions supporting nuclear testing readiness.[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 nuclear tests of weapons that they designed, developed, and are certifying.

Not all of the existing inactive stockpile will go through the life-extension program. Hence, our ability to respond to contingencies by uploading weapons kept in an inactive status could decline with the passage of time.

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. The NNSA was supposed to address these problems but has largely failed in this task, partly because "the relationship with the NNSA and the National security labs appears to be broken."[5]

In 1999, the Commission on Maintaining U.S. Nuclear Weapons Expertise concluded that 34 percent of the employees supplying critical skills to the weapons program were more than 50 years old. The number increased to 40 percent in 2009.[6] On average, the U.S. high-technology industry has a more balanced employee age distribution.[7]

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.[8]

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.[9] 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).[10] 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 and, until very recently, little has been done to reverse it" and that "the readiness of forces assigned the nuclear mission has seriously eroded."[11]

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 a nuclear mission and implement a stringent inspection regime.

The success of these changes has been limited. 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.[12] 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.[13]

The ICBM Force Improvement Program was initiated and mostly implemented throughout 2014 and into 2015, and the Air Force shifted over $160 million to address problems, modernize certain facilities, and generally improve morale. The Air Force has also seen an increase in badly needed manpower—but not nearly enough to alleviate manpower concerns. 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. General John E. Hyten, Commander, U.S. Strategic Command (STRATCOM), testified in April 2017 that:

> For decades now, we have held a military advantage over our adversaries, both from a nuclear and conventional standpoint. That is starting to change. As our nation rightly focuses on combating violent extremist organizations and the states that support them, other adversaries have taken the opportunity to develop advanced nuclear and conventional weaponry that rival many of our systems.[14]

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. At the same time, the Trump Administration has an opportunity to reassess the U.S. nuclear force posture, including some of its more misguided elements like discounting Russia's aggressive policies toward the United States and U.S. allies in Europe.

Implications for U.S. National Security

U.S. nuclear forces are not designed to shield the nation from all types of attacks from all adversaries. They are designed to deter large-scale 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. assurances to NATO, Japan, and South Korea that lead these allies either to keep the number of their nuclear weapons lower than otherwise would 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, and the Joint Comprehensive Plan of Action might make reaching this goal easier by providing Iran with money and access to advanced technologies.

This makes U.S. nuclear 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 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.

Since 2010, when the most recent Nuclear Posture Review (NPR) was concluded, the global strategic security environment has become increasingly dangerous. Russia is now engaged in an aggressive nuclear buildup, having added new modern nuclear systems to its arsenal since 2010. Concurrently, Russia 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 nuclear proliferators to 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. would use 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 reliable nuclear enterprise is more likely to sustain its deterrent value than is an outdated and questionable one.

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 physical infrastructure that designs, manufactures, and maintains U.S. nuclear weapons. The complex also includes the talent of people from physicists to engineers, maintainers, and operators, without which 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 has the potential 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."[15] Since 1993, reliability has been determined through an intensive warhead surveillance program; non-nuclear experiments (that is, without the use of experiments producing nuclear yield); sophisticated calculations using high-performance computing; and related 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 mean a smaller margin of

error should one type be affected by a technical problem that requires the repair or decommissioning of a weapon type or its delivery system. Americans and allies must be confident that U.S. nuclear warheads will perform as expected.[16]

As warheads age, they become less able to perform their mission as expected, and this can complicate military planning significantly. Despite creating impressive amounts of knowledge about nuclear weapons physics and materials chemistry, the U.S. may not be completely certain about the long-term effects of aging components that comprise a nuclear weapon. According to former NNSA spokesman Bryan Wilkes, for example, "We know that plutonium pits have a limited lifetime."[17] A plutonium pit is a crucial component of a nuclear weapon,[18] and with life-extension programs introducing new components to warheads whose radiological effects are not fully known, the level of uncertainty has increased.

The United States has the world's safest and most secure stockpile, but security of long-term storage sites (including overseas 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 does assess overall weapons system reliability, which includes both the warhead and delivery platforms.

Absent nuclear weapons testing, the assessment of weapons reliability becomes more subjective, albeit based on experience and non-nuclear tests. While certainly an educated opinion, it is not a substitute for the type of objective data obtained through nuclear testing. Testing was used to diagnose potential problems and to certify the effectiveness of fixes to those problems. Given that modern simulation is based on nuclear tests that were conducted primarily in the 1950s and 1960s, using testing equipment of that era, there is a great deal that modern testing equipment and computer capability could teach us about nuclear physics.

"[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."[19] 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."[20] 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.[21]

In fiscal year (FY) 2017, the NNSA assessed that the stockpile is safe, secure, reliable, and effective.[22]

The lack of nuclear weapons testing creates some uncertainty concerning the adequacy of fixes to the stockpile when problems are found. This includes updates made in order to correct problems that were found in the weapons or changes in the weapons resulting from life-extension programs. It is simply impossible to duplicate exactly weapons that were designed and built many decades ago. According to 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."[23] The high costs of having to certify weapons without nuclear testing are resulting in fewer types of weapons and, consequently, a greater impact across the inventory if there is an error in 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."[24] The U.S. is pursuing warhead life-extension programs that replace aging components before they can cause reliability problems. However, 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."

Reliability of U.S. Delivery Platforms Score: Strong

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.[25]

The U.S. conducts 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: U.S. ICBMs and SLBMs are flight tested annually, and these tests were successful in 2016. 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.[26] Overall, this factor earns a grade of "strong."

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 which the U.S. used to lead. Since the collapse of the Soviet Union, nuclear weapons 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 weapon 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 weapon designs would also help American experts to remain engaged and knowledgeable, would help to attract the best talent to the nuclear enterprise, 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."[27] 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.

Grade: The lack of plans to modernize nuclear weapons—life-extension programs are not modernization—and restrictions on thinking about new 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 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, but 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, but the U.S. Strategic Command says that a triad is a "requirement."[28] 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. As Bradley Thayer and Thomas Skypek have noted, "Using 2009 as a baseline, the ages of the current systems of the nuclear triad are 39 years for the *Minuteman III*, 19 years for the *Trident II* D-5 SLBM, 48 years for the B-52H, 12 years for the B-2, and 28 years for the *Ohio* Class SSBNs."[29] 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 possible U.S. dependence on Russia as a source of such engines are other long-range concerns.[30]

Grade: U.S. nuclear platforms are in dire need of recapitalization. The U.S. has plans for nuclear triad modernization in place, and funding for these programs has been sustained 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 Laboratories,
- 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 2010 NPR stated:

> In order to remain safe, secure, and effective, the U.S. nuclear stockpile must be supported by a modern physical infrastructure—comprised of the national security laboratories and a complex of supporting facilities—and a highly capable workforce with the specialized skills needed to sustain the nuclear deterrent.[31]

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.[32] U.S. research and development efforts and the industrial base that supports modernization of delivery systems 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 warheads per year, there are limits on the ability to conduct life-extension programs, and Dr. John Foster has reported that the U.S. no longer can "serially produce many crucial components of our nuclear weapons."[33]

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. The NNSA's facilities are old: Upwards of 50 percent are more than 40 years old, nearly 30 percent date to the Manhattan Project of the 1940s, and 12 percent are considered excess or no longer needed.[34] As a consequence, the NNSA had about $3.7 billion in deferred maintenance at the end of FY 2015.

Since 1993, the DOE has not had a facility dedicated to production of plutonium pits, one of the main components of America's nuclear warheads. 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 20 by the middle of the next decade and to between 50 and 80 by the end of the following decade. Russia can produce around 2,000 pits a year.[35]

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."

Quality of People Working in the National Nuclear Laboratories Score: Marginal

Combined with nuclear facilities, U.S. nuclear weapons scientists and engineers are critical to the health of the complex and the stockpile. The 2010 NPR emphasizes that:

> [A] highly skilled workforce [is] needed to ensure the long-term safety, security, and effectiveness of our nuclear arsenal and to support the full range of nuclear security work to include non-proliferation, nuclear forensics, nuclear, counter-terrorism, emergency management, intelligence analysis and treaty verification.[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 no such challenging programs are in place today. The NNSA and its weapons labs understand this problem and, with the support of Congress and despite significant challenges, are taking steps to mentor 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 April 2017.[37]

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, nuclear warhead certifications will rely largely on the judgments of people who have never tested or designed a nuclear weapon. 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.

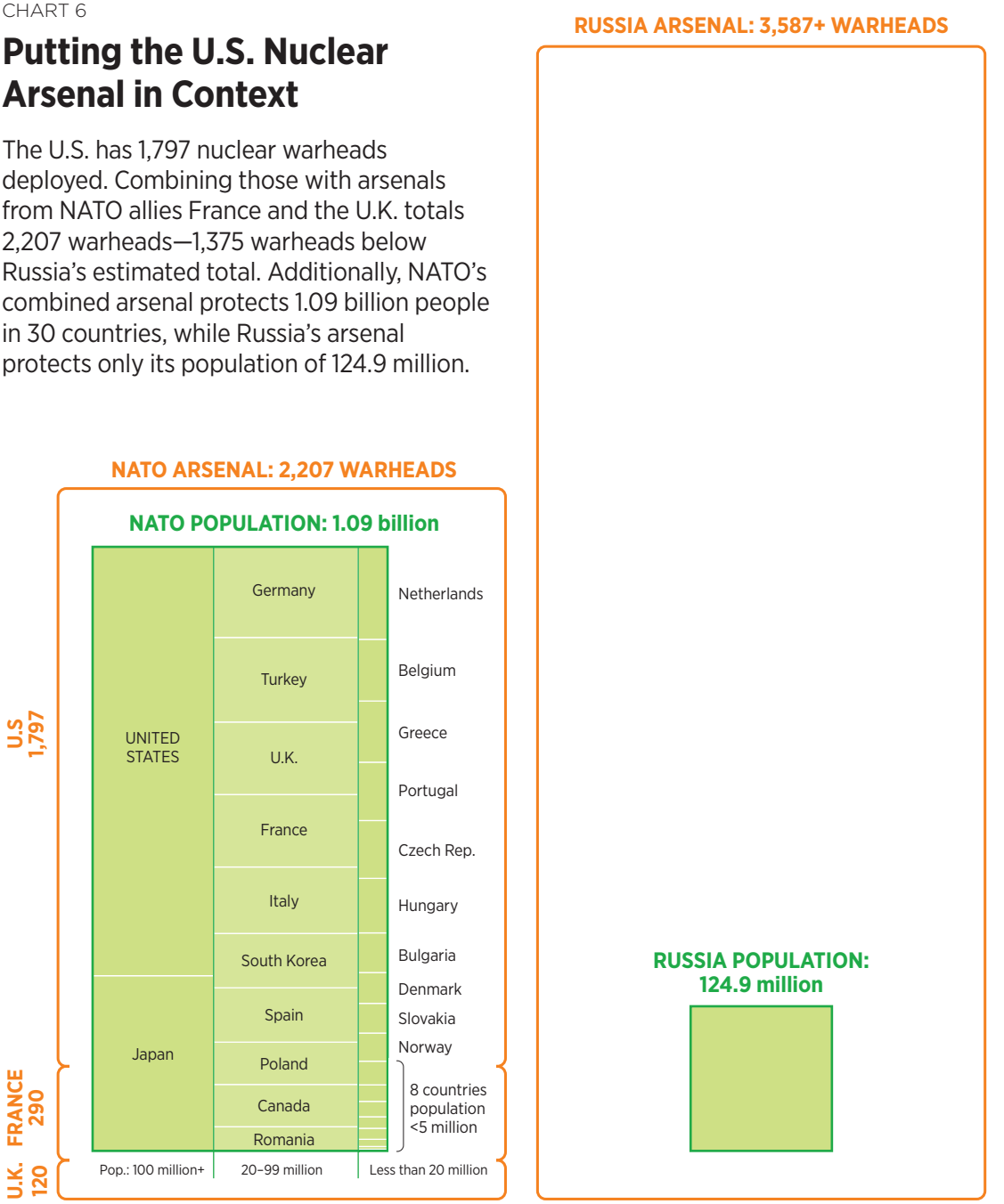
During FY 2017, the services have continued to align resources in order to preserve strategic capabilities in the short term, but long-term impacts remain uncertain. Continued decline in U.S. general-purpose forces eventually could affect nuclear forces, especially the bomber leg of the nuclear triad. 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."

CHART 6

Putting the U.S. Nuclear Arsenal in Context

The U.S. has 1,797 nuclear warheads deployed. Combining those with arsenals from NATO allies France and the U.K. totals 2,207 warheads—1,375 warheads below Russia's estimated total. Additionally, NATO's combined arsenal protects 1.09 billion people in 30 countries, while Russia's arsenal protects only its population of 124.9 million.



NOTES: Figures are from 2015. Warhead totals are estimates.
SOURCES: U.S. Department of State, "New START Treaty Aggregate Numbers of Strategic Offensive Arms," July 1, 2015, http://www.state.gov/t/avc/rls/240062.htm (accessed September 3, 2015); Amy F. Woolf, "Nonstrategic Nuclear Weapons," Congressional Research Service *Report for Members and Committees of Congress*, February 23, 2015, https://www.fas.org/sgp/crs/nuke/RL32572.pdf (accessed September 3, 2015); and Terry Miller and Anthony B. Kim, *2017 Index of Economic Freedom* (Washington: The Heritage Foundation, 2017), http://www.heritage.org/index.

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Allied Assurance Score: Marginal

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.[38] 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 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.

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 for 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." Additionally, the perception among some that America has accepted Iran's nuclear program may encourage other countries in the Middle East region to seek similar capabilities. Thus, allied assurance remains "marginal."

Nuclear Test Readiness Score: Weak

Testing is one of the key elements of a safe, secure, effective, and reliable nuclear deterrent. While the U.S. is currently under a self-imposed nuclear testing moratorium, it maintains a low level of nuclear test readiness at the Nevada National Security Site (formerly Nevada Test Site). This approach is questionable with regard to its efficacy in assuring that the U.S. has the timely ability to conduct yield-producing experiments should it discover a flaw in one or more types of its nuclear weapons that requires experimentation to correct. The U.S. might need to test to develop a weapon with new characteristics that can be validated only by testing and to verify render-safe procedures. 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.

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 between 24 and 36 months, although both the NNSA and Congress required the NNSA to be ready within 18 months in the past.[39] The U.S. could meet the 18-month requirement only if certain domestic regulations, agreements, and laws were waived.[40] 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.[41]

"Test readiness" refers to 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 this goal. The test readiness program is supported by experimental programs at the Nevada National Security Site, nuclear laboratory experiments, and advanced diagnostics development.[42]

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

Though modernization programs for warheads and delivery systems are uncertain, the infrastructure that supports nuclear programs is aged, and nuclear test readiness has revealed troubling problems within the forces, those weak spots are offset by strong delivery platform reliability and allies who remain confident in the U.S. nuclear umbrella. The commitment to warhead life-extension programs and modernization of nuclear delivery platforms is a positive trend that should be maintained. Averaging the subscores across the nuclear enterprise therefore results in an overall score of "marginal."

U.S. Military Power: Nuclear

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Warhead Surety				✓	
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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