U.S. Military Power

An Assessment of U.S. Military Power

America is a global power with global interests. Consequently, its military is tasked with defending the country from attack and protecting its national interests on a corresponding global scale. The United States does not have the luxury of focusing only on one geographic area or narrow challenge to its interests. Its economy depends on global trade; it has obligations with many allies; and it must account for several major competitors that routinely, consistently, and aggressively challenge its interests and seek to displace its influence in key regions. It follows that its military should be commensurately sized for the task and possess the necessary tools, skills, and readiness for action. Beyond that, the U.S. military must be capable of protecting the freedom to use the global commons—the sea, air, space, and cyberspace domains on which American prosperity and political influence depend.

As noted in all preceding editions of the *Index*, however, the U.S. does not have the necessary force to address more than one major regional contingency (MRC) and is not ready to carry out its duties effectively. Consequently, as we have seen during the past few years, the U.S. finds itself increasingly challenged both by major competitors such as China and Russia and by the destabilizing effects of terrorist and insurgent elements operating in regions that are of substantial interest to the U.S. Russia's large-scale, conventional invasion of Ukraine in February 2022 is proof that war in regions of interest to the U.S. remains a feature of modern times—something that is not lost on China as it expands its military power and threatens Japan and other U.S. allies and partners in the Indo-Pacific region more aggressively. Poland, Germany, Lithuania, Japan, and several other countries have taken note of this and are committed to substantially improving the capacity, capability, and readiness of their military forces. The United States, however, has not made a similar commitment.

The SARS-CoV-2 virus that causes the COVID-19 disease affected the ability of U.S. forces to train, exercise, and deploy for much of 2020 and 2021. It also caused disruptions in supply and maintenance activities similar to those experienced in the civilian community. In 2022, its impact was less troublesome as measures to reduce risk and mitigate challenges took effect. Some of the readiness that was lost has been regained, but other factors, like inadequate funding for parts and flight hours, have slowed the pace of progress.

How to Think About Sizing Military Power

Military power consists of many things and is the result of how all of its constituent pieces are brought together to create an effective warfighting force, but it begins with the people and equipment used to conduct war: the weapons, tanks, ships, airplanes, and supporting tools that make it possible for a force to impose its will on another or to prevent such an outcome from happening, which is the point of deterrence.

However, simply counting the number of people, tanks, or combat aircraft that the U.S. possesses would be insufficient because it would lack context. For example, the U.S. Army might have 100 tanks, but to accomplish a specific military task, 1,000 or more might be needed or none at all. It might be that the terrain on which a battle is fought is especially ill-suited to tanks or that the tanks one has are inferior to those of the enemy. The enemy could be quite adept at using tanks, or his tank operations might be integrated into a larger employment concept that leverages the supporting fires of infantry and airpower, whereas one's own tanks are poorly maintained, the crews are not well prepared, or one's doctrine is irrelevant.

Success in war is partly a function of matching the tools of warfare to a specific task and

employing those tools effectively in battle. Get these wrong—tools, objective, competence, or context—and you lose.

Another key element is the military's capacity to conduct operations: how many of the right tools—people, tanks, planes, or ships—it has. One might have the right tools and know how to use them effectively but not have enough to win. Because 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 that requires informed but not certain judgment. The war in Ukraine is a powerful illustration of this. By the numbers, Russia should have achieved a quick victory over the smaller, less modern Ukrainian military. For various reasons that include leadership, tactics, training, and resupply, the Ukrainians have performed much better than the Russians, who have performed poorly overall.

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. A thinking adversary will analyze his opponent for weaknesses or patterns of behavior and seek to develop techniques, approaches, and tools that exploit such shortfalls or predictable patterns—the asymmetries of war. One need not try to match an enemy tank for tank: In many cases, not trying is more effective.

This appears to be what China is doing. Having analyzed U.S. forces, performance characteristics of U.S. platforms and weapons, and the geography and basing options affecting U.S. defense posture in the Indo-Pacific, China has invested heavily in shore-based long-range missiles, an extensive fleet of ships optimized for the local maritime environment, and a deepening inventory of guided munitions. China does not need a force that mirrors that of the U.S.: It is building a force that leverages the asymmetries between China's situation and that of the United States.

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

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

The adequacy of hard power is affected most directly by the resources the nation is willing to apply. Although that decision is informed to a significant degree by an appreciation of threats to U.S. interests and the ability of a given defense portfolio to protect U.S. interests against such threats, it is not informed solely by such considerations; hence the importance of clarity and honesty in determining exactly 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 that will be necessary to support that power. After defining the national interests to be protected, the DOD can use worst-case scenarios to determine the maximum challenges the U.S. military might have to overcome. Another way is to redefine what constitutes a threat. By taking a different view of whether major actors pose a meaningful threat and of the extent to which friends and allies have the ability to assist the U.S. in meeting security objectives, one can arrive at different conclusions about the necessary level of 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 and the expansion of its military capabilities as a natural occurrence commensurate with its strengthening status. There can be dramatically different perspectives with respect to how China might use its military power and what would constitute an effective U.S. response, and the difference between these perspectives can have a dramatic impact on how one thinks about U.S. defense requirements. So, too, can policymakers amplify or downplay risk to justify defense budget decisions.

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

- Does the country need enough for two major combat operations (MCOs) at roughly the same time or just enough for a single major operation and some number of lesser cases?

- To what extent should "presence" tasks—the use of forces for routine engagement with partner countries or simply to be on hand in a region for crisis response—be in addition to or a subset of a military force that is sized to handle two major regional conflicts?

- How much value should be assigned to advanced technologies as they are incorporated into the force, especially if they have not been proven in combat settings?

- What is the likelihood of conventional war, and (if one thinks it is minimal) what level of risk is one willing to accept that sufficient warning will allow for rearming?

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 example that is frequently cited by analysts. 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.

Since that study, the government has undertaken others as Administrations, national conditions, and world events have changed the context of national security. Quadrennial Defense Reviews (QDRs) were conducted in 1997, 2010, and 2014 and were accompanied by independent National Defense Panel (NDP) reports that reviewed and commented on them. Both sets of documents purported to serve as key assessments, but analysts came to minimize their value, regarding them as justifications for executive branch policy preferences (the QDR reports) or overly broad generalized commentaries (the NDP reports) that lack substantive discussion about threats to U.S. interests, a credible strategy for dealing with them, and the actual ability of the U.S. military to meet national security requirements.

The QDR was replaced by the National Defense Strategy (NDS), released in 2018,[3] and the independent perspectives of the formal DOD review by the National Defense Strategy Commission, which released its view of the NDS in November 2018.[4] Departing from their predecessors, neither document proposed specific force structures or end strength goals for the services, but both were very clear in arguing that America's military should be able to address more than one major security challenge at a time. The commission's report went so far as to criticize the NDS for not making a stronger case for a larger military that would be capable of meeting the challenges posed by four named competitors—China, Russia, Iran, and North Korea—while also possessing the capacity to address lesser, though still important, military tasks that included presence, crisis response, and assistance missions.

The Biden Administration has not yet produced a national defense strategy to replace the one issued by the Trump Administration in 2018, although it has released an Interim National Security Strategic Guidance (INSSG) that echoes the general goal for the U.S. military to "deter and prevent adversaries from directly threatening the United States and our allies, inhibiting access to the global commons, or dominating key regions,"[5] all of which are themes that have remained remarkably consistent from

one Administration to the next for several decades. Taken at face value and considering the challenges posed simultaneously by a multitude of competitors in several regions, the INSSG seems to imply that the military should have the capability and capacity to meet this objective.

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 since the late 1980s have made comparing combat power more difficult. What was largely a platform-versus-platform model has shifted somewhat to a munitions-versus-target model. Evidence of this has been seen on recent battlefields in Nagorno-Karabakh and Ukraine.

The proliferation of precise weaponry means increasingly that each round, bomb, rocket, missile, and even (in some instances) individual bullet can hit its intended target, thus decreasing the number of munitions needed to prosecute an operation. It also means that an operating environment's lethality increases significantly for the people and platforms involved. We have reached the point at which, instead of focusing primarily on how many ships or airplanes the enemy can bring to bear against one's own force, one must consider how many "smart munitions" the enemy has when thinking about how many platforms and people are needed to win a combat engagement.[6] The increasing presence of unmanned systems that can deliver precision-guided munitions against targets adds complexity and danger to the modern battlefield. There is also the higher cost of fielding precision weapons rather than less expensive but less accurate conventional (unguided) munitions.

In one sense, increased precision and the technological advances now being incorporated into U.S. weapons, platforms, and operating concepts make it possible to do far more than ever before with fewer assets.

- Platform signature reduction (stealth) makes it harder for the enemy to find and target them, and the increased precision of weapons makes it possible for fewer platforms to hit many more targets.

- The U.S. military's ability to harness computers, modern telecommunications, space-based platforms—such as for surveillance, communications, and positioning-navigation-timing (PNT) support from GPS satellites—and networked operations potentially means that in certain situations, smaller forces can have far greater effect in battle than was possible at any other time in history (although these same advances also enable enemy forces).

- Some military functions—such as seizing, holding, and occupying territory—may require a certain number of soldiers no matter how state-of-the-art their equipment may be. For example, the number of infantry squads needed to secure an urban area where line of sight is constrained and precision weapons have limited utility is the same as the number needed in World War II. Again, current operations in Ukraine are illustrative as Russian forces find that seizing, occupying, and holding ground is a manpower-intensive effort.

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

As advanced technology has become more affordable, it has become more accessible for nearly any actor, whether state or non-state.[7] Consequently, it may well be that the outcomes of future wars will depend far more on the skill of the forces and their capacity to sustain operations over time than they will on some great disparity in technology. If so, readiness and capacity will become more important than absolute advances in capability.

All of this illustrates the difficulties of and need for exercising judgment in assessing the adequacy

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

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

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

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

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

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

What Is Not Being Assessed

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

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

Obviously, this is not the totality of service capabilities, and it certainly is not everything needed for war. Nevertheless, these measures can be viewed as surrogates that subsume or represent the vast number of other things that make these units of measure possible and effective in battle. For example, combat forces depend on a vast logistics system that supplies everything from food and water to fuel, ammunition, and repair parts. Military operations require engineer support, and the force needs medical, dental, and administrative capabilities. The military also fields units that transport combat power and its sustainment to wherever they may be needed around the world.

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

The scope of this *Index* does not extend to analysis of everything that makes hard power possible; it focuses on the status of the hard power itself. It also does not assess the services' Reserve and

National Guard components, although they account for roughly one-third of the U.S. military force and have been essential to the conduct of operations since September 2001.[8] Consistent assessment of their capability, readiness, and operational role is challenging because each service determines the balance among its Active, Reserve, and National Guard elements differently: Only the Army and Air Force have Guard elements; the Navy and Marine Corps do not. This balance can change from year to year and is based on factors that include cost of the respective elements, availability for operational employment, time needed to respond to an emergent crisis, allocation of roles among the elements, and political considerations.[9]

As with other elements that are essential to the effective employment of combat power—logistics, medical support, strategic lift, training, etc.—the U.S. military could not handle a major conflict without the Reserve and Guard forces. Nevertheless, to make the challenge of annually assessing the status of U.S. military strength using consistent metrics over time more manageable, this *Index* looks at something that is usually associated with the Active component of each service: the baseline requirement for a given amount of combat power that is readily available for use in a major combat operation. There are exceptions, however. For example, in the *2020 Index*, four Army National Guard BCTs were counted as "available" for use because of the significant amounts of additional resources that had been dedicated specifically to these formations to raise their readiness levels.[10]

The Defense Budget and Strategic Guidance

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

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

This *Index* enthusiastically adopts this approach: interests, threats, requirements, resulting force, and associated budget. Spending less than the amount needed to maintain a two-MRC force results in policy debates about where to accept risk: force modernization, the capacity to conduct large-scale or multiple simultaneous operations, or force readiness. The composition of the force and the understanding of military risk have become more salient issues with the shift toward competition with China and Russia. Both the 2017 National Security Strategy[11] and the 2021 Interim National Security Strategic Guidance[12] recognize that meeting the challenges posed by these two large, well-equipped, and well-resourced countries requires a U.S. force that is modern, ready, and effective in all domains of warfare. During their deliberations on the fiscal year (FY) 2022 defense budget, Members of Congress had no updated National Defense Strategy or National Security Strategy to use as a guide.

FY 2022 was the first of the Biden Administration, and the President's party also controlled both chambers of Congress. The Administration initially requested $715 billion for the base discretionary budget of the Department of Defense, which is a 1.6 percent increase over the previous fiscal year's budget.[13] This relative frugality stood in stark contrast to the massive increases requested for other federal departments: increases of more than 40 percent for the Department of Education, more than 14 percent for the Department of Transportation, and more than 29 percent for the Department of Commerce.[14]

Congressional leaders saw Biden's proposal as inadequate, and both chambers acted through the appropriations and authorization bills to increase the defense budget by $27.3 billion over the requested amount. The argument that carried the day was based on the need to stop the divestment of combat-relevant assets, marginally increase the

procurement of hardware, and further invest in research and development of emerging technologies.[15] This increase represented both a rejection of platform retirements proposed by the Biden Administration and Congress's assessment of what is needed to tackle the challenges and threats faced by our armed forces.

The FY 2022 base discretionary budget for the Department of Defense was $742.3 billion.[16] This represents the resources allocated to pay for America's military forces (manpower, equipment, and training); their enabling capabilities (things like transportation, satellites, defense intelligence, and research and development); and their institutional support (bases and stations, facilities, recruiting, and the like).

With the congressional increase, the FY 2022 defense budget was 7.3 percent higher in nominal terms than the FY 2021 budget. Unfortunately, FY 2022 was also marked by the return of inflationary levels that the nation had not experienced for 40 years: By the end of 2021, inflation had reached 7 percent.[17] By increasing fuel, food, raw materials, and labor costs, inflation affects the defense budget as much as it does any household budget. Therefore, the price of merely maintaining our current force structure has risen considerably in the past year and is likely to rise further in the coming years as inflation continues to raise costs.

FY 2022 was also affected by Russia's war of aggression against Ukraine. The war started on February 24, 2022, but the FY 2022 budget was signed into law on March 15, 2022.[18] Though FY 2022 started 5.5 months before passage of the full-year appropriations bill, the delayed start of the actual budget allowed it to be adjusted to account for the war in Ukraine. The appropriations law for FY 2022 included $13.6 billion in assistance to Ukraine, $3.5 billion of which was for defense assistance and $3 billion of which was for operations support for U.S. European Command.[19] Because of the need to replenish the stocks of weapons being shipped to Ukraine and to pay for the redeployment of American troops to Europe, the war's budgetary impacts on America's armed forces will continue.

Adding to these challenges, part of the federal government's response to the coronavirus pandemic was a very substantial increase in government spending. Federal outlays jumped from $4.4 trillion in 2019 to $6.8 trillion in 2021, and the result was a $3.1 trillion budgetary deficit in FY 2020 and a $2.7 trillion deficit in FY 2021.[20] This extremely high level of budgetary deficit should shape how the country assesses the federal government's budgetary priorities, especially when added to a national debt that had reached $28.43 trillion by the end of FY 2021.[21] The public debt, which has been building for years, will continue to consume federal taxpayers' dollars and will have to be balanced against all other federal priorities.

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

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 relatively rare, although they have occurred every 15 years on average.[22] In between (and even during) such occurrences, the military is used to support regional engagement, crisis response, strategic deterrence, and humanitarian assistance as well as to support civil authorities and U.S. diplomacy.

All of the U.S. Unified Geographic Combatant Commands, or COCOMS[23]—Northern Command (NORTHCOM); European Command (EUCOM); Central Command (CENTCOM); Indo-Pacific Command (INDOPACOM); Southern Command (SOUTHCOM); and Africa Command (AFRICOM)—have annual and long-term plans through which they engage with countries in their assigned regions. Engagements range from very small unit training events with the forces of a single partner country to larger bilateral and sometimes multilateral military exercises. Such events help to foster working relationships with other countries, acquire a more detailed understanding of regional political–military dynamics and on-the-ground conditions in areas of interest, and signal U.S. security interests to friends and competitors.

To support such COCOM efforts, the services provide forces that are based permanently in their respective regions or that operate in them temporarily on a rotational basis. To make these regional rotations possible, the services must maintain base forces that are large enough to train, deploy,

support, receive back, and again make ready a stream of units that ideally is enough to meet validated COCOM demand.

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

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

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

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

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

This *Index* focuses on the forces required to win two major wars as the baseline force-sizing metric for the Army, Navy, and Air Force and the one-war-plus-crisis-response paradigm for the Marine Corps. The three large services are sized for global action in more than one theater at a time; the Marines, by virtue of overall size and most recently by direction of the Commandant, focus on one major conflict while ensuring that all Fleet Marine Forces are globally deployable for short-notice, smaller-scale actions.[24] The military's effectiveness, both as a deterrent against opportunistic competitor states and as a valued training partner in the eyes of other countries, derives from its effectiveness (proven or presumed) in winning wars.

Our Approach

With this in mind, we assessed the state of America's military 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) with the design, performance characteristics, technological advancement, and suitability that the force needs to perform its function against an enemy successfully;

- The sufficiency of armored vehicles, ships, airplanes, and other equipment and weapons to win against the enemy;

- The appropriate variety of options to preclude strategic vulnerabilities in the force and give flexibilities to battlefield commanders; and

- The degree to which elements of the force reinforce each other in covering potential vulnerabilities, maximizing strengths, and gaining greater effectiveness through synergies that are not possible in narrowly stovepiped, linear approaches to war.

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

The most recent evidence of this was seen in the hasty evacuation of civilians from Afghanistan in August 2021 once the Biden Administration ordered the end of U.S. operations in that country. Though subject to severe criticism both during and after its execution, almost all of which had to do with the politics surrounding the decision to withdraw and the context that framed the nature of the operation, the operation itself was an extraordinary feat of military effectiveness within tight time constraints and tremendous pressure. Approximately 124,000 civilians were evacuated via the Hamid Karzai International Airport, situated on the outskirts of Kabul, during the latter two weeks of August. The effort involved 6,000 troops on the ground and approximately 800 aircraft from 30 countries (250 of which were U.S. Air Force transports), all coordinated and controlled by U.S. military personnel.[25] No other country could have executed such a mission under such conditions.

A modern "major combat operation"[26] along the lines of those upon which Pentagon planners base their requirements would feature a major opponent possessing modern integrated air defenses; naval power (surface and undersea); advanced combat aircraft (to include bombers); a substantial inventory of short-range, medium-range, and long-range missiles; current-generation ground forces (tanks, armored vehicles, artillery, rockets, and anti-armor weaponry); cruise missiles; and (in some cases) nuclear weapons. Such a situation involving an actor capable of threatening vital national interests would present a challenge that is comprehensively different from the challenges that the U.S. Joint Force has faced in past decades.

Since 2018, given its focus on counterinsurgency, stability, and advise-and-assist operations since 2004 and the 2018 NDS directive to prepare for conflict in an era of great-power competition, the military community has focused on its suitability and readiness for major conventional warfare.[27]

- 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;

- The Marine Corps has undertaken a dramatic restructuring to posture itself more effectively for high-end warfare against a major opponent, focusing specifically on China and the littorals of the Indo-Pacific but also appreciating that its new capabilities will be broadly applicable elsewhere; and

- Both the Navy and the Air Force have acknowledged the evolved threat environment that will demand more of them in the coming decade than they have had to deal with during the past 20 years.

This *Index* ascertains the relevance and health of military service capabilities by looking at such factors as the average age of equipment, the 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 addressed by senior service officials when providing testimony to Congress or examining specific areas in other official statements.

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

Capacity. The U.S. military must have a sufficient quantity of the right capability or capabilities. When speaking of platforms such as planes and ships, a troubling and fairly consistent trend within U.S. military acquisition characterizes the path from requirement to fielded capability. Along the way to acquiring the capability, several linked things happen that result in far less of a presumed "critical capability" than was supposedly required.

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

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

Something similar happens with force structure size: the number of units and total number of personnel the services say they need to meet the objectives established by the Commander in Chief and the Secretary of Defense in their strategic guidance.

- The Marine Corps has stated that it needs 27 infantry battalions to fully satisfy the validated requirements of the regional Combatant Commanders, yet it currently fields only 22 and has stated that it plans to drop to 21 in order to make resources available for experimentation and modernization.[28]
- In 2012, the Army was building toward 48 brigade combat teams, but incremental budget cuts reduced that number over time to 31—less than two-thirds the number that the Army originally thought was necessary.
- The Navy has produced various assessments of fleet size since the end of the Cold War, from 313 ships to 372 ships with some working estimates as high as 500 manned ships.

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 national 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 for most of the force.

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 any given time. Some percentage of the force will always be unavailable because of long-term maintenance overhaul, especially for Navy ships; unit training cycles; employment in myriad

engagement and small-crisis response tasks that continue even during major conflicts; a standing commitment with allies to maintain U.S. forces in a given country or region; and the need to keep some portion of the force uncommitted to serve as a strategic reserve.

The historical record shows that, on average, the U.S. Army commits 21 BCTs to a major conflict; thus, a two-MRC standard would require that 42 BCTs be available for actual use. But an Army built to field only 42 BCTs would also be an Army that could find itself entirely committed to war, leaving nothing back as a strategic reserve to replace combat losses or to handle other U.S. security interests. Although new technologies and additional capabilities have made current BCTs more capable than those they replaced, one thing remains the same: Today's BCT, like its predecessors, can be committed to only one place at a time and must be able to account for combat losses, especially if it engages a similarly modernized enemy force. Thus, regardless of modernity, numbers still matter.

Again, this *Index* assesses only the Active component of the service, albeit with full awareness that the Army also has Reserve and National Guard components that together account for half of the total Army. The additional capacity needed to meet these "above two-MRC requirements" could be handled by these other components or mobilized to supplement Active-component commitments. In fact, this is how the Army thinks about meeting operational demands and is at the heart of the long-running debate within the total Army about the roles and contributions of its various 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 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,[29] 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.[30] To this force allocation we added 20 percent, both to account for forces and platforms that are likely to be unavailable and to provide a strategic reserve to guard against unforeseen demands.

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

- **Army:** 50 BCTs.
- **Navy:** at least 400 ships and 624 strike aircraft.
- **Air Force:** 1,200 fighter/attack aircraft.
- **Marine Corps:** 30 battalions.

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

Readiness. The consequences of the sharp reductions in funding mandated by sequestration over the past decade have caused military service officials, senior DOD officials, and even Members of Congress to warn of the dangers of re-creating the "hollow force" of the 1970s when units existed on paper but were staffed at reduced levels, minimally trained, and woefully ill-equipped.[31] To avoid this, the services have traded quantity/capacity and modernization to ensure that what they do have is "ready" for employment.

Supplemental funding in FY 2017, a higher topline in FY 2018, and sustained increases in FY 2019 and FY 2020 have helped to stop the bleeding and have enabled the services to plan and implement readiness recovery efforts. Massive federal spending in response to the COVID-19 pandemic in calendar year 2020 led to fiscal pressure on defense accounts in future years, but gains in readiness were preserved during FY 2020. Ensuring adequate readiness in FY 2021 was difficult given the challenges created by COVID-19 during the preceding year. In FY 2022, the services continued their effort to find

an appropriate balance among capability, capacity, and readiness, at first benefiting from a reduction in combat operations and the easing of COVID-related restrictions and disruptions but then forced to contend with a loss in spending power caused by rising inflation.

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

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

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

- How does one place a value on the combat effectiveness of such concepts as Air-Sea Battle, Multi-Domain Operations, Littoral Operations in a Contested Environment, Distributed Maritime Operations, Network-centric Operations, or Joint Operational Access when they have not been tested in battle?

- 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. is pursuing so that the political will to conduct sustained operations in the face of mounting losses might differ dramatically?

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

New capabilities such as unmanned systems, cyber tools, hypervelocity platforms and weapons, and the use of artificial intelligence to achieve a better understanding of operations and orchestrate them more effectively have the potential to change military force posture calculations in the future. At the present time, however, they are not realized in any practical sense.

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

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

Endnotes

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7. The use of low-cost drones to attack tanks and other armored vehicles during the 2020 war between Armenia and Azerbaijan proved devastatingly effective. See Benjamin Brimelow, "A Brief, Bloody War in a Corner of Asia Is a Warning About Why the Tank's Days of Dominance May Be Over," *Business Insider*, November 24, 2020, https://www.businessinsider.com/drones-in-armenia-azerbaijan-war-raises-doubt-about-tanks-future-2020-11 (accessed July 22, 2022). In late June 2021, U.S. forces conducted air strikes against Iranian-backed militia groups in Syria that had been using drones to attack U.S. forces in the region—further evidence of the proliferation of these unmanned systems that enable non-state groups to attack state forces with some level of effectiveness. See David Martin and Tucker Reals, "U.S. Airstrikes Hit Iranian-Backed Militias in Iraq and Syria," CBS News, June 28, 2021, https://www.cbsnews.com/news/us-airstrikes-iran-linked-militias-iraq-syria/ (accessed July 22, 2022).
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23. U.S. Space Command (USSPACECOM) is also considered a geographic command, but within the context of this discussion, SPACECOM's interactions with other countries and the extent to which it must deal with units and peoples operating on its terrain are much different from those of terrestrial commands.
24. In previous editions of the *Index*, the capacity of the Marine Corps was assessed against a two-war requirement of 36 battalions: a historical average of 15 battalions for a major conflict (twice that for two) and a 20 percent buffer, bringing the total to 36. The Corps has consistently maintained that it is a one-war force and has no intention of growing to the size needed to fight two wars. Its annual budget requests and top-level planning documents reflect this position. Having assessed that the Indo-Pacific region will continue to be of central importance to the U.S., noting that China is a more worrisome "pacing threat" than any other competitor, and that the Joint Force lacks the ability to operate within the range of intensely weaponized, layered defenses featuring large numbers of precision-guided munitions, the Corps is reshaping itself to optimize its capabilities and organizational structures for this challenge. This *Index* concurs with this effort but assesses that the Corps will still need greater capacity to succeed in war in the very circumstances for which the Marines believe they must prepare. For a detailed examination of the current state of the Corps, see Dakota Wood, "The U.S. Marine Corps: A Service in Transition," Heritage Foundation *Backgrounder* No. 3501, June 16, 2020, https://www.heritage.org/sites/default/files/2020-06/BG3501_0.pdf.
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28. General David H. Berger, Commandant of the Marine Corps, "Force Design 2030," March 2020, pp. 7–8, https://www.hqmc.marines.mil/Portals/142/Docs/CMC38%20Force%20Design%202030%20Report%20Phase%20I%20and%20II.pdf?ver=2020-03-26-121328-460 (accessed July 22, 2022).
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U.S. Army

Thomas W. Spoehr

The U.S. Army is America's primary agent for the conduct of land warfare. Although it is capable of all types of operations across the range of military operations and support to civil authorities, its chief value to the nation is its ability to defeat and destroy enemy land forces in battle.

The Army is engaged throughout the world in protecting and advancing U.S. interests. From May 2021 to April 2022, the Army provided 120,000 soldiers to the Joint Force in 140 different countries.[1] Most notably it has deployed significant forces to NATO countries as a deterrent to further aggression by Russia. Since Vladimir Putin began his invasion of Ukraine on February 24, 2022, the Army has deployed two Corps, two Division Headquarters, six Brigade Combat Teams, and two Combat Aviation Brigades to Europe.

On May 12, 2022, speaking of the deployments to Europe, Secretary of the Army Christine Wormuth and Army Chief of Staff General James C. McConville testified that:

> Never before has the U.S. Army moved so many forces so quickly. It took less than one week after receiving deployment orders for an armored brigade to deploy from Savannah, Georgia and be on the ground in Germany starting live-fire exercises with tanks drawn from [Army Prepositioned Stock] in Europe. That is a testament to years spent investing in our alliances and partnerships, and to maintaining strong relationships that enabled the Army [to enjoy] the access and presence needed to bolster NATO deterrence.[2]

The Army, like the other military services, finds itself under extraordinary operational and financial pressure. In some cases, advances in firepower like ballistic missiles, electronic warfare, and loitering munitions delivered by drones fielded by adversaries like China have outpaced the U.S. Army's capabilities. Information-age warfare requires new levels of speed and precision in Army sensor-to-shooter chains. Autonomy is changing the character of warfare, and the Army has developed some bold ideas about how to take advantage of this technology.

In her initial message to the Army, Secretary Wormuth set out six objectives. The first, and arguably most important is to "put the Army on a sustainable strategic path amidst this uncertainty." Wormuth acknowledged that the Army is "facing increased fiscal pressures" And while the objective of "a sustainable strategic path" is noble and well-founded, it is not at all clear how the Army will be able to find such a path given its significant year-over-year losses in buying power.[3]

When inflation is factored in, the Army has lost $46 billion in buying power since fiscal year (FY) 2019, and if we assume an inflation factor of 5 percent from 2022 to 2023 (which is likely conservative), the Administration's $177.5 billion FY 2023 budget request for the Army represents a loss of more than $6 billion just from its FY 2022 enacted budget.[4] Signs of budget strain are clearly visible in the Army's proposal to cut its end strength; in modernization accounts slashed (with procurement cut by 7 percent and research and development down by 6 percent); and in military construction accounts that are now below historic levels.[5]

Enduring Relevance of Land Power. Arguments that America no longer needs a strong modern Army because, for example, China is largely a maritime threat ignore history. We need to look no further than today's newspaper headlines about war

in Europe between Russia and Ukraine to remember that capable land power is an enduring need for the United States.

America has a horrible record of predicting where it will fight its next war. As former Secretary of Defense Robert Gates famously said:

> When it comes to predicting the nature and location of our next military engagements, since Vietnam, our record has been perfect. We have never once gotten it right, from the Mayaguez to Grenada, Panama, Somalia, the Balkans, Haiti, Kuwait, Iraq, and more—we had no idea a year before any of these missions that we would be so engaged.[6]

America should not be willing to gamble that the next conflict will be in the Indo-Pacific and put all our eggs in one basket and ignore the need for land power.

Many also overlook the fact that great-power competition with China and Russia is a global contest, which means that we face the enduring need to counter aggression wherever it may occur, not just within the territory or waters of China or Russia. All of this reinforces the reality that America has a long-term need for modernized, sufficiently sized land power.

Lingering Effects of the Pandemic. The Army has largely surmounted the direct challenges posed by the COVID-19 pandemic, but some others have been more persistent. Major collective training events had to be cancelled, and the virus upended Army recruiting efforts in FY 2021, but the Army eventually achieved its desired overall end strength, albeit by relying more on reenlistments than on recruiting.[7] In 2022, combined with other structural factors, the reordering of the U.S. economy that was caused by the pandemic continues to frustrate recruiting efforts.

An Army Recruiting Crisis. The Army's FY 2023 budget request reflects a reduction of 12,000 in end strength.[8] The Army has endeavored to portray this cut as both temporary and driven by a desire to maintain a quality force. In reality, the Army and, to a degree, the other military services are facing a recruiting crisis the likes of which they have not experienced since the transition to the All-Volunteer Force in 1973.[9] Since 2018, the Army has been missing its recruiting goals and making up the difference with strong numbers of reenlistments. Now facing extraordinary financial pressure and in order to save money, it has been forced to face reality and cut spaces for servicemembers that it does not anticipate being able to recruit.

The reasons for the recruiting crisis are many.

- The percentage of Americans that qualify for military service without a waiver has dropped from 29 percent in 2016 to 23 percent in 2022.
- The predominant factor in disqualification is obesity.
- Low unemployment makes recruiting difficult, and as this book was being prepared, the U.S. unemployment rate "was 3.6 percent for the third month in a row."[10]
- A requirement for volunteers to be vaccinated against COVID-19 is disqualifying some applicants.
- Finally, for a variety of reasons that are beyond the scope of this study, fewer Americans express a desire to serve in the armed forces.[11]

The results of this recruiting crisis include lower manning in Army formations, critical shortages in certain career fields, and lower overall readiness. If the crisis is not ameliorated, its longer-term implications are even more consequential.

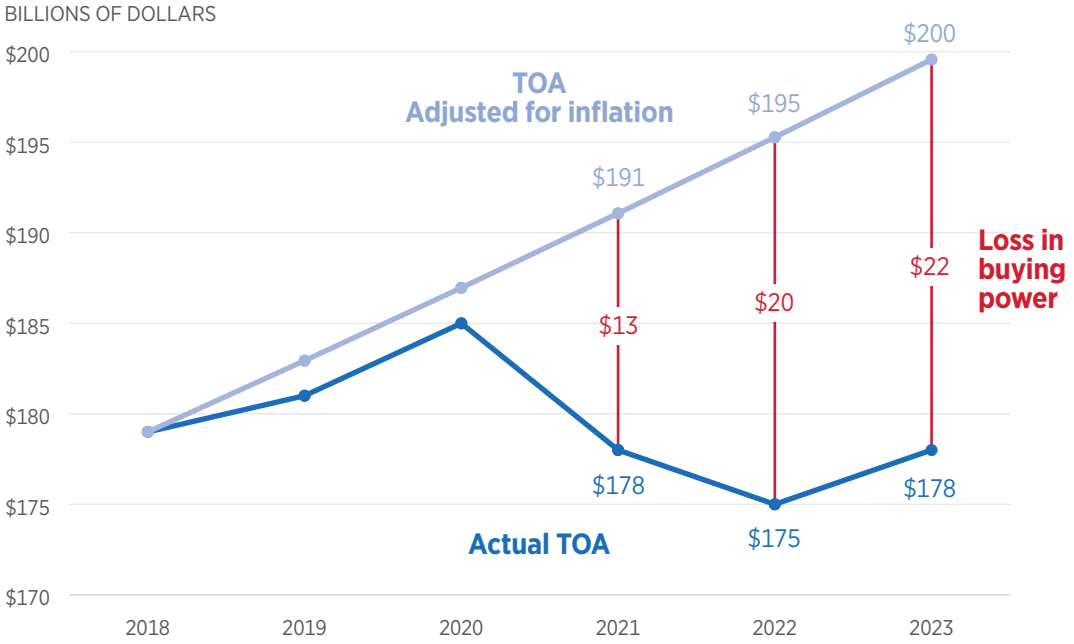
A Capable Force Showing Strain of Chronic Underfunding. The U.S. Army is currently the world's most powerful army, but it is also too small and insufficiently modern to meet even the modest requirements of the 2018 National Defense Strategy (NDS),[12] much less to handle two major regional contingencies simultaneously, which many experts believe is essential.[13]

Even though the conflict in Iraq has largely ended and the military has withdrawn from Afghanistan, the Army's single-minded focus on counterinsurgency during the period from 2001 to 2016 precluded the service from modernizing the key combat capabilities that it needs now for near-peer competition. In 2011, for example, the Army cancelled its only mid-tier air defense program, the Surface Launched Advanced Medium-Range Air-to-Air Missile (SLAMRAAM), based on its assessment that it would not face a threat from the air in the

CHART 5

Army Budget Hit by Both Cuts and Inflation

Not only is the Army's total obligation authority (TOA) declining in real terms, but due to inflation, those declines have resulted in an additional loss of buying power since 2018. Combined losses from 2018 to 2023 total $59 billion.



SOURCES: Honorable Gabe Camarillo, Under Secretary of the Army, "Army Fiscal Year 2023 Budget Overview," March 28, 2022, p. 5, https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2023/pbr/Army%20FY%202023%20Budget%20Overview.pdf (accessed August 17, 2022), and Executive Office of the President, Office of Management and Budget, *Budget of the U.S. Government, Fiscal Year 2023*, https://www.whitehouse.gov/wp-content/uploads/2022/03/budget_fy2023.pdf (accessed August 17, 2022).

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foreseeable future.[14] The Army's last major modernization efforts occurred in the 1980s with the fielding of the M-1 Abrams Tank, the M-2 Bradley Fighting Vehicle, and the Blackhawk and Apache helicopters. As General McConville has cogently argued, "we must modernize the Army. Every 40 years the Army needs to transform. It did in 1940, it did in 1980 and we're in 2020 right now."[15]

The Army's ability to transition from counterinsurgency operations was further constrained by a period of fiscal austerity that began with the Budget Control Act (BCA) of 2011.[16] The inability to fund what was needed led to difficult across-the-board tradeoffs in equipment, manpower, and operations accounts. Budget pressure drove the Department of Defense (DOD) in 2014 to consider cutting the Army's Active component end strength from more than 500,000 to 420,000. If implemented, this would have resulted in "the smallest number of troops since before the Second World War."[17] Multiple equipment programs were cancelled.

The change in Administrations in 2017 forestalled those cuts in end strength. However, the addition of billions of dollars by Congress and the Trump Administration, while it served to arrest the decline of the Army and significantly improved unit readiness, was not sufficient to modernize or significantly increase the size of the force.[18]

A Change in Strategic Direction? As of May 2022, the Biden Administration had been in office for 16

months, yet it remains unclear what direction its National Security or National Defense strategies will take. The Administration's Interim National Security Guidance provided little insight into its thinking with respect to national defense and does not mention the Army or any other military service.[19] The Administration has released a one-and-a-half-page fact sheet on its National Defense Strategy, but it provides no useful details.[20]

Consequences of the Loss in Buying Power. Despite relatively broad agreement that the DOD budget needed real growth of 3 percent to 5 percent to avoid a strategy–budget mismatch,[21] the defense budget topline did not meet that target in FY 2019 and has not done so since.

Of all the services, the Army has fared the worst in terms of resources. Its funding levels plateaued with the FY 2020 budget and since then have declined. The Army received $181 billion in FY 2019, $185 billion in FY 2020, $178 billion in FY 2021, and $175 billion in FY 2022 and has requested $178 billion for FY 2023.[22] Because of the inexorable annual bite of inflation and the decline in budget authority, the Army budget for FY 2023 represents a net loss of about 11 percent in buying power, or $46 billion, since FY 2019.

Summarizing the Army budget at a recent hearing, General McConville candidly reported: "You know Congressman, we're trying to give you the best army we can with the resources we get."[23] General McConville's more than $5 billion Unfunded Priority List containing hundreds of critical items is a testament to what the Army was not able to include in its FY 2023 budget request: family housing, cold weather clothing, Stinger missiles, counter unmanned aerial vehicle systems, and air defense systems—among many other categories of funding.[24]

Capacity

Capacity refers to the sufficiency of forces and equipment needed to execute the National Defense Strategy. One of the ways the Army quantifies its warfighting capacity is by numbers of Brigade Combat Teams (BCTs).

Brigade Combat Teams. BCTs are the Army's primary combined arms, close combat force. They often operate as part of a division or joint task force, both of which are the basic building blocks for employment of Army combat forces. BCTs are usually employed within a larger framework of U.S. land operations but are equipped and organized so that they can conduct limited independent operations as circumstances demand.[25]

BCTs range between 4,000 and 4,700 soldiers in size. There are three types of BCTs: Infantry, Armored, and Stryker. At its core, each of these formations has three maneuver battalions enabled by multiple other units such as artillery, engineers, reconnaissance, logistics, and signal units.[26]

The simplest way to understand the status of hard Army combat power is to know the readiness, quantity, and modernization level of BCTs. This section deals with the number of BCTs in the force.

Since 2012, the number of active BCTs has been in decline. In January 2012, "DOD announced [that] the Army would reduce the size of the Active Army starting in 2012 from a post-9/11 peak in 2010 of about 570,000 soldiers to 490,000 soldiers by the end of 2017." Later guidance revised that figure downward "to a range of 440–450,000 soldiers."[27] In 2013, the Army announced that because of those end strength reductions and the priorities of the prior Administration, the number of Regular Army BCTs would be reduced from 45 to 33.[28] Subsequent reductions reduced the number of Regular Army BCTs from 33 to 31, where they remain today.[29]

When President Donald Trump and Congress reversed the planned drawdown in Army end strength and authorized growth beginning in 2017, instead of "re-growing" the numbers of BCTs, the Army chose to "thicken" the force and raise the manning levels within the individual BCTs to increase unit readiness. The Army's goal was to fill operational units to 105 percent of their authorized manning,[30] but the decision announced in the FY 2023 budget to cut end strength by 12,000 soldiers will reverse those trends.

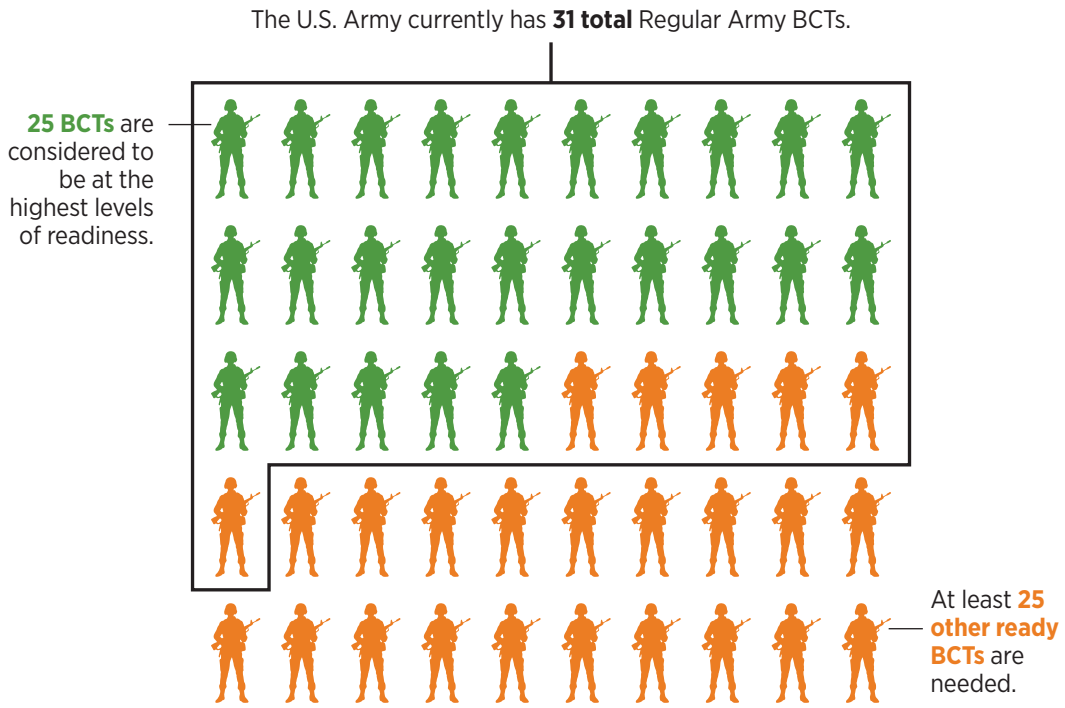
Combat Aviation Brigades. The Regular Army also has a separate air component that is organized into Combat Aviation Brigades (CABs). CABs are made up of Army rotorcraft, such as the AH-64 Apache, and perform various roles including attack, reconnaissance, and assault. The number of Army aviation units also has been reduced. In May 2015, the Army deactivated one of its 12 CABs, leaving only 11 in the Regular Army.[31]

Generating Force. CABs and Stryker, Infantry, and Armored BCTs make up the Army's main combat fighting forces, but they obviously do not make up the entirety of the Army. In the Active

FIGURE 1

Army Capacity: Brigade Combat Teams

Based on historical force requirements, The Heritage Foundation assesses that the Army needs a total of 50 Brigade Combat Teams (BCTs).



* Includes four Army National Guard BCTs.

SOURCE: Email to the author from Headquarters, Department of the Army, Public Affairs office, July 6, 2022.

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component, there are 194,000 soldiers in combat units, 119,000 in support units, and 138,000 in overhead units. Overhead is composed of administrative units and units providing such types of support as preparing and training troops for deployments, carrying out key logistics tasks, staffing headquarters, and overseeing military schools and Army educational institutions.

Functional or Multifunctional Support Brigades. In addition to the institutional Army, a great number of functional or multifunctional support brigades, amounting to approximately 46 percent of the force,[32] provide air defense; engineering; explosive ordnance disposal; chemical, biological, radiological, and nuclear protection; military police; military intelligence; and medical support among other types of battlefield support. Special operations forces such as the 75th Ranger Regiment, six Special Forces Groups, and the 160th Special Operations Aviation Regiment are also included in these numbers.

New Concepts and Supporting Force Structure. The Army is trying to adapt its force structure to meet the anticipated new demands of near-peer competition. The foundations for these changes are contained in the Army's Multi-Domain Operations (MDO) concept, published in December 2018, which describes how the Army views the future.[33]

In January 2022, the Army announced that it planned to modify its force structure for MDO under the designation "Army 2030." As part of this initiative, the Army plans to reorganize divisions

TABLE 4

Major Army Combat Formations

Brigade Combat Teams	Regular Army	Army National Guard	Total
Infantry Brigade Combat Teams	13	20	33
Stryker Brigade Combat Teams	7	2	9
Armored Brigade Combat Teams	11	5	16
Total	**31**	**27**	**58**

Aviation Brigades	Regular Army	Army National Guard	Total
Combat Aviation Brigades	11	–	11
Expeditionary Combat Aviation Brigades	–	8	8
Theater Aviation Brigades	–	2	2
Total	**11**	**10**	**21**

SOURCES:

- U.S. Department of the Army, *Department of the Army Fiscal Year (FY) 2023 Budget Estimates, Volume 1, Operation and Maintenance, Army, Justification of Estimates*, April 2022, pp. 57 and 121, https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2023/Base%20Budget/Operation%20and%20Maintenance/OMA_Volume_1.pdf (accessed August 17, 2022).
- U.S. Department of the Army, *Department of the Army Fiscal Year (FY) 2023 Budget Estimates, Volume 1, Operation and Maintenance, Army National Guard, Justification Book*, April 2022, pp. 38 and 94, https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2023/Base%20Budget/Operation%20and%20Maintenance/OMNG_Vol_1.pdf (accessed August 17, 2022).

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into five different types: Standard Light, Standard Heavy, Penetration, Joint Force Entry Air Assault, and Joint Force Entry Airborne.[34] Very little information has been made public regarding the missions, the organization of these divisions, and the timeline for conversions. As part of its adaptation to MDO, the Army reactivated V Corps Headquarters on October 16, 2020, to provide operational planning, mission command, and oversight of rotational forces in Europe.[35]

The Army also has announced plans to create five Multi-Domain Task Forces (MDTFs). One MDTF is currently stationed at Joint Base Lewis–McChord in Washington State. Another is in Wiesbaden Germany, aligned to Europe. These task forces contain rockets, missiles, military intelligence, and other capabilities that will allow Army forces to operate seamlessly with joint partners and conduct multi-domain operations.[36] A third MDTF included in the Army's FY 2023 budget will be "tied" to the Indo-Pacific with exact stationing still to be determined.[37]

To relieve the stress on the use of BCTs for advisory missions, the Army has activated six Security Force Assistance Brigades (SFABs). These units, each one of which is composed of about 800 soldiers, are designed specifically to train, advise, and mentor other partner-nation military units. The Army had been using BCTs for this mission, but because train-and-assist missions typically require senior officers and noncommissioned officers, a BCT comprised predominantly of junior soldiers was a poor fit. The SFABs will be regionally aligned to combatant commands. Of the six SFABs, one is in the National Guard, and the other five are in the Regular Army.[38]

Force Too Small to Execute the NDS. Army leaders have consistently stated that the Army is too small to execute the National Defense Strategy at less than significant risk. For FY 2022, the Army had an authorized total end strength of 1,010,500 soldiers:

- 485,000 in the Regular Army,
- 189,500 in the Army Reserve, and
- 336,000 in the Army National Guard (ARNG).[39]

In May 2021, Army Chief of Staff McConville testified that "[w]hen we take a look at end-strength, I would like to grow the Army. We've done analysis like the previous chief [General Mark Milley] talked about. 540 to 550 [thousand] is about the right size of the Army."[40] In an earlier discussion with reporters, McConville stated, "I would have a bigger...sized Army if I thought we could afford it, I think we need it, I really do.... I think the regular Army should be somewhere around 540–550 [thousand].... [W]e're sitting right now at 485,000."[41]

The Army's plan to increase the size of the Regular Army force has recently been slammed into reverse because of budget cuts and recruiting challenges. The Army had planned to raise the Regular Army incrementally to above 500,000 by adding approximately 2,000 soldiers per year.[42] At that rate, it would have reached 500,000 by around 2028. Now even that modest plan is off the table. As a result of bleak defense budget forecasts and recruiting difficulties, the Army has proposed to cut its active end strength by 12,000 in FY 2023.[43]

Overall end strength dictates how many BCTs the Army can form, and by cutting end strength, not only will the service not be able to add more combat units, but it will likely have to reduce the manning levels in the units it possesses. This will drive a higher operational tempo (OPTEMPO) for Army units and increase risk both for the force and for the ability of the Army to carry out its mission.

Many outside experts agree that the U.S. Army is too small. In 2017, Congress established the National Defense Strategy Commission to provide an "independent, non-partisan review of the 2018 National Defense Strategy." Two of the commissioners, Dr. Kathleen Hicks and Mr. Michael McCord, are now top DOD leaders. Among its findings, the commission unanimously reported that the NDS now charges the military with facing "five credible challengers, including two major-power competitors, and three distinctly different geographic and operational environments." The commission assessed that "[t]his being the case, a two-war force sizing construct makes more strategic sense today than at any previous point in the post-Cold War era." In other words, "*[s]imply put, the United States needs a larger force than it has today if it is to meet the objectives of the strategy.*"[44]

In addition to the increased strategic risk of not being able to execute the NDS within the desired time frame, the combination of an insufficient number of BCTs and a lower-than-required Army end strength has resulted in a higher-than-desired level of OPTEMPO. Assistant Deputy Chief of Staff, G-3/5/7, Major General Sean Swindell recently stated that the Army had tried to reduce the demands on the force, but that "effort has been going in the opposite direction."[45]

Army Force Posture. The Army also has transitioned from a force with a third of its strength typically stationed overseas, as it was during the Cold War, to a force that is mostly based in the continental United States. In 1985, 31 percent of the active-duty Army was stationed overseas; by 2015, that figure had declined to 9 percent.[46] The desire to find a peace dividend following the dissolution of the Soviet Union, combined with a reluctance to close bases in the United States, led to large-scale base closures and force reductions overseas. Even though the 2018 NDS (the most recently publicly available defense strategy) placed a high premium on how the Joint Force is postured, achieving that goal will be very difficult with the vast bulk of the Army now in the United States.

Among Army units that deploy periodically are Armored Brigade Combat Teams (ABCTs) and Patriot Battalions that rotate to and from Europe, Kuwait, and Korea. Rather than relying on forward-stationed BCTs, the Army rotates ABCTs to these regions on a "heel-to-toe" basis so that there is never a gap.

The Russia–Ukraine War has brought the issue of stationing more Army forces in Europe back to the forefront. Joint Chiefs of Staff Chairman General Mark Milley has suggested that the U.S. should establish more permanent European bases and rotate more forces to the continent.[47] There is disagreement as to which represents the better

option: rotated forces or forward-stationed forces. Proponents of rotational BCTs argue that they arrive fully trained, that they remain at a high state of readiness throughout their typically nine-month overseas rotation, and that the cost of providing for accompanying military families is avoided. Those who favor forward-stationed forces point to a lower overall cost, forces that typically are more familiar with the operating environment, and a more reassuring presence for our allies.[48] In reality, both types of force postures are needed, not only for the reasons mentioned, but also because the mechanisms by which a unit is deployed, received into theater, and integrated with the force stationed abroad must be practiced on a regular basis.

Capability

Capability in this context refers to the quality, performance, suitability, and age of the Army's various types of combat equipment. In general, the Army is using equipment developed in the 1970s, fielded in the 1980s, and incrementally upgraded since then. This "modernization gap" was caused by several factors: the predominant focus on the wars in Iraq and Afghanistan since 9/11; pressures caused by budget cuts, especially those associated with the BCA; and failures in major modernization programs like the Future Combat System, Ground Combat Vehicle, and Crusader artillery system.

Army leaders today clearly view this situation as a serious challenge. General McConville believes that modernization cannot be deferred any longer:

> [E]veryone believes, and I believe strongly–– that we must transform and modernize the Army now. So we've got to do that. We're three years into it, I think we've got some really good programs going. We probably need about two or three more years of good solid budgets. And I think that's something we have to do.[49]

Emphasizing the point, McConville also said recently that "we must transform the Army, now. Every 40 years, I would argue or suggest the Army transforms. It did it in 1940, it did it when I came in, in the Army in 1980. Now, we're in 2020, and we must transform the Army."[50]

Equipment Losing Its Competitive Advantage. As an example of how Army equipment is falling behind that of our competitors, the Army Tactical Missile System (ATACMS), first introduced in 1991, is the Army's only ground-launched precision missile. Because of the Intermediate Range Nuclear Forces Treaty's restrictions and other factors, it had a maximum range of 300 kilometers. China and Russia have much more substantial inventories of conventional, precision, ground-launched missiles and rockets. China has nine major ground-launched missile systems and more than 425 launchers. These capable systems can range from 600 kilometers (DF-11A and DF-15) to 4,000 kilometers (DF-26).[51] Russia, on the other hand, has the widest inventory of missiles in the world: at least four conventional ground-launched missile systems that can range from 120 kilometers (SS-21) to 2,500 kilometers (SSC-8).[52] The Army plans to field a new precision strike missile by 2023, but for now, that system remains a plan rather than a capability.[53]

Another example is the main battle tank. When the M-1 Abrams was introduced in 1980, it was indisputably the world's best tank. Now, in 2022, before the war with Ukraine, Russia was reportedly going to export versions of its T-14 Armata tank, which has an unmanned turret, reinforced frontal armor, an information management system that controls all elements of the tank, a circular Doppler radar, an option for a 155 mm gun, and 360-degree ultraviolet high-definition cameras.[54] Other assessments rate two other tanks—the German Leopard 2A7 and the South Korean K2 Black Panther—as superior to the M-1A2 SEP v3.[55] The M-1A2 SEP v3 (the latest version) is a very good tank, but the decisive advantage the U.S. once enjoyed in tank warfare has now disappeared.

Similarly, the U.S. Army's Patriot Missile System is an excellent system, but countries such as Saudi Arabia, Turkey, and India have either purchased or recently expressed interest in buying the Russian competitor system, the S-400.[56] The question has to be asked: Why?

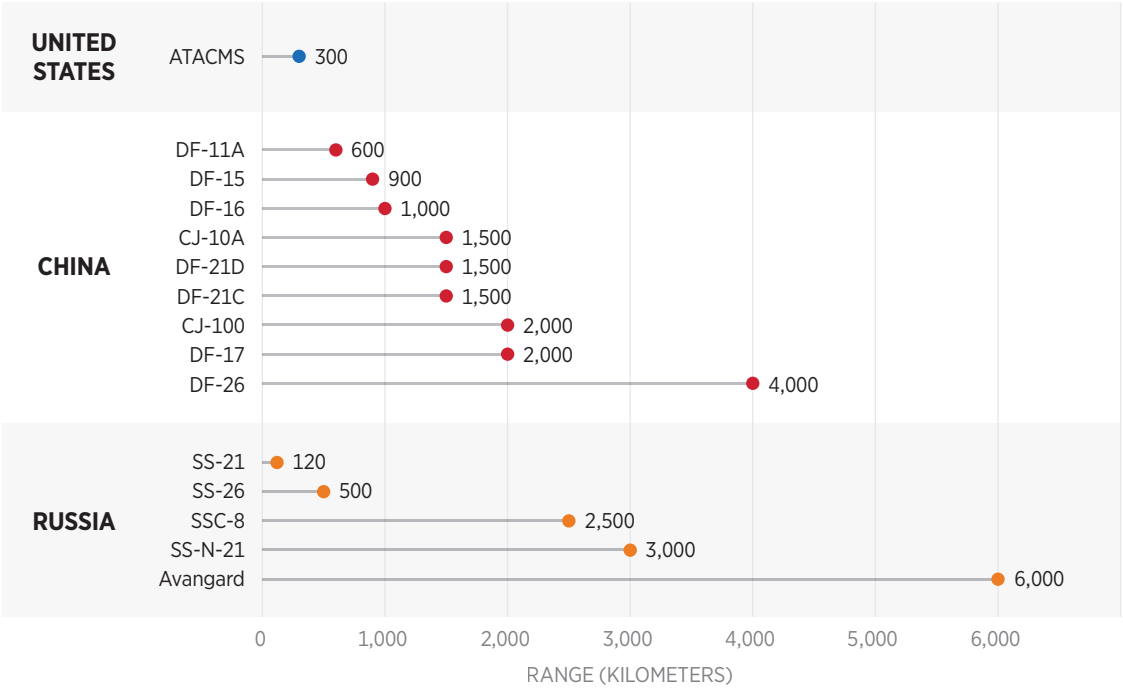
Within the Army's inventory of equipment are thousands of combat systems, including small arms, trucks, aircraft, soldier-carried weapons, radios, tracked vehicles, artillery systems, missiles, and drones. The following updates with respect to some of the major systems as they pertain to Armored, Stryker, and Infantry BCTs and Combat Aviation Brigades are by no means exhaustive.

Armored Brigade Combat Team (ABCT). The Armored BCT's role is to "close with the enemy by

CHART 6

U.S. Lags Behind China, Russia in Land-Based Missiles

GROUND-LAUNCHED CONVENTIONAL-CAPABLE PRECISION MISSILE SYSTEMS



SOURCES:

- China Power Team, "How Are China's Land-based Conventional Missile Forces Evolving?" Center for Strategic and International Studies, China Power Project, updated May 12, 2021, https://chinapower.csis.org/conventional-missiles/ (accessed August 17, 2022).
- Center for Strategic and International Studies, Missile Defense Project, "Missiles of Russia," *Missile Threat*, last updated August 10, 2021, https://missilethreat.csis.org/country/russia/ (accessed August 17, 2022).
- U.S. Army, Acquisition Support Center, "Army Tactical Missile System (ATACMS)," https://asc.army.mil/web/portfolio-item/atacms/ (accessed August 17, 2022).

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means of fire and movement to destroy or capture enemy forces, or to repel enemy attacks by fire, close combat, and counterattack to control land areas, including populations and resources."[57] The Abrams Main Battle Tank (most recent version in production: M1A2 SEPv3, "scheduled for First Unit Equipped in FY 2020"[58]) and Bradley Fighting Vehicle (most recent version: M2A4, first unit equipped in April 2022[59]) are the primary Armored BCT combat platforms.

The M-1 tank and Bradley Fighting Vehicle first entered service in 1980 and 1981, respectively. There are 87 M-1 Abrams tanks and 152 Bradley Fighting Vehicle variants in an ABCT.[60] Despite upgrades, the M-1 tank and the Bradley are now at least 40 years old, and their replacements will likely not arrive until the platforms are at least 50 years old.

Optionally Manned Fighting Vehicle (OMFV). The Army's replacement program for the Bradley, the Optionally Manned Fighting Vehicle, was on an aggressive timeline, but the Army cancelled the request for proposals in January 2020 and rereleased an RFP for what it called a "concept design" in December 2020. Five teams were selected to come up with designs for the OMFV. The next milestone was in July 2022 when the government released a final

RFP. An award for three contractors to produce detailed designs is expected in the second quarter of FY 2023,[61] and "[t]he Army now plans for the first unit to be equipped [with the OMFV] in the fourth quarter of FY2028."[62] Flat or declining funding such as the Army is currently experiencing may impact those plans.

New Tank? A potential clean-sheet replacement for the M-1 tank is even further down the road. The Army does not intend to decide "what direction we want to go for decisive lethality and survivability on the battlefield" until at least 2023.[63] Meanwhile, the Army has another upgrade in development for the Abrams platform: the M1A2 SEPv4, which would incorporate a third-generation Forward-Looking Infrared (FLIR) sensor.[64]

Armored Multi-Purpose Vehicle (AMPV). The venerable M113 multi-purpose personnel carrier is also part of an ABCT and fills multiple roles such as mortar carrier and ambulance. It entered service in 1960 and is scheduled to be replaced by the new Armored Multi-Purpose Vehicle (AMPV), which after numerous delays "entered the low-rate initial production phase (LRIP)" on January 25, 2019.[65] The system's first fieldings are now expected during the second quarter of FY 2023.[66] The Army's FY 2023 budget requested to procure 72 AMPVs. At that rate, it will take the Army 40 years to meet its objective of 2,897 AMPVs.[67]

Stryker Brigade Combat Team (SBCT). The Stryker BCT "is an expeditionary combined arms force organized around mounted infantry" and is able to "operate effectively in most terrain and weather conditions" because of its rapid strategic deployment and mobility.[68] Stryker BCTs are equipped with approximately 321 eight-wheeled Stryker vehicles.[69] Relatively speaking, these vehicles are among the Army's newest combat platforms, having entered service in 2001. In response to an Operational Needs Statement, the Stryker BCT in Europe received Strykers fitted with a 30 mm cannon to provide an improved anti-armor capability.[70] Based on the success of that effort, the Army decided to outfit at least three of its SBCTs equipped with the Double V-hull, which affords better underbody protection against such threats as improvised explosive devices (IEDs), with the 30 mm autocannon.[71] The next SBCT to receive the cannons (after the 2nd Cavalry Regiment) will be the 1-2 SBCT at Joint Base Lewis–McChord in Washington State.[72] The Army is also integrating Javelin anti-tank missiles on the Stryker platform and test-fired this capability in April 2022.[73]

Infantry Brigade Combat Team (IBCT). The Infantry BCT "is an expeditionary, combined arms formation optimized for dismounted operations in *complex terrain*—a geographical area consisting of an urban center larger than a village and/or of two or more types of restrictive terrain or environmental conditions occupying the same space."[74] Infantry BCTs have fewer vehicles and rely on lighter platforms such as trucks, High Mobility Multipurpose Wheeled Vehicles (HMMWVs), and Joint Light Tactical Vehicles (JLTVs) for mobility.

Joint Light Tactical Vehicle (JLTV). The JLTV combines the protection offered by Mine Resistant Ambush Protected Vehicles (MRAPs) with the mobility of the original unarmored HMMWV. The vehicle features design improvements that increase its survivability against anti-armor weapons and IEDs. The Army Procurement Objective is 49,099, replacing about 50 percent of the current HMMWV fleet.

Requested FY 2023 funding of $703.1 million would support procurement of 1,528 JLTVs and 1,381 trailers. This reflects an increase in funding for this program ($574.6 million was enacted for FY 2022), suggesting that the Army is committed to this program, at least in the short term. Considering the 5,426 JLTVs the Army has already procured,[75] as well as procurement at a rate of 1,528 vehicles (the FY 2023 rate), the Army will not reach its procurement objective for the JLTV until 2050, thereby forcing continued reliance on aging HMMWVs, which began fielding in 1983.[76]

Mobile Protected Firepower (MPF). The Army is developing an armored gun system called Mobile Protected Firepower to provide IBCTs with the firepower to engage enemy armored vehicles and fortifications. In 2020, the Army received 24 prototypes (12 each from General Dynamics Land Systems and BAE) for testing and evaluation. The Army announced in June 2022 that the winner of the competition was General Dynamics Land Systems. The first units are expected to receive MPF in FY 2025.[77]

Ground Mobility Vehicle (GMV). Airborne BCTs are the first IBCTs to receive a new platform to increase their speed and mobility. The GMV (also referred to as the Infantry Squad Vehicle) provides enhanced tactical mobility for an IBCT nine-soldier infantry squad with their associated equipment. GM Defense was selected for the production contract in

TABLE 5

Procurement of Select Army Systems Will Take Decades to Complete

System	Army Acquisition Objective	Funded Through FY 2023	Years Needed to Complete Army Fielding at FY 2023 Procurement Rate
Armored Multi-Purpose Vehicle (AMPV)	2,897	519	33
Joint Assault Bridge (JAB)	297	126	28
Armored Breacher Vehicle (ABV)	201	48	13
Mobile Protected Firepower (MPF)	504	51	16
Paladin Integrated Management (PIM) Howitzer	689	378	12
Joint Lightweight Tactical Vehicle (JLTV)	49,099	4,757	29

SOURCES: U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2023 Budget Estimates, Army, Justification Book of Procurement of W&TCV, Army,* April 2022, pp. 1 and 81, https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2023/Base%20 Budget/Procurement/WTCV_ARMY_II.pdf (accessed August 17, 2022), and U.S. Department of the Army, *Department of Defense Fiscal Year (FY) 2023 Budget Estimates, Army, Justification Book Volume 1 of 3, Other Procurement, Army, Tactical and Support Vehicles, Budget Activity 1*, April 2022, p. 49, https://www.asafm.army.mil/Portals/72/Documents/BudgetMaterial/2023/Base%20Budget/Procurement/OPA_BA1_Tactical_Support_ Vehicles.pdf (accessed August 17, 2022).

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June 2020. The Army has approved a procurement objective of 11 IBCT sets at 59 vehicles per IBCT for a total of 649 vehicles. The approved Army acquisition objective is 2,406, but for some unspecified reason, funding for the program is projected to stop in FY 2024 with 848 systems procured.[78]

Combat Aviation Brigade. CABs are composed of AH-64 Apache attack, UH-60 Black Hawk medium-lift, and CH-47 heavy-lift Chinook helicopters. The Army has been methodically upgrading these fleets for decades, but the FY 2023 budget request continues the reduction in aircraft procurement that began in FY 2022. This continued cutback in helicopter modernization, if enacted, would extend the amount of time necessary to put aircraft crews in the latest version of these critical platforms. This is a continued reflection of downward budget pressure and incurs additional risk for the Army.

UH/HH-60. The acquisition objective for the H-60 medium-lift helicopter is 1,375 H-60Ms and 760 recapitalized 60-A/L/Vs for a total of 2,135 aircraft. The FY 2023 procurement request for the UH-60M is $718.5 million, which would support the procurement of 25 aircraft (one more than the 24 requested in FY 2021 before congressional adds).[79]

CH-47. The CH-47F Chinook, a rebuilt variant of the Army's CH-47D heavy-lift helicopter, has an acquisition objective of 535 aircraft (a reduction of 15 from last year) and, with no replacement on the horizon, is expected to remain the Army's heavy-lift helicopter for the foreseeable future. The FY 2023 budget request of $187.9 million would support the service life extension of six aircraft, all of which would be the MH-47G special operations model.[80]

AH-64. The AH-64E heavy attack helicopter has an acquisition objective of 812 aircraft (a combination of remanufactured and new build), which is being met by the building of new aircraft and remanufacturing of older AH-64 models. The $693.9 FY 2023 procurement request would support the purchase of 35 AH-64E aircraft[81] (five more than the 30 requested in the FY 2022 budget before congressional adds).

Overall, the Army's equipment inventory, while increasingly dated, is maintained well. Despite high usage in Afghanistan and Iraq, most Army platforms

are relatively "young" because the Army deliberately undertook and Congress funded a "reset" plan that includes "[r]epairing and reconditioning systems to bring them back to a satisfactory operating condition." Under its current modernization plans, "the Army envisions [the M-1 Abrams Tank, the M-2/M-3 Bradley Fighting Vehicle (BFV), and the M-1126 Stryker Combat Vehicle] to be in service with Active and National Guard forces beyond FY 2028."[82]

In addition to seeing to the viability of today's equipment, the military must look to the health of future equipment programs. Although future modernization programs are not current hard-power capabilities that can be applied against an enemy force today, they are a leading indicator of a service's overall fitness for future sustained combat operations. In future years, the service could be forced to engage an enemy with aging equipment and no program in place to maintain viability or endurance in sustained operations.

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

After years of a singular focus on counterinsurgency followed by concentration on the current readiness of the force, the Army is now playing catch-up in equipment modernization. General Milley, for example, has said that China is "on a path...to be on par with the U.S. at some point in the future."[83] While his statement is intentionally ambiguous, General Milley was clearly conveying his concern about the pace of China's modernization and the very real danger that the U.S. military could lose its current advantages.

New Organizations and Emphasis on Modernization. In 2017, the Army established eight cross-functional teams (CFTs) to improve the management of its top modernization priorities, and in 2018, it established a new four-star headquarters, Army Futures Command, to lead modernization efforts.[84] Time will tell whether the new structures, commands, and emphasis result in long-term improvement in modernization posture. The Army aspires to develop and procure an entire new generation of equipment based on its six modernization priorities: "long range precision fires, next generation combat vehicles, future vertical lift, network, air and missile defense, and Soldier lethality."[85]

Although the Army has put in place new organizations, plans, and strategies to manage modernization, the future is uncertain, and Army programs are in a fragile state with only a few in an active procurement status. The Army has shown great willingness to make tough choices and reallocate funding toward its modernization programs, but this has usually been at the expense of end strength or reduction in the total quantity of new items purchased. "There has been real progress in [modernization] over the last three or four years, but that progress is fragile," Lieutenant General James Pasquarette, a former senior Army budget official, has warned. "We continue to fund [the top] priority programs at the cost of the other programs in the equipping portfolio."[86]

As budget challenges such as nuclear deterrence programs, inflation, rising personnel costs, health care, and the need to invest in programs to respond to China's increasingly aggressive activities continue to present themselves, the Army desperately needs time and funding to modernize its inventory of equipment. Recent modernization programs seem to be on track except for the OMFV program and the Integrated Visual Augmentation System,[87] both of which needed a reboot. Limited numbers of Stryker vehicle-mounted Maneuver Short Range Air Defense (M-SHORAD) systems have been delivered to Europe.[88] Army officials are currently optimistic about future fielding dates for equipment like the Extended Range Cannon Artillery, a hypersonic weapon firing battery, and the Precision Strike Missile, all of which are scheduled to begin delivery in FY 2023, but their success will depend on sustained funding.

Readiness

BCT Readiness. Over the past four years, the Army has made significant progress in increasing the readiness of its forces. Its goal is to have 66 percent of the Regular Army and 33 percent of National Guard BCTs at the highest levels of readiness.[89]

As of July 6, 2022, the Army reported that "81 percent of Active Component Brigade Combat Teams are at the highest levels of tactical readiness,"[90] 15 percentage points above its goal and 23 percentage points above last year's reported level. This means that 25 of the Army's 31 active BCTs were at either C1 or C2, the two highest levels of tactical readiness,

and ready to perform all or most of their wartime missions immediately. The *2022 Index* reported that 21 Regular Army BCTs were at the highest levels of readiness.

There also are 27 BCTs in the Army National Guard: five Armor, 20 Infantry, and two Stryker. The Army has allocated two Combat Training Center (CTC) rotations for two National Guard BCTs. The two BCTs conducting CTC rotations "are resourced to achieve company-level proficiency," and the remaining 25 "are on a path to platoon minus-level proficiency."[91] These training levels dictate that additional training time would be required before the unit could be deployed.

Training Resources Slashed. In the FY 2023 budget request, funding for training activities is maintained at the low level first established in FY 2022. When measuring training resourcing for Brigade Combat Teams, the Army uses full-spectrum training miles (FSTMs), which represents the number of miles that formations are resourced to drive their primary vehicles on an annual basis. For Combat Aviation Brigades, the Army uses hours per crew per month (H/C/M), which reflects the number of hours that aviation crews can fly their helicopters per month.

According to the Army's budget justification exhibits, "[t]he FY 2023 budget funds unit Operating Tempo (OPTEMPO) at 1,235 Full Spectrum Training Miles for non-deployed units" and "358,000 Flying Hours (11.1 hours per crew per month), an increase from FY 2022 (10.3 H/C/M)" to meet "required training readiness levels." The FY 2023 proposed active FSTM is slightly higher (7 percent) than resourced levels of 1,150 miles and higher (11 percent) than the 10.0 active flying hours per crew per month enacted in the FY 2022 budget.[92]

Training Level Goals Reduced. The Army is coping with reduced training resources by shifting training to lower echelons, where it is less expensive. Its strategy, begun in FY 2022, "focuses resources on squad, platoon and company level training to achieve highly trained companies."[93] Starting with the FY 2022 budget justification books, the Army began to omit the Unit Proficiency Level Goal, which for years has been BCT; it is likely now battalion or company.

CTC Rotations. The Army uses Combat Training Centers to train its forces to desired levels of proficiency. Specifically, this important program "provide[s] realistic joint and combined arms training...approximating actual combat" and increases "unit readiness for deployment and warfighting."[94] For FY 2023, "the Army is resourcing 22 Brigade Combat Team (BCT)-level CTC rotations...(17 Active BCT-level rotations, 2 BCT- level for the Army National Guard, and 3 for units on rotation in Europe)."[95]

New Readiness Model. The Army has transitioned from one readiness model to another. Its Sustainable Readiness Model, implementation of which began in 2017, was intended to give units more predictability. Its new Regionally Aligned Readiness and Modernization Model (ReARMM) is designed to "better balance operational tempo (OPTEMPO) with dedicated periods for conducting missions, training, and modernization."[96] ReARMM features units that spend eight months in a modernization-training-mission cycle while preparing to deploy to a specific part of the world. The Army shifted to this new model on October 1, 2021.[97]

In general, the Army continues to be challenged by structural readiness problems as evidenced by too small a force attempting to satisfy too many global presence requirements and Operations Plan (OPLAN) warfighting requirements. If demand is not reduced, the funding cuts and end strength reduction featured in the FY 2023 budget can be expected to result in a continued decline in readiness.

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 (MRC). 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 approximately four in Operation Iraqi Freedom—an average of 16 BCTs (or 21 if the much smaller Operation Iraqi Freedom initial invasion operation is excluded). In the 2010 Quadrennial Defense Review, the Obama Administration recommended a force capable of deploying 45 Active BCTs. Previous government force-sizing documents discuss Army force structure in terms

of divisions and consistently advocate for 10–11 divisions, which equates to roughly 37 Active BCTs.

Considering the varying recommendations of 35–45 BCTs and the actual experience of nearly 21 BCTs deployed per major engagement, our assessment is that 42 BCTs would be needed to fight two MRCs.[98] Taking into account the need for a strategic reserve, the Army force should also include an additional 20 percent of the 42 BCTs, resulting in an overall requirement of 50 BCTs.

Previous editions of the *Index* had counted a small number of Army National Guard BCTs in the overall count of available BCTs. Because the Army no longer makes mention of Army National Guard BCTs at the highest state of readiness, they are no longer counted in this edition of the *Index*. The Army has 31 Regular Army BCTs compared to a two-MRC construct requirement of 50. The Army's overall capacity score therefore remains unchanged from 2022.

- **Two-MRC Benchmark:** 50 Brigade Combat Teams.
- **Actual FY 2022 Level:** 31 Regular Army Brigade Combat Teams.

The Army's current BCT capacity equals 62 percent of the two-MRC benchmark and is therefore scored as "weak."

Capability Score: Marginal

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

Despite modest progress with the JLTV, Mobile Protected Firepower, Ground Mobility Vehicle, and AMPV programs, and in spite of such promising developments as creation of Army Futures Command, CFTs, and the initiation of new Research, Development, Testing and Evaluation (RDTE) funded programs, nearly all new Army equipment programs remain in the development phase and in most cases are one to two years from entering procurement. FY 2023 requested funding levels for procurement and research and development are down 7 percent compared to the FY 2022 enacted levels, which slows the pace of Army equipping and reduces the speed of procurement to below industry's minimum sustainment rates in some cases. The result of the FY 2023 budget request would be an Army aging faster than it is modernizing.

Readiness Score: Very Strong

The Army reports that 81 percent of its 31 Regular Army BCTs are at the highest state of readiness.[99] No National Guard BCTs were at those levels of readiness. The Army's internal requirement is for "66 percent…of the active component BCTs [to be] at the highest readiness levels."[100] Using the assessment methods of this *Index*, this results in a percentage of service requirement of 100 percent, or "very strong."

Overall U.S. Army Score: Marginal

The Army's overall score is calculated based on an unweighted average of its capacity, capability, and readiness scores. The unweighted average is 3.33; thus, the overall Army score is "marginal." This was derived from the aggregate score for capacity ("weak"); capability ("marginal"); and readiness ("very strong"). This score is the same as the assessment of the *2022 Index*, which also rated the Army as "marginal" overall.

U.S. Military Power: Army

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

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Main Battle Tank

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
M1A1/2 Abrams Inventory: **344/1,635** Fleet age: **31.5/14.5** Date: **1980/1993** The Abrams is the Army's primary ground combat system and main battle tank in its Armored Brigade Combat Teams (ABCTs). It is a tracked, low-profile, land combat assault weapon that provides mobility, lethal firepower, and protection. The Abrams went through a remanufacture program to extend its life expectancy to 2045.	3	4	**Decisive Lethality Platform (DLP)** The DLP program, in its earliest stages of conceptualization, is a notional manned or unmanned vehicle that could replace some or all of the Abrams tanks. This program is part of the Next Generation Combat Vehicle (NGCV) program, which is number two among the Army's "Big Six" modernization priorities. The soonest a replacement for the Abrams tank could conceivably be introduced is 2033.		

Infantry Fighting Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
M2 Bradley Inventory: **3,310** Fleet age: **23** Date: **1981** The Bradley is a fully tracked, lightly armored vehicle meant to transport infantry by providing protection from artillery and employing mounted firepower. The Bradley complements the Abrams tank in Armored Brigade Combat Teams (ABCTs). The Bradley underwent a remanufacture program to extend its life expectancy to 2045.	3	3	**Optionally Manned Fighting Vehicle (OMFV)** The OMFV is intended to replace the M2-Bradley Infantry Fighting Vehicle (IFV) and in its objective state will have the ability to conduct remotely controlled operations. In 2021, the Army awarded five firm-fixed-price contracts as part of the OMFV Concept Design Phase in which competing firms were asked to develop digital designs. The Army plans to choose three teams in the third quarter of FY 2023 to build up to 11 prototype vehicles. This program is part of the Next Generation Combat Vehicle (NGCV) program, which is number two among the Army's "Big Six" modernization priorities. The Army plans for the first unit to be equipped by FY 2029.		

Armored Fighting Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Stryker Inventory: **4,115** Fleet age: **10.5** Date: **2001** The Stryker is a wheeled vehicle that is the main platform in Stryker BCTs. The program was considered an interim vehicle to serve until the arrival of the Future Combat System (FCS), but that program was cancelled because of technology and cost problems. The original Stryker is being replaced with Double-V-Hull variants. The Double V Hull provides increased under-vehicle blast protection. The Stryker is expected to remain in service for 30-plus years.	4	4	None		

NOTE: See page 353 for details on fleet ages, dates, and procurement spending.

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Armored Personnel Carrier

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
M113 Armored Personnel Carrier Inventory: **3,954** Fleet age: **39** Date: **1960** The fully tracked M113 personnel carrier serves in a supporting role for Armored Brigade Combat Teams (ABCTs) and in units above brigade level. As the first mass-produced aluminum combat vehicle, the M113 was made to protect against small arms fire while being light enough to be transportable. The army planned to replace the M113 with the Armored Multi-Purpose Vehicle, but due to reduced production rates and higher commodity prices, the cost per vehicle has increased, and the replacement program will take an extended period of time. Plans are to use the current platform until 2045.	1	2	**Armored Multi-Purpose Vehicle (AMPV)** Timeline: **2018–TBD** The AMPV has been adapted from the Bradley Fighting Vehicle, which largely allowed the program to bypass an extensive technology development phase. The fleet will consist of five variants. Although total AMPV production remains behind schedule due to early manufacturing troubles, AMPV production rates reportedly are planned to increase to 131 vehicles per year by FY 2024 and continue at that rate at least until 2027. **PROCUREMENT** 447 2,450 **SPENDING** *($ millions)* $1,578 $13,746	2	4

Light Wheeled Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
HMMWV Inventory: **108,467** Fleet age: **19.5** Date: **1985** The High Mobility Multipurpose Wheeled Vehicle (HMMWV) is a lightweight, highly mobile, high-performance wheeled vehicle used for a variety of purposes in combat or combat support services units. The expected life span of the HMMWV is 15 years. A portion of the HMMWV fleet is slowly being replaced by the Joint Light Tactical Vehicle (JLTV).	1	1	**Joint Light Tactical Vehicle (JLTV)** Timeline: **2015–2036** The JLTV vehicle program is an Army-led, joint-service program that is replacing a portion of the Army's HMMWVs with light tactical wheeled vehicles. The JLTV provides improved protection, reliability, maneuverability, and survivability of vehicles. In June 2019, the Army approved the JLTV for full-rate production. Production is underway, although current budget shortfalls have forced the Army to reduce procurement quantities. **PROCUREMENT** 5,806 12,942 **SPENDING** *($ millions)* $1,459 $3,885	3	3

NOTE: See page 353 for details on fleet ages, dates, timelines, and procurement spending.

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Attack Helicopter

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
AH-64 D Apache Inventory: **295** Fleet age: **17.5** Date: **1997** The Apache attack helicopter is designed to support Brigade Combat Teams (BCTs) in the full spectrum of modern warfare including destroying armor, personnel, and material targets. The Apache has a modular open systems architecture that allows it to incorporate the latest communications, navigation, sensor, and weapon systems. The expected life cycle is about 20 years.	2	3	**AH-64E Reman** Timeline: **2010–TBD** The AH-64E Reman (short for remanufactured) is a program to remanufacture older Apache helicopters into the more advanced AH-64E version which is fully digital and meets the Army's joint interoperability goals for the future. The AH-64E has a new airframe and can carry modern munitions, including the JAGM missile, giving it significant combat capability as the Army's only heavy attack helicopter. **PROCUREMENT*** 512 110 **SPENDING*** *($ millions)* $8,537 $2,017	3	5
AH-64E Inventory: **458** Fleet age: **5** Date: **2012** The AH-64E variant is a remanufactured or newly built version of the AH-64D Apache attack helicopter with substantial upgrades in powerplant, avionics, communications, and weapons capabilities making it the Army's most advanced attack helicopter. The expected life cycle is about 20 years.	5	5	**AH-64E New Build** Timeline: **2010-2027** The AH-64E New Build program produces new-build, not rebuilt, Apaches. The program is meant to modernize and sustain the current Apache inventory. The AH-64E has more modern and interoperable systems and is able to carry modern munitions, including the JAGM missile. Budget cuts in the 2022 request will likely close the AH-64E new build line as the cost of procurement is significantly higher due to the need for all-new components for the new build program. **PROCUREMENT*** 81 0 **SPENDING*** *($ millions)* $2,139	3	5

* Additional procurement expected.
NOTE: See page 353 for details on fleet ages, dates, timelines, and procurement spending.

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
UH-60A Black Hawk Inventory: **48** Fleet age: **39.5** Date: **1978** The UH-60A is the Army's primary medium-lift utility transport helicopter that provides air assault, aeromedical evacuation, and support for special operations. The expected life span is about 25 years. This variant of the Black Hawk is now being replaced by the newer UH-60M variant.	1	2	**UH-60M Black Hawk** Timeline: **2004–TBD** The UH-60M, which began full production in 2007, serves to modernize and replace current Black Hawk inventories in line with the Army's Modernization Strategy, National Military Strategy, and National Defense Strategy. The newer M-variant is a digital networked platform that will improve the Black Hawk's range and lift by upgrading the rotor blades, engine, and computers. **PROCUREMENT*** 1,196 / 100 **SPENDING*** *($ millions)* $17,744 / $2,867	3	4
UH-60M Black Hawk Inventory: **1,185** Fleet age: **8.5** Date: **2005** The UH-60M is the modernized version of the original UH-60A Black Hawk helicopter. It has multiple upgrades including multimission capabilities, a new airframe, advanced digital avionics, and a powerful propulsion system. As the UH-60A is retired, the M-variant will be the main medium-lift rotorcraft used by the Army. They are expected to remain in service until at least 2030.	5	4			

Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
CH-47F Chinook Inventory: **451** Fleet age: **10** Date: **2002** The F-variant of the CH-47 Chinook heavy-lift helicopter includes a new digital cockpit and monolithic airframe to reduce vibrations. It transports forces and equipment while providing other functions such as parachute drops and aircraft recovery. The expected life span is 35 years. The Army plans to use the CH-47F until the late 2030s.	5	5	**CH-47F** Timeline: **2001–TBD** Currently in production, the CH-47F program is intended to keep the fleet of heavy-lift rotorcraft viable for use in modern combat as older variants of the CH-47, notably the CH-47D, are retired. The program includes both remanufactured and new builds of CH-47s. The F-variant has engine and airframe upgrades to lower the maintenance requirements. Total procurement numbers include the MH-47G configuration that is used by U.S. Special Operations Command. **PROCUREMENT*** 392 / 30 **SPENDING*** *($ millions)* $10,452 / $963	3	4

* Additional procurement expected.
NOTE: See page 353 for details on fleet ages, dates, timelines, and procurement spending.

ARMY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Intelligence, Surveillance, and Reconnaissance (ISR)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
MQ-1C Gray Eagle Inventory: **175** Fleet age: **4.75** Date: **2011** The Gray Eagle is a medium-altitude long-endurance (MALE) unmanned aerial vehicle (UAV) used to conduct intelligence, surveillance, and reconnaissance (ISR) missions. It offers better range, altitude, and payload flexibility than was offered by earlier systems. The Army does not plan to procure new Gray Eagles.	4	3	**MQ-1C Gray Eagle** Timeline: **2010–2022** The MQ-1C UAV is an unmanned aircraft system that provides the Army with reconnaissance, surveillance, and target acquisition capabilities. The Army did not plan to procure new MQ-1Cs for FY2023. Four Gray Eagles originally slotted to go to the Army may be sold to Ukraine as of June 2022. **PROCUREMENT** 0 **SPENDING** *($ millions)* $432 $25	4	5

* Additional procurement expected.
NOTES: See Methodology for descriptions of scores. Fleet age is the average between the first and last years of delivery. The date is the year of first delivery. The timeline is from the first year of procurement to the last year of delivery/procurement. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E).

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98. Note that the first figures derive from an average BCT size of 4,500 and average division size of 15,000. The second set of numbers derives from the current average of around 3.5 BCTs per division and analysis of the structure of each Army division.
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U.S. Navy

Brent D. Sadler

The U.S. Navy, Marine Corps, and Coast Guard (known collectively as the sea services) have enabled America to project power across the oceans, controlling activities on the seas when and where needed. In testimony before the Senate Armed Services Committee, the Secretary of the Navy has stated that:

> [The Navy] will invest [its] resources through a concise, clear, and transparent strategy centered on three primary lines of effort:
>
> 1. Strengthen Maritime Dominance.
> 2. Empower Our People.
> 3. Expand Strategic Partnerships.[1]

To these ends, President Joseph Biden's proposed $180.5 billion Navy budget for FY 2023 "represents a $9.1 billion increase over our FY 2022 enacted President's Budget (including supplementals for disaster relief funding, Red Hill, and Operation Allies Welcome funding)" and an overall increase of 4.8 percent.[2] While this increase is much needed, it is doubtful that this level of investment can deliver on the Secretary's goals given a rapidly modernizing and expanding Chinese fleet and inflation that is well above 7 percent.

The Navy remains under immense strain to maintain readiness for combat while also conducting the daily peacetime operations that are necessary to compete with the activities of China and Russia. In the year since publication of the *2022 Index of U.S. Military Strength*, there have been several significant developments that are important to the Navy:

- As of June 22, 2022, "3,371 active component and 3,448 Ready Reserve service members remain[ed] unvaccinated," and there "[had] been 1,229 separations for refusing the COVID-19 vaccine."[3]
- Russia invaded Ukraine on February 24, 2022, and since then has lost several warships to anti-ship missiles launched from shore.[4]
- Submarine *Connecticut* ran into an uncharted seamount on October 2, 2021, in the South China Sea, sustaining significant damage that led to its eventual stateside dry-docking where it remained as of May 24, 2022.[5]
- President Biden announced the Australia–U.K.–U.S. (AUKUS) partnership on September 15, 2021, with the goal of developing an Australian nuclear submarine program.[6] While important if successful, it will also place an added burden on the Navy's limited nuclear shipbuilding intellectual and industrial capacity.
- On September 9, 2021, the Navy's Fifth Fleet, based in Bahrain, established Task Force 59 to integrate and accelerate operational employment of naval unmanned systems.[7]

Strategic Framework. To address today's maritime competition more effectively, the sea services have released a new naval strategy, *Advantage at Sea*. If the new strategy is fully executed, the Navy will be conducting more assertive forward presence operations to challenge Chinese and Russian maritime coercion.[8] To this end, the Navy appears to be adjusting its deployment patterns to meet new demands caused by the war in Ukraine and increasing tensions in Asia: Two carrier strike groups have been

sustained in the western Pacific and eastern Mediterranean since December 2021.[9]

As the U.S. military's primary maritime arm, the Navy is charged to provide the enduring forward global presence required of this strategy while retaining war-winning forces. The Navy therefore continues to focus its investments in several functional areas: power projection, control of the seas, maritime security, strategic deterrence, and domain access. This approach is informed by several key documents:

- The 2021 *Interim National Security Strategic Guidance*;[10]
- The December 2020 *Advantage at Sea* naval strategy;[11]
- The 2022 *National Defense Strategy* (NDS) (as this edition of the *Index* was being prepared, only an unclassified fact sheet had been released to the public);[12] and
- The Global Force Management Allocation Plan (GFMAP).[13]

U.S. official strategic guidance requires the Navy to act beyond the demands of conventional warfighting. China and Russia use their fleets to establish a physical presence in regions that are important to their economic and security interests in order to influence the policies of other countries. To counter their influence, the U.S. Navy similarly sails ships in these waters to reassure allies of U.S. commitments and signal to competitors that they do not have a free hand to impose their will. This means that the Navy must balance two key missions: ensuring that it has a fleet that is ready for war while also using that fleet for peacetime "presence" operations. Both missions require crews and ships that are materially ready for action and a fleet that is large enough to maintain presence and marshal enough combat power to win in battle.

On July 26, 2022, the Chief of Naval Operations (CNO) released a new Navigation Plan 2022 (NAVPLAN 2022) to provide guidance for the Navy's contribution to the execution of the National Defense Strategy. In this latest edition, the CNO continues his emphasis on forward presence in the United States' daily competition with rivals like China and prioritizes investments in key capabilities like defense against anti-ship missiles and other forms of attack, logistical support capabilities that remain viable in combat, and the ability to share information even when the enemy is targeting. NAVPLAN 2022 also emphasizes weapons with increased range, new deception capabilities, and improved abilities to make time-critical decisions.[14]

All of this reflects a continuation of demands stemming from the Distributed Maritime Operations concept that has been deemed critical to defeating Chinese anti-access and area denial capabilities. However, NAVPLAN 2022 lacks a clear timeline either for delivering these capabilities or for ensuring that the fleet is able to employ them in what the CNO acknowledges is a dangerous decade. NAVPLAN 2022 also adds to the several fleet-sizing plans offered by the Navy in recent years, calling for a fleet of 350 manned and 150 unmanned warships along with 3,000 naval aircraft—but without clearly explaining how it will achieve results in a way that the other plans could not. Whether this plan will deliver a fleet with new capabilities in time to deter an increasingly aggressive China remains highly questionable just as it was with its predecessors.

This *Index* focuses on the following elements as the primary criteria by which to measure U.S. naval strength:

- Sufficient **capacity** to defeat enemies in major combat operations and provide a credible peacetime forward presence to maintain freedom of shipping lanes and deter aggression;
- Sufficient technical **capability** to ensure that the Navy is able to defeat potential adversaries; and
- Sufficient **readiness** to ensure that the fleet can "fight tonight" given proper material maintenance, personnel training, and physical well-being.

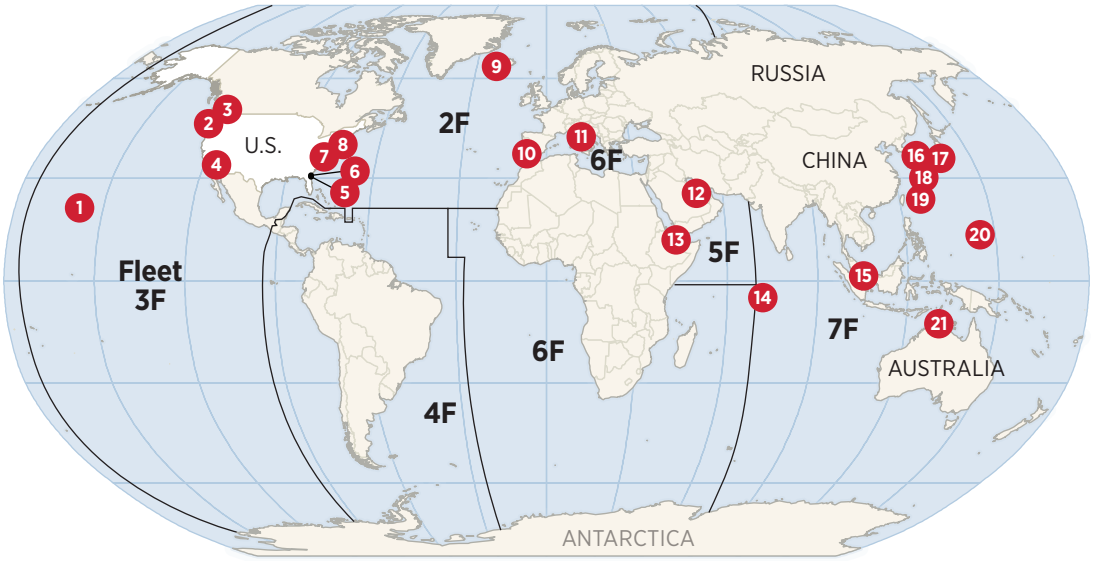
Capacity

Force Structure. The Navy is unique relative to the other services in that its capacity requirements must meet two separate objectives:

1. During peacetime, the Navy must maintain a global presence in distant regions both to deter potential aggressors and to assure allies and security partners.

MAP 15

Key U.S. Naval Installations



1. **Joint Base Pearl Harbor-Hickham, HI**
   U.S. Pacific Fleet headquarters
2. **Naval Base Kitsap**
3. **Naval Station Everett, WA**
4. **Naval Base San Diego and Naval Base Coronado, CA**
   U.S. Third Fleet headquarters
5. **Naval Station Mayport, FL**
   U.S. Fourth Fleet headquarters
6. **Naval Submarine Base King's Bay, GA**
7. **Naval Base Norfolk and Joint Expeditionary Base Little Creek, VA**
   U.S. Fleet Forces Command and U.S. Second Fleet headquarters
8. **Naval Submarine Base New London, CT**
9. **Keflavik, Iceland—Expeditionary Maritime Operations Center**
10. **Naval Station Rota, Spain**
11. **Naval Support Activity Gaeta, Italy**
    U.S. Sixth Fleet headquarters
12. **Naval Support Activity, Bahrain**
    U.S. Fifth Fleet headquarters
13. **Lemonnier, Djibouti—Camp Lemonnier**
14. **Diego Garcia—Navy Support Facility Diego Garcia**
15. **Singapore—Commander Logistics Group Western Pacific**
16. **Buson, South Korea—Fleet Activities Chinhae Navy Base**
17. **U.S. Fleet Activity Yokosuka, Japan**
    U.S. Seventh Fleet headquarters
18. **U.S. Fleet Activity Sasebo, Japan**
19. **Okinawa, Japan—Naval Base White Beach**
20. **Naval Base Guam—Navy Expeditionary Force Command Pacific headquarters**
21. **Darwin, Australia—Marine Rotational Force Darwin**

NOTE: Fleet boundaries are approximate.
SOURCE: Heritage Foundation research.

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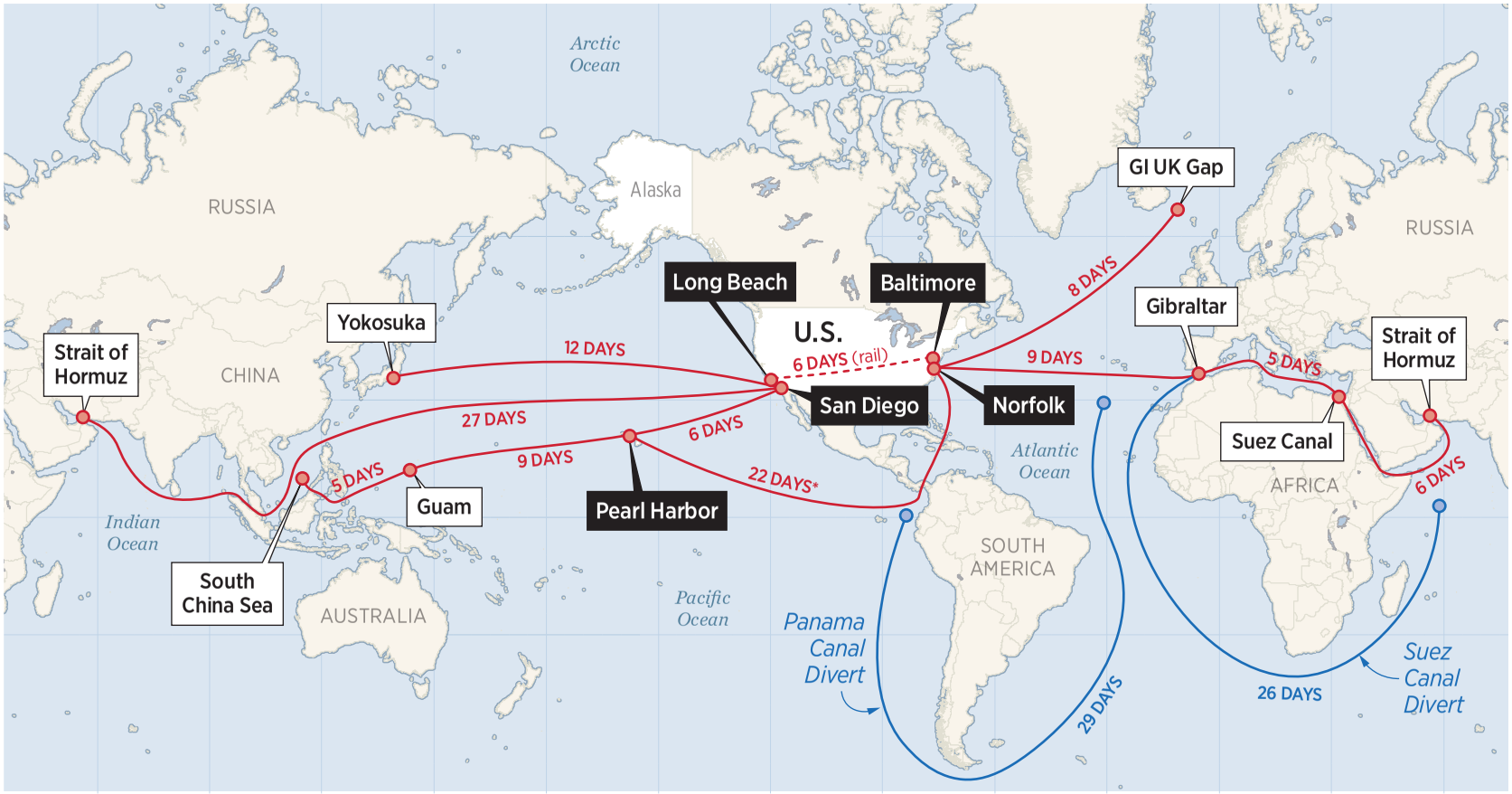
MAP 16

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

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



* Assumes no delay in passage through the Panama Canal.

SOURCE: Heritage Foundation research.

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2. The Navy must be able to win wars. To this end, the Navy measures capacity by the size of its battle force, which is composed of ships it considers directly connected to combat missions.[15]

This *Index* continues the benchmark set in the *2019 Index*: 400 ships to ensure the capability to fight two major regional contingencies (MRCs) simultaneously or nearly simultaneously, plus a 20 percent strategic reserve, and historical levels of 100 ships forward deployed in peacetime.[16] This 400-ship fleet is centered on providing:

- 13 Carrier Strike Groups (CSGs);
- 13 carrier air wings with a minimum of 624 strike fighter aircraft;[17] and
- 15 Expeditionary Strike Groups (ESGs).[18]

Unmanned platforms are not included because they have not matured as a practical asset. They hold great potential and will likely be a significant capability, but until they are developed and fielded in larger numbers, their impact on the Navy's warfighting potential remains speculative. The same holds true across the fleet when it comes to new classes of ships. The Navy is investing in research, modeling, war gaming, and intellectual exercises to improve its understanding of the potential utility of new ship and fleet designs, but until new ships are added to the fleet, it is hard to know how they will affect the Navy's ability to perform its missions. Consequently, this *Index* measures what is known and can be known in naval affairs, assessing the current Navy's size, modernity, and readiness to perform its most important missions today.

Relative to the above metric, the Navy's fleet of 298 warships as of June 27, 2022, is inadequate and places greater strain on the ability of ships and crews to meet existing operational requirements. To alleviate the operational stress on an undersized fleet, the Navy has attempted since 2016 to build a larger fleet. However, for myriad reasons, it has been unable to achieve sustained growth and in fact has underdelivered by approximately 10 ships each year since 2016.[19] In the past, the Navy has had some success in meeting operational requirements with fewer ships by posturing ships forward as it has done in Rota, Spain, and Guam.

At a February 2022 naval conference, the Chief of Naval Operations (CNO) stated, "I've concluded—consistent with the analysis—that we need a naval force of over 500 ships."[20] He went on to specify that this fleet would include 12 carriers, 19 to 20 large amphibious warships, more than 30 smaller amphibious ships, 60 destroyers, 50 frigates, 70 attack submarines, and a dozen ballistic missile submarines, all backed by 100 support ships and 150 unmanned vessels. Based on the CNO's military advice and Heritage Foundation analysis, today's fleet remains too small to meet today's threats with maximum effectiveness.

Posture/Presence. Although the Navy remains committed to sustaining forward presence, it has struggled to meet the requests of regional Combatant Commanders. The result has been longer and more frequent deployments to meet a historical steady-state forward presence of 100 warships.[21] In 1985, at the height of the Cold War, the percentage of the 571-ship fleet deployed was less than 15 percent, and throughout the 1990s, deployments seldom exceeded the six-month norm: Only 4 percent to 7 percent of the fleet exceeded six-month deployments on an annual basis.[22] Using the Navy's aircraft carrier fleet—the most taxed platform—as a sample set, for 20 years, approximately 25 percent of the aircraft carrier fleet has been deployed. Following the 2017 deadly collisions involving USS *McCain* and USS *Fitzgerald*, the overall fleet deployment percentage dropped temporarily to less than 20 percent, but it surged again to almost 30 percent in 2020.[23]

The numbers as of June 27, 2022, are fairly typical for a total battle force of 298 deployable ships with 102 warships at sea: 67 deployed and underway and 35 underway on local operations for an operational tempo (OPTEMPO) of 34 percent, double the OPTEMPO that characterized the Cold War.[24] Given Combatant Commanders' requirements for naval presence, there is impetus to have as many ships forward deployed as possible by:

- **Homeporting.** The ships, crew, and their families are stationed at the port or based abroad (for example, a CSG in Yokosuka, Japan).
- **Forward Stationing.** Only the ships are based abroad, and crews are rotated out to the ship.[25] This deployment model is currently used for Littoral Combat Ships (LCS) and *Ohio*-class

guided missile submarines (SSGNs) manned with rotating blue and gold crews, effectively doubling the normal forward deployment time (for example, LCS in Singapore).

These options allow one forward-based ship to provide a greater level of presence than four ships based in the continental United States (CONUS) can provide by offsetting the time needed to transit ships to and familiarize their crews with distant theaters.[26] This is captured in the Navy's GFM planning assumptions: a forward-deployed presence rate of 19 percent for a CONUS-based ship compared to a 67 percent presence rate for an overseas-homeported ship.[27] To date, the Navy's use of homeporting and forward stationing has not mitigated the effect of the reduction in overall fleet size on forward presence.

Shipbuilding Capacity. To meet stated fleet-size goals, the Navy must build faster and maintain more ships than its current capacity. However, significant shortfalls in shipyards, both government and commercial, make it hard to accomplish either task, and underfunded defense budgets make it even more difficult. Given the limited ability to build ships, the Navy will struggle to meet the congressionally mandated 355-ship goal,[28] much less the 400-ship goal advocated in this *Index*.

A bright spot in FY 2020 was the Navy's procurement of 12 ships, which marked a high point in shipbuilding over the past 20 years.[29] However, subsequent procurement has not kept pace. The Navy purchased 10 new warships in FY 2021. Congress overruled the President's purchase of eight, raising him to 13 new buys in FY 2022,[30] but this still misses congressional mandates for a fleet of 12 aircraft carriers.[31] Instead, the aircraft carrier fleet could shrink to nine (possibly augmented by a light carrier yet to be defined).[32] The current long-range shipbuilding plan does not indicate a desire to reverse the downward trends; instead, the "PB2023 shipbuilding plan includes procurement of 9 manned ships in FY2023 and 51 manned battle force ships within the [Future years Defense Program]. Based on the corresponding projected funding levels in the FYDP, the battle force inventory will be 280 manned ships by FY2027."[33]

Meanwhile, diminished demand for ships has led shipbuilders to divest workforce and delay capital investments. From 2005 to 2020, the Navy's procurement of new warships increased the size of the fleet from 291 to 296 warships; at the same time, China's navy grew from 216 to 360 warships.[34] If the Navy is to build a larger fleet, more shipbuilders will have to be hired and trained—a lengthy process that precedes any expansion of the fleet. However, recent labor statistics comparing 2017 to 2021 show some positive trends, with total shipbuilding labor involved in production, like welders and pipefitters, adding 3,134 workers.[35]

Of particular concern is the increased production of nuclear-powered warships, most notably nuclear-powered submarines that would be vital in any conflict with China. Limited nuclear shipbuilding capacity[36] may constrain the Navy's plans to increase the build rate from two attack submarines per year to three while concurrently building one ballistic missile submarine.[37] To support a larger nuclear-powered fleet, the relevant public shipyards have increased their workforce by 16 percent since 2013, but this still falls short of the workforce needed to achieve the Navy's objectives.[38] As demand increases for nuclear-powered warships to pace the threat from China and Russia into the foreseeable future, it remains to be seen whether the public shipyards will be able to sustain the recruitment of skilled labor in the numbers needed.

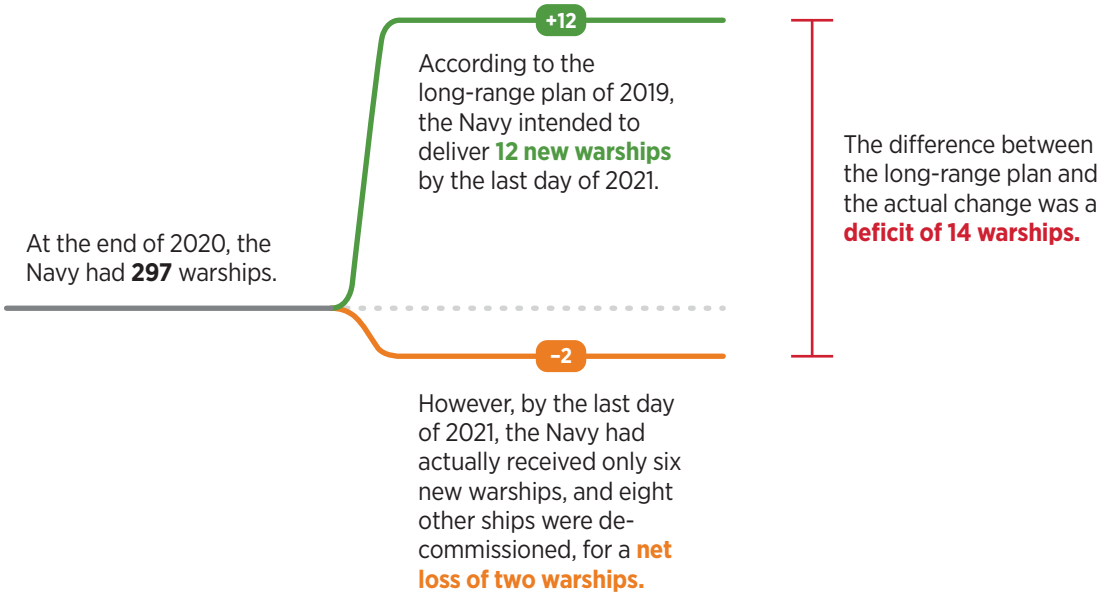
As it stands today, the most senior naval officer, the Chief of Naval Operations, has admitted that current funding will not build or maintain the larger fleet that both the Navy and this *Index* say is needed and Congress has mandated. Nothing has changed to alter his 2021 assessment that current budgets can only "sustain a Navy of about 300 to 305 ships."[39]

Manpower. In 2018, the Navy assessed that its manpower would need to grow by approximately 35,000 to achieve an end strength of 360,395 sailors to support a 355-ship Navy.[40] For comparison, the last time the Navy had a similar number of ships was in 1997, when it had 359 ships and also had a total of 398,847 personnel.[41] As of June 15, 2022, the Navy consisted of 344,827 officers and sailors, up 1,916 from June 2021 but 15,568 short of the number needed by 2034.[42] To improve personnel readiness and meet the demands of a growing fleet, the Navy added 5,100 sailors in FY 2020.[43] The FY 2021 budget continued these increases in active-duty manning end strength by an additional 7,300 sailors.[44]

Regrettably, trends for the Navy's personnel budget and for its recruiting and retention efforts have begun to point in the wrong direction. Despite the

FIGURE 2

Change in Navy Battle Fleet Size, 2020–2021



SOURCES: U.S. Naval Institute News, "UNSI News Fleet and Marine Tracker: Jan. 4, 2021," January 4, 2021, https://news.usni.org/2021/01/04/usni-news-fleet-and-marine-tracker-jan-4-2021 (accessed August 3, 2022); Offce of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfare System Requirements–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020*, March 2019, https://media.defense.gov/2020/May/18/2002302045/-1/-1/1/PB20_SHIPBUILDING_PLAN.PDF (accessed August 3, 2022); and Naval Sea Systems Command, Naval Vessel Register, "Fleet Size," http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML (accessed August 3, 2022).

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need for more sailors and officers, total end strength has fallen from 347,677 in FY 2021 to 346,300 in FY 2023 and is trending toward 336,600 in FY 2027.[45] It remains to be seen whether retention rates can be sustained to meet long-range manning needs in the face of a tightening labor market and dismissals for non-compliance with COVID vaccine mandates.

Despite the acknowledged need to increase the Navy's cadre of officers and enlisted sailors, the President's FY 2023 budget continues the recent trend toward reduced end strength. This proposed budget, combined with last year's, decreases the Navy's end strength by a total of 2,120 officers and sailors in the Active component and 900 in the reserves while increasing the civilian workforce by 269 full-time employees.[46] Such sustained reductions are surprising in view of the Government Accountability Office's findings that persistent crew manning shortfalls on ships are as high as 15 percent and compound crew fatigue, which was a contributing factor in several fatal collisions in 2017.[47]

Finally, the effort to attract people to join the Navy is made more difficult by wages that are not keeping up with inflated costs of living. In the battle for people, last year's 2.7 percent pay raise and the proposed 4.6 percent raise planned for FY 2023[48] are not helping the Navy to make a compelling case for young people to join and stay in the service. Using the Consumer Price Index, pay is trailing the rate of inflation, which in April 2022 had reached 8.5 percent.[49]

Capability

A complete measure of naval capabilities requires an assessment of U.S. platforms against enemy weapons in plausible scenarios. The Navy routinely conducts war games, exercises, and simulations to

TABLE 6

Navy Fleet Design

Platform Class	Navy Plan, May 2022	BY 2027 Recommendation	BY 2027 Navy Plan, Dec. 2020	BY 2027 Navy Plan, April 2022	BY 2045 Range per Future Naval Force Study, 2020
Unmanned (LUSV, MUSV, XLUUV)	0*	36	21**	n/a**	143 to 242
Aircraft Carriers (CVN, CVNE, CVS)	11	12	10	10	8 to 17
Large Surface Combatant	93	110	97	86	73 to 88
Small Surface Combatant	32	37	34	23	60 to 67
Logistics and Support Vessels	62	90	82	74	96 to 117
Submarines (SSBN, SSGN, SSN)	68	77	67	62	84 to 90
Amphibious Warships	32	41	32	25	61 to 67
Total Without Unmanned	298	367	322	280	382 to 446
Total	298	403	343	280	525 to 688

* As of May 2022, the U.S. Navy had only prototypes in operation for XLUUV, LUSV, and MUSV.

** 21 unmanned vessels were planned for procurement by fiscal year 2026; the long-range plan included no procurement data for unmanned platforms in 2022.

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assess this, but insight into its assessments is limited by their classified nature. This *Index* therefore assesses capability based on remaining hull life, mission effectiveness, payloads, and the feasibility of maintaining the platform's technological edge.

Most of the Navy's fleet consists of older platforms: Of the Navy's 20 classes of ships, only eight are in production. However, at $230.8 billion, the Department of the Navy's proposed budget for FY 2023 represents a real dollar increase of $1.9 billion,

which is a relative increase of 8.7 percent from the previous year; procurement is increased by only 4 percent.[50] The following are highlights by platform.

Ballistic Missile Submarines (SSBN). The *Columbia*-class will relieve the aging *Ohio*-class SSBN fleet. Because of the implications of this change for the nation's strategic nuclear deterrence, the *Columbia*-class SSBN remains the Navy's top acquisition priority. To ensure the continuity of this leg of the U.S. nuclear triad, the first *Columbia*-class SSBN must be delivered on time for its first deterrent patrol in 2031.[51] To achieve this goal, the Navy signed a $9.47 billion contract in November 2020 with General Dynamics Electric Boat for the first in-class boat and advanced procurement for long-lead-time components of the second hull.[52] At a May 18, 2022, hearing, it was noted that the lead ship's keel-laying ceremony was to be on June 6, 2022.

However, there are concerns in Congress that the Department of Defense (DOD) may not be fully utilizing special authorities granted the Navy to ensure that this critical program is adequately resourced. Specifically, in 2014, the Congress established the National Sea-Based Deterrence Fund, which has saved more than $1.4 billion using flexible funding but "has yet to utilize the core function of the NSBDF—namely, to provide increased flexibility to repurpose funds into it to buy down the fiscal impact of the program on our other shipbuilding priorities."[53]

Nuclear Attack Submarines (SSN). SSNs are multi-mission platforms whose stealth enables clandestine intelligence collection; surveillance; anti-submarine warfare (ASW); anti-surface warfare (ASuW); special operations forces insertion and extraction; land attack strikes; and offensive mine warfare. The newest class of SSN, the Block V *Virginia* with the Virginia Payload Module (VPM) enhancement, is important to the Navy's overall strike capacity, enabling the employment of an additional 28 Tomahawk cruise missiles over earlier SSN variants.[54] Construction of Block V submarines began in September 2019 with the *Oklahoma* (SSN 802) to be delivered May 2027 and three more boats to be delivered before the end of the decade.[55]

The FY 2021 National Defense Authorization Act included additional funds for advanced procurement that preserves a future option to buy as many as 10 *Virginia*-class submarines through FY 2023. As indicated previously, increasing *Virginia*-class production has raised concerns regarding strain on the industrial base, and the FY 2023 budget would put $1.6 billion toward expansion of the submarine industrial base "to support the Navy plan of serial production of 1 COLUMBIA plus 2 VIRGINIAs starting in FY25/26."[56] Quality control of the supply chain is a key factor in submarine construction, and if it is not done well, the consequences can be catastrophic. That is why the premature replacement of critical submarine parts in 2021—parts that are intended to last the life of the boat—remains a concern.[57] Added vigilance will be required as the Navy finds new suppliers to meet future increased submarine production as well as the potential need to provide support to AUKUS.

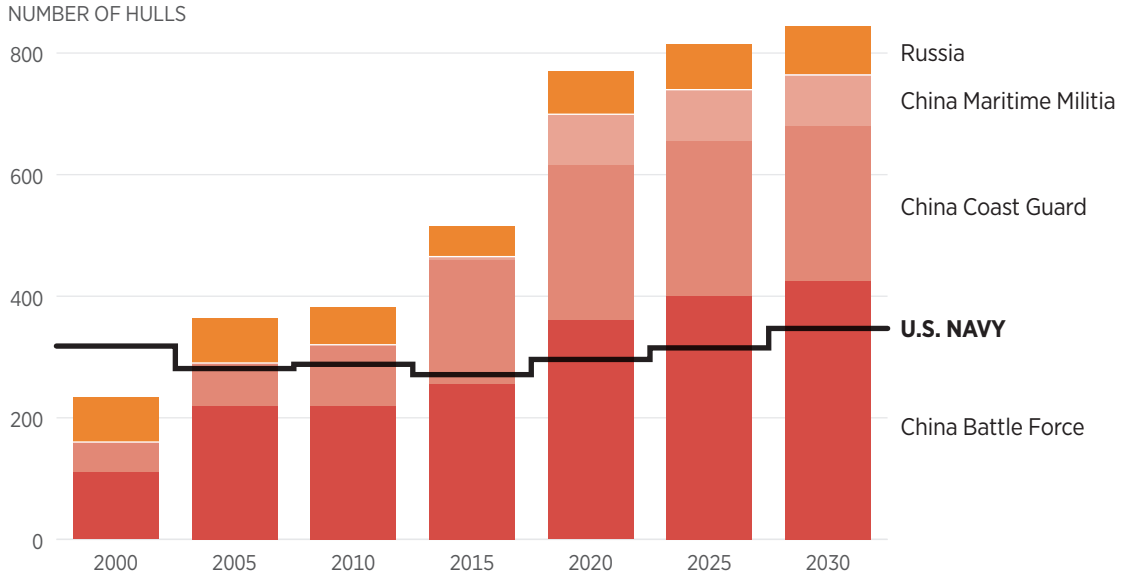
Aircraft Carriers (CVN). The Navy has 11 nuclear-powered aircraft carriers: 10 *Nimitz*-class and one *Ford*-class. The Navy has been making progress in overcoming nagging issues with several advanced systems, notably advanced weapons elevators, and the *Ford*'s first operational deployment is on track for the fall of 2022.[58] The second ship in the class, *Kennedy* (CVN 79), was christened on December 7, 2019, and remains on schedule for delivery in 2024, followed by *Enterprise* (CVN 80), which is in early construction.

The U.S. lead in this category of naval power may be waning as China completes construction of its first super carrier. As the U.S. Navy struggles to build, maintain, and crew a fleet of 11 aircraft carriers, China is rapidly catching up both in numbers and platform capability. Its newest carrier, the Type-003, like the *Ford*-class, will utilize electromagnetic catapults that will give its air wing greater range and sortie rates, thus greatly narrowing the capability gap.[59] The Type-003 is China's second indigenously built carrier, marking a significant engineering milestone, and there has been renewed emphasis on having the ship delivered before the next Chinese Communist Party congress, which is scheduled for the fall of 2022.[60] China's growing naval aviation and aircraft carrier capabilities place added stress on U.S. naval aviation and air defenses.

Large Surface Combatants. The Navy's large surface combatants consist of the *Ticonderoga*-class cruiser, the *Zumwalt*-class destroyer, and the *Arleigh Burke*–class destroyer. If the President's FY 2023 budget is executed, the Navy will decommission five aged cruisers. This will decrement the Navy's sea-launched firepower by 316 vertical launch tubes

CHART 7

U.S. vs. China and Russia Navies: Fleet Expansion Trends



NOTE: U.S. figures are actual through 2020. Figures for 2025 and 2030 are from the Navy's December 2020 30-year shipbuilding plan. See U.S. Navy, Office of the Chief of Naval Operations, Deputy Chief of Naval Operations (Warfighting Requirements and Capabilities–OPNAV N9), *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels*, December 9, 2020, https://media.defense.gov/2020/Dec/10/2002549918/-1/-1/1/SHIPBUILDING%20PLAN%20DEC%2020_NAVY_OSD_OMB_FINAL.PDF (accessed September 3, 2021).

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- Michael A. McDevitt, Rear Admiral, U.S. Navy (Ret.), prepared statement in hearing, *Department of Defense's Role in Competing with China*, Committee of Armed Services, U.S. House of Representatives, 116th Cong. 2nd Sess., January 15, 2020, pp. 76–88, https://www.govinfo.gov/content/pkg/CHRG-116hhrg40508/pdf/CHRG-116hhrg40508.pdf (accessed September 2, 2021).

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when measured against FY 2023 delivery of new strike-capable ships and submarines. Attempts to extend the life of the aging *Ticonderoga*-class cruisers have yielded mixed results as deferred upgrades and past incomplete maintenance are now driving up operating costs.[61]

In FY 2022, the Navy procured two *Arleigh Burke*–class DDG 51 destroyers, bringing the total on active duty in the fleet to 70. Fourteen more have been ordered. The *Zumwalt* class was envisioned as bringing advanced capabilities to the fleet, but the program has suffered technological problems and cost overruns, and the Navy has not indicated that it intends to acquire more than the three that have already been purchased and are being built out: the USS *Zumwalt* (DDG-1000), which was delivered on

April 24, 2020; USS *Michael Monsoor* (DDG-1001), which was commissioned on January 26, 2019; and USS *Lyndon B. Johnson* (DDG-1002), which is completing checks before delivery to the Navy in 2024.[62] The *Zumwalt* was to achieve initial operational capability (IOC) by September 2021, which the Navy pushed back to December 2021.[63] As of May 2022, a revised timeline for achieving IOC had not been made public.

To reach 355 ships by 2034, the Navy plans several class-wide service life extensions, notably extension of the DDG-51-class service life from 35 to 40 years and modernization of older hulls. The FY 2020 budget included $4 billion for modernization of 19 destroyers from FY 2021 through FY 2024.[64] The previously noted planned decommissioning of five cruisers in FY 2023 makes this more critical.

Small Surface Combatants. The Navy's small surface combatants consist principally of the *Avenger*-class mine countermeasures (MCM) ship; the Littoral Combat Ship (LCS); and the *Constellation*-class frigate (FFG), which began production in 2021. In January 2021, the Navy halted production of the mono-hull LCS *Freedom*-variant until issues involving the design of its propulsion system are resolved. In the meantime, the top speed of affected ships (currently 40-plus knots) is reportedly limited to 34 knots.[65] Last year, the fleet of 23 LCS (10 *Freedom*-variant and 13 *Independence*-variant) was expected to grow to 34 and be joined by 18 frigates by FY 2034.[66] Since then, the Navy has reversed course and terminated the LCS anti-submarine mission module program (10 units originally planned) and plans to decommission the remaining nine *Freedom* monohull variant.[67]

On August 20, 2020, the Navy decommissioned three of its aging *Avenger*-class MCM ships, leaving eight in service overseas in Sasebo, Japan, and Manama, Bahrain. These represent the only ship class dedicated to countering the mine threat.[68] The current long-range shipbuilding plan confirms that the Navy intends to operate these aged MCMs through FY 2027.[69]

As these ships reach the end of their service life, the Navy is relying on the development of mine countermeasure mission packages for the LCS to provide this capability. At an April 2022 webinar, the CNO indicated that these mission modules are on track to reach IOC by the end of 2022.[70] In an unanticipated move, the Navy began to arm LCS with the naval strike missile, giving these ships a long-range anti-ship capability that they had lacked despite notable operations by the class in the South China Sea.[71] On December 9, 2021, the San Diego-based *Independence*-variant *Oakland* received this new capability.[72]

Instead of requesting additional LCS, the Navy has focused on a new frigate. On April 30, 2020, the Navy awarded Fincantieri $795 million to build the lead ship at its Marinette Marine shipyard in Wisconsin based on a proven design currently in service with the French and Italian navies.[73] While the design for the U.S. ship has not been finalized, the frigate is intended to be a multi-mission warship with 32 VLS cells, up to 16 containerized naval strike missiles (NSM), and one helicopter.[74] In May 2021, the Navy contracted for the second ship in the class, the USS *Congress* (FFG-63).[75] In FY 2022 a third ship was purchased with two more planned for purchase in FY 2024.

The Navy continues to explore options to expand production eventually to as many as four ships a year. To do this, the Navy intends to begin production at a second yard by FY 2025; a decision on this "follow yard" is expected by FY 2023. In 2021, Austal USA broke new ground on a steel production facility that could position it to bid as the second yard,[76] but the FY 2022 appropriations bill contains language that may defer identification of this second yard until after delivery of the first frigate during FY 2026. To replicate Fincantieri Marine's Wisconsin shipyard would likely cost over $700 million.

Amphibious Ships. Commandant of the Marine Corps General David Berger issued the 38th Commandant's Planning Guidance in July 2019 and Force Design 2030 in March 2020. Both documents signaled a break with past Marine Corps requests for amphibious lift, specifically moving away from the requirement for 38 amphibious ships to support an amphibious force of two Marine Expeditionary Brigades (MEB).[77] The Commandant envisions a larger yet affordable fleet of smaller, low-signature amphibious ships—the Light Amphibious Warship (LAW)—that enable littoral maneuver and associated logistics support in a contested theater.[78] However, the amphibious fleet remains centered on fewer large ships.

The Navy's Future Naval Force Study (FNFS)[79] and December 2020 30-year shipbuilding plan acknowledged the growing importance of the LAW, which will have to be produced rapidly and in

sufficient numbers in order to actualize the naval forces' distributed concepts of operations (e.g., Marine Littoral Regiments and Distributed Maritime Operations). According to the April 2022 long-range shipbuilding plan, the Navy intends to purchase the first LAW in FY 2025. The Marine Corps had intended to have the ship under contract by the summer of 2022, but because of delays, it has begun to use alternative platforms to train and work out operational concepts so that it will be ready when the ship eventually is delivered.[80]

As of July 1, 2022, the Navy had nine amphibious assault ships in the fleet (seven *Wasp*-class LHD and two *America*-class LHA); 12 amphibious transport docks (LPD); and 11 dock landing ships (LSD).[81] The FY 2021 budget included $250 million in additional funds to accelerate construction of LHA-9 following the July 2020 catastrophic fire on *Bonhomme Richard* (LHD-6).[82] The decision to decommission the damaged ship further exposed limitations in shipyard capacity, as repairs would have had a negative effect on other planned shipbuilding and maintenance.[83]

The Navy's LSDs, the *Whidbey Island*–class and *Harpers Ferry*–class amphibious vessels, are scheduled to reach the end of their 40-year service lives beginning in 2025. LPD-30 began construction in April 2020 and when delivered will be the first of 13 *San Antonio*–class Flight II ships to replace the legacy LSD ships. The 12th first flight *San Antonio*–class ship (LPD 28) was delivered six months later than reported in the *2022 Index*.[84] The FY 2021 budget included $500 million "to maximize the benefit of the amphibious ship procurement authorities provided elsewhere in this Act through the procurement of long lead material for LPD–32 and LPD–33."[85] In the Navy's FY 2023 proposed budget, LPD-32 would be the last Flight II purchased of the originally envisioned 13; the Marine Corps is seeking procurement of the fourth LPD-33 Flight II as its top unfunded request.[86]

Unmanned Systems. The Navy does not include unmanned ships in counting its battle force size. Previous long-range shipbuilding plans envisioned the purchase of 13 Large Unmanned Surface Vessels (LUSV); one Medium Unmanned Surface Vessel (MUSV); and eight Extra Large Undersea Unmanned Vessels (XLUUV) by FY 2026.[87] On May 18, 2021, one of these experimental LUSV vessels, the *Nomad*, was seen transiting the Panama Canal on its way to Surface Development Squadron (SURFDESRON) 1.[88] In April 2020, the Navy took delivery of its second MUSV *Sea Hunter* prototype, joining two LUSV, and the *Zumwalt* destroyer under SURFDEVRON 1.[89] Since the *2022 Index*, there has been significant progress in learning what it will take to operate a fleet of unmanned naval warships and their limitations.

The Navy reached a significant milestone in September 2021 when its small fleet of unmanned surface ships launched and hit a target with an SM-6 interceptor missile.[90] After spending years in a laboratory and controlled at-sea navigational tests, unmanned ships are now deploying. That same month, Task Force 59, based in the Persian Gulf and comprised of smaller unmanned drones and vessels, conducted International Maritime Exercise 2022 (IMX22) with 10 nations and more than 80 unmanned platforms in the Red Sea.[91] Despite these advances, the FY 2023 budget will slow the pace of procurement with the next LUSV procured in FY 2025 and the next XLUUV in FY 2024 for a combined total of 12 of these craft by FY 2027.[92] Overall, the Navy is making progress in maturing its unmanned fleet.

Logistics, Auxiliary, and Expeditionary Ships. Expeditionary support vessels are highly flexible platforms of two types: those used for prepositioning and sustaining forward operations and others used for high-speed lift in uncontested environments. The Navy has five of the former (two Expeditionary Transfer Dock [ESD] and three Expeditionary Sea Base [ESB] vessels) and 12 of the latter (shallow-draft Expeditionary Fast Transport [EPF] vessels). In March and April 2022, ESB *Hershel Williams* (ESB 4) demonstrated the versatility of these ships during maritime security missions with African coast guards and navies. In August 2021, it conducted a counter-piracy exercise with the Brazilian navy. At the same time, China was attempting to secure a base in Equatorial Guinea.[93] The Navy christened ESB 6, USNS *John L. Canley*, on June 25, 2022, and ESB 7, USNS *Robert E. Simanek*, "is currently under construction."[94]

With their shallow draft and versatile cargo capacity, EPFs offer unique capabilities that are well suited to austere but uncontested waters. Specifically, these ships can transport 600 short tons of military cargo (for example, main battle tanks) 1,200 nautical miles at 35 knots. The Navy christened its

13th EPF, the *Apalachicola*, on November 13, 2021, and construction is progressing.[95] In March 2021, the Navy revised its contract with Austal USA for $235 million to modify EPF 14 and the future EPF 15 to be high-speed hospital ships with the capability of embarking a V-22 tilt-rotor aircraft.[96] The keel for EPF 14 configured as a hospital ship was laid on January 26, 2022, and construction of EPF 15 in the same configuration commenced the same month.[97]

The Navy's Combat Logistics Force (CLF) includes dry-cargo and ammunition ships (T-AKE); fast combat support ships (T-AOE); and oilers (AO). The CLF provides critical support, including at-sea replenishment, that enables the Navy to sustain the fleet at sea for prolonged periods. The Navy's future oiler *John Lewis* (T-AO 205) was procured in 2016 and launched five years later on January 12, 2021; 20 ships of this class are planned.[98] However, because of a flooding incident at the graving dock, delivery of *John Lewis* has been delayed, and this in turn has caused cascading delays of 12 to 15 months in construction of the second through sixth ships.[99]

To sustain the number of oilers needed by the fleet, the Navy will have to receive the first two of this class by FY 2023.[100] Secretary of Defense Lloyd Austin's March 7, 2022, decision to dismantle Red Hill fuel storage facilities in Hawaii will generate additional pressure to increase the Navy's at-sea oiler fleet to meet operational needs in the Pacific. A plan specifying how the Navy will mitigate the loss of these massive Pacific fuel storage facilities was due by May 31, 2022.[101]

Strike Platforms and Key Munitions. The FY 2023 budget continues the Navy's focus on long-range offensive strikes launched from ships, submarines, and aircraft. Notable capability enhancements funded in the FY 2023 budget include Conventional Prompt Strike (CPS), a maneuverable hypersonic non-nuclear weapon for long-range strikes that receives support for initial deployment on the *Zumwalt*-class destroyer in FY 2025, and the upgraded Block V Maritime Strike Tomahawk (MST) with improved targeting.[102]

To counter the threat posed by the Chinese PL-15 long-range air-to-air missile, which has an operational range of 186 miles, the Navy is working with the Air Force to develop the AIM-120 Advanced Medium-Range missile, the operational range of which has not been made public.[103] In March 2021, the Air Force reported a record long-range kill of a drone target by this developmental missile from one of its F-15C fighters.[104] If this report is accurate, it indicates that development of this needed capability is proceeding apace.

Shore-Based Anti-Ship Capabilities. Following the August 2019 U.S. withdrawal from the Intermediate-Range Nuclear Forces (INF) Treaty, new intermediate-range (500–1,000 miles) conventional ground-launched strike options became politically viable. This is especially important in Asia where such capable missiles deployed to the first island chain would have great relevance in any conflict with China.[105]

The FY 2020 budget included $76 million to develop ground-launched cruise missiles.[106] The FY 2021 budget included $59.6 million in additional funds to procure 36 ground-based anti-ship missiles.[107] The FY 2023 budget, building on recent successes, continues this upward investment in development and increased production of these weapon systems. A photo of the launch of a U.S. Marine Corps truck-mounted Naval Strike Missile—ostensibly part of the Navy–Marine Expeditionary Ship Interdiction System (NMESIS)—was released in April 2021.[108] The FY 2023 budget will fund low-rate initial production of 115 Naval Strike Missiles and associated development of Marine Corps platoon-level targeting systems.[109] Ukraine's use of shore-based anti-ship missiles to sink Russia's Black Sea flag ship, the *Moskva*, in April 2022 has renewed interest in such systems.

Electronic Warfare (EW). The purpose of electronic warfare is to control the electromagnetic spectrum (EMS) by exploiting, deceiving, or denying its use by an enemy while ensuring its use by friendly forces. It is therefore a critical element of successful modern warfare. The final dedicated EW aircraft, the EA-18G Growler, was delivered in July 2019, meeting the Navy's requirement to provide this capability to nine carrier air wings (CVW), five expeditionary squadrons, and one reserve squadron.[110] Anticipating the EA-18G's retirement in the 2030s, the Navy has been exploring follow-on manned and unmanned systems, but no new developments have been reported in 2022.

The Navy's proposal to retire all of its expeditionary electronic attack squadrons by FY 2025 has come as a surprise.[111] Unless there is a replacement capability, retirement of these aircraft removes the EW coverage provided by these units from forward

airfields, shifting the support burden to nearby naval platforms and the other services.

Air Early Warning. The E-2D forms the hub of the Naval Integrated Control Counter Air (NIFC-CA) system and provides critical theater air and missile defense capabilities. The Navy's FY 2021 budget supported the procurement of four aircraft with an additional 10 to be procured over the next two years.[112] The FY 2023 budget completes this plan by including procurement of the final five new E-2D aircraft, which are important air control platforms.

High Energy Laser (HEL). HEL systems provide the potential to engage targets or shoot down missiles without being limited by how much ammunition can be carried onboard ship. A significant milestone was achieved when USS *Portland* (LPD-27) used its HEL Weapon System Demonstrator to shoot down an unmanned aerial vehicle (UAV) over the Pacific on May 16, 2020.[113] This was followed by the Navy's decision to begin installation of a HEL system—the HELIOS (60 kw) laser—on destroyers in 2021 beginning with USS *Preble*.[114] HELIOS is a scalable laser system that is integrated into the ship's weapons control and radar systems and can dazzle and confuse threats, disable small boats, or shoot down smaller air threats.

In April 2022, the Navy demonstrated the ability of its Layered Laser Defense HEL system to shoot down a drone simulating a cruise missile.[115] Successful tests like this and the ongoing deployment of the HELIOS on destroyer *Preble* will be followed by installation of a much stronger 100 kw laser on *Portland* (LPD-27) that approaches the powers needed for missile defense.[116] However, until field testing against meaningful threat platforms is conducted across a range of weather conditions, the effectiveness of such systems will remain unproven.

Command and Control. Networked communications are essential to successful military operations. The information passed over these networks includes sensitive data on such subjects as targeting and logistics, and this makes cyber security, communications, and the information systems that generate and relay this information critical elements of the DOD information enterprise.

On October 1, 2020, Chief of Naval Operations Admiral Michael Gilday signed two memos establishing Project Overmatch. The goal was to achieve situational awareness and effective command and control of a geographically dispersed naval force. In his two memos, the CNO directed that investments be made to deliver network architectures, unmanned capabilities, and data analytics to ensure that the Navy can operate and dominate in a contested environment.[117] The CNO also directed the Navy to leverage related Air Force efforts on JADC2, now a Joint Force effort involving all of the military branches. Remarkably, despite the significance of the effort, little has been publicly released on Project Overmatch; what *is* known is that it involves three classified funding lines with initial deployment slated for 2023.[118] In unofficial venues, it has been hinted that the first platform to employ JADC2 capabilities will be an aircraft carrier, but public statements indicate that the objective is to connect all platform data flows, analyze them for classification, and make predictive targeting recommendations. If successful, artificial intelligence paired with resilient communications and big data analytics can enable a key element of Distributed Maritime Operations (DMO).

Readiness

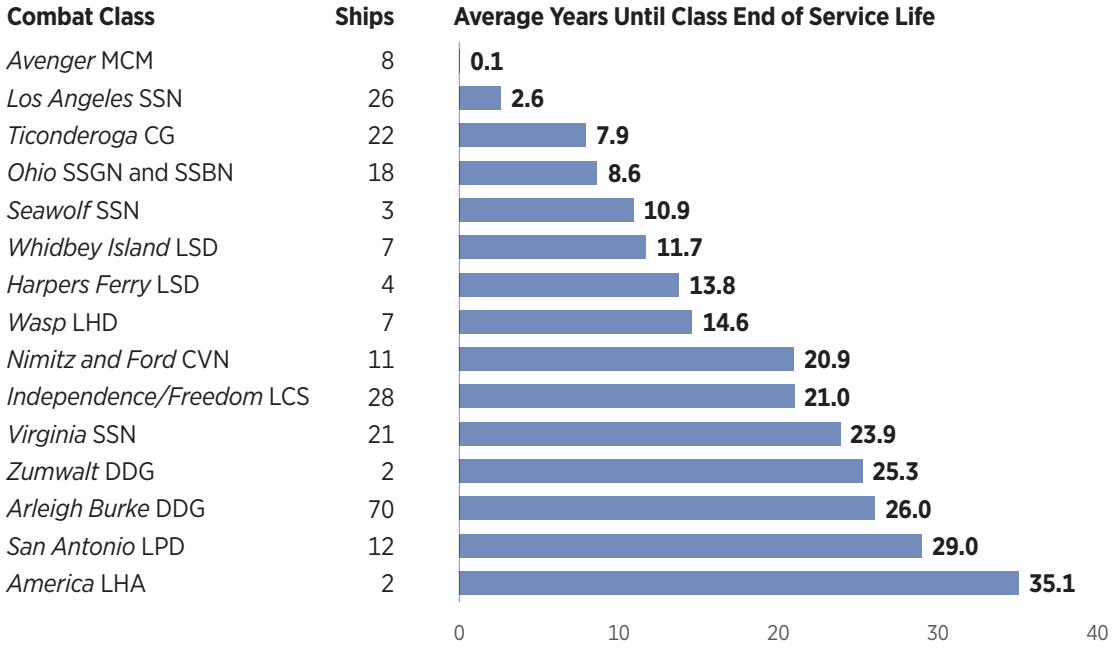
In the 1980s, the Navy had nearly 600 ships in the fleet and kept roughly 100 (17 percent) deployed at any one time. As of June 22, 2022, the fleet numbered 298 ships, of which 94 (31.5 percent) were at sea or deployed. With fewer ships carrying an unchanging operational workload, training schedules become shorter and deployments become longer. The commanding officer's discretionary time for training and crew familiarization is a precious commodity that is made ever scarcer by the increasing operational demands on fewer ships.

FY 2019 marked the first time in more than a decade that DOD and the Navy did not have to operate under a continuing resolution for at least part of the fiscal year. Having a full fiscal year to plan and execute maintenance and operations helped the Navy to continue on its path to restoring fleet readiness. However, as CNO Admiral John Richardson explained to the Senate Armed Services Committee in April 2018, it will take until late 2021 or 2022 to restore fleet readiness to an "acceptable" level if adequate funding is maintained; without "stable and adequate funding," it will take longer.[119] Unfortunately, the Navy began FY 2020 under a continuing resolution that delayed planned maintenance for USS *Bainbridge* (DDG 96) and USS *Gonzalez* (DDG 66).[120]

Given this recent history, as well as the effects of COVID, and the demands of unplanned urgent

CHART 8

Navy Combat Ships Nearing End of Service Life



NOTE: Figures are based on calculations for August 2022.
SOURCE: U.S. Navy, Naval Sea Systems Command, Naval Vessel Register, "Fleet Size," http://www.nvr.navy.mil/NVRSHIPS/FLEETSIZE.HTML (accessed August 17, 2022).

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ship repairs brought about by such incidents as the grounding of the submarine *Connecticut*, the Navy still has much to do.

Impact of COVID-19. The eruption of the COVID-19 pandemic in 2020 caused many problems for the U.S. Navy. USS *Theodore Roosevelt* (CVN 71), for example, was forced to quarantine for 55 days in Guam; the major biannual international Rim of the Pacific Exercise (RIMPAC) was scaled down; 1,629 reservists were called to active duty to backfill high-risk shipyard workers conducting critical maintenance; and the Navy was restricted to using "safe haven" COVID-free ports. In May 2021, the CNO assessed that the Navy managed the pandemic with minimal operational impact but with added time at sea and delays for family reunions pending quarantines.[121]

In fact, as the pandemic recedes, the Navy's response has been a success overall. As of June 22, 2022, total cumulative COVID cases among the Navy's active-duty uniformed personnel numbered 97,880 with 17 deaths, and only 3,371 remained unvaccinated, of which 214 had approved exemptions to the mandated vaccination.[122] Given vaccination rates and ebbing danger, the Navy appears to be past the COVID epidemic. It is therefore expected that the Navy will implement lessons learned from this experience to prepare for future pandemics and biological attacks.

Maintenance and Repairs. Naval Sea Systems Command completed its Shipyard Optimization and Recapitalization Plan in September 2018.[123] Three years later, the improvement of public shipyard capacities is just beginning. The initial step of building digital models to inform future upgrades to the Navy's four public shipyards was expected to be complete by the end of 2021, but remained

incomplete as of June 2022. Attempts by Congress to accelerate the effort have not been effective.[124] At a May 10, 2022, Senate hearing, it became apparent both that the original costs were significantly underestimated and that timelines are slipping. During that hearing, the Government Accountability Office reported that:

- "[F]rom 2017 to 2020, the backlog of restoration and modernization projects at the Navy shipyards has grown by over $1.6 billion, an increase of 31 percent."[125]

- "In 2018, the Navy estimated that it would need to invest about $4 billion in its dry docks to obtain the capacity to perform the 67 availabilities it cannot currently support. This estimate included 14 dry dock projects planned over [a] 20-year span. However...the Navy's first three dry dock projects have grown in cost from an estimated $970 million in 2018 to over $5.1 billion in 2022, an increase of more than 400 percent."[126]

- "In a 2021 report to Congress, the Navy stated it would complete the ADPs by fiscal year 2021. However, in a September 2021 update of that report, the Navy stated the [Area Development Plans] would be complete four years later, in fiscal year 2025."[127]

Training, Ranges, and Live-Fire Exercises. Ship and aircraft operations and training are critical to fleet readiness. The Navy seeks to meet fleet readiness requirements by funding 58 underway days for each deployed warship and 24 underway days for each non-deployed warship per quarter. Less clear is how much of this time is spent on crew training and whether the Navy assesses this as effective in meeting needed operational proficiencies.

To improve warfighting proficiency, the Navy is seeking to expand and update instrumentation of the training range at Naval Air Station Fallon, Nevada, to enable practice with the most advanced weapon systems.[128] This training range fits into the larger five-year $27.3 billion Pacific Deterrence Initiative (PDI), led by Indo Pacific Command, that is intended partly to transform the way the Navy trains for high-end conflict and improve training with U.S. allies in the Pacific.[129] Of particular importance to the Navy are PDI investments to modernize the Pacific Missile Range Facility (PMRF); the Joint Pacific Alaska Range Complex (JPARC); and the Combined/Joint Military Training (CJMT) Commonwealth Northern Mariana Islands in order to improve training for operations across all domains: air, land, sea, space, and cyber.[130]

The FY 2023 budget earmarks $6.1 billion of DOD's topline budget for PDI. Especially important are long lead time infrastructure projects in Guam and Tinian in the northern Marianas. This year's PDI budget includes the largest amount allocated so far for exercises, training, experimentation, and innovation: approximately $2.3 billion.[131] To measure the effectiveness of these investments, the Navy will need to demonstrate increased frequency of exercises that practice high-end warfighting independently, jointly, and with key allies such as Australia, Japan, and South Korea. This should include increased numbers of realistic free-play events and increased by-hull frequency of live-fire drills.

Finally, not forgotten are the 2017 collisions of USS *John S. McCain* (DDG 56) and USS *Fitzgerald* (DDG 62) in which 17 sailors were lost. Findings of the subsequent investigations, which highlighted the importance of operational risk management and unit readiness, remain relevant.[132] To ensure that these tragic events are not repeated, the following broad institutional recommendations in the Secretary of the Navy's *Strategic Readiness Review* should be implemented:

- "The creation of combat ready forces must take equal footing with meeting the immediate demands of Combatant Commanders."

- "The Navy must establish realistic limits regarding the number of ready ships and sailors and, short of combat, not acquiesce to emergent requirements with assets that are not fully ready."

- "The Navy must realign and streamline its command and control structures to tightly align responsibility, authority, and accountability."

- "Navy leadership at all levels must foster a culture of learning and create the structures and processes that fully embrace this commitment."[133]

A reminder that the above recommendations remain relevant was the October 2021 grounding of submarine *Connecticut* in the South China Sea. The subsequent investigation found the event avoidable while operating in poorly surveyed waters—a reminder of the risk as well as vigilance required at sea.[134]

Scoring the U.S. Navy

Capacity Score: Very Weak

This *Index* assesses that a battle force consisting of 400 manned ships is required for the U.S. Navy to do what is expected of it today. The Navy's current battle force fleet of 298 ships and intensified operational tempo combine to reveal a service that is much too small relative to its tasks. Contributing to a lower assessment is the Navy's persistent inability to arrest and reverse the continued diminution of its fleet while adversary forces grow in number and capability. On its current trajectory, the Navy will shrink further to 280 ships by 2037. The result is a score of "very weak," which is down from the *2022 Index*. Depending on the Navy's ability to realize aggressive growth, reverse early decommissioning plans, increase its end strength, and develop creative service life extensions, its capacity score will probably remain "very weak" for the foreseeable future.

Capability Score: Marginal Trending Toward Weak

The overall capability score for the Navy remains "marginal" with downward pressure as the Navy's technological edge narrows against peer competitors China and Russia. The combination of a fleet that is aging faster than old ships are being replaced and the rapid growth of competitor navies with modern technologies has only intensified the danger for U.S. naval power. Without meaningful progress in fielding systems that are able to defend against an array of threats, greater integration of unmanned systems into the fleet, and development of a family of new long-range weapons, especially in air-to-air combat, next year's capability score could well decline to "weak."

Readiness Score: Weak

The Navy's readiness is rated lower this year as "weak." This is due primarily to the Navy's persistent struggle to recapitalize antiquated, inadequate maintenance infrastructure and workforce to meet current needs. The effectiveness of training and exercises measured against China will be an increasingly critical metric in this score.

Overall U.S. Navy Score: Weak

The Navy's overall score for the *2023 Index* is "weak" driven by lower scores in capacity and readiness. To correct this trend, the Navy will have to eliminate several readiness and capacity bottlenecks while seeing to it that America has an operational fleet with the numbers and capabilities postured to counter Russian and Chinese naval advances. There is added urgency given that China is aggressively posturing itself to obtain maximum advantage over Taiwan and many of the U.S. Navy's efforts to improve itself will take several years to realize.

U.S. Military Power: Navy

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

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Aircraft Carrier

PLATFORM	Age Score	Capability Score
***Nimitz*-Class Aircraft Carrier (CVN-68)** Inventory: **10** Fleet age: **30** Date: **1975** The *Nimitz*-class is a nuclear-powered multipurpose carrier. The aircraft carrier and its embarked carrier air wing can perform a variety of missions including maritime security operations and power projection. Its planned service life is 50 years. The class will start retiring in FY 2025, starting with CVN-68 USS *Nimitz* and CVN-69 USS *Eisenhower*, and will be replaced by the *Ford*-class carriers.	3	3
***Ford*-Class Aircraft Carrier (CVN-78)** Inventory: **1** Fleet age: **5** Date: **2017** The *Ford*-class incorporates new technologies that will increase aircraft sortie rates, reduce manning, provide greater electrical power for future weapons systems, and decrease operating costs. Its planned service life is 50 years. CVN-78 is expected to deploy in the fall of 2022 after five years of delays. CVN-79 is awaiting testing while CVN-80 and CVN-81 are under construction.	5	4

REPLACEMENT PROGRAM	Size Score	Health Score
***Ford*-Class Aircraft Carrier (CVN-78)** Timeline: **2017–TBD**	2	2

Currently in production, the *Ford*-class will replace the *Nimitz*-class aircraft carriers. The *Ford*-class design uses the basic *Nimitz*-class hull form but incorporates several improvements to achieve a 33 percent higher sortie rate, a smaller crew with approximately 600 fewer sailors, two and a half times more electrical power, and over $4 billion in life-cycle cost savings over the *Nimitz*-class. The ship completed Planned Incremental Availability on March 1 after six months of modernization and maintenance work. The crew is currently undergoing training to prepare for the first deployment of the ship in the fall of 2022. The ship's intended life expectancy is 50 years.

PROCUREMENT

SPENDING *($ millions)*

NOTE: See page 386 for details on fleet ages, dates, timelines, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Large Surface Combatant

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***Ticonderoga*-Class Cruiser (CG-47)** Inventory: **22** Fleet age: **33.5** Date: **1981** The *Ticonderoga*-class is a multi-mission battle force ship equipped with the Aegis Weapons System. While it can perform strike, anti-surface warfare and anti-submarine warfare, its primary focus is air and missile defense. The cruisers have a life expectancy of 40 years. The Navy plans to retire the entire cruiser fleet by FY 2027.	2	3	***Zumwalt*-Class Destroyer (DDG-1000)** Timeline: **2016–2024** The DDG-1000 was designed to be a new-generation destroyer capable of handling more advanced weapon systems for long-range strike with a hull design aimed to reduce radar detectability for its original primary mission of naval surface fire support (NSFS). The DDG-1000 program was intended to produce a total of 32 ships, but this number has been reduced to three. The first DDG-1000 was commissioned in October 2016. DDG-1002, the last ship of the class, is expected to be delivered in 2024. **PROCUREMENT** 3 **SPENDING** *($ millions)* $4,092	1	1
***Zumwalt*-Class Destroyer (DDG-1000)** Inventory: **1** Fleet age: **4.5** Date: **2016** The *Zumwalt*-class is multi-mission destroyer that incorporates several technological improvements such as a stealthy hull design and integrated electric-drive propulsion system. Although it has passed sea trials, it continues to experience problems with its combat systems. The third and final ship of the class was commissioned in FY 2020, with DDG 1002 currently awaiting Combat Systems testing before entering the service.	5	2			
***Arleigh Burke*-Class Destroyer (DDG-51)** Inventory: **70** Fleet age: **15.5** Date: **1991** The *Arleigh Burke*-class is a multi-mission guided missile destroyer featuring the Aegis Weapons System with a primary mission of air defense. The Navy procured two in FY 2022 and will continue to procure two more each fiscal year. The destroyers will begin to decommission starting in FY 2027 with DDG-51.	3	4	***Arleigh Burke*-Class Destroyer (DDG-51)** Timeline: **1991–2029** DDG-51 production was restarted in FY 2013 to make up for the reduction in DDG-1000 acquisitions. Beginning in FY 2017, all DDG-51s procured will be the Flight III design, which includes the Advanced Missile Defense Radar (AMDR), a more capable missile defense radar. The Navy procured two destroyers in FY 2022 and plans to procure two more each fiscal year. The destroyers are believed to have an extended life span of 45 years of operational service. **PROCUREMENT** 89 12 **SPENDING** *($ millions)* $95,474 $25,785	3	4

NOTE: See page 386 for details on fleet ages, dates, timelines, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Small Surface Combatant

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Littoral Combat Ship (LCS) Inventory: **22** Fleet age: **7** Date: **2008** The Littoral Combat Ship includes two classes: the *Independence*-class and the *Freedom*-class. The modular LCS design *depends* on mission packages (MP) to provide warfighting capabilities in the SUW, ASW and MCM mission areas. The ship has an expected service life of 25 years. However, the Navy is planning to decommission nine *Freedom*-class LCS under its FY 2023 budget proposal as well as two *Independence*-class LCS in FY 2024, despite resistance from Congress.	5	2	**Littoral Combat Ship (LCS)** Timeline: **1991–2024** The LCS is intended to fulfill the mine countermeasure, antisubmarine warfare, and surface warfare roles for the Navy. It is designed to operate in near-shore environments but is also capable of open-ocean operation. It works better with smaller ships than the DDG-51. In the FY 2023 budget proposal, the Navy has marked all nine *Freedom*-class ships currently in service for early disposal. The *Independence*-class LCS would remain as the sole small surface combatant after the retirement of the MCM ships and until the new FFG-62 frigates are delivered. The decision to scrap the *Freedom*-class LCS does not affect the ships currently under construction. **PROCUREMENT** 33 **SPENDING** *($ millions)* $16,182	2	2
***Avenger*-Class Mine Counter Measure (MCM-1)** Inventory: **8** Fleet age: **31.5** Date: **1983** *Avenger*-class ships are designed as mine sweepers/hunter-killers capable of finding, classifying and destroying moored and bottom mines. The class has an expected 30-year service life. The remaining MCMs are expected to be decommissioned throughout the 2020s. While there is no direct replacement single-mission MCM ship in production, the Navy plans to fill its mine countermeasure role with the LCS and its MCM MP.	1	2	**FFG Frigate** Timeline: **1991–2030** A new program called the FFG-62 will augment the LCS program to fill out the remaining 20-ship small surface combatant requirement for a total of 52 small surface combatants. The ships will be 496 feet with a top speed of 29 miles per hour and a range of 6,000 nautical miles. Its purpose is to escort carrier battle groups and high-value convoys. It will accommodate 32 VLS cells to handle high-powered missiles and machine guns. The first ship should be delivered by 2026 and be operational by 2030. The current contract would provide 10 hulls by 203, with a total of 20 FFG-62 frigates in the fleet. Procurement has been one frigate per fiscal year with the Navy requesting to procure one more in FY 2023. **PROCUREMENT** 3 17 **SPENDING** *($ millions)* $3,425 $17,636	N/A	N/A

NOTE: See page 386 for details on fleet ages, dates, timelines, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

SSGN Cruise Missile Submarine

PLATFORM	Age Score	Capability Score	MODERNIZATION PROGRAM	Size Score	Health Score
***Ohio*-Class (SSGN-726)** Inventory: **4** Fleet age: **39.5** Date: **1981** The SSGNs provide the Navy with a large stealthy strike and special operations mission capabilities. From 2002–2007, the four oldest *Ohio*-class ballistic missile submarines were converted to guided missile submarines. Each SSGN is capable of carrying up to 154 Tomahawk land-attack cruise missiles and up to 66 special operations forces for clandestine insertion and retrieval. All four SSGNs will retire between FY 2026 and FY 2028. The Navy tentatively plans to replace the SSGNs with a new Large Payload Submarine beginning in FY 2036, but loss of the SSGN undersea strike capability will be mitigated by the *Virginia*-class Payload Module (VPM). It had a planned service life of 42 years, but this may be extended.	1	4	None		

NOTE: See page 386 for details on fleet ages, dates, timelines, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Attack Submarines

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***Seawolf*-Class (SSN-21)** Inventory: **3** Fleet age: **21** Date: **1997** The *Seawolf*-class is exceptionally quiet, fast, well-armed, and equipped with advanced sensors. Though lacking a vertical launch system, the *Seawolf*-class has eight torpedo tubes and can hold up to 50 weapons in its torpedo room. Although the Navy planned to build 29 submarines, the program was cut to three submarines. The *Seawolf*-class has a 33-year expected service life. They have been succeeded by the *Virginia*-class attack submarine.	3	4	***Virginia*-Class (SSN-774)** Timeline: **2004–2036** The *Virginia*-class is in production and will replace the *Los Angeles*–class and *Seawolf*-class attack submarines as they are decommissioned. The *Virginia*-class Payload Module (VPM) will be incorporated into eight of the 11 planned Block V submarines beginning in FY 2019. VPM includes four large-diameter, vertical launch tubes that can carry up to 28 additional Tomahawk missiles or other payloads. The planned service life of the *Virginia*-class is 33 years. Thirty-four have been procured so far at a rate of two per year. **PROCUREMENT** 36 12 **SPENDING** *($ millions)* $65,406 $32,882	2	3
***Los Angeles*–Class (SSN-688)** Inventory: **28** Fleet age: **36** Date: **1976** The *Los Angeles*-class comprises the largest portion of the Navy's attack submarine fleet. They are multi-mission submarines that can perform covert intelligence collection, surveillance, ASW, ASuW, and land attack strike. The *Los Angeles*–class has a 33-year expected service life. Between 2022 and 2028, 14 *Los Angeles*–class submarines will be retired and replaced by the *Virginia*-class.	1	3			
***Virginia*-Class (SSN-774)** Inventory: **19** Fleet age: **9** Date: **2004** The *Virginia*-class is the U.S. Navy's next-generation attack submarine. The *Virginia*-class includes several improvements over previous attack submarine classes that provide increased acoustic stealth, improved SOF support, greater strike payload capacity and reduced operating costs. The planned service life of the *Virginia*-class is 33 years. The *Virginia*-class is in production and will replace the *Los Angeles*–class and *Seawolf*-class attack submarines as they are decommissioned. Thirty-six have been procured so far, at a rate of two per year.	4	4			

NOTE: See page 386 for details on fleet ages, dates, timelines, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

SSBN Ballistic Missile Submarine

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***Ohio*-Class (SSBN)** Inventory: **14** Fleet age: **33** Date: **1981** The *Ohio*-class SSBN is most survivable leg of the U.S. military's strategic nuclear triad. The *Ohio*-class SSBN's sole mission is strategic nuclear deterrence, for which it carries long-range submarine-launched ballistic missiles. The *Ohio*-class's expected service life is 42 years. The *Ohio*-class fleet will begin retiring in 2027 at an estimated rate of one submarine per year until 2039. The *Ohio*-class fleet will be replaced by 12 *Columbia*-class SSBNs.	2	4	***Columbia*-Class (SSBN–826)** Timeline: **2021–TBD** The 12-boat *Columbia*-class will replace the existing *Ohio*-class nuclear ballistic submarine force, which provides a credible and survivable sea-based strategic deterrent. The Navy's FY 2023 budget submission estimates the total procurement cost of the 12 boats at $112.7 billion. The lead boat, SSBN-826, is expected to be delivered in FY 2027 with its first patrol scheduled for FY 2031. Due to complications from the pandemic and technical challenges, the program could be delayed. Despite such issues, construction continues to be underway. The *Columbia*-class will have a 42-year life expectancy. **PROCUREMENT** 1 / 11 **SPENDING** *($ millions)* $50,787		

Amphibious Warfare Ship

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***Wasp*-Class Amphibious Assault Ship (LHD-1)** Inventory: **7** Fleet age: **23** Date: **1989** The *Wasp*-class can support amphibious landing operations with Marine Corps landing craft via its well deck. It can also support Marine Air Combat Element operations with helicopters, tilt-rotor aircraft and Vertical/Short Take-Off and Landing (V/STOL). This ship has a planned 40-year service life.	2	3	***America*-Class (LHA–6)** Timeline: **2014–2028** LHA Flight 0 (LHA-6 and 7) were built without a well deck to provide more space for Marine Corp aviation maintenance and storage as well as increased JP-5 fuel capacity. LHA Flight 1 (LHA-8 and beyond) will reincorporate a well deck for increased mission flexibility. The *America*-class is in production with three LHA 6s already procured. In the FY 2023 budget estimate, the Navy has requested procurement for LHA-9. **PROCUREMENT** 3 / 1 **SPENDING** *($ millions)* $3,667 / $1,085	3	3
***America*-Class Amphibious Assault Ship (LHA-6)** Inventory: **2** Fleet age: **5** Date: **2014** This new class of large-deck amphibious assault ships is meant to replace the retiring *Wasp*-class LHD. LHAs are the largest of all amphibious warfare ships, resembling a small aircraft carrier. The *America*-class is designed to accommodate the Marine Corps' F-35Bs. In the FY 2023 budget estimates, the Navy plans to procure one LHA.	5	4			

NOTE: See page 386 for details on fleet ages, dates, timelines, and procurement spending.

Amphibious Warfare Ship (Cont.)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
***San Antonio*-Class Amphibious Transport Dock (LPD-17)** Inventory: **11** Fleet age: **10.5** Date: **2006** The LPDs have well decks that allow the USMC to conduct amphibious operations with its landing craft. The LPD can also carry four CH-46s or two MV-22s. Eleven of the planned 13 Flight I LPD-17-class ships are operational with the remaining two under construction. The class has a 40-year planned service life. As of FY 2022, two of the LPD Flight II-class have been procured.	4	3	***San Antonio*–Class Amphibious Transport Dock (LPD-17)** Timeline: **2006–2017** The 13 LPD-17s are replacements for the *San Antonio*–class LPDs. Both Flight I and Flight II LPDs are multi-mission ships designed to embark, transport and land elements of a Marine landing force by helicopters, tilt rotor aircraft, landing craft, and amphibious vehicles. **PROCUREMENT**: 13 **SPENDING** *($ millions)*: $13,836	5	4
***Whidbey Island*–Class Dock Landing Ship (LSD-41)** Inventory: **7** Fleet age: **33.5** Date: **1985** LSD 41 *Whidbey Island*–class ships were designed specifically to transport and launch four Marine Corps Landing Craft Air Cushion vehicles. They have an expected service life of 40 years. All eight ships in the class will retire between FY 2026 and FY 2033. LSD-41-class will be replaced by LPD–17 Flight II program, which began procurement in FY 2018. Before 2026, the Navy plans to retire six of the *Whidbey Island*–class ships.	2		**LPD-17 Flight II** Timeline: **2025–2029** Previously known as LX(R), the LPD–17 Flight II program will procure 13 ships to replace the Navy's LSD-type ships. The Navy originally planned to procure the first Flight II ship in FY 2020, but accelerated procurement funding enabled procurement of the first LPD-17 Flight II in FY 2018. The Navy delayed the second ship planned for FY 2020, until FY 2021. In the FY 2023 budget request, the Navy requested procurement for one Flight II. **PROCUREMENT**: 2 / 1 **SPENDING** *($ millions)*: $2,926 / $1,673	5	4
***Harpers Ferry*-Class Dock Landing Ships (LSD-49)** Inventory: **4** Fleet age: **25.5** Date: **1995** The *Harpers Ferry*-class reduced LCAC capacity to two while increasing cargo capacity. They have an expected service life of 40 years and all ships will be retired by FY 2038. The LSD-49 will be replaced by the LPD–17 Flight II, which began procurement in FY 2018. Before 2026, the Navy plans to retire four of the *Harpers Ferry*–class ships.	3				

NOTE: See page 386 for details on fleet ages, dates, timelines, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Airborne Early Warning

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
E-2C Hawkeye Inventory: **26** Fleet age: **39** Date: **1973** The E-2C Hawkeye is a battle management and airborne early warning aircraft. The aircraft uses computerized radar and electronic surveillance sensors for threat analysis and early warning. The E-2C fleet received a series of upgrades to mechanical and computer systems around the year 2000. While still operational, the E-2C is nearing the end of its service life and is being replaced by the E-2D Advanced Hawkeye.	1	3	**E-2D Advanced Hawkeye** Timeline: **2014–2023** The E-2D Advanced Hawkeye replaces the legacy E-2C and is in production. The Navy received approval for a five year multi-year procurement plan beginning in FY 2019 for 24 aircraft to complete the program of record. An additional five aircraft were requested for procurement in FY 2023 after five were procured in FY 2022. **PROCUREMENT** 112 / 13 **SPENDING** *($ millions)* $14,569 / $3,490	4	4
E-2D Advanced Hawkeye Inventory: **48** Fleet age: **4.5** Date: **2014** The E-2D program is the next-generation, carrier-based early warning, command, and control aircraft that provides improved battle space detection, supports theater air missile defense, and offers improved operational availability. The E-2D AHE is replacement for the E-2C platform. As of FY 2022, 112 E-2D AHE were procured, and an additional five aircraft are requested for FY 2023.	5	4			

Electronic Attack Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
EA-18G Growler Inventory: **158** Fleet age: **9** Date: **2009** The EA-18G Growler is the U.S. Navy's electronic attack aircraft, providing tactical jamming and suppression of enemy air defenses. The final EA-18G aircraft was delivered in FY 2018, bringing the total to 160 aircraft and fulfilling the Navy's requirement. It replaced the legacy EA-6B Prowlers. The Navy proposed to retire 25 EA-18Gs across five land-based expeditionary electronic attack squadrons in its FY 2023 budget request. However, the Senate Armed Services Committee, in its markup of the FY 2023 National Defense Authorization Act (NDAA), prevented the retirement of the aircraft. The final decision to retire the 25 EA-18Gs waits to be confirmed.	5	4	None		

NOTE: See page 386 for details on fleet ages, dates, timelines, and procurement spending.

NAVY SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Fighter/Attack Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
F/A-18E/F Super Hornet Inventory: **598** Fleet age: **18** Date: **2001** The F/A-18 E/F Super Hornet has longer range, greater weapons payload, and increased survivability than the F/A-18A-D Legacy Hornet. The Navy plans to achieve a 50/50 mix of two F-35C squadrons and two F/A-18E/F Block III squadrons per carrier air wing by the mid-2030s. The ongoing service life extension program will extend the life of all Super Hornets to 9,000 flight hours. As of FY 2022, 690 F/A-18 E/F Super Hornets were procured.	3	3	**F-35C Joint Strike Fighter** Timeline: **2019–TBD** The F-35C is the Navy's variant of the Joint Strike Fighter. The Joint Strike Fighter faced many issues during its developmental stages, including engine problems, software development delays, cost overruns incurring a Nunn–McCurdy breach, and structural problems. The Navy declared initial operational capability (IOC) of the F-35C in February 2019. The planned procurement of 273 F-35Cs will replace over 500 Super Hornets. As of FY 2022, 164 of the aircraft have been procured with an additional 13 being requested for procurement in FY 2023. **PROCUREMENT** 164 205 **SPENDING** *($ millions)* $24,778 $24,774	2	3
F-35C Joint Strike Fighter Inventory: **35** Fleet age: **2** Date: **2019** The C-variant is the Navy's fifth-generation aircraft, brining radar-evading technology to the carrier deck for the first time. The F-35C performs a variety of missions to include air-to-air combat, air-to-ground strikes, and ISR missions. As of FY 2022, 164 of the F-35C variant were procured, with 205 expected to be procured beginning in FY 2023.	5	4	**F/A-18 Super Hornet** The Navy plans to buy 108 Block III Super Hornets by 2024 and modernize most of its existing Super Hornets to Block II standards. All Block III Super Hornets will have a life span of 10,000 flight hours, which is 50 percent greater than that of earlier F/A-18E/F aircraft. As of FY 2022, 690 F/A-18 E/F Super Hornets were procured.		

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

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Littoral Combat Ship

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U.S. Air Force

John Venable

The mission of the U.S. Air Force has expanded significantly since 1947 when the USAF became a separate service. Initially, operations were divided among four major components—Strategic Air Command, Tactical Air Command, Air Defense Command, and Military Air Transport Service—that collectively reflected the Air Force's "fly, fight, and win" nature. Space's rise to prominence in the early 1950s brought a host of capabilities that would expand the service's portfolio and increase its capabilities in the mission areas of intelligence, surveillance, and reconnaissance (ISR) and command and control (C2). With the birth of the Space Force in December 2019,[1] the Air Force began to move its space and space-related personnel assets to the new service. The impact of that change, coupled with the lingering effects of the global COVID-19 pandemic that were highlighted in the *2022 Index of Military Strength*, continue to hamper the trajectory of the Air Force.

The creation of the Space Force affected three Air Force mission areas: air and space superiority, ISR, and C2. Each of these mission areas was born from air-breathing assets, and while the loss of the space portfolio has reduced the service's inherent capabilities, they remain within the Department of the Air Force (DAF) and should allow the Air Force to focus the weight of its efforts on core missions in the air and cyber domains.

Today's Air Force has five principal missions:

- Air superiority (space superiority is now the responsibility of the Space Force);
- Intelligence, surveillance, and reconnaissance;
- Mobility and lift;
- Global strike; and
- Command and control.

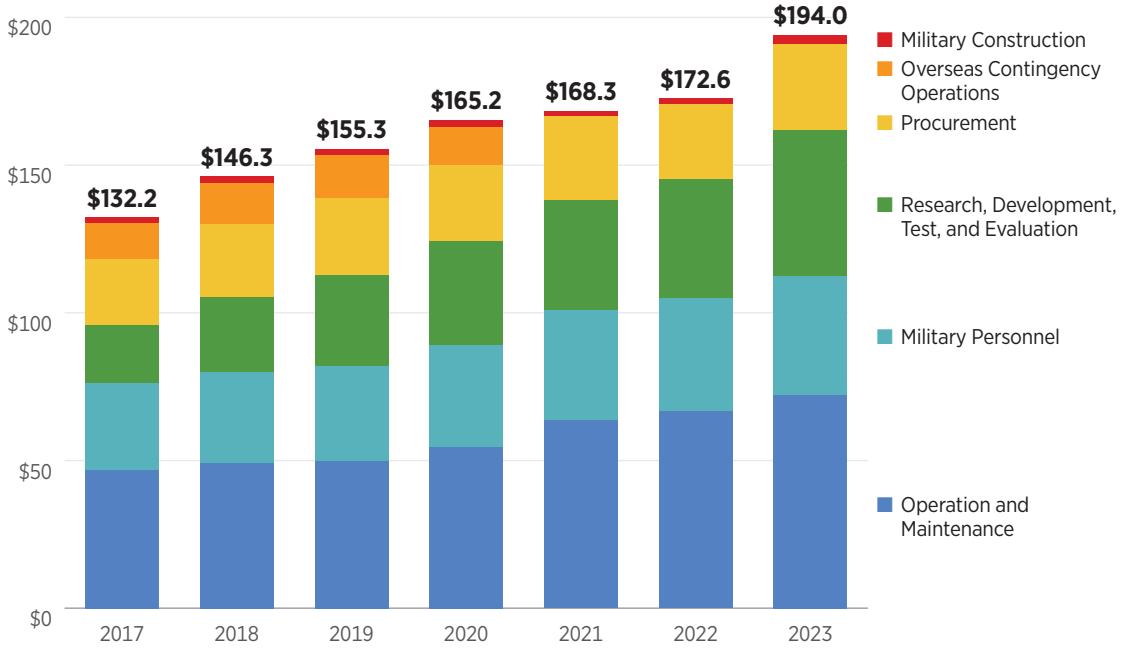
The summer of 2022 should have found the Air Force all but fully recovered from the effects of COVID-19. Readiness levels as measured by operational sortie rates and flying hours should have been well above the historic lows reached during the pandemic; instead, they have grown only marginally. The service's ability (or willingness) to fund and then generate sorties and flying hours for training has now spiraled well below the hollow-force days of the Carter Administration with equally dismal readiness levels. Training pipeline capacity for basic military training, officer accessions, and pilot training are back up to pre-pandemic levels, but a vibrant job market and steadily increasing civilian wages have stymied recruiting, and while the Air Force met its recruiting goals in 2021, it will struggle to meet accession requirements for fiscal year (FY) 2022.[2] Moreover, in spite of more than 30 years of reductions in force size that left the Air Force 25 percent below the capacity level required for a fight with a peer competitor,[3] the service has conveyed its intentions to reduce the fighter force by almost 20 percent over the next five years.[4]

On its face, that might not seem to be particularly worrisome, but the force structure required for a fight with China would significantly exceed the demands of a single major regional contingency (MRC). It would also require capability and readiness levels that significantly exceed what the Air Force possesses as it enters FY 2023. The Air Force did not have the funding required to increase capacity or develop any one of those critical areas, and it continues to defer their development under the overused mantra

CHART 9

Air Force Budgets, 2017–2023

IN BILLIONS OF U.S. DOLLARS



NOTE: FY 2023 figures are proposed.
SOURCES: Extracted from U.S. Air Force budget summaries for FY 2017 through FY 2023. For example: Table 1, "Air Force Budget Highlights Summary," in U.S. Department of the Air Force, *United States Air Force Fiscal Year 2017 Budget Overview*, February 2016, p. 15, https://www.saffm.hq.af.mil/Portals/84/documents/FY17/AFD-160209-036.pdf?ver=2016-08-24-102126-717 (accessed September 8, 2022), and Table 1, "Department of the Air Force Budget Summary," in U.S. Department of the Air Force, *Department of the Air Force FY 2023 Budget Overview*, p. 2, https://www.safm.hq.af.mil/Portals/84/documents/FY23/SUPPORT_/BOB_28Mar_1125_LoRes.pdf?ver=5nrA8bBfhWoUSrvZ09CeHA%3d%3d (accessed September 8, 2022).

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of "taking more risk." Understanding the depth of the hole this service is in begins with a bit of history.

Unlike some of the other services, the Air Force did not grow larger during the post-9/11 buildup. Instead, it grew smaller as acquisitions of new aircraft failed to offset programmed retirements of older aircraft. Following the sequestration debacle in 2012, the Air Force began to trade size for quality.[5] Presidential defense budgets from 2012 through 2017 during the Obama Administration proved merely aspirational, and as the service sustained the war on terrorism, it struggled also to sustain the type of readiness required to prevail in a major regional contingency (MRC) against a near-peer threat.

The Air Force was forced to make strategic trades in capacity, capability, and readiness to meet the operational demands of the war on terrorism and develop the force it needed for the future. The collective effects left the Air Force of 2016 with just 55 total force fighter squadrons, and the readiness levels within those organizations were very low. Just four of the Air Force's 32 active-duty fighter squadrons were ready for conflict with a near-peer competitor, and just 14 others were considered ready even for low-threat combat operations.[6]

Recognizing the threat from a rising China and resurgent Russia, the 2018 National Defense Strategy (NDS) directed the services to prepare for a

large-scale, high-intensity conventional conflict with a peer adversary.[7] Later that same year, the Air Force released "The Air Force We Need" (TAFWN), a study of the capacity it would need to fight and help the U.S. win such a war. Based on thousands of war-game simulations, the study found that the service needed to grow by 25 percent, from 312 to 386 squadrons, to execute that strategy. That growth included one additional airlift squadron and seven additional fighter, five additional bomber, and 14 additional tanker squadrons,[8] which equates to an additional 182 fighter, 50 bomber, 210 air refueling, and 15 airlift platforms.[9] During the same period, the service's most senior leaders emphasized the need for more time in the air for aircrews. Secretary of the Air Force Heather Wilson, for example, "noted that even when air crews go abroad and fly combat missions, such as those against violent extremists such as the Islamic State, they're not practicing skills that would be required for a high-end fight against an advanced adversary such as Russia."[10] Taken together, all of these demands required a bigger budget.

In a series of speeches in 2018, Secretary Wilson and Air Force Chief of Staff General David Goldfein highlighted the shortfall and the need for more funding to increase the service's capacity with next-generation platforms: in other words, to buy all-new-design aircraft rather than continuing to purchase aircraft that have been in production since the 1980s and 1990s.[11] To meet that requirement, the Trump Administration increased DAF funding by 31 percent from 2017 to 2021.[12]

Considering the shortfall in aircraft, one might assume that the Air Force increased its procurement budget and accelerated acquisition of fifth-generation offensive platforms (F-35A) and next-generation tanker aircraft (KC-46A) during that period by a substantial margin. However, funding for aircraft procurement remained relatively flat, growing from $22.4 billion in FY 2017 to just $25.6 billion in FY 2022—a rate of growth that did not keep up with inflation. The budget for procurement fell from $28.4 billion in FY 2021 to $25.6 billion in FY 2022. While the President's budget for FY 2023 increased procurement to $29.3 billion,[13] it had not been approved as this edition of the *Index* was being prepared. If it is not approved, the service will be forced to operate on continuing resolutions. Moreover, even if the budget is fully funded, the impact of inflation has meant that procurement has been flat from FY 2017 to FY 2023, even as the service's budget has grown by 21 percent over the same period.

The budget for research, development, test and evaluation (RDT&E), on the other hand, has more than doubled since FY 2017, growing from $20.5 billion in FY 2017 to $49.2 billion in FY 2023. It now exceeds procurement by almost 70 percent.[14] In spite of TAFWN's finding that the Air Force was 25 percent too small for its mission sets, the Air Force announced last year that it would retire 421 F-22, F-15C, F-16C, and A-10 fighters by the end of FY 2026 while acquiring just 304.[15] However, earlier this year, it was revealed that the Air Force plans to cut 1,468 aircraft from its fleet over the Future Years Defense Program (FYDP) and that this will include the accelerated retirement of 646 fighters and procurement of just 246 over that period.[16] If enacted, this would equate to a net reduction of 19 percent of the total fighter fleet.

Capacity

At the height of the Cold War buildup in 1987, the active-duty Air Force had an inventory of 3,082 fighter, 331 bomber, 576 air refueling, and 331 strategic airlift platforms. When the strategic reserve assets within the Air National Guard and Air Force Reserve are added, the 1987 totals were 4,468 fighter, 331 bomber, 704 air refueling, and 362 strategic airlift platforms. After the fall of the Iron Curtain, the United States shifted from a force-sizing construct centered on great-power competition to one capable of winning two simultaneous or nearly simultaneous MRCs. Those numbers for capacity have been reduced significantly over the years.

It is projected that at the end of FY 2022, the Air Force will have a total aircraft inventory (TAI) of 2,099 fighters, 140 bombers, 483 tankers, and 274 strategic airlift platforms. With the rollout of the President's budget for FY 2023, the service announced its plan to reduce 167 total fighters from its inventory, reducing its TAI to 1,932 fighters, 140 bombers, 483 tankers, and 274 strategic airlift aircraft by the end of FY 2023.[17] At that point, the Air Force will have a total force that equates to 43 percent of the fighter, 42 percent of the bomber, and 69 percent of the tanker and airlift assets that it possessed the last time the United States was prepared to fight a peer competitor.

The idea that aircraft production lines will somehow surge to come to the rescue in a peer-level crisis

may seem plausible to some,[18] but even if Congress were to throw an unlimited amount of funding at production lines, it would take from two to three years for those additional assets to arrive.[19]

The *Index of U.S. Military Strength* uses "combat-coded" fighter aircraft within the Active Component of the U.S. Air Force to assess capacity. Combat-coded aircraft and related squadrons are aircraft and units with an assigned wartime mission, which means that those numbers exclude units and aircraft assigned to training, operational test and evaluation (OT&E), and other missions.

The software and munitions carriage and delivery capability of aircraft in non-combat-coded units renders them incompatible with and/or less survivable than combat-coded versions of the same aircraft. For example, all F-35As may appear to be ready for combat, but training wings and test and evaluation jets have hardware and software limitations that would severely curtail their utility and effectiveness in combat. Even if those jets were slated for upgrades, hardware updates sideline jets for several months, and training wings and certain test organizations are generally the last to receive those upgrades.

Of the 5,564 manned and unmanned aircraft projected to be in the USAF's inventory at the end of FY 2022, 1,487 are active-duty fighters, and 940 of those are combat-coded aircraft.[20] It is important to separate the active-duty fighters and units from the strategic reserve because it would take several months to get elements of the latter up to manning and readiness levels that allowed their first elements to deploy. Unfortunately, other factors also affect the number of fighters the service could actually employ in combat.

Most squadrons will have to pack up and deploy several thousand miles to be able to fight. Because of the additional wartime manning requirements and the fact that most squadrons have several jets that are in disrepair at any given time, it takes the resources of approximately three active-duty squadrons to deploy two combat-capable fighter units forward.[21] That effectively reduces the total number of active-duty, combat-coded fighters to 626 jets.

The strategic reserve has 661 fighters, 519 of which are combat coded. Because of the additional manning requirements and the fact that Guard and Reserve units generally have just one squadron at each location, it takes two squadrons to deploy one combat-capable unit forward.[22] In terms of capacity, this means that 626 active-duty and 259 strategic reserve fighters, for a total of 885 combat-coded fighters, could be deployed into combat, leaving virtually nothing in reserve. However, recent squadron deployments in response to a request from the Commander of U.S. European Command following Russia's invasion of Ukraine were fulfilled with 12 jets—packages that were referred to as "squadrons." This may have reflected the "lead force package" (LFP) concept within the 2020 Air Force posture statement: "More than 90% of our pacing squadrons are ready to 'fight tonight' with their lead force packages—the first Airmen to deploy at the beginning of a conflict."[23] However, it is more likely a combination of LFPs and severe readiness challenges within the fighter force.

Capacity also relies on the stockpile of available munitions and the production capacity of the munitions industry. The actual number of munitions within the U.S. stockpile is classified, but there are indicators that make it possible to assess the overall health of this vital area. The inventory for precision-guided munitions (PGM) was severely stressed by nearly 18 years of sustained combat operations and budget actions that limited the service's ability to procure replacements and increase stockpiles. From 2017 through 2021, funding for munitions was significant, and the service, believing the inventory is now sufficiently restocked, has reduced the number of PGMs it will acquire to a total of 6,473 munitions in FY 2023.

However, even though the munitions stockpile may have returned to a level that is capable of supporting a surge in expenditures associated with a conflict similar to the global war on terrorism—loosely encompassing operations in Afghanistan and Iraq—it probably would not support a peer-level fight that lasted more than a few weeks. Typically, there is a delay of 24–36 months between funding and delivery of additional munitions, and while the potential exists for a rapid expansion of production, it is hard to envision how such an expansion could be rapid enough to exceed demand before the stockpile is depleted. (See Table 7.)

Advances in the jamming of global navigation satellite systems (GNSS) like GPS have been significant over the past 20 years, and the number, types, and effectiveness of jammers are growing.[24] In the days leading up to its invasion of Ukraine and throughout

TABLE 7

Precision-Guided Munitions Expenditures and Programmed Acquisitions

TOTAL MUNITIONS EXPENDED

	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022*
JDAM	30,664	5,462	7,354	4,004	4,242	4,032
HELLFIRE	1,536	2,110	2,449	1,019	1,023	180
SDB-I/II	4,507	749	1,289	397	98	84
APKWS	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
JASSM-ER	360	19	16	10	8	0
LGB	276	373	106	6,078	5,625	4,356
ARRW**	0	0	0	0	0	2
LRASM	0	0	0	0	0	0
Total	**38,092**	**9,462**	**11,963**	**11,508**	**10,996**	**8,654**

TOTAL MUNITIONS ACQUIRED

	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023*
JDAM	35,106	36,000	25,000	16,800	1,919	1,241
HELLFIRE	3,629	3,734	3,859	4,517	1,176	5,151
SDB-I/II	7,312	6,254	8,253	3,205	1,983	5,837
APKWS	10,621	6879	15,642	1,323	12,801	11,199
JASSM-ER	360	360	390	400	525	390
LGB	0	0	0	0	0	0
ARRW**	0	0	0	0	12	0
LRASM	0	0	0	0	0	28
Total	**57,777**	**53,976**	**53,893**	**26,994**	**18,416**	**23,818**

* Estimate based on data from President's Budget.

** Air-launched Rapid Response Weapon (ARRW) is a hypersonic, long-range, conventional air-to-surface missile with precision-guided, prompt-strike capability from stand-off ranges.

SOURCES: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information, May 11, 2022; Table 2, "U.S. Air Force Budget Summary," in U.S. Department of the Air Force, *Department of the Air Force FY 2023 Budget Overview*, p. 4, https://www.saffm.hq.af.mil/Portals/84/documents/FY23/SUPPORT_/BOB_28Mar_1125_LoRes.pdf?ver=5nrA8bBfhWoUSrvZ09CeHA%3d%3d (accessed September 8, 2022); U.S. Department of the Air Force, *Department of Defense Fiscal Year (FY) 2022 Budget Estimates, Air Force Justification Book Volume 1 of 1, Procurement of Ammunition, Air Force*, May 2021, p. Volume 1-7, https://www.saffm.hq.af.mil/Portals/84/documents/FY22/PROCUREMENT_/FY22%20DAF%20J-Book%20-%203011%20-%20Ammunition%20Proc.pdf?ver=PaFt7rWf7aiKYJhl-cpv9w%3d%3d (accessed September 8, 2022); and Dario Leone, "Second Successful Test of AGM-183A ARRW Hypersonic Weapon, Booster Tests Complete," The Aviation Geek Club, July 14, 2022, https://theaviationgeekclub.com/second-successful-test-of-agm-183a-arrw-hypersonic-weapon-booster-tests-complete/ (accessed September 8, 2022).

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its combat operations, Russia has used its systems to jam signals in the region to hamper the employment of Ukrainian and Allied GNSS guided weapons systems against its troops and equipment, and the areas covered by the effects of those systems can be considerable.[25] The employment of such systems in a war with a peer adversary could significantly diminish the accuracy of weapons like JDAMs and SDBs that rely on reliable GPS guidance to hit their targets.

Although there has been significant research toward making munitions less susceptible to the effects of GPS jammers, there is little evidence that such munitions would retain their accuracy during a full-up conflict with a peer adversary. Attacking targets in that environment using GPS guidance alone might require many more munitions and sorties than would otherwise be necessary, and this probably would deplete the inventory of GPS guided munitions much faster and with markedly less effect than is likely accounted for in current war plans.

The only weapons in the U.S. inventory that can fully counter GPS/electronic jammers and reliably hit their targets are those that can track physical targets with laser, optical, or infrared seeker heads. The Air Force has not acquired PaveWay or Maverick missiles for several years, and most GPS guided munitions do not have seeker heads or a secondary capability to track and guide on a target in a degraded GPS environment.

To cover this gap, the Air Force has added a laser guidance capability to its already effective GBU-53 smaller diameter bomb (SDB I). Known as the SDB II, the weapon "uses Link 16 and ultra-high frequency datalinks, along with infrared guidance, to provide course corrections" and hit "both fixed and moving targets."[26] Funding in the FY 2023 budget will also support the acquisition of 4,200 JDAM guidance kits with laser sensors that will give this munition a seeker to acquire/track targets.[27] Unfortunately, the service has not yet acquired the SDB II or the advanced JDAM guidance kits in numbers required for conflict with a peer competitor.

Capability

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

Any assessment of capability includes both the incorporation of advanced technologies and the overall health of the inventory. Most aircraft have programmed life spans of 20 to 30 years based on a programmed level of annual flying hours. The bending and flexing of airframes over time in the air generates predictable levels of stress and fatigue on everything from metal airframe structures to electrical wiring harnesses.

The average age of Air Force aircraft is 29.4 years, and in some fleets, such as the B-52 bomber, the average is more than 60 years. In addition, KC-135s comprise 75 percent of the Air Force's 483 tankers and are more than 61 years old on average. By the end of FY 2023, 95 brand-new KC-46s will make up 20 percent of the tanker inventory, but they will not be capable of refueling aircraft during combat operations—the jet's primary mission—until FY 2024.[28] By that time, the Air Force will have taken possession of some 103 KC-46s. The Air Force estimates that the fix for problems in the KC-46's refueling boom and remote vision system (RVS) should be ready by the spring of 2024. Assuming the boom and RVS redesign goes as planned, retrofitting jets that the service has already accepted will take several years, and the operational impact of that process will be significant: 103 strategic air refueling assets will be unusable in real-world operations in 2024. That number will grow to 110 jets in 2025, equating to 23 percent of the fleet that will be unable to fulfill operational taskings reliably.[29]

The average age of the F-15C fleet is 37.8 years,[30] significantly exceeding the programmed service life of a fleet that comprises more than half of USAF air superiority platforms.[31] The planes in the F-16C and F-16D fleets are 31 and 31.9 years old, respectively, on average.[32] In 2018, the Air Force announced its intent to extend the service lives of 300 F-16s through a major service life extension program (SLEP) that will allow those jets to fly through 2050.[33] SLEPs lengthen the useful life of airframes, and these F-16 modifications also include funding for the modernization of avionics within those airframes. These modifications are costly, and the added expense reduces the amount of funding the service has to invest in modernization, which is critical to ensuring future capability. Even with a SLEP, there is a direct

TABLE 8

Air Force Total Aircraft Inventory (Page 1 of 3)

	FY 2022					MISSION-CAPABLE (MC)				FY 2023		
Type	Active Duty	Air National Guard	Air Force Reserve	Total	Average Age in Years	MC Rate FY 2020	MC Rate FY 2021	Change	Average Daily MC Aircraft, FY 2023	Programmed Retirements	Programmed Acquisitions	Total
A010C	141	85	55	281	41	72%	73%	1%	189	-21	0	260
AC130J	30	0	0	30	4	82%	84%	2%	25	0	0	30
B-1B	45	0	0	45	35	53%	41%	-12%	18	0	0	45
B-2A	20	0	0	20	27	62%	59%	-3%	12	0	0	20
B-52H	58	0	18	76	61	61%	59%	-2%	45	0	0	76
C-130H	0	86	42	128	30	70%	69%	-1%	82	-10	0	118
C-130J	114	27	10	151	13	79%	76%	-3%	116	0	2	153
C-5M	36	0	16	52	35	61%	57%	-3%	30	0	0	52
C-17A	146	50	26	222	20	82%	80%	-2%	178	0	0	222
CV022B	52	0	0	52	9	54%	51%	-3%	26	0	0	52
E003B	2	0	0	2	43	66%	56%	-10%	0	-2	0	0
E003C	2	0	0	2	38	77%	0%	-77%	0	-2	0	0
E003G	27	0	0	27	42	71%	61%	-10%	10	-11	0	16
E008C	0	12	0	12	22	67%	62%	-5%	2	-8	0	4
E11	4	0	0	4	11	n/a	n/a	n/a	n/a	0	2	6
EC130H	7	0	0	7	48	67%	67%	0%	3	-3	0	4
EC130J	0	7	0	7	22	53%	64%	12%	4	-1	0	6
F015C	46	122	0	168	38	72%	69%	-2%	74	-61	0	107
F015D	4	14	0	18	38	71%	69%	-2%	8	-6	0	12
F015E	218	0	0	218	30	69%	66%	-3%	144	0	0	218

TABLE 8

Air Force Total Aircraft Inventory (Page 2 of 3)

	FY 2022					MISSION-CAPABLE (MC)				FY 2023		
Type	Active Duty	Air National Guard	Air Force Reserve	Total	Average Age in Years	MC Rate FY 2020	MC Rate FY 2021	Change	Average Daily MC Aircraft, FY 2023	Programmed Retirements	Programmed Acquisitions	Total
F015EX	2	0	0	2	1.5	n/a	0%	n/a	0	0	6	8
F016C	421	277	52	750	32	74%	72%	–2%	521	–22	0	728
F016D	98	39	2	139	33	72%	69%	–3%	94	–4	0	135
F022A	166	20	0	186	16	52%	51%	–1%	95	0	0	186
F035A	356	20	0	376	5	76%	69%	–7%	297	0	56	432
HC130J	21	12	6	39	6	80%	76%	–4%	30	0	0	39
HH060G	38	18	16	72	29	69%	71%	2%	43	–12	0	60
HH060W	25	0	0	25	0.5	0%	0%	0%	0	0	14	39
KC010A	36	0	0	36	38	81%	79%	–1%	21	–10	0	26
KC046A	52	12	7	71	2	67%	71%	5%	68	0	24	95
KC135R	119	140	62	321	60	73%	71%	–2%	219	–13	0	308
KC135T	30	24	0	54	63	73%	70%	–3%	38	0	0	54
LC130H	0	10	0	10	36	44%	43%	–1%	4	0	0	10
MC130H	11	0	0	11	33	74%	75%	1%	0	–11	0	0
MC130J	55	0	0	55	7	76%	79%	3%	47	0	4	59
MQ009A	340	24	0	364	7	91%	90%	–1%	248	–100	12	276
RC135S	3	0	0	3	60	88%	86%	–2%	3	0	0	3
RC135U	2	0	0	2	58	87%	82%	–5%	2	0	0	2
RC135V	8	0	0	8	58	78%	73%	–5%	6	0	0	8
RC135W	12	0	0	12	60	81%	66%	–15%	8	0	0	12

TABLE 8

Air Force Total Aircraft Inventory (Page 3 of 3)

	FY 2022					MISSION-CAPABLE (MC)				FY 2023		
Type	Active Duty	Air National Guard	Air Force Reserve	Total	Average Age in Years	MC Rate FY 2020	MC Rate FY 2021	Change	Average Daily MC Aircraft, FY 2023	Programmed Retirements	Programmed Acquisitions	Total
RQ–4	10	0	0	10	12	74%	74%	0%	7	–1	0	9
T001A	177	0	0	177	28	68%	74%	6%	94	–50	0	127
T006A	442	0	0	442	17	74%	71%	–3%	314	0	0	442
T007A	0	0	0	5	1	0%	71%	0%	4	0	0	5
T038A	53	0	0	53	56	71%	72%	1%	38	0	0	53
T038C	439	0	0	439	56	65%	63%	–2%	276	0	0	439
U2	31	0	0	31	40	73%	76%	2%	23	0	0	31

SOURCES: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information, May 11, 2022; Table 2, "Department of the Air Force Budget Summary," in U.S. Department of the Air Force, *Department of the Air Force FY 2023 Budget Overview*, p. 4, https://www.saffm.hq.af.mil/Portals/84/documents/FY23/SUPPORT_/BOB_28Mar_1125_LoRes.pdf?ver=5nrA8bBfhWoUSrvZ09CeHA%3d%3d (accessed August 29, 2022); and International Institute for Strategic Studies, *The Military Balance 2022: The Annual Assessment of Global Military Capabilities and Defence Economics* (London: Routledge, 2022), pp. 56–59 (accessed August 14, 2022).

correlation between aircraft age and the maintainability of those platforms. (See Table 8.)

The Air Force's ISR and lift capabilities face similar problems in specific areas that affect both capability and capacity. The majority of the Air Force's ISR aircraft are now unmanned aerial vehicles (UAVs). The Air Force will divest 100 MQ-9 Block-1 aircraft and accept delivery of 12 MQ-9 Block-5s in FY 2023 for a total of 276 Reapers.[34] The service divested the last of its fleet of EQ-4s and Block 30 RQ-4s in FY 2021 and FY 2022, respectively. The RQ-4 Block 40 fleet remains in service, and the RQ-4 Block 30 mission will be carried on by the 40-year-old U-2,[35] which is scheduled to be divested by the end of the current FYDP.[36]

The E-8 Joint Surveillance Target Attack Radar System (J-STARS) and RC-135 Rivet Joint are critical ISR platforms. Each was built on the Boeing 707 platform, and the last one came off the production line 43 years ago. The Air Force will divest eight of its remaining E-8s in FY 2023, leaving it with just three operational platforms.[37]

The Air Force is working on an incremental approach for a J-STARS replacement that focuses on advanced and disaggregated sensors (a system of systems) that would require enhanced and hardened communications links. Known as the Advanced Battle Management System (ABMS), it is envisioned as an all-encompassing approach to both airborne and ground Battle Management Command and Control (BMC2) that would allow the Air Force both to fight and to support joint and coalition partners in high-end engagements.[38]

With respect to air combat, the Air Force will retire 67 more F-15C/Ds in FY 2023, leaving just 119 in its inventory.[39] Concerns about what platform will fill this role when the F-15C is retired are fully justified. Just 186 of 750 planned F-22A stealth air superiority fighters were acquired to replace the F-15C,[40] and the service has announced its intent to retire 33 Block 20 F-22s in FY 2023. If those jets are retired,[41] the fleet will be reduced to just 153 jets.[42]

The service's already low ability to fulfill operational requirements for air superiority fighters will be further strained by a 10-year program, intended to refurbish the low-observable coatings on the F-22's engine inlets and inspect and overhaul the aircraft's flight control system, that will run through 2031.[43] That program, coupled with the F-22's low mission capability rate, will significantly hobble the availability of this system in a fight with a peer competitor.

The Air Force's number-one acquisition priority remains the F-35A, the next-generation fighter that is scheduled to replace all legacy multirole and close air support aircraft. The jet's full operating capability (FOC) was delivered in early 2018.[44] The F-35A's multirole design favors the air-to-ground mission, but its fifth-generation faculties will also be dominant in an air-to-air role, allowing it to augment the F-22A in many scenarios.[45] In spite of the jet's dominant performance in the air, relatively high mission-capable rates, and acquisition and sustainment costs that are at or below those for the F-15EX,[46] the Air Force has reduced the number of F-35As that it will acquire to just 33 jets in FY 2023 and 29 in FY 2024.[47]

In terms of funding, the second major USAF acquisition priority is the B-21 Raider, formerly called the Long-Range Strike Bomber (LRSB). The USAF awarded Northrop Grumman the B-21 contract to build the Engineering and Manufacturing Development (EMD) phase, which includes associated training and support systems and initial production lots. The program has completed an Integrated Baseline Review for the overall B-21 development effort as well as the jet's Preliminary Design Review. The Air Force is committed to a minimum of 100 B-21s at an average cost of $639 million per plane in FY 2019 dollars.[48]

With the budget agreement that was reached for FY 2018 and FY 2019, the Secretary of the Air Force announced the service's intent to retire all B-1s and B-2s and sustain a fleet comprised of 100 B-21s and 71 B-52s.[49] The B-21 Raider and B-52s "will form a two-bomber fleet that will incrementally replace the aging fleet of B-1 Lancer and the B-2 Spirit bombers," and the B-21 is "slated to hit full operations in the mid-2020s."[50] The Air Force retired 17 B-1s in 2021 and continues to execute a SLEP on the remaining fleet of 44 to restore the bomber's engines to their original specifications. The Air Force had planned to modernize the B-2's Defense Management System but cancelled the plan in 2021 because of a software coding mismatch with its legacy computer system.[51] Stores Management Operational Flight Program and Common Very-Low-Frequency/Low Frequency Receiver Program elements will be fielded to ensure that this penetrating bomber remains viable in highly contested environments, keeping it fully mission capable until it is replaced by the B-21.[52]

Modernization efforts for the B-52 are also underway. The jet was designed in the 1950s, and the current fleet entered service in the 1960s. The FY 2018 budget funded the re-engineering of this fleet with upgrades that will include a new Long-Range Standoff (LRSO) cruise missile, improved radar, new computers, new communication links, and a new suite of electronic warfare countermeasures. The aircraft will remain in the inventory through 2050.[53]

Acquisition of the KC-46A air refueling tanker is another critical enabler for the service. As previously noted, the KC-46 has experienced a series of problems and delays, the most recent of which involves the air refueling system that currently cannot refuel fighters in an operational environment. The Air Force will have 95 KC-46s by the end of FY 2023[54] and will acquire another 84 tankers for a total of 179 by the end of FY 2029. The KC-46 will replace less than half of the current tanker fleet and will leave the Air Force with more than 200 aging KC-135s (already averaging 61 years old) that still need to be recapitalized.[55]

When the Secretary of the Air Force (SECAF) and the Chief of Staff of the Air Force (CSAF) rolled out "The Air Force We Need" in 2018 to expand the number of squadrons from 312 to 386, one of their goals was to fill the ranks of those new squadrons with only the newest generation of aircraft—F-35s, B-21s, and KC-46s—because of the capabilities that those platforms bring to bear.[56] Curiously, the Air Force is now acquiring the fourth-generation F-15EX, based primarily on the ill-conceived notion that it will be cheaper to acquire and operate than the F-35A.[57] The FY 2023 budget funds 24 F-15EXs and signals an intent to cap the purchase at just 80 jets. With the latest cuts in the fighter force, the service has reversed course on its stated intent to use them to replace Air National Guard F-15Cs; instead, approximately half of the F-15EX fleet will be fielded in active-duty units. Although the service will offset some of its fighter fleet retirements with this new hardware, the F-15EX is a step backwards and will not be survivable in anything more than low-threat environments by the time this weapons system reaches initial operating capability (IOC).

Readiness

The 2018 National Defense Strategy's focus on peer-level war was designed to facilitate a clear and rapid paradigm shift away from the tiered levels of readiness the Air Force had adopted because of years of relentless deployments and funding shortfalls. In a move that would refine the service's focus on great-power competition as spelled out by the new NDS, Secretary of Defense James Mattis directed the Air Force to increase the mission-capable rates of the F-16, F-22, and F-35 aircraft to 80 percent by the end of September 2019.[58] The move was designed to make more of an all-too-small fleet of combat aircraft available to deploy in the numbers required to deter or defeat a peer adversary.

Early in 2019, General Goldfein stated that the service would likely not meet the 80 percent mission-capable (MC) threshold directive until 2020, and in the spring of 2020, he made it clear that the threshold was no longer a focus for the Air Force. MC rates are a measure of how much of a certain fleet is "ready to go" at a given time, and the general stated in clear terms that he regarded the statistic as an inaccurate portrayal of the service's overall health.

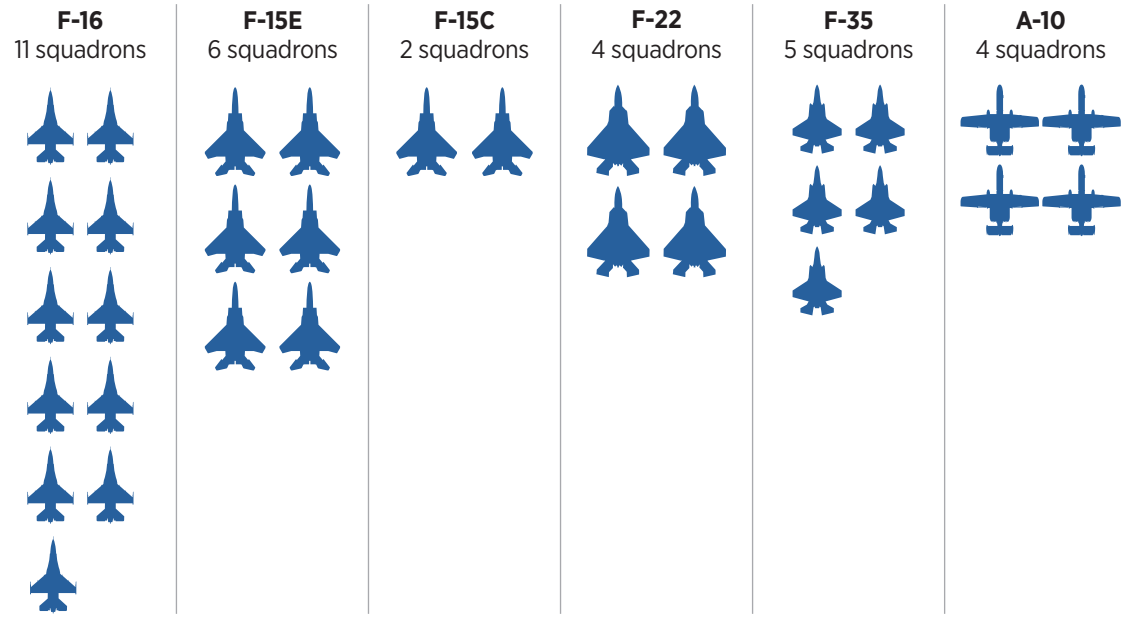
Instead of using that historic marker for readiness, the service moved to highlight how deployable a portion of any fleet was within a short period of time[59] and shifted its focus to the number of "force elements"—fighters, bombers, and tankers—that it has across the Air Force and how quickly those forces need to be ready. One of the examples that Goldfein used was the rapid deployment of a "task force" of four B-52s to the Middle East in May 2019.[60] The bombers, from Barksdale Air Force Base, Louisiana, had two days from notification to deployment, and while the ability to deploy four of 58 operational bombers rapidly is a capability, it is more in line with responding to a regional contingency than it is with taking on a peer adversary.

In the USAF's FY 2020 posture statement, Secretary Wilson and Chief of Staff Goldfein said that more than 90 percent of the "lead force packages" within the service's 204 "pacing squadrons" are "ready to 'fight tonight.'" They went on to say that "pacing squadrons are on track to reach 80% readiness before the end of Fiscal Year 2020."[61] A short time later, however, the service abandoned even the illusion that it was working to achieve that goal.

The FY 2022 Air Force posture statement offered no more clarity or assurances of readiness; instead, it moved to change the paradigm of readiness into a three-phase force-generation model designed to "articulate readiness impacts and capacity limits."[62] In FY 2023, it morphed again into what is now known as the Air Force Generation (AFFORGEN), dividing

FIGURE 3

Air Force Active-Duty Combat-Coded Fighter Squadrons (32 Total)



SOURCES: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information, May 11, 2022, and International Institute for Strategic Studies, *The Military Balance 2022: The Annual Assessment of Global Military Capabilities and Defence Economics* (London: Routledge, 2022), pp. 56–59 (accessed August 15, 2022).

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the deployable combat Air Force into four six-month phases of readiness known as "Ready, Available to Commit, Reset, and Prepare." In theory, the model "builds high-end and sustainable readiness toward future missions by balancing elements of current availability, modernization and risk,"[63] but from the outset, it represents little more than an attempt to change the dialog surrounding what are perhaps the lowest levels of readiness in Air Force history.

In 2017, the Secretary of the Air Force and the Chief of Staff informed Congress that "[w]e are at our lowest state of full spectrum readiness in our history."[64] In the four years since their testimony, DOD has stifled open conversation or testimony about readiness, limiting the Air Force's ability to be forthcoming with open-source readiness indicators. While this makes any assessment of readiness difficult, there are three areas that can support an assessment:

- MC rates,
- Aircrew training, and
- Deployability.

MC rates are defined as the percentage of a unit's aircraft that are capable of executing its mission set. Multiplying MC rates by the actual number of aircraft within a particular fleet yields the physical operational capacity of a weapons system. Several factors drive MC rates. The two most common to mature systems are operations and maintenance (O&M) funding and qualified manning to generate, fix, and fly those jets. Collectively, they dictate the number of sorties and flight hours that units have available for aircrew training.

The last time the United States was prepared to fight a peer competitor, the Air Force had more

TABLE 9

Air Force Flying Hours and Weapons System Sustainment (WSS) Funding

Dollar figures are in millions.

Fiscal Year	Flying Hours	Flying Hours Budget (Nominal Dollars)	WSS Budget (Nominal Dollars)	Flying Hours Budget (2023 Dollars)	WSS Budget (2023 Dollars)
2012	1,189,723	$6,900	$11,900	$8,901	$15,351
2013*	1,165,592	$7,100	$11,600	$9,017	$14,732
2014	1,203,877	$7,800	$10,500	$9,762	$13,141
2015	1,202,971	$7,600	$10,700	$9,500	$13,375
2016	1,219,557	$7,800	$11,500	$9,625	$14,191
2017	1,165,203	$6,700	$12,000	$8,100	$14,508
2018	1,423,000	$6,200	$11,900	$7,316	$14,042
2019	1,454,283	$5,813	$13,161	$6,737	$15,254
2020	1,325,156	$6,063	$14,847	$6,942	$17,000
2021	1,238,206	$6,575	$13,552	$7,186	$14,812
2022	1,150,715	$5,647	$12,299	$5,647	$12,299
2023	1,126,000	$5,872	$13,288	$5,872	$13,288

* Budget Control Act, also known as sequestration, implemented.

NOTES: Weapons System Sustainment supports aircraft sustainment through an enterprise-level concept for managing Depot Maintenance, Contractor Logistic Support (spare parts), Sustaining Engineering, and Technical Orders.

SOURCES: Extracted from U.S. Air Force budget summaries for FY 2013 through FY 2023. For example: U.S. Department of the Air Force, *United States Air Force FY 2013 Budget Overview*, February 2012, p. 12, https://www.saffm.hq.af.mil/Portals/84/ documents/FY13/AFD-120209-052.pdf?ver=2016-08-24-090344-023 (accessed September 8, 2022), and "U.S. Air Force Budget Highlights," in U.S. Department of the Air Force, *Department of the Air Force FY 2023 Budget Overview*, p. 3, https://www.saffm.hq.af. mil/Portals/84/documents/FY23/SUPPORT_/BOB_28Mar_1125_LoRes.pdf?ver=5nrA8bBfhWoUSrvZ09CeHA%3d%3d (accessed September 8, 2022).

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than 700 F-15C air superiority fighters with an MC rate of more than 80 percent for that fleet. If just 500 of them were combat coded, more than 400 mission-capable jets were ready to fight the Soviet Union. Conversely, there are 186 F-22As in the total aircraft inventory, but 28 are dedicated trainers, and 16 are primary development aircraft inventory used for testing new equipment, which leaves just 142 operational jets. In 2021, the F-22A had an MC rate of 51 percent, which means that just 72 F-22As could be committed to combat at any given time.[65] Although the F-22A is an incredibly capable fighter and 72 F-22s would be a formidable capability against a regional threat, that number would be grossly insufficient for a peer fight.

Similarly, there are 33 operational B-1s in the Lancer fleet.[66] With an MC rate of 41 percent in FY 2021 (down from 52 percent in FY 2020), 13 are available for combat at any given time during the year. The B-2 fleet's small size and 59 percent MC rate mean that, on average, just 12 are combat capable. If the B-52's 58-plane operational fleet and 59 percent mission-capable rate are added, a total of 63 Air Force bombers were capable of executing combat missions on any given day in 2021.[67] For a summary of the mission-capable rates for combat-coded

TABLE 10

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

	Combat-Coded Fighters	Average Age in Years	Mission-Capable Rate	Mission-Capable Combat-Coded Fighters
A-10C	115	41	73%	83
F-15C	55	38	69%	38
F-15E	164	30	66%	109
F-16C	336	32	72%	240
F-22A	133	16	51%	68
F-35A	139	5	69%	96
Total	**942**			**634**

NOTE: Thirteen months were added to the age of aircraft because of differences between aircraft data capture dates from the 2022 USAF Almanac and the publication date of this edition of the *Index*.
SOURCES: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force mission-capable rates, May 11, 2022; Table, "Equipment: Aircraft Total Active Inventory (TAI) (As of Sept. 30, 2021)," in "Air Force & Space Force Almanac 2022," *Air Force Magazine*, Vol. 105, No. 6 and 7 (June/July 2022), p. 70, https://www.airforcemag.com/app/uploads/2022/07/Almanac2022_Fullissue-1.pdf (accessed September 8, 2022); and endnote 20.

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(operational) aircraft of the five fighter weapons systems, see Table 10.

Maintenance manning remains healthy across the board. (See Table 11.) If funding for flying hours and spare parts were robust, MC rates would rise, giving pilots more sorties and the capability to sharpen their combat mission-capable skills. Unfortunately, funding for flying hours has increased marginally in the years immediately following sequestration, and the number of available sorties falls well short of the minimum number required for pilots to be considered combat mission capable.

Unlike maintenance manning, the pilot shortage continues to plague the service. In March 2017, Lieutenant General Gina M. Grosso, Air Force Deputy Chief of Staff for Manpower, Personnel, and Services, testified that at the end of FY 2016, the Air Force had a shortfall of 1,555 pilots. Of that total, the Air Force was short 1,211 fighter pilots: 873 Active and 338 from the Active Reserve Component (ARC).[68] Even with the temporary surge in retention caused by COVID-19, the Total Force shortfall is 1,650: 650 Active and 1,000 ARC.[69]

The Air Force graduated 1,200 pilots in FY 2018, added 1,279 in FY 2019, and projected that 1,480 would graduate in 2020, but the impact of COVID-19 was such that only 1,263 received their wings. Another 1,381 graduated in FY 2021, and the Air Force estimated that the number would be similar for FY 2022.

Those projected numbers rely on a very high annual graduation rate of approximately 94 percent of the candidates that enter flight school during any given year. According to the Air Force, the graduation rates for the past four years were 98 percent in 2018, 94 percent in 2019, 85 percent in 2020 (COVID-19), and 95.5 percent in 2021. The vast majority of those who washed out from flight school in 2021 were eliminated for health, discipline, or other reasons not specifically related to performance; only 0.27 percent were eliminated based on performance.[70]

Throughout the pilot shortage, the Air Force has done an excellent job of emphasizing operational manning instead of placing experienced fighter pilots at staffs and schools, but the currency and qualifications of the pilots in operational units are at least as important as manning levels. Although the quality

TABLE 11

Air Force Maintenance Manning

Skill Level	Authorized	Assigned	Manning Percentage
3–level (Apprentice)	15,078	15,994	106%
5–level (Journeyman)	36,704	36,151	98%
7–level (Craftsman)	18,443	18,390	100%

NOTE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations refused to provide manning data for calendar year 2021. Data shown are for calendar year 2020 and are assumed to be correct for 2021.
SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force mission-capable rates, May 17, 2021.

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of sorties is admittedly subjective, a healthy rate of three sorties a week and flying hours averaging more than 200 hours a year have been established as "sufficient" over more than six decades of fighter pilot training.[71] In the words of General Bill Creech, "Higher sortie rates mean increased proficiency for our combat aircrews,"[72] and given the right number of sorties and quality flight time, it takes seven years beyond mission qualification in a fighter for an individual to maximize his potential as a fighter pilot.[73]

COVID-19's impact on flying hours hit the Air Force as it was beginning to recover from an 18-year drought in training for combat with a near-peer competitor. Flying hours and sortie rates across all fighter platforms fell to historic lows as the average line combat mission-ready fighter pilot received less than 1.4 sorties a week and 131 hours of flying time per year.[74] Those numbers increased only marginally in 2021 to 1.5 sorties a week and 133.3 hours of flight time per year, not much above the all-time lows experienced the preceding year. That equates to roughly two-thirds the number of sorties required to meet the minimum sortie threshold to qualify pilots as combat mission capable throughout the Combat Air Force (CAF).

Those numbers are so low in a high-performance fighter that pilot competence levels drop to the point where even excellent pilots begin to question their execution of very basic tasks and where the execution of complex mission tasks can become overwhelming.[75] In a speech delivered on September 21, 2022, General Mark Kelly stated that the average fighter pilot received just 6.8 hours of flying time per month for a total of 81.6 hours of flying time in 2021.[76] No matter which data point is selected, the numbers reflect an Air Force that would struggle in a fight with a regional competitor and founder in a war with a peer adversary.

The last time that fighter pilots received an average of 150 hours of flying time and more than 2 sorties a week for an entire year was when the service was beginning to recover from sequestration in 2015. In spite of a budget that has increased by more than 75 percent in the years since, the number of flying hours the Air Force funds has remained abysmal. The number of funded flying hours dropped from 1.33 million in FY 2020 to 1.24 million in FY 2021 to 1.15 million in FY 2022,[77] and they will fall again in FY 2023 to 1.13 million hours[78]—a level below which the Air Force was flying the year sequestration took effect.[79] Every reduction in funding for hours has been accompanied by a note stating that the hours were budgeted to "the maximum executable level," but that is, at best, misleading as the only constraint beyond funding is maintenance manning, which has been healthy since 2019. (See Table 9.)

The current generation of fighter pilots, those who have been actively flying for the last seven years, has never experienced a healthy rate of operational flying. It will take several years of flying three or more sorties a week to regain the level of competence required to dominate a peer competitor,

TABLE 12

Average Hours All Fighter Pilots Received per Month

	2017	2018	2019	2020	2021	Percentage Change, 2020 to 2021
F-22	10.8	10.8	10.5	6.9	7.6	11%
F-35A	10.4	10.4	14.4	10.2	8.8	–13%
F-15C	10.5	10.5	11.8	4.8	9.0	88%
F-16C	12.2	12.2	12.1	6.7	10.4	54%
F-15E	18.3	18.3	20.3	13.0	12.8	–2%
A-10	15.1	15.1	16.5	12.2	10.7	–13%
All Jets	13.0	12.9	14.1	8.7	10.0	16%
Average Hours per Year	155.4	154.6	168.7	104.3	120.6	16%

SOURCE: Headquarters U.S. Air Force, Deputy Chief of Staff for Operations, written response to Heritage Foundation request for information on Air Force fighter pilot flight hours, August 24, 2022.

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but the Air Force is not moving to make that happen. Readiness, as measured by any acceptable means, is incredibly low and it is no surprise that Air Force Chief of Staff, General C. Q. Brown is trying to shift the focus away from readiness or even redefine it using criteria that has yet to released, or perhaps even formulated.[80] Either way, the effort will undoubtedly further erode the combat capability of the Air Force, pilot competency, and flying safety.

Deployability. Because long-term inspections and depot-level work affect the availability of support equipment and aircraft, it takes three active-duty squadrons to deploy two squadrons forward. For that reason, up until the end of the Cold War, the Air Force organizational structure was based on a three-squadron wing. On any given day, units have several aircraft that are not flyable because of long-term inspections, deep maintenance, or the need for spare parts. By using aircraft from one of the three squadrons to "plus up" the others, the wing could immediately deploy two full-strength units into combat. The handful of fully flyable jets and pilots left at the home station could then be used to train new and inbound pilots up to mission-ready status so that, among other things, they could replace pilots that were lost during combat.[81]

Normal, active duty fighter squadron manning levels are based on a ratio of 1.25 aircrew members for every aircraft,[82] which means that a unit with 24 assigned aircraft should have 30 line pilots and five supervisor pilots who are combat mission ready.[83] Flight times, sortie rates, mission planning teams, and flight supervision requirements are significantly higher in combat, and to cover those requirements, the manning ratio normally increases to 1.50 pilots per aircraft, or 36 line pilots per squadron. In other words, every squadron deployed to fight requires six more pilots than it has on its roster.[84] Pilots from "donor" squadrons can fill those slots for the deploying units.

With the downsizing that has taken place since the end of the Cold War and the reduction in the number of fighter squadrons, the Active Air Force has reduced the number of fighter squadrons to two or even one in many wings. All operational Guard and Reserve wings are comprised of a single squadron, which complicates the math behind the total number of deployable fighter squadrons.

Of the 55 operational fighter squadrons on the Air Force roster, 32 are Active and 23 are Guard or Reserve Units. (See Figure 3.) Using the notion that it takes three squadrons to get two active-duty squadrons forward, the airframe disposition of each active-duty wing would allow just 21 active-duty fighter squadron equivalents (24 fighter aircraft each) to deploy to a fight. That equates to 480 active-duty

fighters that could deploy to meet a crisis situation, which is well short of the 600 it takes to win a single MRC and means that a war with a peer competitor would draw heavily on our strategic reserve.

Guard and Reserve units face the same manning and deployment challenges that the active-duty service faces, except that the vast majority of those units have just one fighter squadron per wing, further straining their ability to muster the airframes and manning needed to meet an emergency deployment.[85] Planning for low-threat, low-intensity deployments to Operation Iraqi Freedom and Operation Enduring Freedom took this into consideration by mapping deployments out months (often years) in advance of the required movement, allowing pilots to deconflict their civilian work schedules not just for the deployment, but also to get the training and time in the air that they needed to employ successfully in those low-threat combat operations.[86] Nevertheless, it was common for Guard units to pull pilots from other units to fulfill manning requirements for "rainbow" fighter squadrons,[87] and in a conflict where there is little time from warning order to deployment, it would likely take two Guard and Reserve squadrons to enable one to deploy forward.[88]

The average Guard and Reserve fighter squadron has one-third fewer jets than similar active-duty units have. By rainbowing units with similar aircraft, the Guard and Reserve could muster 12 squadrons as a strategic reserve of 288 fighters that could deploy sometime after the active-duty units deploy. In other words, the service could muster just 768 fighters (480 Active and 288 Guard and Reserve) for a peer-level fight. However, the gravity of that mix is not fully understood. The Guard and Reserve numbers are based on airframes alone, but other factors such as manning levels would also limit the number of sorties and the amount of combat power that those fighters could generate continually in a high-end confrontation with a peer competitor.

The declaration in Air Force posture statements for FY 2020 and FY 2021 that lead force packages within the service's 204 pacing squadrons are ready to fight also conveys the fact that only portions of its most capable squadrons have enough mission-capable aircraft and aircrews that are "closer" to the minimum Combat Mission Capable sortie requirements to respond somewhat readily to a crisis. Because of the pilot shortage, actual unit manning levels in fighter squadrons are below peacetime requirements (if only slightly), which obviously is not enough to meet the significantly increased demands and the tempo required for combat operations.

The service has already moved the majority of pilots who were in staff or other non-flying billets back to the cockpit in an effort to relieve the manning shortfall. Thus, the only way units can meet wartime manning requirements is by pulling pilots from other "donor" squadrons. The complications that this involves are significant and call into question the idea that the portions of the 55 fighter squadrons that are unable to deploy immediately in a crisis could be combined to create more combat power. The vast majority of aircraft and aircrew that are left would be used for homeland defense and to train replacement pilots or to replace aircraft that are lost through combat attrition.

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 squadron, that equates to a requirement of 500 Active Component fighter aircraft to execute one MRC. Adding a planning factor of 20 percent for spares and attrition reserves brings the number to 600 aircraft.

As part of its overall assessment of capacity, the *2023 Index* looks for 1,200 active-duty, combat-coded fighter aircraft to meet the baseline requirement for two MRCs.[89] That number of fighters lines up well with the fighter requirement from the 2018 TAFWN, which the Commander of Air Combat Command recently reaffirmed is the actual capacity requirement for today's Air Force.[90] The bomber, tanker, and strategic air requirements from that study are also used in this assessment.

- **Two-MRC Fighter—Threshold:** 1,200 combat-coded active-duty fighters / 62 squadrons.
- **Two-MRC Fighter—Actual 2022 Level:** 940 active-duty combat-coded fighters (78 percent) / 55 total force squadrons (88 percent).
- **TAFWN Bomber Squadron—Threshold:** 14 combat-coded bomber squadrons / 140 bombers.
- **TAFWN Bomber Squadron—Actual 2022 Level:** nine combat-coded bomber squadrons (64 percent) / 111 combat-coded bombers (79 percent).
- **TAFWN Tanker Squadron—Threshold:** 54 tanker squadrons / 540 combat-coded tankers.
- **TAFWN Tanker Squadron—Actual 2022 Level:** 43 combat-coded tanker squadrons (80 percent) / 454 combat-coded tankers (84 percent).
- **TAFWN Airlift Squadron—Threshold:** 54 airlift squadrons / 540 combat-coded airlifters.
- **TAFWN Airlift Squadron—Actual 2022 Level:** 48 combat-coded airlift squadrons (89 percent) / 532 combat-coded airlifters (99 percent).

Based on a pure count of combat-coded squadrons and platforms that have achieved IOC, the USAF currently is at 86 percent of the capacity required to meet a two-MRC/TAFWN benchmark. However, the disposition of those assets limits the ability of the service to deploy them rapidly to a crisis region. While the active fighter and bomber assets that are available would likely prove adequate to fight and win a single regional conflict, when they are coupled with the low mission capability rates of those aircraft (see Table 10), the global sourcing needed to field the required combat fighter force assets would leave the rest of the world uncovered.

Nevertheless, the capacity level is well within the methodology's range of "marginal." However, with programmed retirements that will exceed acquisitions, capacity is now trending downward.

Capability Score: Marginal

The Air Force's capability score is "marginal," based on scores of "strong" for "Size of Modernization Program," "marginal" for "Age of Equipment" and "Health of Modernization Programs," but "weak" for "Capability of Equipment." These assessments are the same as those in the *2022 Index*. New F-35 and KC-46 aircraft continue to roll off their respective production lines, but these additions are more than offset by aircraft retirements. As a consequence, this score will probably not improve over the next three to five years.

Readiness Score: Very Weak

The Air Force scores "very weak" for readiness in the *2023 Index*, a grade lower than it received in the *2022 Index and the lowest of the five-grade scale*. The USAF's sustained pilot deficit certainly contributes to this assessment, but the incredibly low sortie rates and flying hours would prevent any Air Force combat-coded fighter squadron from being able to execute all or even most of its wartime mission. At best, half of the cadre of pilots within the most capable units will be able to execute some of the unit's wartime missions. The Air Force's mission-capable rates have increased only slightly from 2021, and the intent of the current CSAF to sustain or further reduce operational training sorties reflects a service that would struggle to respond to a regional contingency much less hold the readiness levels, competence, and confidence levels required to square off against a peer competitor.[91] Readiness continues to trend downward.

The FY 2023 Air Force statement mentions the word "ready" just four times, and never in the context of current readiness levels.[92] The Air Force should be prepared to respond quickly to an emergent crisis not with a "task force" of four bombers, but with the speed and capacity required to stop a peer competitor in its tracks. With the significant curtailment of deployments in support of the global war on terrorism, the Air Force should be much farther along in its full-spectrum readiness than we have witnessed to date.

Overall U.S. Air Force Score: Very Weak

This is a result of the lowest of the USAF's three scores: a capacity score of "marginal," capability score of "marginal," and readiness score of "very weak." Like a three legged stool, success or failure

is determined by the weakest leg. The shortage of pilots and flying time for those pilots degrades the ability of the Air Force to generate the quality of combat air power that would be needed to meet wartime requirements. Fighter pilots should receive an average of three or more sorties a week and 200 hours per year to develop the skill sets needed to survive in combat, and while some readiness issues can be written off to the effects of COVID-19, the service is making a calculated decision not to acquire more aircraft or fund the accounts required for any significant increase in training and numbers of sorties.

Although there is a chance that it might win a single MRC in any theater, there is little doubt that the Air Force would struggle in war with a peer competitor. Both the time required to win such a conflict and the attendant rates of attrition would be much higher than they would be if the service had moved aggressively to increase high-end training and acquire the fifth-generation weapon systems required to dominate such a fight.

U.S. Military Power: Air Force

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

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Strategic Bomber

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
B-52 Stratofortress Inventory: **76** Fleet age: **61** Date: **1961** The B-52, the oldest of the bombers, provides global strike capabilities with conventional or nuclear payloads. Programmed upgrades for B-52 include a new communications, avionics, and Multi-Functional Color Displays. The Air Force plans to use this aircraft through the 2050s as a compliment to the B-21 Raider.	1		The B-21 is an advanced stealth bomber that is currently programmed to begin replacing all B-1s and B-2s within the Air Force bomber fleet in the late 2020s and expand to a fleet of at least 100 aircraft. Flight testing, originally scheduled for late 2022, has been pushed back to 2023 because of unspecified delays. However, the Raider is still projected to enter service in the mid-2020s.		
B-1B Lancer Inventory: **45** Fleet age: **35** Date: **1986** Nicknamed "The Bone," the B-1B Lancer is a long-range, multi-mission, supersonic conventional bomber that has served the United States Air Force since 1985. Originally designed for nuclear capabilities, the B-1 switched to an exclusively conventional combat role in the mid-1990s. In September 2020, the entire Air Force B-1B Lancer fleet completed the Integrated Battle Station upgrade to modernize the jet's datalinks, cockpit displays, and test system. The B-1B is scheduled to be phased out in 2032.	2	2			
B-2 Spirit Inventory: **20** Fleet age: **27** Date: **1997** The B-2 bomber provides the USAF with global strike capabilities for both nuclear and conventional payloads. The stealth bomber's communication suite is currently being upgraded, and efforts are being made to increase its loadout and the ability of its payload to strike hardened and buried targets. The current plan is to begin phasing out the B-2 in 2032.	3	4			

NOTE: See page 423 for details on fleet ages, dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Ground Attack/Multi-Role Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
A-10 Thunderbolt II Inventory: **260** Fleet age: **41** Date: **1977** The A-10 is the only USAF platform designed specifically for close air support mission using both self-designated precision-guided munitions and an internal 30mm cannon. While the retirement of the A-10 has been in discussion for years, Congress's denial of both the Air Force's request to retire the A-10 in 2021 and a subsequent request to cut 42 A-10s in FY 2022 indicates that the aircraft may fly for years to come.	2	2	**F-35A** Timeline: **2016–2035** The F-35A is a multi-role stealth fighter that achieved IOC on August 2, 2016. The Block 4 version of the jet, meant to significantly increase combat capability, remains under development, leading to concerns about rising retrofit costs for existing F-35 aircraft, which in recent years have led to reduced procurement of the aircraft. The Block 4 modification will be retrofitted into all Block 3 F-35s. **PROCUREMENT** 508 / 1,255 **SPENDING** *($ millions)* $55,618 / $124,889	4	3
F-16C Falcon Inventory: **863** Fleet age: **32** Date: **1980** The F-16 is a multi-role aircraft capable of tactical nuclear delivery, all-weather strike, and Suppression of Enemy Air Defenses (SEAD). Improvements to the F-16's radar, mission computer, and cockpit displays and an ongoing Service Life Extension Program (SLEP) will keep this jet flying through the late 2040s.					
F-35A Lightning Inventory: **432** Fleet age: **5** Date: **2016** See Ground Attack Replacement Program entry. The F-35 is a multi-role stealth fighter that became operational in 2016. By the end of FY 2022, the Air Force will have received 326 of a planned purchase of 1,763 aircraft.	5	5			
F-15E Strike Eagle Inventory: **218** Fleet age: **30** Date: **1989** The F-15E is a multi-role aircraft capable of all-weather, deep interdiction/attack, and tactical nuclear weapons delivery. Upgrades include an AESA radar, EPAWSS self-defense suite, a new central computer, and cockpit displays.	2	2			

NOTE: See page 423 for details on fleet ages, dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Fighter Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
F-15C/D Eagle Inventory: **119** Fleet age: **38** Date: **1975** The F-15C is an air superiority fighter that has been in service since the late 1970s. The jet is receiving upgrades that include a new AESA radar and self- defenses needed to survive and fight in contested airspace. The F-15C inventory is currently being reduced by the Air Force after determinations that a Service Life Extension Program (SLEP) would not be cost-effective with 48 aircraft being divested in FY 2022 ahead of fleetwide recapitalization by the F-15Ex.	1	2	**F-15 EX** Timeline: **TBD–2024** The F-15EX, the most advanced Eagle variant, is based on the F-15QA as a replacement for the legacy F-15C/D. The USAF awarded Boeing a $1.2 billion contract for the first eight of up to 144 new-build F-15EX jets on July 13, 2020. FY 2021 funds procure an additional 12 aircraft and 12 more in FY 2022. The Air Force accepted the first two F-15EXs in FY 2021 and expects the next six fighters in 2023. **PROCUREMENT** 24 48 **SPENDING** *($ millions)* $2,338 $5,120	1	1
F-22A Raptor Inventory: **186** Fleet age: **16** Date: **2005** The F-22 is the preeminent air superiority stealth fighter aircraft, modified to enable precision-guided weapons delivery. The jet is currently undergoing a modification called RAAMP that will improve reliability, maintainability, and performance. In FY 2022, the jet will also begin fielding the Link-16, which will allow it to transmit data with legacy aircraft via Multifunctional Information Distribution System/Joint Tactical Radio System (MIDS/JTRS). The Air Force could begin to replace the F-22 as early as the 2030s as it seeks to leverage new technologies developed from its NGAD program.	4	5	None		

NOTE: See page 423 for details on fleet ages, dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Tanker

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
KC-10 Extender Inventory: **26** Fleet age: **38** Date: **1981** The KC-10 is multi-role tanker and airlift platform that can refuel both boom- and drogue-compatible fighters on the same mission. Recent modifications have enabled a service life extension through 2045. While Congress blocked efforts by the Air Force to begin retiring the aircraft in 2021, the Air Force retired eight KC-10s in FY 2022 and plans to retire 14 in FY 2023 to make way for the KC-10's replacement, the KC-46.	2	5	**KC-46** Timeline: **TBD–2027** This aircraft is a multi-role tanker/airlift platform that can refuel both boom- and drogue-compatible fighters on the same mission. The Air Force accepted the first of 179 programmed aircraft in 2019. The program has significant problems with the remote vision system and boom that currently limit it to refueling fourth-generation jets in non-combat operations. The Air Force will receive another 24 jets in FY 2023 with this same limitation, bringing the total number of KC-46s in the inventory to 95. **PROCUREMENT** 109 66 **SPENDING** *($ millions)* $17,807 $13,110	3	1
KC-135 Stratotanker Inventory: **362** Fleet age: **62** Date: **1957** The KC-135 is a multi-role tanker/airlift platform capable of simultaneous cargo and AE missions. The aircraft has undergone several modifications, mainly engine upgrades to improve performance and reliability. Air Force plans to further modify the aircraft with Block 45 upgrades: additional glass cockpit display for engine instrumentation, a radar altimeter, advanced autopilot, and modern flight director at a rate of 38 aircraft per year through 2026. Part of the fleet will be replaced with the KC-46 with the remainder scheduled to be in service through 2050.	1				
KC-46 Pegasus Inventory: **95** Fleet age: **2** Date: **2020** This Pegasus is a multi-role tanker/airlift platform that can refuel both boom- and drogue-compatible fighters on the same mission. The Air Force accepted the first of 179 programmed aircraft in 2019. The program has significant problems with the remote vision system and boom that currently limit it to refueling fourth-generation jets in non-combat operations. The Air Force will receive another 24 jets in FY 2023 with this same limitation, bringing the total number of KC-46s in the inventory to 95.	5	1			

NOTE: See page 423 for details on fleet ages, dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
C–5M Galaxy Inventory: **52** Fleet age: **35** Date: **1970** The C-5 is the USAF's largest mobility aircraft. It can transport 270,000 pounds of cargo over intercontinental ranges and is air refuellable. The M models are heavily modified C-5A/Bs that have new engines, avionics, and structural/reliability fixes. Ongoing mods include a new weather radar and mission computer and improved Large Aircraft IR Countermeasures (LAIRCM).	2	5	None		
C-17 Globemaster III Inventory: **222** Fleet age: **20** Date: **1995** The C-17 is a heavy-lift, strategic transport capable of direct tactical delivery of all classes of military cargo. It is the U.S. military's core airlift asset; it is air refuellable and is capable of operating on small airfields (3,500 ft. by 90 ft.). Ongoing mods include next-generation Large Aircraft Infrared Countermeasures (LAIRCM), structural, safety, and sustainment mods.	4				

Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
C-130J Super Hercules Inventory: **153** Fleet age: **13** Date: **2006** The C-130J is an upgraded tactical airlift platform with a medium-lift capability and multiple variants including the C-130J-30, AC-130J gunship, and HC-130 rescue/air refueling platform. The C-130J-30 can carry 92 airborne troops and lift over 40,000 pounds of cargo. The Air Force Active Component completed its transition to the C-130J in October 2017, but it will continue to procure C-130Js for the Guard and Reserve at least through FY 2023.	5	5	**C-130J** Timeline: **2006–2022** The C-130J is an upgraded tactical airlift platform with a medium-lift capability and multiple variants including the C-130J-30, AC-130J gunship, and HC-130 rescue/air refueling platform. The C-130J-30 can carry 92 airborne troops and lift over 40,000 pounds of cargo. The Air Force Active Component completed its transition to the C-130J in October 2017, but it will continue to procure C-130Js for the Guard and Reserve at least through FY 2023. **PROCUREMENT** 203 **SPENDING** *($ millions)* $18,801 $266	5	5

NOTE: See page 423 for details on fleet ages, dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Intelligence, Surveillance, and Reconnaissance (ISR)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
RQ-4 Global Hawk Inventory: **9** Fleet age: **12** Date: **2011** The Global Hawk is a strategic, high-altitude, long-endurance (HALE), "deep look" ISR platform complementing satellite and manned ISR. Unlike the MQ-9, which is a medium-altitude, long-endurance UAV, the RQ-4 has a higher altitude and longer range.	4	3	None		
MQ-9 A/B Reaper Inventory: **276** Fleet age: **7** Date: **2007** The MQ-9B is a medium-altitude to high-altitude, long-endurance hunter-killer RPA (remotely piloted aircraft) tasked primarily with eliminating time-critical and high-value targets in permissive environments. Additional roles include CAS, CSAR, precision strike, armed overwatch, target development/ designation, and terminal weapon guidance. The MQ-9 fulfills a secondary tactical ISR role utilizing its Multispectral Targeting System-B (MTS-B), Lynx SAR, and/or Gorgon Stare wide-area surveillance. The USAF is attempting to end MQ-9 procurement and seeks to replace the Reaper with a more survivable, flexible, and advanced platform as early as 2031.	5	1	**MQ-9** Timeline: **2007–2022** The MQ-9 is a hunter/killer unmanned Aerial Vehicle (UAV). The Air Force planned to end procurement for the Reaper in FY 2021, but in FY 2021, Congress decided to procure an additional 16 Reapers. With the decline of U.S. counterinsurgency efforts, the Air Force has announced plans to transition the MQ-9 away from counterinsurgency to operating in near contested airspace. The Air Force is planning to replace the Reaper with a more survivable, flexible, and advanced platform as early as 2031. **PROCUREMENT** 371 **SPENDING** *($ millions)* $430 $17	5	5
RC-135 Rivet Joint Inventory: **25** Fleet age: **60** Date: **1972** The RC-135V/W is tasked with real-time electronic and signals intelligence-gathering, analysis, and dissemination in support of theater and strategic-level commanders. The extensively modified C-135s detect, identify, and geolocate signals throughout the electromagnetic spectrum. Rivet Joint is used mostly to exploit electronic battlefield intelligence and deliver near-real-time ISR information to tactical forces, combatant commanders, and National Command Authorities. Ongoing upgrades include new direction-finding COMINT, precision ELINT/SIGINT system integration, wideband SATCOMS, enhanced near real- time data dissemination, and new steerable beam antenna. The Air Force's most recent utility assessment projected that the RC-135 would fly through 2050.	1	4	None		

NOTE: See page 423 for details on fleet ages, dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Intelligence, Surveillance, and Reconnaissance (ISR) (Cont.)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
U-2 Dragon Lady Inventory: **31** Fleet age: **40** Date: **1956** The U-2S is the Air Force's only manned, strategic, high-altitude, long-endurance ISR platform and is capable of SIGINT, IMINT, and MASINT collection. The aircraft's modular payload systems allow it to carry a wide variety of advanced optical, multispectral, EO/IR, SAR, SIGINT, and other payloads simultaneously. Its open system architecture also permits rapid fielding of new sensors to counter emerging threats and requirements. The Air Force is currently upgrading the U-2 with ASARS-2B/C, which will improve the U-2's high-altitude, deep-look radar ground mapping, moving target, and maritime capabilities.	1	4	None		

NOTE: See page 423 for details on fleet ages, dates, timelines, and procurement spending.

AIR FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Command and Control

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
E-3 Sentry Inventory: **16** Fleet age: **42** Date: **1977** The E-3 Airborne Warning and Control System (AWACS) is tasked with all-weather, air and maritime surveillance, command and control, battle management, target, threat, and emitter detection, classification, and tracking. Ongoing upgrades include an urgent operational requirement to shorten kill chains on time-sensitive targets, modernizing airborne moving target indication, and adding high-speed jam-resistant Link 16. Due to difficulties sustaining the E-3, the Air Force has looked into potentially procuring Boeing's E-7A Wedgetail as a compliment to the E-3.	1	1	None		
E-8 JSTARS Inventory: **4** Fleet age: **22** Date: **2001** E-8C is a ground moving target indication (GMTI), airborne battlefield management/command and control platform. Its primary mission is providing theater commanders with ground surveillance data to support tactical operations. Congress approved divestiture of the E-8 in 2022 with four aircraft being retired.					

NOTES: See Methodology for descriptions of scores. The date is the year the platform achieved initial operational capability. The timeline is from the year the platform achieved initial operational capability to its final procurement. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E).

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F-35A

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F-15EX Strike Eagle

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KC-46 Pegasus

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MQ-9 Reaper

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AIR FORCE PLATFORM SUMMARIES

B-52 Stratofortress

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B-1B Lancer

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A-10 Thunderbolt II

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F-35 A Lightning

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F-15C Eagle

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78. Table 2, "U.S. Air Force Budget Summary," in U.S. Department of the Air Force, *Department of the Air Force FY 2023 Budget Overview*, p. 4.
79. The flying hour budget for FY 2013 was $7.1 billion in then-year dollars. The flying hour budget for FY 2023 is $5.87 billion. Extracted from U.S. Air Force budget summaries for the years 2013 and 2023. U.S. Department of the Air Force, *United States Air Force Fiscal Year 2013 Budget Overview*, February 2012, p. 12, https://www.saffm.hq.af.mil/Portals/84/documents/FY13/AFD-120209-052.pdf?ver=2016-08-24-090344-023, and "U.S. Air Force Budget Highlights," in U.S. Department of the Air Force, *Department of the Air Force FY 2023 Budget Overview*, p. 3, https://www.saffm.hq.af.mil/Portals/84/documents/FY23/SUPPORT_/BOB_28Mar_1125_LoRes.pdf?ver=5nrA8bBfhWoUSrvZ09CeHA%3d%3d. (accessed August 29, 2022).
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81. Author's experience through 26 years of Air Force operations coupled with senior leader engagements from 2018–2019.
82. Albert A. Robbert, Anthony D. Rosello, Clarence R. Anderegg, John A. Ausink, James H. Bigelow, William W. Taylor, and James Pita, *Reducing Air Force Fighter Pilot Shortages* (Santa Monica, CA: RAND Corporation, 2015), p. 33, https://www.rand.org/content/dam/rand/pubs/research_reports/RR1100/RR1113/RAND_RR1113.pdf (accessed July 4, 2022).
83. Even though active-duty fighter squadrons have an average of 30 aircraft per squadron, that number includes maintenance spare and attrition reserve platforms. Manning is based on Primary Assigned Aircraft (PAA), which is 24 aircraft for active-duty fighter squadrons.
84. Based on a squadron with 24 Primary Assigned Aircraft. Units with 18 PAA require four additional pilots.
85. The very premise of these units is that they are manned with citizen soldiers whose main source of income is full-time civilian jobs and who are committed to travel and temporary duty locations that make them unavailable for days or weeks at a time. Those units would likely require several days to assemble the manpower needed to deploy, and once an assessment of their real mission currency was made, they would need some period of intense training before a responsible senior leader could employ them in a fight with a peer competitor.
86. "Deployments most suited to the ARC are those in which there is long lead time (six months or more), and in which the operation is of short duration (six days or less), requiring a small force package (12 aircraft or less), and in which the scheduling is flexible." John T. Correll, "Future Total Force," *Air Force Magazine*, Vol. 82, No. 7 (July 1999), p. 32, https://www.airforcemag.com/PDF/MagazineArchive/Documents/1999/July%201999/0799total.pdf (accessed July 4, 2022).
87. The author commanded the 349th Expeditionary Combat Group at Al Udeid, Qatar, from 2004–2005. During that time, he flew with seven different Air National Guard F-16 squadrons. Every one of those units had some level of rainbow manning, and each performed admirably.
88. Interview with senior Air National Guard leader, November 20, 2019.
89. The number of fighters needed for a two-MRC strategy is based on a Heritage Foundation study of airpower requirements and actual fighter deployments for all major combat operations and conflicts from 1950 through 2021.
90. Kelly, "Air Force Fighter Enterprise."
91. See Venable, "Independent Capability Assessment of U.S. Air Force Reveals Readiness Level Below Carter Administration Hollow Force."
92. The FY 2023 Air Force Posture Statement does not discuss current posture; it makes declarative allusions as to what it should or must be ready to do. For example: "[T]o provide effective integrated deterrence, the Department of the Air Force must be fully ready to expeditiously transition to a wartime posture. We must be ready to mobilize against a peer competitor who has spent decades researching and developing the means to attack the systems and infrastructure we depend on to go to war through cyber and non-cyber means." The Honorable Frank Kendall, Secretary of the Air Force; General John W. Raymond, Chief of Space Operations, United States Space Force; and General Charles Q. Brown, Jr., Chief of Staff, United States Air Force, "Department of the Air Force Posture Statement, Fiscal Year 2023," Department of the Air Force Presentation to the Committees and Subcommittees of the United States Senate and the House of Representatives, 117th Cong., 2nd Sess., p. 5, https://www.af.mil/Portals/1/documents/2022SAF/FY23_DAF_Posture_Statement.pdf (accessed July 4, 2022). "These investments ensure today's space capabilities are ready to support day-to-day campaigning in the near-term as the Space Force's modernization efforts pave the way to deliver new architectures that are resilient by design." Ibid., p. 9. "To ensure this capability remains ready, the Air Force is modernizing with the Sentinel system, our Ground Based Strategic Deterrent (GBSD)." Ibid., p. 12.

U.S. Marine Corps

Dakota L. Wood

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. But while Marines have a wide variety of individual assignments, the focus of every Marine is and always has been on combat: Every Marine is first a rifleman.

Over the past several decades, the Marine Corps has positioned itself for crisis response, but while the Corps has maintained its historical, institutional, and much of its doctrinal focus on operations in maritime environments, the majority of its operational experience over the past 20 years has been in sustained land operations. This has led to a dramatic decline in the familiarity of most Marines with conventional amphibious operations and other types of employment within a distinctly maritime setting.[1] Even with the conclusion of military operations in Afghanistan in 2021, by which time the U.S. military presence had been reduced to just 2,500 military personnel, the general shortage of amphibious ships and the absence of any necessity to deploy large numbers of Marines on amphibious shipping still resulted in few opportunities for Marines to gain such experience. Consequently, the Corps' connection to the sea has continued to fade.[2]

Recognizing this shortfall, the Corps' leadership initiated efforts to reorient the service toward enabling and supporting the projection of naval power in heavily contested littoral environments with a particular focus on the Indo-Pacific region and China as the "pacing threat" against which Marine Corps capabilities are being assessed and modified. This reorientation was much more than a simple refocusing on amphibious operations. Following a comprehensive assessment of the operational challenges that the service's operating forces are most likely to face 10 to 15 years in the future, General David H. Berger, Commandant of the Marine Corps, issued Force Design 2030 (FD 2030), his directive to the service to reorganize, re-equip, and retrain Marines in ways that will make them relevant and effective in the presumed operating environment of the next several years and into the 2030s.[3]

As necessary an effort as FD 2030 is, however, the force envisioned by the project has yet to be built (though meaningful progress is being made[4]) and certainly has not yet been proven in battle. Consequently, this *Index* can only assess the Corps that exists today, and our assessments of capacity, capability (modernity), and readiness therefore pertain to the Marine Corps' current status, not to what it might be in the future.

As of May 2022, "approximately 30,000 Marines [were] forward-deployed or forward-stationed, with hundreds more on watch at our embassies across the globe."[5] During the year preceding its fiscal year (FY) 2023 budget request:

> [T]he Marine Corps conducted activities in support of 18 named operations, participated in 11 amphibious operations, engaged in nine theater security cooperation events / programs, participated in 89 named exercises, supported three response efforts associated with Defense Security Cooperation Agency (DSCA) requests, and executed seven response efforts associated with the Coronavirus 2019 (COVID-19) pandemic. Amphibious Ready Groups / Marine

> Expeditionary Units (ARG/MEU) conducted operations in support of combatant commands (COCOMs) along-side regional partners providing a range of deliberate and crisis response options. Joint Task Force – Crisis Response, led by Task Force 51 / 5th Marine Expeditionary Brigade, deployed over 2,000 Marines from the 24th Marine Expeditionary Unit and the Special Purpose Marine Air Ground Task Force - Crisis Response - Central Command (SPMAGTF-CR-CC) to Kabul, Afghanistan in support of non-combatant evacuation operations. The Marine Corps provided crisis response and contingency operations for AFRICOM, EUCOM, and INDOPACOM. In an effort to deepen partner alliance with the United Kingdom (UK), Marine Fighter Attack Squadron (VMFA) 211 deployed ten F-35B Lightning II Joint Strike Fighters onboard Her Majesty's Ship Queen Elizabeth in support of the first operational deployment of the UK Carrier Strike Group since 2011....[6]

The Marine Corps has always prized its crisis-response contributions to national security, and senior service leaders have emphasized this point consistently over the years. Maintaining this emphasis, General Berger has made it central to the Corps' efforts to remain combat credible as adversary capabilities evolve, even at the expense of force capacity (the size of the service) and existing capabilities that, while still of value, are perceived as less relevant to the maritime environment of the Indo-Pacific. Marine Corps leadership has emphasized that China serves as the pacing challenge for the Corps, which means that the military capabilities that China has and is developing, as well as the severity of the challenge presented by China, are a benchmark against which to measure "the level of capabilities that we will need in order to have a relative advantage now and into the future."[7] These capabilities will be applicable not only in a fight with China, but also in other scenarios and regions involving other enemies of lesser magnitude.

Service leadership is assuming that defense budgets will not see any appreciable growth in the next several years, so the Commandant has ordered the Corps to retire or reduce assets and capabilities such as tanks, conventional tube artillery, heavy bridging, and some aircraft and continue to reduce manpower end strength in order to make related funding available for other purposes.

In general for the Joint Force, this *Index* focuses on the forces required to win two major wars as the baseline force-sizing metric for the Army, Navy, and Air Force, but it adopts a different paradigm—one war plus crisis response—for the Marine Corps. The three large services are sized for global action in more than one theater at a time; the Marines, by virtue of overall size and most recently by direction of the Commandant, focus on one major conflict while ensuring that all Fleet Marine Forces are globally deployable for short-notice, smaller-scale actions. Marine Corps officials have emphasized that the results of the FD 2030 redesign will ensure that USMC forces are more capable and relevant in any fight, in any region, but the pacing challenge for Corps planners is China.[8]

In previous editions of the *Index*, the capacity of the Marine Corps was assessed against a two-war requirement of 36 battalions: a historical average of 15 battalions for a major conflict (30 for two major conflicts) and a 20 percent buffer, bringing the total to 36. The Corps has consistently maintained that it is a one-war force and has no intention of growing to the size needed to fight two wars, and both its annual budget requests and its top-level planning documents reflect this position.

However, with China as the primary threat driving Marine Corps force planning and given China's extraordinary investment in modernizing its forces across all capabilities—to include the expansion of various sensors, weapons, and platforms that are essential to the creation of an intensely weaponized, layered defense architecture—this *Index* cannot help but note that the Corps will need greater capacity if it is to succeed in war in the very circumstances for which the Marines believe they must prepare and with which this *Index* concurs.

Capacity

The measures of Marine Corps capacity in this *Index* are similar to those used to assess the Army's: end strength and units (battalions for the Marines and brigades for the Army). The Marine Corps' basic combat unit is the infantry battalion, which is composed of approximately 900 Marines and includes three rifle companies, a weapons company, and a headquarters and service company.[9]

The service has redesignated 3rd Marines, one of its infantry regiments, as 3rd Marine Littoral Regiment (MLR), a new organizational construct it is

using to test ideas put forward in FD 2030.[10] Unlike a conventional Marine regiment, the MLR will have a single Littoral Combat Team (LCT) based on an infantry battalion but also possessing an anti-ship missile battery, a Littoral Anti-Air Battalion, and a Combat Logistics Battalion. The LCT will focus on employment of platoons, which is radically different from a standard battalion's use of companies.[11] While a bold move, 3rd MLR will serve as an operational test bed, deriving experience and insights that feed back into the FD 2030 effort. It is not a standard experimental organization in that it is operationally employed as a full component of the Corps' operating forces, but because it has not yet been standardized across the Corps, it cannot yet serve reliably as a reference by which to assess the Corps.

Infantry. In 2011, the Marine Corps maintained 27 infantry battalions in its Active Component at an authorized end strength of 202,100.[12] As budgets declined, the Corps prioritized readiness through managed reductions in capacity, including a drawdown of forces, and delays or reductions in planned procurement levels. After the Marine Corps fell to a low of 23 Active Component infantry battalions in FY 2015,[13] Congress began to fund gradual increases in end strength, returning the Corps to 24 infantry battalions. The deactivation of 3rd Battalion 8th Marines on May 18, 2021, and 2nd Battalion 3rd Marines on January 21, 2022,[14] left the Corps with 22 infantry battalions. Marine Corps leadership plans to stand down one more battalion, which will bring the Corps to 21 battalions supported by an end strength of 177,000,[15] which is where the Commandant believes it will be stable.[16] The Corps operated with 177,249 Marines in FY 2022.[17]

New requirements have also sapped the Corps' conventional deployable strength. In 2005, the Marines were directed to establish a special operations component to which they ultimately committed 2,700 Marines comprising a regimental-like headquarters, three battalions, a school/training organization, and various supporting elements.[18] In 2010, the Corps established a cyberspace element,[19] redirecting more manpower to new capabilities. The point here is that new requirements arise over time. Unless the Marine Corps' end strength is increased accordingly, establishing new units and capabilities means losing capacity in other areas.

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

Aviation. On May 3, 2022, the Corps published an update to its Aviation Plan (AVPLAN),[20] something it had not done since 2019. The current AVPLAN notes that several initiatives undertaken in 2014 have led to marked improvements in readiness with the Corps setting an objective of 75 percent aviation readiness for FY 2021. To this end, the service has increased funding for aviation-related operations and maintenance by 84 percent since FY 2016. Manning of its aviation units appears to remain a problem in some specialties: The Corps has only 66 percent of the pilots it needs for its fixed-wing aircraft and only one-half of its requirement for its two front-line fighters, the F-35 (40 percent) and F/A-18 (72 percent). However, it has reported strong numbers for its rotary-wing pilots (95 percent) and its enlisted community of maintainers (also 95 percent).[21]

The Corps maintains 18 squadrons of fixed-wing fighter/attack aircraft in its Active Component, one-third of which are equipped with the F-35.[22] Eighteen is a substantial reduction from the approximately 28 it had during Desert Storm.[23] The reduction corresponds with the general shrinking of the U.S. military since the end of the Cold War but is also a consequence of budget restrictions caused by the Budget Control Act of 2011,[24] the costs of operations over the past 20 years without a corresponding increase in funding, and the current budget ceilings imposed by the White House and Congress. The reorientation of Marine Aviation in its capacity, type of aircraft, and balance among the various platforms is dictated by FD 2030, which itself is informed by both budget and operational threat realities.

Although the Corps is introducing the F-35 platform into the fleet, F/A-18 Hornets remain "the primary bridging platform to F-35B/C" and will remain in the force until 2030.[25] This primary tactical aviation capability has to be managed carefully as it is no longer in production. Through various programs, the Marines have extended the service life of their

F/A-18 fleet to 10,000 flight hours, making it possible to keep them in service until FY 2030.[26] A similar effort will keep the venerable AV-8B Harrier in use until FY 2027.[27] At present, the Marines have acquired 142 F-35B—the STOVL (Short Take-Off and Vertical Landing) variant of the Joint Strike Fighter (JSF)—and 22 F-35C (carrier capable) aircraft of a planned 353 F-35B and 67 F-35C models.[28] This has enabled the service to stand up 10 JSF squadrons: six operational, two fleet replacement (used to train new pilots), and one test for F-35Bs, and one operational squadron of F-35C aircraft.[29]

In its heavy-lift rotary-wing fleet, the Corps began a reset of the CH-53E in 2016 to bridge the procurement gap between the CH-53E and the CH-53K King Stallion and aimed to "reset...the entire 143-aircraft fleet by FY20,"[30] but reporting in 2020 indicated that the Corps was moving rather slowly in this effort, and it was only one-third of the way through the process toward the close of the fiscal year.[31] Even when the reset is complete, the service will still be 57 aircraft short of the stated heavy-lift requirement of 200 airframes and will not have enough helicopters to meet its heavy-lift requirement without the transition to the CH-53K.[32]

As for the CH-53K heavy-lift helicopter, the service has reported that the aircraft has achieved initial operational capability (IOC),[33] opening the door for full production of operational units. The service procured nine aircraft in FY 2021 and 11 in FY 2022 and will purchase an additional 10 in FY 2023.[34] Ultimately, the Corps plans to acquire 88 aircraft that will equip five squadrons by FY 2027.[35]

The Corps continues to search for improvements in its MV-22B Osprey, to include testing a version of an electronic warfare radar jamming pod that it uses on other aircraft.[36] In the absence of conventional pylons on which weapons and sensors can be mounted, new capabilities have to be reconfigured to fit inside the aircraft or mounted on the aircraft fuselage.

Notably, the Corps has moved aggressively to implement aviation-related actions specified or implied by FD 2030. In May 2021, it disestablished HMLA-367, a light-attack helicopter squadron in Hawaii, sending its still relatively new attack and utility helicopters to Davis–Monthan Airbase in Arizona where they will be placed in the "boneyard" for possible use in the future. The 27 AH-1Z Viper attack helicopters and 26 UH-1Y Venom utility helicopters that were decommissioned represented approximately one-fifth of the Marine Corps' inventory of such aircraft.[37]

The Marines have also divested two MV-22 squadrons, standing down VMM-264 in FY 2020 and VMM-166 in FY 2021. Though FD 2030 originally proposed reducing MV-22 squadrons to 14, subsequent experimentation led the Commandant to revise his direction to specify retaining 16 squadrons in the Active force while changing the number of aircraft per squadron from 12 to 10.[38] Continuing with its plan to restructure its helicopter fleet, the Corps shuttered a light-attack helicopter squadron in April 2022[39] and will deactivate two more by the end of FY 2023.[40] The Corps is also reducing the number of its heavy-lift squadrons of CH-53s; it deactivated HMH-463 in April 2022[41] and plans to deactivate two more by FY 2024.[42]

Amphibious Ships. Amphibious ships, although driven by the Corps' articulation of what it needs to execute its operational concepts, remain a Navy responsibility. A trio of documents describe the rationale for and nature of the Marine Corps' thinking about how it plans to contribute to the projection of naval power in highly contested environments such as that found in the Indo-Pacific region should the U.S. find itself at war with China.

- In 2017, the Corps and the U.S. Navy jointly released *Littoral Operations in a Contested Environment* (LOCE), in which the services presented general ideas about how to conduct naval operations against a very capable enemy.[43]

- Several months after taking office, General Berger published FD 2030, which set objectives for redesigning the force so that it could do the things implied by LOCE.[44]

- In February 2021, the Corps released an unclassified version of its *Tentative Manual for Expeditionary Advanced Base Operations*, which provided substantial details about the service's evolved thinking about the tactical and organizational challenges posed by high-threat maritime environments.[45]

These documents informed and reinforced Marine Corps and Navy plans to develop and acquire upwards of 35 light amphibious warships (LAWs), new amphibious vessels that would be smaller than

those constituting the current fleet and optimized to support naval operations in the contested environments envisioned by LOCE and Expeditionary Advance Base Operations (EABO).[46] The Marine Corps held 38 amphibious ships as the minimum requirement for many years but stepped away from that as a prelude to redefining its amphibious operations capabilities.[47]

With the evolution of FD 2030 and refinement of related supporting concepts and material requirements, the Corps is now making the case for 31 traditional amphibious ships as the bare minimum needed to execute operations as envisioned in FD 2030, augmented by LAWs.[48] Five companies have been awarded contracts for further concept development of LAWs,[49] but procurement of the first ship has been delayed. According to the Congressional Research Service:

> [T]he Navy had previously envisioned procuring the first LAW in FY2023, but the Navy's FY2023 budget submission defers the procurement of the first LAW to FY2025. The Navy's FY2023 five-year (FY2023-FY2027) shipbuilding plan calls for procuring the first LAW in FY2025, the second in FY2026, and the third and fourth in FY2027. The Navy's FY2023 budget submission states that the contract for the construction of the first LAW would be awarded in December 2024, and that the ship would be delivered in July 2028.[50]

Meanwhile, the number of traditional amphibious ships stood at 32 as of August 2022.[51]

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

Capability

The nature of the Marine Corps' crisis-response role requires capabilities that span all domains. The USMC ship requirement is managed by the Navy, as indicated in the preceding section on capacity, and is covered in the Navy's section of the *Index*. The Marine Corps is engaged in a force-wide redesign per FD 2030 with modernization and divestiture programs shaped accordingly. General Berger has emphasized that his force redesign initiatives are being self-funded, which means that the service has been getting rid of some capabilities that are less relevant to expected operational demands and reducing manpower to redirect that funding to other priorities of greater relevance.

Nevertheless, defense funding has not kept pace with inflation, and there are some things for which the Corps needs additional money. On June 15, 2021, for example:

> Making his case before the House Armed Services Committee…for the Marine Corps' $47.86 billion [FY 2022] budget request, Berger said he has reduced headquarters staffing by 15%, cut legacy systems and end strength, and has nothing left to draw from to fund programs and projects.
>
> "We have wrung just about everything we can out of the Marine Corps internally," Berger said. "We're at the limits of what I can do."
>
> The Marine Corps' budget request represents a 6.2% increase from fiscal 2021, even as the service plans to reduce the size of the active-duty force by 2,700, to 178,500 Marines. The service ultimately wants to reach 174,000 by 2030—roughly the size it was in fiscal 2002.
>
> Berger is using the money he has saved by reorganizing the Marine Corps and shedding capabilities such as tanks and artillery to invest in new technologies and platforms.[52]

On May 11, 2022, in an earlier appearance before the House Armed Services Committee, General Berger similarly emphasized the efforts of the Corps to use existing funds, taken from divestment of various capabilities and realignment of spending, to support changed priorities and new initiatives, noting that the service had self-funded $17 billion of its modernization.[53]

Programs such as the Amphibious Combat Vehicle (ACV), F-35, CH-53K, Naval Strike Missile, and

Light Amphibious Warship continue to be at the top of the list of major items of equipment and weapons, but the Corps is also pursuing a variety of unmanned systems (air, ground, and sea) and has placed great emphasis on smaller pieces of gear and individual-level weapons that will enable tactical units to be more effective.[54] These latter items are typically small in cost when compared with aircraft and armored vehicles, but they can have a decisive effect in small-unit actions in the field.[55]

Vehicles. 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 more than 50 years old and the LAV averaging 40 years old.[56] The Corps had moved to extend the service life of the AAV but abandoned that program as progress with the ACV accelerated.[57] The Corps has stated that:

> [W]e continue to make strategic choices in the divestiture of certain programs to reallocate funds toward building a more lethal, modern, multi-domain, expeditionary force. This has included accepting near-term capacity risk by reducing depot level maintenance for the legacy Amphibious Assault Vehicle (AAV) as we transition to the Amphibious Combat Vehicle (ACV).[58]

The Marine Corps has also been exploring the possibility of replacing its aged Light Armored Vehicle with a collection of vehicles under the Advanced Reconnaissance Vehicle (ARV) program.[59] It requested $48.6 million in its FY 2022 budget submission for research and design work and $70.6 million in its FY 2023 budget request "to provide an initial operational capability of an advanced reconnaissance vehicle and to expand the ARV capability to other mission roles and integrate capabilities that emerge from other programs to further develop and enhance LAR [Light Armored Reconnaissance] operations."[60]

The AAV program hit rough waters on July 30, 2020, with the sinking of an AAV off the California coast near San Clemente Island. In addition to halting all AAV operations until various investigations were completed, the Corps installed supplementary emergency breathing devices in the vehicle and took other steps to improve its safety and survivability.[61] AAV operations were resumed in April 2021 following inspection and modification of vehicles and related training and certification of AAV crews on the improvements.[62] Nine months later, however, the Corps permanently restricted water operations for the AAV, relegating it to a land-only armored vehicle.

"[G]iven] the current state of the amphibious vehicle program," according to a statement issued by the Corps:

> [T]he Commandant of the Marine Corps has decided the AAV will no longer serve as part of regularly scheduled deployments or train in the water during military exercises; AAVs will only return to operating in the water if needed for crisis response. This decision was made in the interest of the long-term health of the amphibious vehicle programs and future capabilities. The AAV will continue to operate on land; 76 percent of its tasks are land-based. In doing so, we reserve the capability to reverse this decision should the need arise.[63]

The Corps, recognizing the problems of its AAV fleet and the urgent need to update for capabilities in line with FD 2030, has accelerated procurement of the ACV. It procured 72 ACVs in FY 2021, purchased another 88 in FY 2022, and has requested funding for 74 in FY 2023.[64] Combined with the 112 vehicles acquired in previous years, the additions bring the number of ACVs in the Corps' inventory to 346 out of a total program objective of 632.[65]

Acquisition of the Joint Light Tactical Vehicle (JLTV) is steady. Since 2017, when fielding of the HMMWV replacement began, the Marines have acquired 5,167 vehicles and have placed another 413 on order with its FY 2023 budget request.[66] Budget documents show plans for the Corps to purchase an additional 2,676 vehicles from FY 2024 through FY 2027.[67] The acquisition objective for JLTV has varied over the years from 5,500 to just over 9,000.[68] Representatives from Marine Corps Systems Command have reported that the objective has been revised again to have the JLTV be a one-for-one replacement for all of the almost 11,000 HMMWVs currently in the inventory.[69]

Aircraft. Fixed-wing fighter-attack aircraft—specifically the AV-8B Harrier and F/A-18 Hornet—continue to age while the Corps pursues delivery of replacement aircraft: the F-35B STOVL variant

to replace the AV-8B, in service since 1985, and the F-35C to replace its carrier-capable F/A-18s. To account for a lengthy transition period, the Corps has undertaken various efforts to extend the service life of its Hornets and Harriers to keep them in service until the end of the decade and, to meet the need to train new pilots even as the service retires the aircraft the pilots will fly, has taken such steps as folding the responsibilities of a formal training squadron into an operational unit.[70]

The Corps has acquired 142 of the 353 F-35B aircraft that it plans to purchase and 48 of the 67 F-35Cs, the version designed for use aboard aircraft carriers.[71] Though the F-35 program has been the subject of vigorous criticism ever since it began, much of this criticism is misplaced today given the superior capabilities the aircraft brings to air operations in heavily contested environments featuring peer-level enemies and the steady decrease in per-unit cost.[72] "As the Commander of United States Indo-Pacific Command (USINDOPACOM) recently noted during testimony," according to General Berger, "'The importance of the F-35 cannot be overstated.'"[73] Additionally, not only is the F-35 "the most advanced fighter, strike, and sensor platform in the world," but "aircraft like the F-35B provide combatant commanders a competitive warfighting advantage," and the Corps "remains focused on accelerated transition to an all F-35 tactical aviation (TACAIR) fleet in order to stay in front of our pacing challenge."[74] The Corps' current concerns about the aircraft have less to do with its capabilities than they do with the overall cost of modern aircraft in general in the constrained budget environment within which the service is working to redesign its force.

Today, the USMC MV-22 Osprey program is operating with few problems and has completed the MV-22's full acquisition objective.[75] The MV-22's capabilities are in high demand from the Combatant Commanders (COCOMS), and the Corps is adding such capabilities as fuel delivery and use of precision-guided munitions to the MV-22 to enhance its value to the COCOMs.

The Corps has struggled with sustainment challenges in the Osprey fleet. In the years since procurement of the first MV-22 in 1999, the fleet has developed more than 70 different configurations.[76] This has led to increased logistical requirements as maintainers have had to be trained to each configuration and not all spare parts are shared. The Marine Corps developed its Common Configuration–Reliability and Modernization program to consolidate the inventory to a common configuration at a rate of "2–3 aircraft installs per year." The program was initiated in FY 2018 and continues as a component of the Corps' V-22 Readiness Program.[77]

The USMC's heavy-lift replacement program, the CH-53K, conducted its first flight on October 27, 2015.[78] The CH-53K will replace the Corps' CH-53E, which is now over 30 years old. Although "unexpected redesigns to critical components" delayed a low-rate initial production decision,[79] the program achieved Milestone C in April 2017. The Corps received $1 billion in FY 2019 to purchase seven aircraft,[80] $848 million for another six in FY 2020,[81] $1.1 billion for an additional nine in FY 2021, and $1.5 billion for 11 more in FY 2022.[82] Its FY 2023 budget request includes $1.67 billion for another 10 aircraft.[83]

Readiness

Riding alongside the Corps' principal Title 10 responsibility to provide "fleet marine forces...for service with the fleet in the seizure or defense of advanced naval bases and for the conduct of such land operations as may be essential to the prosecution of a naval campaign"[84] is its contribution as the military's crisis-response force. This aspect of USMC contributions to national defense has been reinforced by service leaders who take pains to allay concerns that their focus on China and the Indo-Pacific will distract them from this important role.[85] The Corps' readiness must therefore account for both high-end conflict against a major opponent in the most complex operational settings and pop-up crises against lesser opponents that cannot be predicted, all of which implies a force that is ready to go at a moment's notice.

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

> *Readiness is the synthesis of two distinct but interrelated levels. a. unit readiness—The ability to provide capabilities required by the combatant commanders to execute their assigned missions. This is derived from the ability of each unit to deliver the outputs for which it was designed. b. joint readiness—The combatant commander's ability to integrate and synchronize ready combat and support forces to execute his or her assigned missions.*[86]

To this the Commandant has added an expanded perspective that includes force modernization as an essential element to ensure that combat forces remain relevant and therefore ready. As General Berger and Air Force Chief of Staff General Charles Q. Brown, Jr., have argued, only by divesting old capabilities that would not be useful in changed circumstances and investing in new capabilities that account for more capable enemies and the characteristics of key operational theaters can U.S. forces be ready. "To do this," however, "we cannot let our focus on near-term availability consume the resources necessary to generate truly relevant future readiness through adaptive modernization."[87]

Divestiture carries with it some risk unless replacement capabilities are brought into the force as old or legacy capabilities are retired. For example, the Marine Corps' decision to get rid of tanks and a large percentage of its tube artillery means that the service will not have these capabilities should it be called into battle before new items can be fielded. Early reports of promising replacement capabilities to compensate for the loss of the Abrams main battle tank, for example, are encouraging, but the Corps now no longer has tanks while the improved replacement remains to be fielded.[88] This has a bearing on readiness to the extent that the force has a *current* ability to win in combat. The force might be ready but in a different posture. For a few years, the Marines could be more light-infantry than the middle-weight "two-fisted fighter" proudly described by a former Commandant a decade ago.[89]

Unfortunately for this *Index*, the Corps reports its current readiness in vague, generalized terms instead of providing data by which external audiences can independently assess the status of the service. It should be noted, however, that this approach is generally used by all of the services: Detailed readiness reports are classified to prevent potential enemies from obtaining sensitive information.

In the past, the services' leaders would report to Congress in formal testimony the various percentages of key equipment that were or were not available, share the status of primary units or types of force capabilities, and perhaps provide insight into maintenance or supply backlogs. The absence of such details from Marine Corps statements during the past year or two reveals that the Corps prefers not to share such information, at least currently. Corps officials have shared very encouraging anecdotal reports of lessons being learned in force-on-force exercises and the testing of new equipment and weapons that appear to validate the direction and objectives of FD 2030, but our assessment of the Corps' readiness must rely on the tone of statements and discussions, inferences derived from the totality of efforts and programs, and the sense one gets from anecdotal evidence of the seriousness with which the service is preparing for current and future employment.

As mentioned, the Marine Corps has undertaken a great reorientation to ready itself for war not just against China, but against any adversary that has the ability to field modern weapons and sensors in a heavily contested maritime environment. The service believes that the changes it is pursuing to this end will be relevant and necessary for combat environments outside of the Indo-Pacific as well, because many countries are acquiring capabilities that are now possible and affordable with modern technologies. With this as the driver, combined with the reiteration of the Corps' role as a force in readiness, the service's words, actions, and policies strongly imply a focused commitment to combat readiness and rapid progress in realizing the goals of its great reorientation.[90]

To improve force capabilities from the level of the individual to the most senior operational commands, the service is pushing several initiatives. Among them:

- The Marine Corps School of Infantry has revamped its training for entry-level infantry Marines, lengthening its course by nearly half (extending the eight-week course to 14 weeks) and including new coursework and field training intended to sharpen the thinking skills of Marines who will likely find themselves operating more independently than has been the case in the past.[91]

- "In May [2021], the Marine Corps broke ground on a new, state-of-the-art wargaming facility intended to house various capabilities to enhance warfighter preparedness." The Corps intends that the center, planned for use as early as 2024, will "help Marines better visualize the threat environment" and participate in war games of various sizes with a focus on realism and that it will also "provide data to inform decisions

affecting force development [and] support existing and developing weapons platforms and capabilities in all regions of the globe."[92]

- Taking this emphasis on thinking, training, and war-gaming scenarios to the field, the Corps and the Navy teamed to execute a two-week Large Scale Exercise 2021, billed as the largest the services have conducted in many years, that involved 25,000 personnel, 36 live units, 50 virtual units, and a half-dozen major commands spread across 17 time zones.[93]

- On the landward side of testing new capabilities, over the past 18 months, the Marines have conducted a series of force-on-force exercises (free-play exercises employing units with the ability to respond creatively to events rather than being limited to scripted or controlled play), have deployed new force designs in novel ways, and have operationally proved the utility of new force packages in real-world settings, all of which has validated the initial arguments framing FD 2030 and driven adjustments to the effort.[94]

- The Corps has transitioned its 3rd Marine Regiment, based in Hawaii, to a new organizational construct reflecting FD 2030 initiatives. The 3rd Marine Littoral Regiment is serving as the tactical and operational test bed for the service's many initiatives.[95]

Such efforts, from improvements to infantry training to war gaming to large exercises, are steps that appear to be having a positive effect on currently fielded forces. Although proof at scale has yet to be seen, they do reveal attitudes, priorities, and perspectives that reflect a level of seriousness about warfighting.

Within the Marine Corps, perhaps because it is a smaller service, changes in direction and attitude are more easily conveyed to the force by senior leaders and adopted force-wide than is the case in the larger services. While this does not directly replace hard data on mission-capable rates for equipment used by the Marines or cleanly substitute for unclassified reports about the readiness of units composing the Fleet Marine Force, it can be seen as a surrogate for the Corps' attention to its level of readiness. The extended operational demands of Iraq and Afghanistan having concluded, the force is reconstituting its readiness as it reorients toward the requirements of FD 2030, LOCE, and EABO.

Lacking any other direct reporting, this *Index*'s assessment of the Corps' readiness for current operations is therefore an optimistic one.

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 major regional contingency (MRC).[96] This requirement is based on the presumption of a rather conventional force using known (current) equipment and capabilities against a similar opponent.

This *Index* acknowledges the service's work to develop new capabilities and approaches to fighting and is certainly aware of the trends in new technologies and associated thinking about how warfare *might* change in the future, but until this happens, one can assess only what can be known at present. Consequently, the Corps' historical need for 15 battalions (and associated enabling elements) for one major conflict translates to a force of approximately 30 battalions to fight two MRCs simultaneously if we were to retain the metric used in previous editions of the *Index*. The government force-sizing documents that discuss Marine Corps composition support the larger measure. Though the documents that make such a recommendation count the Marines by divisions rather than 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. However, the Corps has repeatedly made the case that it is a one-war force that must also have the ability to serve as the nation's crisis-response force.[97] It has just as consistently resisted growing in end strength even during the years of high operational demand associated with

peak activities in Operation Iraqi Freedom (Iraq) and Operation Enduring Freedom (Afghanistan). Most recently, General Berger has stated flatly that the Corps will trade manpower for modernization and that he intends to shrink the Corps from its current 22 infantry battalions to 21 battalions both to free resources so that they can be applied to new formations and to maintain capability investments in other areas such as Marine Special Operations Command.[98]

Manpower is by far the biggest expense for the Marines. In the Corps' FY 2022 budget, the military personnel account was approximately $14.6 billion (an increase of $200 million over FY 2021),[99] dwarfing both the approximately $9.2 billion allocated for operations and maintenance[100] and the $3.1 billion allocated for the procurement of new equipment.[101] Nevertheless, the historical record of the use of Marine Corps forces in a major contingency argues for the larger number. More than 33,000 Marines, for example, 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.

One could reasonably presume that in a war with China, in which the Marines would employ many small, highly distributed units, the demand for forces would be similar to the demand during these historical instances of Marine Corps employment. The pacing threat for the Corps is China, the archetype for countries developing new tools and operational concepts that will likely require the distribution of the Marine Corps across a large, contested littoral battlespace. Though the Corps has been refining its sense of what these formations will require, they have yet to be proven in operational employment at significant scale. Consequently, we can only assess the service's current status against historical demand. Even a one-major-war Marine Corps should possess a larger end strength and more tactical units (infantry battalions as the surrogate measure for the total Corps) than it currently has, especially with the trend bending downward to even fewer.

As a one-war force that also needs the ability to provide crisis-response forces, sustain operations in the face of combat losses, and sustain its support for efforts that are not USMC-specific such as its service component contribution to U.S. Special Operations Command, the Corps should have a minimum of 30 battalions.

- **One-MRC-Plus Level:** 30 battalions.
- **Actual 2022 Level:** 22 battalions.

The Corps is operating with 73 percent of the number of battalions it should have relative to the revised benchmark set by this *Index* and has stated its intent to shrink from its current 22 battalions to 21 battalions. Marine Corps capacity is therefore scored as "weak," a drop in score from the *2022 Index*. Reducing operational strength by another battalion would bring it to just 70 percent of the strength it should have.

Capability Score: Strong

The Corps receives scores of "marginal" for "Capability of Equipment," "marginal" for "Age of Equipment," "strong" for "Health of Modernization Programs," and "strong" for "Size of Modernization Program." This *Index* recognizes that within the Capability and Age portfolios, the old equipment exists mostly in ground combat vehicles. The Marines have modernized their aviation assets almost completely and are moving aggressively to introduce new ground platforms like the ACV and JLTV to offset the deteriorating condition of the AAV and HMMWV fleets, respectively. In the aggregate, the service's aviation arm and its rapid introduction of new munitions, weapons, and a host of communications equipment, sensors, and unmanned platforms likely compensate for the aged AAV, HMMWV, and AV-8B Harriers, resulting in a score of "strong" for Marine Corps capability.

Readiness Score: Strong

The Corps has exhibited an especially focused and aggressive commitment to ensuring that Marine Corps forces are ready for action. This is the point of FD 2030. However, the history of military services is littered with the debris of grand vision statements and futuristic concepts that were unrealized in practical implementation.

The Marine Corps' effort appears to be substantially different, as evidenced by nearly irrevocable decisions to cashier old equipment and implement significant changes in education and training

programs, dramatic investments in experimentation and war gaming, rapid acquisition of new capabilities, and profound redesign of operational units. The real changes in programs and organizations that reflect its published rhetoric are compelling evidence that the Corps means what it has been saying about maintaining readiness. The authors of the *2023 Index* believe it to be a low-risk proposition to apply the evidence of preparing for the future to current forces in terms of their focus on readiness for combat. The force remains encumbered by old primary equipment, but the service's effort to spend the money needed to keep it serviceable mitigates this problem to a reasonable extent.

The Corps is still too small, but the force it has is fully focused on warfighting. Consequently, the *2023 Index* assesses Marine Corps readiness as "strong," a continuation of the assessment made in the *2022 Index*.

Overall U.S. Marine Corps Score: Strong

The score for the Marine Corps was raised to "strong" from "marginal" in the *2022 Index*, and it remains "strong" in this edition for two reasons: (1) because the *2021 Index* lowered the threshold for capacity from 36 infantry battalions to 30 battalions in acknowledgment of the Corps' argument that it is a one-war force that also stands ready for a broad range of smaller crisis-response tasks and (2) because of the Corps' extraordinary, sustained efforts to modernize (which improves capability) and enhance its readiness during the assessed year.

Of the five services, the Marine Corps is the only one that has a compelling story for change, has a credible and practical plan for change, and is effectively implementing its plan to change. However, in the absence of additional funding in FY 2023, the Corps intends to reduce the number of its battalions even further from 22 to 21, and this reduction, if implemented, will limit the extent to which it can conduct distributed operations as it envisions and to replace combat losses (thus limiting its ability to sustain operations).

Though the service remains hampered by old equipment in some areas, it has nearly completed modernization of its entire aviation component, is making good progress in fielding a new amphibious combat vehicle, and is fast-tracking the acquisition of new anti-ship and anti-air weapons. Full realization of its redesign plan will require the acquisition of a new class of amphibious ships, for which the Corps needs support from the Navy.

U.S. Military Power: Marine Corps

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

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Light Wheeled Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
HMMWV Inventory: **10,859** Fleet age: **24** Date: **1983** The HMMWV, better known as the Humvee, is a light wheeled vehicle used to transport troops and various weapons systems with limited protection against small arms, fragmentation, and blast damage. Initially introduced in the 1980s, HMMWVs are being replaced by the Joint Light Tactical Vehicle (JLTV).	2	2	**Joint Light Tactical Vehicle (JLTV)** Timeline: **2017–2023** The JLTV program is a joint program with the Army, meant eventually to replace all HMMWVs. Full-rate production was achieved in FY 2019. The first set of JLTVs were fielded in March 2019; IOC was achieved in mid-summer 2019. In the fourth quarter of FY 2022, a new contract will be signed to continue production of JTLVs. **PROCUREMENT** 5,167 ■ 3,089 **SPENDING** *($ millions)* $2,239 ■ $3,828	3	4
JLTV Inventory: **5,167** Fleet age: **3** Date: **2019** The Joint Light Tactical Vehicle (JLTV) is taking the place of the HMMWV as a light wheeled vehicle for troop transport. The vehicle provides stronger protection from IEDs and threats with which the Humvee struggled during the conflicts in Iraq and Afghanistan. The JLTV improves reliability, survivability, and transportability while retaining the capability to be outfitted for specific missions.	5	5			

NOTE: See page 448 for details on fleet ages, dates, timelines, and procurement spending. JLTV spending figures reflect the full joint program spending

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Amphibious Assault Vehicle

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
AAV Inventory: **1,200** Fleet age: **50** Date: **1972** The Amphibious Assault Vehicle (AAV) is an amphibious landing vehicle designed to transport Marines from vessels at sea to shore. Though old, the AAV has received numerous upgrades over the years to keep it viable for land combat operations. In 2021, the decision was made to permanently restrict AAVs from amphibious operations due to their age and threat to safety. The AAV will be replaced by the ACV.	1	1	**Amphibious Combat Vehicle (ACV)** Timeline: **2018–2026** The Amphibious Combat Vehicle (ACV) is a wheeled amphibious vehicle that will supplement and eventually replace the AAV. It is designed for increased survivability, the most notable difference being the increased protection from IED's and mines. The ACV features a new remote weapons system, improving situational awareness and ability to track and fire upon targets. The ACV achieved Initial Operational Capability in 2020. **PROCUREMENT** 167 363 **SPENDING** *($ millions)* $1,597 $2,904	3	4
LAV-25 Inventory: **488** Fleet age: **40** Date: **1983** The Light Armored Vehicle (LAV) is an eight-wheeled, armored reconnaissance vehicle. It is designed for off-road and moderate amphibious capabilities. This allows for highly mobile fire support in most terrains. It will be in service until 2035.					

NOTE: See page 448 for details on fleet ages, dates, timelines, and procurement spending.

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Attack Helicopters

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
AH-1Z Viper Inventory: **159** Fleet age: **8** Date: **2010** The AH-1Z Viper replaced the AH-1W Super Cobra as the much improved attack helicopter for the Marine Corps. The Viper has greater speed, payload, and range, as well as upgraded landing gear, advanced weapons systems, and a fully integrated glass cockpit. The Viper provides Marines with close air support, armed escort/reconnaissance, and anti-armor capabilities. The expected operational life span of the Viper is 30 years.	4	5	None		

Tactical Aircraft

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
AV-8B Inventory: **53** Fleet age: **30** Date: **1985** The Harrier is the Marine Corps ground attack aircraft. It is a subsonic jet capable of hovering similar to a helicopter. The Harrier has a vertical/short takeoff and landing (V/STOL) system, designed to fly from amphibious assault ships and unconventional runways. These unique capabilities allow it to operate in a variety of environments that other jets find inaccessible. The aircraft is being replaced by the F-35B and will be fully retired around 2024.	1	1	**F-35B/C** Timeline: **2007–2031** The F-35B (STOVL Variant) is replacing the AV-8B Harrier, providing the Corps a 5th Generation stealth STOVL aircraft. Specifically designed for the Marine Corps, the B-model achieved IOC in 2015. It is being procured at a much higher quantity than the C-model, and full operational capability is expected in the late 2020s. The F-35C (Carrier Variant) is also being procured by the Marine Corps, taking over the role of the F/A-18. Designed for operations by aircraft carrier, the F-35C is being procured to give Marines the ability to launch from carrier while the F-35B launches from amphibious assault ships. The Marines activated their first F-35C squadron in December of 2020. Full operational capability is expected in the late 2020s. **PROCUREMENT** 164 205 **SPENDING** *($ millions)* $24,414 $26,674	4	4
F/A-18 C-D Inventory: **41** Fleet age: **31** Date: **1978** The F/A-18 Hornet is a fighter and attack jet, primarily used by the Marine Corps for traditional strike missions, fleet air defense, and air support. The F/A/18 will no longer fly on carriers and will be replaced by the F-35C. The F/A-18 fleet life has been extended until 2030 in order to bridge the gap between the two aircraft platforms.	2	1			

NOTE: See page 448 for details on fleet ages, dates, timelines, and procurement spending.

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Tactical Aircraft (Cont.)

PLATFORM	Age Score	Capability Score
F-35B Lightning II (STOVL) Inventory: **116** Fleet age: **6** Date: **2015** The F-35B is the Marine Corps variant of the Joint Strike Fighter (JSF) Program. It is a fifth-generation, stealth multi-role fighter. The next-generation technology allows it to dominate combat missions without being detected by the enemy. Unique to the other variants, the B-Model is designed with a Short Take-Off Vertical Landing (STOVL) system, allowing for operation from flight decks and unconventional runways. This combines the unique operational capabilities of the AV-8B Harrier with the new technology offered by the JSF program.	5	5
F-35C Lightning II (CV) Inventory: **10** Fleet age: **1** Date: **2020** The F-35C is the aircraft carrier variant of the Joint Strike Fighter (JSF) Program, used by both the Navy and the Marine Corps. It is a fifth-generation, stealth multi-role fighter. The next-generation technology allows it to dominate multiple types of combat missions without being detected by the enemy. The C-Model, also known as the carrier variant (CV), is specially designed for operation on aircraft carriers. Although the C-Model is used primarily by the Navy, the Marine Corps implemented its first C-Model squadron in December 2020 to complement its pre-existing F-35B fleet. The F-35C will replace the F/A-18 in the Marine Corps inventory.	5	5

NOTE: See page 448 for details on fleet ages, dates, timelines, and procurement spending.

MARINE CORPS SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Medium Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
MV-22B Osprey Inventory: **296** Fleet age: **15** Date: **2007** The Osprey is a vertical takeoff, tilt-rotor aircraft, combining the vertical capabilities of a helicopter and a traditional fixed-wing aircraft. Similar to the AV-8B, this allows the aircraft to take off and land in environments where normal aircraft cannot go. The Osprey provides transport for personnel, cargo lift, and support for expeditionary assaults. The life expectancy of the MV-22B is 23 years.	3	5	**MV-22B** Timeline: **2007–TBD** Fielding of the Osprey was completed in 2019 with the MV-22B replacing the CH-46E helicopter. The modernization program is not facing any serious issues. **PROCUREMENT** 359 / 5 **SPENDING** *($ millions)* $30,502 / $23,095	5	5

Heavy Lift

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
CH-53E Super Stallion Inventory: **136** Fleet age: **33** Date: **1981** The CH-53E is a heavy-lift rotary-wing aircraft. The Super Stallion transports heavy equipment and supplies for amphibious assault operations. The aircraft will operate through 2027, to be replaced by the more advanced CH-53K. The program life of the CH-53E is 41 years.	2	1	**CH-53K** Timeline: **2017–2030** The CH-53K King Stallion program is currently in development. It will replace the aging CH-53E and provide increased range, survivability, and payload. The King Stallion achieved IOC in April of 2022 and is scheduled to deploy in 2024. **PROCUREMENT** 40 / 156 **SPENDING** *($ millions)* $6,397 / $18,428	5	3

Tanker

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
KC-130J Inventory: **63** Fleet age: **12** Date: **2005** The KC-130J is a large multi-role aircraft, used primarily as a tanker and cargo transport and can be equipped for various missions to include air-to-air refueling, reconnaissance, and medevac operations. The airframe is expected to last 38 years.	4	5	**KC-130J** Timeline: **2005–2031** The KC-130J is both a tanker and transport aircraft. The procurement program for the KC-130J is not facing acquisition problems. Procurement planned to be complete by 2024. **PROCUREMENT** 79 / 32 **SPENDING** *($ millions)* $6,098 / $4,616	4	4

NOTE: See Methodology for descriptions of scores. Fleet age is the average between the last year of procurement and the first year of initial operational capability. The date is when the platform achieved initial operational capability. The timeline is from the start of the platform's program to its budgetary conclusion. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E). Total program dollar value reflects the full F–35 joint program, including engine procurement. As part of the F–35 program, the Navy is purchasing 67 F-35Cs for the U.S. Marine Corps that are included here. The MV-22B program also includes some costs from U.S. Air Force procurement. AH-1Z costs include costs of UH-1 procurement.

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U.S. Space Force

John Venable

The U.S. Space Force (USSF) was created with enactment of the fiscal year (FY) 2020 National Defense Authorization Act (NDAA) on December 20, 2019.[1] Established as the fifth uniformed service within the Department of Defense (DOD) and the second service within the Department of the Air Force (DAF), the USSF functions under the direction and leadership of the Secretary of the Air Force. The FY 2020 NDAA specifies that a four-star general will serve as Chief of Space Operations (CSO) and as a full member of the Joint Chiefs of Staff.[2]

The Space Force's mission is to organize, train, and equip forces "to protect U.S. and allied interests in space and to provide space capabilities to the joint force." Its responsibilities include "developing Guardians [military space professionals], acquiring military space systems, maturing the military doctrine for space power, and organizing space forces to present to our Combatant Commands."[3]

A 2001 RAND study estimated that 95 percent of all civilian and commercial space technologies have direct applicability to military systems or are of dual use. That fact and the capabilities that those two sectors bring to the Space Force are critical to an assessment of this new service.[4] The domination of great-power competition in space relies increasingly on the interwoven efforts of all three U.S. sectors—military, civil, and commercial space.

Background

More than any other nation, America has enjoyed the technological advantages of space, and we now rely on it for nearly every aspect of our lives. Banking, commerce, travel, entertainment, the functions of government, and our military all depend on our assets in space.[5]

Though our reliance on our spaceborne systems has been recognized by every President since Dwight Eisenhower in the mid-1950s, various issues kept the United States from developing a single service charged with managing space assets and capabilities. In 1961, the Air Force was named executive agent for space research and development, but at that point, the Army and Navy already had well-established programs.[6] Every Administration sustained this splintered approach for the next six decades, but U.S. space capabilities still advanced at a stunning pace.

The effectiveness of the DOD's space support missions was put on full display during Operation Desert Storm,[7] and adversary nations did much more than take note. They recognized the growing U.S. dependence on space and began to position themselves to move against it.

As early as 2001, a congressionally mandated report warned of our growing dependence on space and the vulnerability of U.S. assets in that domain and ultimately recommended establishing a Space Corps within the DAF.[8] Those recommendations were set aside following the terrorist attacks of September 11, 2001, and by the mid-2010s, the command and control of space had fragmented across at least 60 different DOD offices.[9] All the while, U.S. reliance on the Global Positioning System (GPS) for air, land, and sea maneuver, targeting, and engagement has grown to the point of being nearly universal, exposing a critical vulnerability that our adversaries have moved to exploit.

Both China and Russia have developed doctrine, organizations, and capabilities to challenge U.S. access to and operations in the space domain. Concurrently, their own use of space is expanding significantly. These nations have demonstrated the capability to put American space assets at risk, and until very recently, the United States had not taken

overt steps to protect those systems, much less to develop its own warfighting capability in that domain.

The FY 2017 NDAA mandated that DOD conduct a review of the organization and command and control of space assets within the department.[10] Shortly after the FY 2017 NDAA was enacted, President Donald Trump directed that a Space Force be established within the DAF.[11] Congress concurred and authorized the creation of the USSF with enactment of the FY 2020 NDAA.

An important addition to the U.S. warfighting command structure was the reestablishment of U.S. Space Command as the 11th Combatant Command within the Department of Defense. The mission of Space Command is to conduct "operations in, from, and to space to deter conflict, and if necessary, defeat aggression, deliver space combat power for the joint/combined force, and defend U.S. vital interests with allies and partners."[12]

U.S. Space Force Organization

The USSF Headquarters and Office of the Chief of Space Operations are located in the Pentagon. When Congress authorized the Space Force, it limited its scope to Air Force organizations and personnel located at five major installations:

- The 21st Space Wing at Peterson Air Force Base, Colorado;
- The 30th Space Wing at Vandenberg Air Force Base, California;
- The 45th Space Wing at Patrick Air Force Base, Florida;
- The 50th Space Wing at Schriever Air Force Base, Colorado; and
- The 460th Space Wing at Buckley Air Force Base, Colorado.[13]

Those personnel, organizations, and structures have been or will be restructured and rolled into three major field commands that fall directly under the CSO:

- Space Operations Command (SpOC);
- Space Systems Command (SSC); and
- Space Training and Readiness Command (STARCOM).[14]

These three commands lead the next tier of organizations, called Deltas and Garrisons. Deltas are equivalent to Air Force Groups, are led by a colonel, and are tasked with and responsible for specific missions and operations. Garrisons are also the equivalent of Air Force Groups and support Deltas with functions similar to those of Air Force base-level command. Squadrons are the final level of command and will fall under Deltas and Garrisons.[15]

Space Operations Command. SpOC was established on October 22, 2020, as the first major USSF field command.[16] Currently located at Peterson Air Force Base, Colorado, SpOC is led by a three-star general and is responsible for organizing, training, and equipping space forces assigned to Combatant Commands. The SpOC at Vandenberg Air Force Base, California, was redesignated as SpOC West and continues to conduct operations in support of Combatant Commanders.

Space Systems Command. This command stood up on August 13, 2021, at Los Angeles Air Force Base[17] to oversee the development, acquisition, and maintenance of satellites and ground systems, the procurement of SATCOM and launch services, and investments in next-generation technologies. SSC is led by a three-star general who oversees the Space Force's approximately $15.8 billion annual budget for research, development, test, and evaluation (RDT&E) and the acquisition of new systems.[18] SSC absorbed the Space and Missile Systems Center (SMC), located at Los Angeles Air Force Base, California; the Commercial Satellite Communications Office based in Washington, D.C.;[19] and the Space Vehicles Directorate at Kirkland Air Force Base, New Mexico.[20]

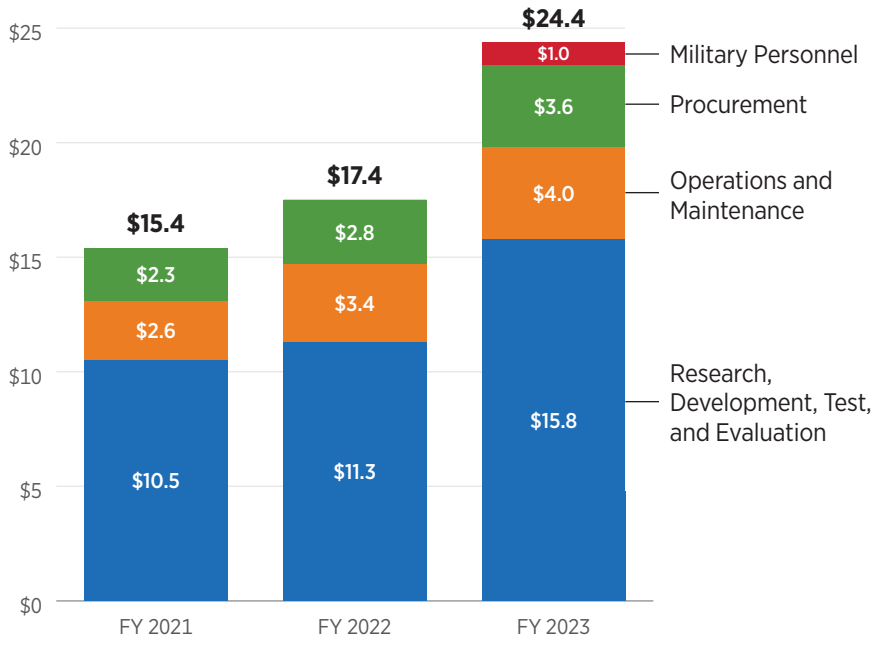
Space Training and Readiness Command. STARCOM is the third USSF field organization and stood up on August 23, 2021, at Peterson Air Force Base in Colorado. It is led by a two-star general and is responsible for the education and training of space professionals.[21]

Personnel. The FY 2023 Air Force budget request supports 8,600 military and 4,927 civilian Space Force personnel, respectively, up from 8,400 military and 4,364 civilian, respectively, in FY 2022, and a total end strength of 13,527, up from 12,764 in FY 2002.[22] The 2020 NDAA specified that only

CHART 10

U.S. Space Force Budget

IN BILLIONS OF DOLLARS



NOTE: U.S. Space Force personnel costs for fiscal years 2021 ($800.3 million) and 2022 ($929.8 million) were funded by the U.S. Air Force budget.

SOURCES: U.S. Air Force budget summaries for fiscal years 2021, 2022, and 2023. For example: Table 3, "U.S. Space Force Budget Summary," in U.S. Department of the Air Force, *Department of the Air Force Fiscal Year 2023 Budget Overview*, p. 6, https://www.safm.hq.af.mil/Portals/84/documents/FY23/SUPPORT_/BOB_28Mar_1125_LoRes.pdf?ver=5nrA8bBfhWoUSrvZ09CeHA%3d%3d (accessed August 18, 2022).

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the Air Force was required to provide personnel for the Space Force, and with the redesignation of Air Force Space Command (AFSPC) as Space Operations Command, approximately 16,000 Air Force active-duty and civilian personnel were assigned to support the USSF.[23]

The Space Force began to accept interservice transfer applications for the first time on June 15, 2022.[24] In June, the Naval Satellite Operations Center (NAVSOC) based at Naval Base Ventura County in Mugu, California, was transferred to the USSF and redesignated as the 10th Space Operations Squadron (SOC). On August 15, 2022, the Army announced the transfer of its satellite communications functions, conducted by the 53rd Signal Battalion, along with approximately 300 uniformed and 200 civilian Army personnel who work those systems. Those personnel are based in Maryland, Hawaii, Germany, and Japan and will remain at those duty locations as the USSF's 53rd Space Operations Squadron. Many of the Army and Navy transfers were supposed to happen at the beginning of FY 2022 but were delayed because of the congressional delay in passing the FY 2022 budget. With the Army's SATCOM mission transfer, the Space Force is now the only DOD organization that conducts satellite and transmission control for the Defense Satellite Communications System (DSCS) and Wideband Global SATCOM (WGS) Satellite constellations.[25]

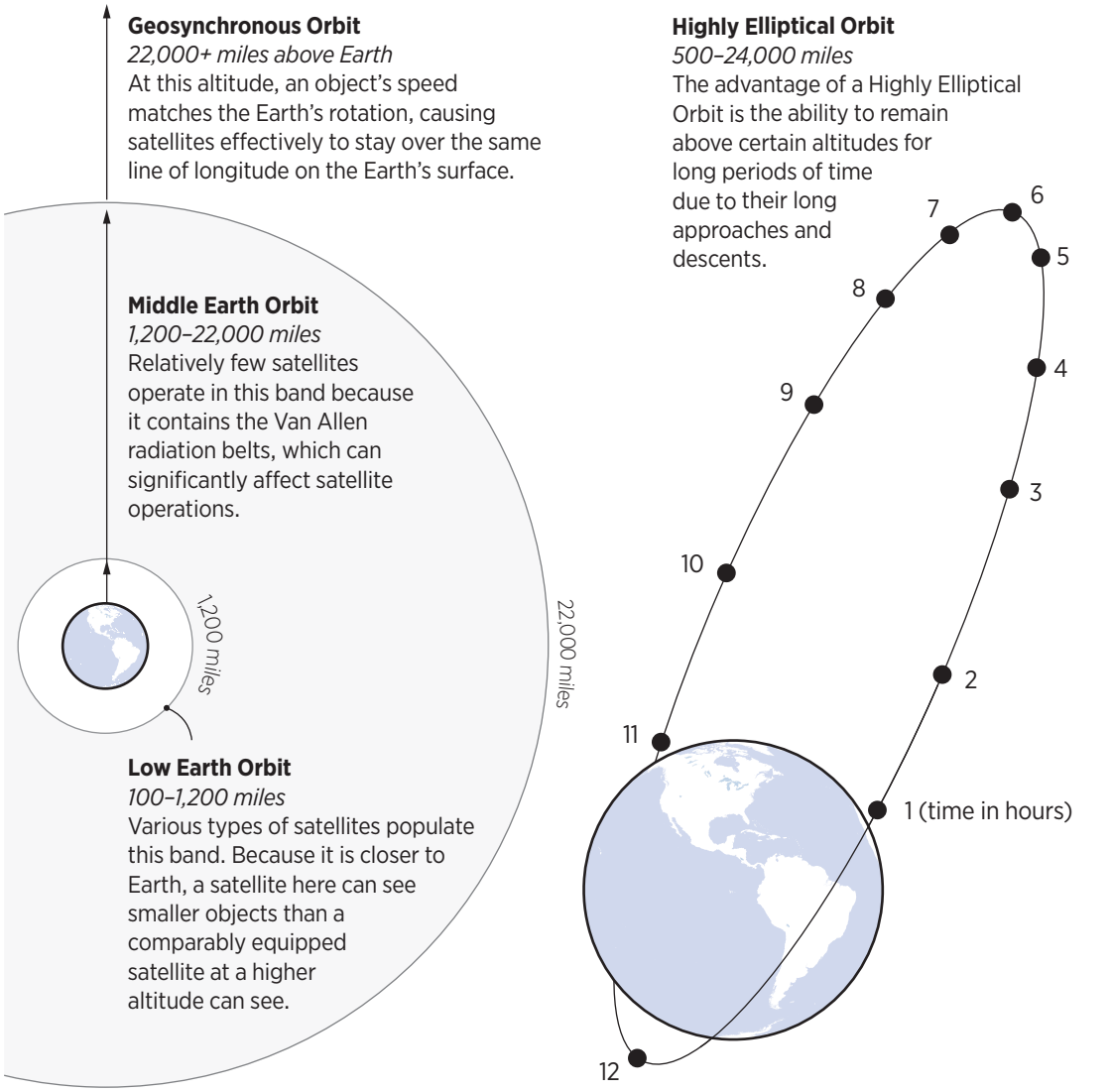
"To officially transfer from one military service to another," according to the USSF, "a military member separates from the current service and commissions or enlists into the new service in their current rank."[26]

Funding

The President's budget request for FY 2023 lays out a relatively robust level of funding for every

FIGURE 4

Types of Earth Orbits



SOURCE: Heritage Foundation research.

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aspect of the new service's mission set. The budget for Operations and Maintenance (O&M) is $4.0 billion; the budget for RDT&E is $15.8 billion; and procurement adds another $3.6 billion for a total of $24.5 billion, a 41 percent increase from FY 2022.[27]

Assuming that the President's budget is fully funded, the Space Force, as noted, will have an authorized end strength of 13,527 military and civilian personnel, an increase of 763 from FY 2022.[28] The combination of robust funding and manpower levels will allow the CSO to continue to focus on building a strong organizational foundation and filling critical billets with the right people.

Capacity

The classified nature of deployed space assets makes listing specific capacity levels within the Space Force portfolio, much less attempting to

assess the service's capability to execute its mission, a challenging exercise. The USSF's position, navigation, and timing (PNT); command and control (C2); communications (Comm); weather; and intelligence, surveillance, and reconnaissance (ISR) satellites are unrivaled and provide extraordinary capabilities. Its space situational awareness (SSA) satellites and terrestrial-based capabilities are also unrivaled, but they are limited and require additional resourcing. Each satellite, satellite constellation, and terrestrial space surveillance site has unique characteristics and an expected life span.

Satellite Constellations

The Space Force's mission is conducted through a network of satellites, ground-based radar, ground stations, and situational awareness nodes. In 2018, the Secretary of the Air Force stated that the service operates 77 satellites that provide information on position, navigation, and timing (PNT), weather, communications, command and control, missile warning, and nuclear detonation that is "vital to national security."[29] An estimated 114 satellites now reside within the Space Force portfolio. (See Table 14).

Global Positioning System (37 Satellites). Perhaps the best-known constellation of satellites under Space Force control is the Global Positioning System, which provides PNT for millions of simultaneous users around the world. It takes 24 of these satellites to provide seamless global coverage, and 31 are operational.[30] Currently, six additional satellites that have been decommissioned serve as on-orbit spares, bringing the total to 37.

GPS III is the latest upgrade to the platform and incorporates a more robust anti-jamming capability. The fifth GPS III satellite was launched into orbit in June 2021.[31] The sixth reportedly is scheduled for launch in January 2023, and the seventh and eighth have been completed and are awaiting their turn in the launch queue.[32] GPS III satellites have a civilian signal that is interoperable with other Global Navigation Satellite Systems (GNSS) such as the European Galileo network and the Japanese Quazi-Zenith Satellite System, adding an impressive level of resiliency to the constellation.[33]

Defense Meteorological Satellite Program (DMSP) (Three Satellites). Defense weather satellites have been collecting weather data and providing forecasts for U.S. military operations since 1962 through the Defense Meteorological Satellite Program (DMSP).[34] Currently, three DMSP satellites[35] are operational and in polar low-Earth orbit (LEO).[36]

The main sensors for these weather satellites are optical, and each provides continuous visual and infrared imagery of cloud cover over an area approximately 1,600 nautical miles wide, enabling complete global coverage of weather features every 14 hours.[37] Launched between 1999 and 2009 with a life expectancy of just five years, they have continued to deliver exceptional data well beyond their expected lifetimes.[38]

Military Strategic and Tactical Relay (Milstar) (Five Satellites). Milstar is a satellite communications (SATCOM) system designed in the 1980s to provide the National Command Authorities (President, Vice President, Secretary of Defense, Joint Chiefs of Staff, and Combatant Commanders) assured, survivable global communications with a low probability of intercept or detection. This constellation was designed to overcome enemy jamming and nuclear effects and was considered the DOD's most robust and reliable SATCOM system when it was fielded. Milstar was fielded from 1993 through 2004 with a designed life of 10 years.[39]

Advanced Extremely High Frequency System (AEHF) (Six Satellites).[40] Like Milstar, AEHF provides and sustains secure, jam-resistant communications and C2 for high-priority military assets located anywhere in the world. Each AEHF satellite provides more capacity than the entire five-satellite Milstar constellation with five times the Milstar data rates, enabling real-time video, battlefield maps, and targeting data for tactical users.[41] The AEHF constellation was launched into geosynchronous orbit (GEO) from 2010–2020 with a satellite design life of 14 years.[42]

Defense Satellite Communications System (DSCS) (Seven Satellites). These satellites provide nuclear-hardened, global communications to the Defense Department, the Department of State, and the National Command Authorities. The system is capable of high data rates and provides anti-jamming capabilities. These satellites were fielded from 1998 through 2003 into GEO with 10-year life spans.[43]

Wideband Global SATCOM (WGS) (10 Satellites). WGS is a joint-service program funded by the U.S. Air Force and U.S. Army, along with international partners Australia and Canada, and is used by all

DOD services as well as National Command Authorities. Once known as the Wideband Gapfiller Satellite,[44] WGS provides Super High Frequency (SHF) wideband communications, using direct broadcast satellite technology to provide C2 for U.S. and allied forces. With solid capabilities that include phased array antennas and digital signal processing technology, this system delivers a flexible architecture with a satellite life span of up to 14 years.

Fleet Satellite Communications System (FLTSATCOM) (Six Satellites).[45] FLTSATCOM is a constellation of five operational satellites used by the Navy, Air Force, and presidential command network. The system was launched into GEO between 1978 and 1989 to serve as a secure communications link between the three users with a design life of five years.[46] This constellation was transferred from the U.S. Navy to the Space Force on June 6, 2022.[47]

Ultra-High Frequency Follow-On (UFO) (10 Satellites). The UFO constellation was designed to replace FLTSATCOM to provide communications for tactical users including aircraft, ships, submarines, and ground forces. UFO provides almost twice the throughput and 10 percent more power per channel than FLTSATCOM. This UFO constellation of satellites was launched into GEO between 1993 and 2003 with a life expectancy of from 14 to 15 years.[48] The system was transferred from the U.S. Navy to the Space Force on June 6, 2022.[49]

Mobile User Objective System (MUOS) (Five Satellites). MUOS is a next-generation narrowband tactical satellite communications system designed for tactical users with the goal of significantly improving ground communications, even for troops in the most remote locations or in buildings with no other satellite access. MUOS satellites were launched into GEO from 2012 through 2016 with a design life of 15 years and provide the ability to provide the transmission of 10 times more information volume than can be transmitted with UFO.[50] This constellation was transferred from the U.S. Navy to the Space Force on June 6, 2022.[51]

Space-Based Infra-Red System (SBIRS) (10 Satellites). SBIRS is an integrated constellation of satellites designed to deliver early missile warning and provide intercept cues for missile defenses. This surveillance network was designed to incorporate three satellites in highly elliptical orbit (HEO) and eight others in GEO, each working in concert with ground-based data processing and command and control centers. Because SBIRS HEO is a retaskable orbit, these satellites can be moved to more optimal orbits/viewpoints as mission requirements dictate. Four SBIRS HEO satellites and six SBIRS GEO satellites are now in orbit (GEO-6, the final satellite in this constellation, was launched into orbit on August 4, 2022).[52]

The funding that was removed from SBIRS was shifted to a new program, Next-Generation Overhead Persistent Infrared (Next-Gen OPIR), which will include a new ground-control system. Fielding of this strategically survivable constellation of missile warning satellites is scheduled to begin sometime in FY 2023.[53]

Defense Support Program (DSP) (Five Satellites). DSP is a classified constellation that was designed to detect launches of intercontinental ballistic missiles (ICBMs) or submarine-launched ballistic missiles (SLBMs) against the U.S. and its allies. Its secondary missions include detection of space launch missions or nuclear weapons testing and detonations, as well as launches of shorter-ranged ballistic missiles. The DSP constellation is in GEO and uses infrared sensors to pick up the heat from missile booster plumes against the Earth's background. Phase 1 placed four satellites in orbit from 1970 through 1973[54] and was followed by Phase 2, which placed six satellites in orbit from 1979–1987.[55] Phase 3 consisted of 10 DSP satellites that were launched from 1989–2007.[56]

Although Phase 3 DSP satellites have long exceeded their design lifetimes, reliability has exceeded expectations. At least five[57] and as many as eight are still providing reliable data and are now integrated with and controlled by the SBIRS program ground station.[58]

Space Situational Awareness Systems

Knowledge of hostile space systems—their locations, their positional history, and how those satellites and other spacecraft are maneuvering in real time—conveys intent and collectively shapes the protocols and counterspace decisions that follow. Space situational awareness is therefore critical to every aspect of defensive and offensive counterspace operations and forms the foundation for DOD counterspace activities.[59]

In addition to adversary systems, other significant threats are in orbit. The National Aeronautics and Space Administration (NASA) estimates that

as many as a half-million objects with diameters between 0.4 inches and four inches are circling the Earth.[60] In August of 2021, the Space Force was tracking some 35,000 objects in LEO alone, but that was before the Russian ASAT test in November of that year that created some 1,500 additional pieces of trackable debris and thousands more that are too small to track.[61] Even very small pieces of debris moving at LEO orbital speeds of between 15,600 and 17,900 miles an hour[62] threaten everything from satellites to the International Space Station.[63]

Maintaining a high level of situational awareness of satellites and debris orbiting across the depth and vast dimensions of potential Earth orbits requires a robust and seamless network of space-based and 23 terrestrial-based sensors, the earthbound portion of which is known collectively as the Space Surveillance Network (SSN). Understanding the capabilities and limitations of that network naturally begins with understanding the numbers and types of space-based and ground-based systems.

Six acknowledged satellites (with four other likely satellites) and six dedicated and 17 collateral or contributing terrestrial-based sensors help to maintain situational awareness of satellites and other objects in space. The satellites, known collectively as the Space-Based Surveillance System (SBSS), operate in concert with ground-based sensors but without their limitations such as suitable weather and sunlight that can blind ground-based optical sensors.

Some satellites track objects and debris fields from LEO. Others operate from a much higher orbital position (GEO) and are capable of maneuvering to perform detailed inspections of orbiting items that are of especially high interest.

Geosynchronous Space Situational Awareness Program (GSSAP) (Six Satellites). This classified surveillance constellation can accurately track and characterize objects in orbit.[64] Operating near GEO, GSSAP satellites are maneuverable and therefore able to perform rendezvous and proximity operations (RPO) on objects of interest in space.[65] Launched in pairs, the first two GSSAP satellites were put in orbit on July 28, 2014; the second two were launched on August 19, 2016; and a third pair was launched on January 21, 2022.[66] Each GSSAP satellite has an estimated life span of seven years.[67]

Space-Based Space Surveillance System-1 (SBSS-1) (One Satellite). The SBSS-1 satellite was launched into LEO in 2010 to detect and track space objects, such as satellites and orbital debris. This satellite has a seven-year life expectancy.[68]

Space Tracking and Surveillance System Advanced Technology Risk Reduction (STSS-ATR) (One Satellite). STSS-ATR is an RDT&E satellite placed in a polar LEO on May 5, 2009, for the Missile Defense Agency (MDA) to test an alternate technology for potential missile defense application.[69]

Space Tracking and Surveillance System (STSS) (Two Satellites). Formerly known as SBIRS-Low, the two STSS satellites carry a very capable set of infrared and visible sensors for detecting and tracking ballistic missiles through all phases of their trajectory. These satellites were launched into LEO in 2009 with programmed life spans of two years.[70]

Terrestrial-Based Sensors (23 Sensors). There are six dedicated, ground-based radar sensors that track satellites and orbital debris, including the Space Fence on Kwajalein Atoll in the South Pacific. Seven collateral radar sensors are part of the network, but their primary mission is to detect and track ICBMs and SLBMs and to test and evaluate other systems.[71] Another 10 contributing SSN sensors controlled by other organizations or agencies provide space surveillance support upon request from the National Space Defense Center (NSDC).[72] The Space Fence radar emits a very narrow, fan-shaped beam in the north–south direction that "paints" satellites and debris from low-Earth orbit as they fly through the radar fan, and it can track objects all the way out to GEO.

Reconnaissance and Imaging Satellites (Number Unknown). Although the history of the Air Force is steeped in these reconnaissance systems, the operational details of each constellation are classified. In the late 1990s and early 2000s, the Air Force moved to develop and field a constellation of space-based radar satellites. That program (known as Lacrosse/Onyx) launched five satellites, each carrying a synthetic aperture radar (SAR) as its prime imaging sensor. Because SAR systems can see through clouds with high resolution, they offer the potential to provide a capability from which it is hard to hide.[73]

Space Launch Capacity

The Space Force manages the National Security Space Launch (NSSL) program, a Major Defense Acquisition Program that acquires launch services

TABLE 13

Space Launches by Country Since 2010

	U.S.	China	Russia	India
2010	17	16	16	3
2011	19	19	20	3
2012	12	19	12	2
2013	19	15	18	3
2014	21	15	22	4
2015	19	19	14	3
2016	24	22	13	7
2017	29	18	13	4
2018	29	39	13	7
2019	20	34	14	6
2020	53	19	21	14
2021	57	51	23	1
2022	101	26	21	5
Total	**420**	**312**	**220**	**62**

NOTE: Figures for 2022 include actual and projected launches.
SOURCE: Space Launch Schedule, https://www.spacelaunchschedule.com/ (accessed August 15, 2022). heritage.org

from private companies to deliver national security satellites into orbit. Currently, the NSSL uses the Atlas V and Delta IV Heavy launch vehicles from United Launch Alliance (ULA) and the Falcon 9 and Falcon Heavy from SpaceX to launch national security payloads.

In 2018, the Air Force awarded three launch services agreements to space launch companies to develop their launch vehicles for a second phase of the NSSL. In 2020, the Space Force awarded two launch services procurement contracts to ULA and SpaceX, and those two vendors will provide space launch services for the Space Force through 2027.[74]

In 2010, four organizations, including NASA, were involved in launching manned and unmanned systems into space. Today, 11 private American corporations are engaged in placing satellites into orbit.[75] In 2022, U.S. companies are scheduled to launch 101 missions into space, and China and Russia are scheduled to conduct 26 and 21 launches, respectively.[76] The numbers for China and Russia are based on launch schedules published for each of those countries and are often misleading. China planned 22 launches in 2021, but it actually executed 51 missions into space, which was just behind the U.S.'s 57 space shots for that same year.[77] America is still outpacing its peers with this vital capability, but the competition appears to be gaining.

Capability

With an estimated 114 satellites in its portfolio, the USSF can meet much of the communications, collection, and imagery demand placed on it by the National Command Authorities and the strategic-level intelligence requirements of the Defense Department. However, getting real-time satellite intelligence to warfighters at the operational and tactical levels is still problematic. The loss of even a small number of those 114 satellites could significantly impact operational capabilities across the DOD.

Backbone Satellites (89 Satellites). In spite of an ever-growing demand, the PNT services offered by GPS are unrivaled in both capacity and capability. With 31 operational GPS satellites in orbit and

TABLE 14

U.S. Satellites in Orbit

System	Function	Satellites
GPS	Positioning, Navigation, and Timing	37
DMSP	Weather	3
Milstar	Communications	5
AEHF	Communications	6
DSCS	Communications	7
WGS	Communications	10
FLTSAT	Communications	6
UFO	Communications	10
MUOS	Communications	5
SBIRS	Missile Warning	10
DSP	Missile Warning	5
GSSAP	Space Surveillance	6
SBSS	Space Surveillance	1
STSS-ATR	Missile Defense and Space Tracking	1
STSS	Missile Defense and Space Tracking	2
Total		**114**

NOTE: Data are current as of July 31, 2022.
SOURCES:

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TABLE 15

U.S. Space Launches by Organization

Company	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Space X	2	0	2	3	6	8	8	18	21	13	27	30	61
Northrup Grumman	2	4	1	5	2	0	2	3	2	3	5	4	5
United Launch Alliance	8	11	10	11	14	12	12	8	8	5	6	5	9
Astra	0	0	0	0	0	0	0	0	1	0	0	1	1
Rocket Lab, LTD	0	0	0	0	0	0	0	0	0	0	2	4	11
Firefly Aerospace	0	0	0	0	0	0	0	0	0	0	0	1	3
NASA	3	3	0	0	0	0	0	0	0	0	0	0	0
Blue Origin	0	0	0	0	0	2	4	0	0	1	1	6	3
Virgin Orbit	0	0	0	0	0	0	0	0	0	0	1	2	3
Terran	0	0	0	0	0	0	0	0	0	0	0	0	1
ABL Space Systems	0	0	0	0	0	0	0	0	0	0	0	0	2
Launcher	0	0	0	0	0	0	0	0	0	0	0	0	1
NASA	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	**15**	**18**	**13**	**19**	**22**	**22**	**26**	**29**	**32**	**22**	**42**	**53**	**101**

NOTES: Figures for 2022 include actual and projected launches. No Blue Origin launch to date has been orbital.
SOURCE: Space Launch Schedule, "USA Launch Schedule," https://www.spacelaunchschedule.com/category/usa/ (accessed August 15, 2022).

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seven spaceborne (dormant) spares, the system has enough redundancy and resiliency to handle losses associated with normal (not combat-related) space operations.

The current and growing DOD demands for imagery and collection are another thing entirely. The shortfall is projected to be so great that the Departments of the Air Force and Army, the National Reconnaissance Office, and other agencies have invested in and are employing the services of commercial organizations to provide collection and imagery on demand.[78]

Over the past several years, the U.S. Army has conducted a series of exercises called Project Convergence (PC), which are designed to test the capability of DOD and commercial spaceborne systems to provide the intelligence, imagery, and communications linkages for warfighters in the service's "close fight." In PC20, Brigade Combat Teams (BCTs), Combat Aviation Brigades (CABs), and Expeditionary Signal Battalion-Enhanced (ESB-E) units were given access to 600 commercial SpaceX Starlink satellites in LEO[79] where low latency (time for signals to get to satellites and back to other users) readily enables tactical employment.[80]

The capabilities associated with defense and commercial satellites in low-Earth orbit have only grown over the years. In 2021, the Army launched three Gunsmoke-J CubeSat satellites to demonstrate advanced information collection in direct support of Army combat operations,[81] expanding the Army's inherent targeting capability.[82] Coupled with the sensors on Starlink's rapidly expanding constellation, which numbers more than 2,662 satellites,[83] these systems will enable the Army's concept for a Multi-Domain Operations (MDO)–Capable Force by 2028 and an MDO-Ready Force by 2035.[84]

The capabilities and resiliency offered by commercial systems like Starlink have been clearly demonstrated in Ukraine, where thousands of deployed Starlink Internet terminals have ensured Ukraine's internal and external connectivity with Western governments, nullifying a significant part of Russia's information campaign.[85] Starlink reportedly

TABLE 16

Satellites by Weight

Group Name	Weight	Size
Large Satellite	1,000+ kilograms	Large
Medium Satellite	500–1,000 kilograms	Medium
Mini Satellite	100–500 kilograms	Small
Micro Satellite	10–100 kilograms	Small
Nano Satellite (CubeSats)	1–10 kilograms	Small
Pico Satellite	0.1–1 kilograms	Small
Femto Satellite	<100 grams	Small

SOURCE: Table 1, "Satellites by Mass," in Chalie L. Galliand, "Study of the Small: Potential for Operational Military Use of CubeSats," 24th Annual AIAA/USU [American Institute of Aeronautics and Astronautics/Utah State University] Conference on Small Satellites, August 10, 2010, p. 1, https:// digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1199&context=smallsat (accessed August 18, 2022).

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also has the ability to provide a very accurate PNT backup for GPS, which will become increasingly important for all of the services as the competition in space intensifies.[86] Integrating LEO, Mid Earth Orbit (MEO), and GEO satellite capabilities will continue to increase network resiliency by providing multiple communications options for the warfighter.[87] The capabilities demonstrated in the PC exercise series are similar to those sought in the Air Force's Advanced Battle Management System (ABMS) and the Navy's Overmatch C2 development programs.[88]

Intelligence, Surveillance, and Reconnaissance (15 Satellites). The USSF has 15 known spaceborne systems dedicated to missile launch warning. While the SBIRS constellation is two GEO satellites short of design, its 10 satellites, coupled with the five DSP satellites, provide global coverage and generally excellent response times.

As noted, the current portfolio of reconnaissance satellites, while highly classified, meets many of the essential strategic requirements of the National Command Authority (NCA) and the Defense Department. However, Space Force capabilities fall well short of the needs of the services. The Department of the Air Force is therefore investing in and employing the services of commercial organizations to meet the on-demand collection and imagery needs of USSF customers.[89]

Space Situational Awareness (10 Satellites and 23 Terrestrial-Based Systems). The Space Force's six acknowledged SSA satellites, four other unacknowledged satellites, six dedicated and 17 collateral and contributing ground-based sensors help to maintain situational awareness of satellites and other objects in space. However, the limited number and inherent limitations of the sensors within the SBSS leave significant gaps in coverage. Those gaps are addressed by prediction, and every time a satellite maneuvers, "the process of initial discovery by a sensor, creation of an initial element set, and refinement of that element set needs to be repeated."[90]

The backbone and ISR assets within the USSF are critically important; however, the focus of the *Index of U.S. Military Strength* is primarily on assessing the classic "hard combat power" found in defensive and offensive systems.

Defensive Capabilities

Defensive systems and operations are designed to protect friendly space capabilities against kinetic anti-satellite (ASAT) weapons, high-powered lasers, laser dazzling or blinding, and high-powered microwave systems.[91]

The first challenge in defense is detecting an attack, and a host of sensors exist that can detect the launch of terrestrial-based ASAT weapons. With 14

satellites dedicated to detecting missile launches, it is possible for the USSF to determine an ASAT's trajectory, identify the targeted satellite, and alert operators in time for them to take evasive action with those systems. Unfortunately, the gaps in the SSA network highlighted earlier make the timely assessment of and response to such an attack on a specific U.S. satellite difficult.

Detecting other (non-missile) attacks presents another problem, and the Space Force has fielded a system that can deal with one part of that challenge. Operated by ground-based units, Bounty Hunter can detect an adversary's attempts to deceive, disrupt, deny, or degrade satellite communications by monitoring electromagnetic interference across multiple frequency bands. Bounty Hunter operators can locate sources of intentional and unintentional interference and minimize them.[92] This system achieved initial operational capability (IOC) in the summer of 2020 and is a significant addition to the Space Force portfolio, but it has no known capability to detect or counter lasers.

USSF satellites need a sensor package that allows them to self-detect hostile system engagement and report it to operators who are positioned to take defensive actions or that incorporates artificial intelligence (AI) that will allow the satellite to maneuver autonomously while maintaining mission capacity. Those capabilities are currently not known to exist.

Cyberattacks present a different challenge to space-based systems. Like other kinetic and non-kinetic attacks, cyber intrusions can cause service disruptions, sensor interference, or the permanent loss of satellite capabilities. Additionally, an effective cyberattack could corrupt the satellite's data stream to reliant elements or systems—or even allow an adversary to seize control of a satellite. According to the Royal Institute of International Affairs, the U.S. is well behind its peer competitors in this area and should assume that its satellite constellations have already been penetrated and compromised.[93]

In spite of current limitations, protective measures that the service can take now to safeguard its spaceborne systems can be separated into two categories of systems and actions: active and passive.

- An active defense is really offensive in nature and includes engagements to destroy, nullify, or reduce enemy systems that put U.S. and allied systems and capabilities at risk.
- Passive defense measures increase survivability through asset diversification, including the deployment of more space systems in different orbits, as well as real-time satellite maneuverability and self-protection.[94]

Shortly before the USSF became an independent service, the Air Force made clear that it wanted to build a constellation of thousands of small satellites (SmallSats) in low-Earth orbit to provide a redundant, diversified portfolio of capabilities. Over time, it has become apparent that those expanding constellations will be comprised of both military and civilian satellites.[95]

Offensive Systems

The Air Force's FY 2017 budget included $158 million to develop offensive space capabilities over a period of five years.[96] The only offensive space system of record within the USSF that can be found in open-source literature is a system called Meadowlands.

Meadowlands is a mobile, terrestrial-based, counter-communications system (CCS) that delivers effects to thwart adversary SATCOM in a given area of responsibility (AOR). The effects of Meadowlands are reversible: When the system is turned off, the communications linkages it was targeting return to their original functionality.[97]

Readiness

The Space Force was born of a congressionally mandated study that included a plan for the incremental transition of operational Air Force space assets and personnel to the new service. Throughout the plan's execution, the USSF has been deliberate in its hiring and is on a path to developing a solid cadre of personnel and a strong organizational culture.

The operations assumed by the USSF to support strategic and high-end operational-level support have proceeded uninterrupted, and readiness has remained high, but those operations were primarily supportive in nature and did not include robust, nearly real-time support to tactical units. While the service is undoubtedly moving forward on credible defensive and offensive readiness, there is little evidence that it is ready for the threat envisioned by Congress when it authorized creation of the Space Force.

Scoring the U.S. Space Force

Capacity Score: Weak

The number and types of backbone and ISR assets are sufficient to support global PNT requirements and the majority of strategic-level communications, imagery, and collection requirements of the National Command Authorities and the Department of Defense. However, the Space Force is not capable of meeting current—much less future—on-demand, operational, and tactical-level warfighter requirements.

As noted in the capability section, the gaps in the SBSS are covered by prediction, and operators of adversarial satellites can time their maneuvers to take advantage of those gaps. With the influx of SmallSats, the potential for the number of U.S. military satellites in orbit to grow from a few hundred to several thousand over the next three years is very real. (See Table 13.) If new commercial, allied, and adversary SmallSats are added to the mix, it is highly likely that the number of operational satellites in orbit will double over that same period. Although increasing numbers alone will challenge the current Space Surveillance Network, the number of unannounced orbital changes among those satellites will make it markedly more difficult to keep track of bad actors.

The U.S. had announced plans to build a second, strategically located Space Fence like the one on Kwajalein Atoll in Western Australia in 2021, but that site has yet to be funded.[98] Even if a second Space Fence does eventually materialize, the Space Force will still need more satellites that are dedicated to this mission.[99]

The service's two counterspace weapons systems (Meadowlands and Bounty Hunter) cover only a fraction of the offensive and defensive capabilities required to win a conflict in space. Other counterspace systems are probably being developed or, like cyber, already in play without public announcement. Nevertheless, the USSF's current visible capacity is not sufficient to support, fight, or weather a war with a peer competitor.

Capability Score: Weak

The current space asset modernization plan that is visible to the public follows the same incremental replacement and fielding design that has been in practice for decades. The vast majority of backbone and ISR assets have exceeded their designed life spans, and the DAF's willingness to delay and/or defer the acquisition of replacement systems remains a legacy of that department.

The capability of backbone and ISR satellites is marginal, but that is more than offset by the gaps in SSA and the apparent lack of defensive and offensive capabilities ("very weak"). The capability score is therefore "weak," the result of being scored "weak" in "Size of Modernization Program," "weak" for "Age of Equipment" and "Health of Modernization Programs," and "weak" for "Capability of Equipment."

Readiness Score: Weak

The mission sets, space assets, and personnel that transitioned to the Space Force and those that have been assigned to support the USSF from the other services have not missed an operational beat since the Space Force stood up in 2019. Throughout that period, the readiness levels have seamlessly sustained backbone and ISR support to the NCA, DOD, Combatant Commanders, and warfighters around the world.

However, there is little evidence that the USSF has improved its readiness to provide nearly real-time support to operational and tactical levels of force operations ("marginal") or that it is ready in any way to execute defensive and offensive counterspace operations to the degree envisioned by Congress when it authorized creation of the Space Force ("very weak").

Overall U.S. Space Force Score: Weak

This is an unweighted average of the USSF's capacity score of "weak," capability score of "weak," and readiness score of "weak."

U.S. Military Power: Space

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

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Navigation

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Global Positioning System (GPS) Inventory: **37** Fleet age: **12.5** Date: **1997** GPS satellites provide precise positioning, navigation, and timing (PNT) to millions of simultaneous users around the world. The current constellation of 37 satellites is comprised of Block IIR (launched from 1997-2004), IIR-M (2005-2009), IIF (2010-2016) and III/IIIF (first launch 2018) birds with steadily increasing capabilities.	5	5	**GPS III** Timeline: **2019–TBD** GPS III is the latest upgrade to the GPS platform and incorporates more robust anti-jamming capabilities. It is interoperable with other countries' Global Navigation Satellite Systems, which adds resilience to the GPS system. **PROCUREMENT** 5 14 **SPENDING** *($ millions)* $1,451 $5,568	5	5

Missile Warning

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Space Based Infrared System (SBIRS) Inventory: **10** Fleet age: **8** Date: **2006** An integrated constellation of 10 satellites, SBIRS is designed to deliver early missile warning and provide intercept cues for missile defenses. The satellites are retaskable, which means they can be moved to more optimum orbits and viewpoints as mission requirements dictate. The program was ended early due to cost, schedule, and performance issues.	5	5	**Next Generation Persistent Infrared (Next-Gen OPIR)** Timeline: **TBD** When the SBIRS program was ended early, its remaining funding was shifted to its follow-on program, the Next-Gen OPIR. This program's objective is to deliver resilient detection and tracking capability in a contested environment, given the advances in adversary rocket propulsion technology.		
Defense Support Program (DSP) Inventory: **5** Fleet age: **22** Date: **1970** These satellites were designed to detect intercontinental ballistic missile and Sea-launched ballistic missile launches against the U.S. and its allies. They can also detect space launch missions and nuclear weapons testing/detonations. Phase 3 satellites were launched from 1989 to 2007 and have long exceeded their designed lifetimes, but at least five of those satellites are still providing reliable data and are integrated with the SBIRS program.	1	4			

NOTE: See page 473 for details on fleet ages, dates, timelines, and procurement spending.

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Space Surveillance

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Space Based Surveillance System (SBSS) Inventory: **1** Fleet age: **12** Date: **2010** This single satellite uses multiple types of sensors to track man-made objects and debris fields in orbit.	3	3	None		

Missile Defense

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Space Tracking and Surveillance System Advanced Technology Risk Reduction (STSS-ATR) Inventory: **1** Fleet age: **13** Date: **2009** This research, development, testing, and evaluation (RDT&E) satellite was originally launched by the Missile Defense Agency to explore different capabilities and technology but was transferred to the Air Force in 2011.	3	3	None		

Space Object Tracking

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Geosynchronous Space Situational Awareness Program (GSSAP) Inventory: **6** Fleet age: **5** Date: **2014** This highly classified, six-satellite constellation can accurately track and characterize objects in orbit using electro-optical and emissions sensors. Their maneuverability allows them to conduct rendezvous and proximity operations (RPO) on space objects, giving them the potential to conduct offensive operations against other nations' assets.	5	5	None		

NOTE: See page 473 for details on fleet ages, dates, timelines, and procurement spending.

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Weather

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Defense Meteorological Satellite Program (DMSP) Inventory: **3** Fleet age: **18** Date: **1999** Since 1962, defense weather satellites in the DMSP have been collecting weather data and providing forecasts for U.S. military operations. This three-satellite constellation was launched between 1999 and 2009 with only a five-year life expectancy, but they have continued to provide accurate meteorological data well beyond that timeframe and are still in use today.	1	4	**Weather System Follow-on Microwave Satellite (WSF-M)** Timeline: **TBD** This next-generation weather satellite will be capable of mapping both terrestrial and space weather and is scheduled to be fielded in 2023. It covers three gaps in DOD's current weather monitoring capability: ocean surface vector winds, tropical cyclone intensity, and "energetic charged particles" in low earth orbit.		

Communications

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Milstar Inventory: **5** Fleet age: **23.5** Date: **1994** Milstar is a satellite communications system designed in the 1980s to provide the National Command Authorities with global communications that were assured, were survivable, and carried low probability of interception or detection. Designed to overcome nuclear effects and enemy jamming, this five satellite constellation was considered the most robust and reliable DOD SATCOM system at the time of fielding.	1	3	None		
Advanced Extremely High Frequency System (AEHF) Inventory: **6** Fleet age: **7** Date: **2010** The AEHF constellation is the follow-on to Milstar. Each of the six satellites provides DOD with more capacity than the entire Milstar constellation with five times the Milstar data rates. The system offers secure, jam-resistant communications and command and control for military ground, sea, and air assets located anywhere in the world.	5	5			

NOTE: See page 473 for details on fleet ages, dates, timelines, and procurement spending.

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Communications (Cont.)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Defense Satellite Communications System (DSCS) Inventory: **7** Fleet age: **29.5** Date: **1982** This system of seven satellites provides nuclear-hardened, global communications with anti-jamming capabilities to the Defense Department, State Department, and National Command Authorities.	1	2	None		
Wideband Global SATCOM (WGS) Inventory: **10** Fleet age: **9** Date: **2007** WGS, formerly known as the Wideband Gapfiller Satellite, is a joint-service program funded by the U.S. Air Force and U.S. Army along with international partners Australia and Canada. The 10-satellite constellation uses direct broadcast satellite technology to provide command and control for U.S. and allied forces.	4	5			
Fleet Satellite Communications System (FLTSATCOM) Inventory: **6** Fleet age: **38.5** Date: **1978** This constellation of six operational satellites is used by the Navy, the Air Force, and the presidential command network. It was transferred from the Navy to the Space Force in June 2022.	1	3			
Ultra-High Frequency Follow-On (UFO) Inventory: **10** Fleet age: **24** Date: **1993** The 10-satellite UFO constellation was designed to replace FLTSATCOM and provides communications for tactical users including aircraft, ships, submarines, and ground forces. The Navy transferred this system to the Space Force in June 2022.	1	3			

NOTE: See page 473 for details on fleet ages, dates, timelines, and procurement spending.

SPACE FORCE SCORES

1 2 3 4 5
Weakest ⟷ Strongest

Procurement and Spending ■ Through FY 2022 ■ Pending

Communications (Cont.)

PLATFORM	Age Score	Capability Score	REPLACEMENT PROGRAM	Size Score	Health Score
Mobile User Objective System (MUOS) Inventory: **5** Fleet age: **8** Date: **2012** This next-generation narrowband tactical satellite communications system is designed for tactical users, significantly improving ground communications even for troops in highly remote locations or buildings with no other satellite access. The Navy transferred this five-satellite constellation to the Space Force in June 2022.	4	5	None		

NOTES: See Methodology for descriptions of scores. Fleet age is the average between the last year of procurement and the first year of initial operational capability. The date is when the platform achieved initial operational capability. The timeline is from the start of the platform's program to its budgetary conclusion. Spending does not include advanced procurement or research, development, test, and evaluation (RDT&E).

U.S. Space Force Modernization Table Citations

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U.S. Nuclear Weapons

Patty-Jane Geller

To assess U.S. nuclear weapons, one must understand the essential role they play in U.S. national security, the increasing nuclear threat posed by adversaries, and the current state of U.S. nuclear forces and their supporting infrastructure.

The Important Role of U.S. Nuclear Weapons

Understanding the importance of nuclear weapons allows for a better grasp of a framework within which to view the status of U.S. nuclear capabilities. U.S nuclear weapons have played a critical role in preventing conflict among major powers since the end of World War II. Given their ability to deter large-scale attacks that threaten the U.S. homeland, allies, and forward-deployed troops and to assure allies and partners, nuclear deterrence has remained the number one U.S. national security mission.[1] Operationally, all U.S. military operations rely on the backstop of U.S. nuclear deterrence.[2] It is therefore critical that the United States maintain a modern and flexible nuclear arsenal that can deter a diverse range of threats from a diverse set of potential adversaries.

The more specific roles of U.S. nuclear weapons outlined by U.S. policy have been adjusted over time. The most up-to-date policy documents that describe these roles are the 2018 Nuclear Posture Review (NPR) and the 2020 Nuclear Employment Strategy, which reflected the deterioration of the threat environment since 2010. The NPR specifies that:

> Given the diverse threats and profound uncertainties of the current and future threat environment, U.S. nuclear forces play the following critical roles in U.S. national security strategy. They contribute to the:
>
> - Deterrence of nuclear and non-nuclear attack;
> - Assurance of allies and partners;
> - Achievement of U.S. objectives if deterrence fails; and
> - Capacity to hedge against an uncertain future.[3]

These roles were outlined in more detailed language in the Obama Administration's 2010 NPR and 2013 Nuclear Employment Strategy. The 2010 NPR, for example, lists the "five key objectives of our nuclear policies and posture" as:

1. Preventing nuclear proliferation and nuclear terrorism;
2. Reducing the role of U.S. nuclear weapons in U.S. national security strategy;
3. Maintaining strategic deterrence and stability at reduced nuclear force levels;
4. Strengthening regional deterrence and reassuring U.S. allies and partners; and
5. Sustaining a safe, secure, and effective nuclear arsenal.[4]

The Biden Administration has not yet released its 2022 NPR to the public, but a fact sheet notes the continued commitment to deterring both nuclear and non-nuclear attacks and says that "[t]he United States would only consider the use of nuclear weapons in extreme circumstances to defend the vital interests of the United States or its allies and partners."[5] These roles or their prioritization

may be adjusted over time—for instance, the Biden Administration's fact sheet seems to deemphasize (although not eliminate) the role of nuclear weapons in deterring non-nuclear attacks—but generally are likely to endure.

To achieve these objectives, the U.S. nuclear portfolio must balance the appropriate levels of capacity, capability, variety, flexibility, and readiness. What matters most in deterrence is not what the United States thinks will be effective, but the psychological perceptions—among both adversaries *and* allies—of America's willingness to use nuclear forces to defend its interests. If an adversary believes it can fight a limited nuclear war, for instance, U.S. leaders must convince that adversary otherwise. In addition, military roles and requirements for nuclear weapons will differ from adversary to adversary based on each country's values, strategy, and goals.

The United States also extends its nuclear umbrella to more than 30 allies and partners that rely on the United States to defend them from large-scale conventional attacks and existential threats from regional adversaries. This additional responsibility imposes requirements for U.S. nuclear force posture beyond defense of the U.S. homeland. U.S. nuclear forces underpin the broad nonproliferation regime by assuring allies—including NATO, Japan, South Korea, and Australia—that they can forgo their own development of nuclear capabilities. Erosion of the credibility of American nuclear forces could lead a country like Japan or South Korea to pursue an independent nuclear option, in which case the result could be a profoundly negative impact on stability across the region.

In addition to deterrence and assurance, the United States historically has committed to achieving its political and military objectives if nuclear deterrence fails. This goal also contributes to deterrence both by convincing an adversary that it could not start and win a nuclear war and by minimizing U.S. subjection to nuclear coercion by peer nuclear adversaries. U.S. forces must therefore be survivable and postured to engage their targets successfully if such a deterrence failure makes it necessary to use nuclear weapons.

Finally, U.S. nuclear capabilities must have the capacity to hedge against an uncertain future. It takes years or decades to develop the capabilities of nuclear weapons and their supporting infrastructure—an infrastructure that the United States neglected for decades until quite recently. Decisions regarding nuclear forces that are made today will affect the United States for decades into the future. Since it cannot accurately predict the extent of the future threat, the U.S. must maintain a nuclear enterprise that can respond to changes in the global security environment.

An Increasingly Threatening Global Environment

Any assessment of nuclear capabilities requires an understanding of the threat environment, as any U.S. strategy or force posture must account for the threat it is meant to deter or defeat. The threat the United States faces today is unprecedented. For the first time in its history, the United States must face two nuclear peer competitors at once—Russia and China.[6] This differs drastically from the paradigm based on the bilateral deterrence relationship involving the United States and the Soviet Union during the Cold War, because a multipolar nuclear threat environment presents new and complex challenges. As a result, the assessment in this *Index* must be weighed against this emerging nuclear threat.

Russia is engaged in an aggressive nuclear expansion, having added several new nuclear systems to its arsenal since 2010. The United States is only beginning to modernize its existing nuclear systems, but Russia's modernization effort is about 89 percent complete.[7] Russia also is developing such "novel technologies" as a nuclear-powered cruise missile and nuclear-capable unmanned underwater vehicle and is arming delivery platforms with nuclear-tipped hypersonic glide vehicles.[8]

In addition, Russia maintains a stockpile of at least 2,000 non-strategic nuclear weapons, unconstrained by any arms control agreement.[9] Defense Intelligence Agency Director Lieutenant General Robert Ashley has said that Russia is expected to increase this category of nuclear weapons—a category in which it "potentially outnumber[s]" the United States by 10 to 1.[10] This disparity is of special concern because Russia's recent nuclear doctrine indicates a lower threshold for use of these tactical nuclear weapons. According to the 2018 Nuclear Posture Review, Moscow "mistakenly assesses that the threat of nuclear escalation or actual first use of nuclear weapons would serve to 'de-escalate' a conflict on terms favorable to Russia."[11] Russia has also been engaging in nuclear saber-rattling over its war on

Ukraine, issuing both subtle and blatant nuclear threats in an attempt to coerce the West into staying out of the conflict.[12]

China is engaged in what Admiral Charles A. Richard, Commander of U.S. Strategic Command (STRATCOM), has described as a "breathtaking" expansion of its nuclear capabilities as part of a strategic breakout that will require immediate and significant Department of Defense (DOD) capability shifts.[13] The Pentagon's 2021 report on *Military and Security Developments Involving the People's Republic of China* confirmed that China would have at least 1,000 nuclear warheads—roughly five times the size of its current stockpile—by the end of the decade.[14] In addition, China "appears to be building more than 100 new missile silos in the desert" that would likely carry the DF-41, China's most modern ICBM, which can carry multiple warheads.[15]

With respect to its nuclear capabilities, China has completed its nuclear triad with the addition of a strategic nuclear-capable bomber, is deploying hundreds of theater-range ballistic missiles in the Indo-Pacific that can strike U.S. bases and allied territory with precision, and is testing and deploying nuclear-capable hypersonic weapons including one that orbited the globe on a fractional orbital bombardment system (FOBS) before being released to glide to its target.[16] Evidence also suggests that China is shifting a portion of its nuclear forces to Launch-on-Warning (LOW) posture as it improves its early warning systems.[17]

Combined with a refusal to discuss its forces or intent with the United States, this shift in posture increases the likelihood of mistakes and miscalculations.[18] Unlike the United States and Russia, which share a long history of communicating through arms control discussions and treaties to reduce these risks, China has not participated in these risk reduction measures. The sheer magnitude of its nuclear expansion and qualitative upgrades has led senior leaders to conclude that China has become a nuclear peer to the United States and Russia and eventually could even surpass U.S. nuclear capabilities.[19] China no longer has a minimum deterrence capability; instead, it "possesses the capability to employ any coercive nuclear strategy today."[20]

In addition to two nuclear peers, the United States must account for the nuclear threats posed by its rogue state adversaries. North Korea is advancing its nuclear weapons and missile capabilities. It continues to produce fissile material to build new nuclear weapons; has developed a new "monster" ICBM that supposedly is able to carry multiple warheads; and as of the time this book was being prepared, had conducted 31 tests of its ground-based and sea-based ballistic missiles in 2022, including its first ICBM test since 2017.[21] According to the U.S. Special Representative for North Korea, Pyongyang could conduct an underground nuclear test at "any time."[22]

Iran, in addition to being the world's principal state sponsor of terrorism, continues to enrich uranium at dangerous levels and has recently acquired enough fissile material to produce a nuclear bomb according to the International Atomic Energy Agency.[23] A nuclear Iran would have significant implications both for stability in the region and for U.S. non-proliferation goals.

Finally, given the role of U.S. nuclear weapons in deterring attacks using conventional weapons, it is important to consider non-nuclear threats posed by adversaries. Both Russia and China are deploying advanced conventional capabilities like conventionally armed hypersonic missiles and even conventionally armed cruise missiles capable of striking the U.S. homeland just below the nuclear threshold.[24] China, Russia, and Iran have been accused of violating both the Biological Weapons Convention (BWC) and the Chemical Weapons Convention (CWC).[25] North Korea also is in violation of the BWC and is thought to possess chemical weapons. (It is not, however, a signatory to the CWC.) Especially since the United States does not possess chemical or biological weapons of its own, nuclear weapons will continue to play a role in deterring these threats.

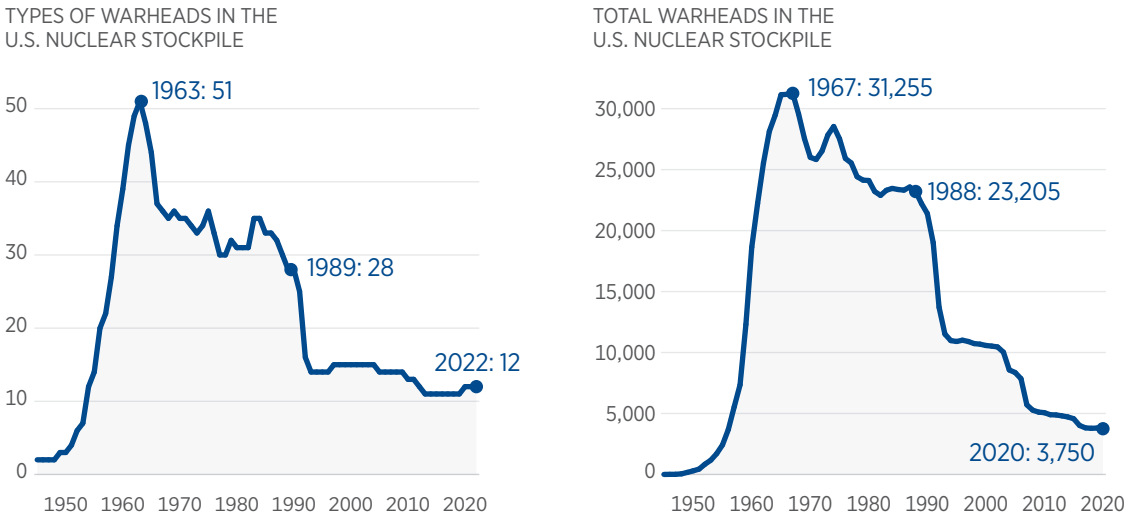
Current U.S. Nuclear Capabilities and Maintenance Challenges

To assess U.S. nuclear weapons capabilities, it is important to understand the current state of those capabilities and the challenges associated with maintaining them. The United States maintains a force posture based on the guidelines set forth by the New Strategic Arms Reduction Treaty (New START) signed with Russia in 2010.

To abide by New START limits, the United States maintains 14 *Ohio*-class ballistic missile submarines (SSBNs), 12 of which are operational and each of which is armed with 20 Trident II D5 submarine-launched ballistic missiles (SLBMs);

CHART 11

A Smaller and Less Diverse Nuclear Arsenal



NOTE: Quantities include deployed warheads and warheads in reserve, but the U.S. is limited by New START to only 1,550 deployed warheads.
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400 single-warhead Minuteman III intercontinental ballistic missiles (ICBMs) deployed among 450 silos; and about 60 nuclear-capable B-52 and B-2 bombers that can be armed with gravity bombs or air-launched cruise missiles.[26] As of September 2021, the United States was deploying 1,389 warheads under New START counting rules.[27] Additionally, the United States maintains about 200 B61 tactical gravity bombs. About 100 of these bombs "are deployed in Europe, of which about 60 are earmarked for use by NATO aircraft. The remaining 100 bombs are in central storage in the United States as backup and contingency missions in the Indo-Pacific region."[28]

The United States is working to modernize these nuclear forces, which continue to age beyond their original intended lifetimes. U.S. nuclear delivery systems, warheads, and nuclear supporting infrastructure were all developed during the Cold War and have no margin for further life extension. As stated by Admiral Richards:

> We are at a point where end-of-life limitations and the cumulative effects of underinvestment in our nuclear deterrent and supporting infrastructure leave us with no operational margin. The Nation simply cannot attempt to indefinitely life-extend leftover Cold War weapon systems and successfully support our National strategy. Pacing the threat requires dedicated and sustained funding for the entire nuclear enterprise and NC3 Next Generation modernization must be a priority.[29]

Faced with this set of circumstances, the United States must contend with three overarching challenges:

- The need to recapitalize all components of its nuclear forces,
- The need to refurbish an aging and crumbling nuclear weapons infrastructure, and
- The need to recruit and train talented personnel that has been created by an aging workforce.

This nuclear modernization program dates back to around 2010 and is based on the size of the current arsenal, which is meant to deter only one nuclear peer: Russia. The extraordinary technical and geopolitical developments being realized today—China's nuclear breakout and Russia's nuclear expansion—were generally not anticipated as the Obama Administration went about finalizing our nuclear force structure for the coming decades.[30] This assumption of a more benign threat environment influenced decisions about the nuclear force structure that the United States is pursuing today.

The United States for the most part is replacing its nuclear forces on a one-to-one basis rather than adding new or additional capabilities. The *Columbia*-class nuclear submarine, for example, will have eight fewer missile tubes than its predecessor, the *Ohio*-class, and therefore less firing capacity.[31] The only significant change in the U.S. nuclear arsenal was the deployment of W76-2 low-yield warheads for the SLBMs in 2020, and it did not increase capacity. The 2018 NPR also recommended a nuclear-armed, sea-launched cruise missile to develop in the longer term, but this proposal has not gained necessary support from the current Administration.

To provide assurance against changes in a geopolitical situation like those that are occurring today, as well as assurance against failures in the U.S. stockpile, the United States preserves an upload capability that allows it to increase the number of nuclear warheads on each type of its delivery vehicles. The U.S. Minuteman III ICBM, for example, is currently deployed with only one Mk12A/W78 warhead, but it can carry as many as three; the Trident II SLBM can carry several warheads at once; and the B-52 bomber can carry additional cruise missiles.[32]

The reduced number of missile tubes on the future *Columbia*-class SSBN will in turn reduce the strategic submarine force's upload capacity. However, this hedge capacity is limited, as uploading warheads onto the Minuteman III missiles would prove to be both time-consuming and costly, and the United States could not exploit the bomber upload capacity during peacetime because bombers currently remain off alert. Uncertainty as to whether the United States will have enough modern warheads or air-launched cruise missiles will remain another potential impediment to upload capacity.

The United States also maintains an inactive stockpile that includes near-term hedge warheads that "can serve as active ready warheads within prescribed activation timelines" and reserve warheads that can provide "a long-term response to risk mitigation for technical failures in the stockpile."[33]

The United States has not designed or built a nuclear warhead since the end of the Cold War. Instead, the National Nuclear Security Administration (NNSA) uses life-extension programs (LEPs) to extend the service lives of existing weapons in the stockpile, some of which date back to the 1960s. While LEPs replace or upgrade most components in a nuclear warhead, all warheads will eventually need to be replaced because their nuclear components—specifically, plutonium pits that comprise the cores of warheads—are also subject to aging.[34] The United States is the only nuclear state that lacks the capability to produce plutonium pits in quantity. The

NNSA's fiscal year (FY) 2023 budget request notes that "[t]he Plutonium Modernization program provides funding for efforts across the nuclear security enterprise to restore the Nation's capability to produce 80 pits per year (ppy)" and that "NNSA remains committed to achieving the statutory pit production capability goals on the path to 80 ppy."[35]

Demographic challenges within the nuclear weapons labs also affect the ability of the U.S. to modernize its warhead stockpile. Most scientists and engineers with practical hands-on experience in nuclear weapons design and testing are retired. This means that the certification of weapons that were designed and tested as far back as the 1960s depends on the scientific judgment of designers and engineers who have never been involved in either the testing or the design and development of nuclear weapons. In recent years, NNSA has invested in enabling its workforce to exercise critical nuclear weapons design and development skills that have not been fully exercised since the end of the Cold War. These skills must be available when needed to support modern warhead development programs for U.S. SLBMs and ICBMs.

The shift in emphasis away from the nuclear mission after the end of the Cold War led to a diminished ability to conduct key activities at the nuclear laboratories. According to NNSA Administrator Jill Hruby, "the nuclear stockpile is safe, secure, reliable, and effective," but "NNSA is aware that legacy infrastructure is well beyond its intended life designs and incapable of providing all the capabilities needed to deliver on the modernization efforts, especially with the demanding production schedules."[36] As a result of this neglect, NNSA must recapitalize the nuclear weapons complex at the same time the nation faces the need to modernize its aging nuclear warheads.

In recent years, bipartisan congressional support for the nuclear mission has been strong, and nuclear modernization has received additional funding. Preservation of that bipartisan consensus will be critical as these programs mature and begin to introduce modern nuclear systems to the force.

In FY 2022, the Biden Administration, supported by Congress, advanced the comprehensive modernization program for nuclear forces that was initiated by President Barack Obama and continued by the Trump Administration. Despite some opposition, Congress funded the two previous Presidents' budget requests for these programs as well. Because such modernization activities require consistent, stable, long-term funding commitments, this continued bipartisan support has been critical.

The NNSA received $20.7 billion in FY 2022, which was about $1 billion more than it received in FY 2021 and included full funding for major efforts like modernization of plutonium pit production and five warhead modernization programs.[37] The FY 2023 budget would continue these efforts with an NNSA topline of $21.4 billion.[38] The FY 2023 budget also supports modernization programs to replace the triad, including the Ground Based Strategic Deterrent (GBSD), recently named "Sentinel"; Long Range Stand Off Weapon (LRSO); *Columbia*-class nuclear submarine; and B-21 Raider bomber.

In FY 2022, Congress also provided funding to begin research and development on a nuclear-armed, sea-launched cruise missile (SLCM-N), which was proposed in the 2018 NPR in light of the worsened security environment with Russia and China.[39] However, the Biden Administration removed funding for this capability in its FY 2023 budget request. President Biden's Interim National Security Strategic Guidance describes a goal of "reduc[ing] the role of nuclear weapons in our national security strategy," and it is likely that this goal influenced the decision to cancel the SLCM-N.[40]

Assessing U.S. Nuclear Force Capacity

To assess the military services, other sections in this *Index* use a combination of government strategies or assessments and historical data based on capacity and capabilities that the United States has needed to fight wars in the past. For example, using data from four previous wars and strategies over time, this *Index* assesses Army Brigade Combat Team (BCT) capacity based on a total of 50 BCTs required to deal with two major regional conflicts.[41]

Assessing the capacity of U.S. nuclear weapons, however, presents several serious difficulties. Because a nuclear war has never been fought, there are no historical data that can be used to determine a baseline for how much nuclear capability the United States needs. The only instance of nuclear weapons employment was the U.S. bombing of Hiroshima and Nagasaki in 1945, but that does not provide any information on how much nuclear capability is needed because the United States was the only nuclear-weapon state and did not yet maintain a functioning nuclear arsenal.

Moreover, since deterrence depends on what an adversary perceives to be a credible threat, it is very difficult to determine how many warheads, and on how many and what types of platforms, the United States needs to deter an adversary. Deterrence requires an understanding of what an adversary values and what it will take to convince the adversary not to take a certain action. One way to measure needed nuclear capacity could be to analyze the size of the nuclear force that the U.S. needed to deter the Soviet Union during the Cold War, but using past data on the size of U.S. and Soviet nuclear arsenals would not apply to today's nuclear environment, because three-peer deterrence dynamics inherently differ from a two-party dynamic of "mutually assured destruction."

Nevertheless, it is possible to draw some conclusions about the adequacy of the size and structure of the current U.S. nuclear force posture. A force that is sized to deter only one nuclear peer is not likely to be sufficient to deter two nuclear peers—both Russia and China. Consensus during the early years of the Obama Administration centered around the assessment that Russia was the primary nuclear threat; that China would likely grow its nuclear arsenal, but not beyond its minimum deterrence posture; and that nuclear proliferation in Iran or an India–Pakistan nuclear conflict would dominate future nuclear threats.[42] Then-STRATCOM Commander General Kevin Chilton testified in 2010 that "I think the arsenal that we have is exactly what is needed today to provide the deterrent."[43] A nuclear force that was capable of countering the threats we faced in 2010 is most likely not capable of countering the threats we face today.

There is a direct relationship between adversary capabilities and what the U.S. needs for deterrence. Fundamental to the concept of deterrence is the ability to hold at risk the assets that our adversaries value most, including their nuclear forces and accompanying infrastructure. For deterrence to be credible, the United States maintains the amount and types of nuclear weapons that it needs to convince adversaries that can strike these targets if necessary. Given the increase in targets resulting from China's nuclear expansion, this logic points to a likelihood that current U.S. nuclear weapon capacity is insufficient.

This capacity deficiency is particularly acute in the category of tactical nuclear weapons: non-strategic nuclear weapons that can be deployed directly to a region of conflict as opposed to ICBMs launched from the homeland or SSBNs that remain far out at sea. U.S. tactical nuclear weapons can be compared to Russia's arsenal of non-strategic nuclear weapons that are not limited by New START and China's arsenal of hundreds of nuclear-capable medium-range to intermediate-range missiles deployed in the Indo-Pacific. Compared to Russia's arsenal of more than 2,000 non-strategic weapons, the United States deploys about 100 tactical weapons in NATO states. Compared to China, the United States deploys no nuclear weapons to the Indo-Pacific.

The 2018 NPR studied these disparities and assessed that the United States needed two supplemental capabilities—the W76-2 and the SLCM-N—to rectify this imbalance. The United States fielded the W76-2, but the future of the SLCM-N remains uncertain. Meanwhile, this disparity has worsened since the 2018 review. In April 2022, Admiral Richard wrote in a letter to Congress that "the current situation in Ukraine and China's nuclear trajectory convinces me a deterrence and assurance gap exists."[44] The SLCM-N is therefore necessary. Other senior military leaders who agree include:

- Admiral Charles A. Richard, Commander, U.S. Strategic Command;
- General Mark A. Milley, Chairman, Joint Chiefs of Staff;
- Admiral Christopher W. Grady, Vice Chairman, Joint Chiefs of Staff;
- General Tod D. Wolters, Commander, U.S. European Command; and
- Admiral Michael M. Gilday, Chief of Naval Operations.[45]

These assessments that more is needed to address the tactical nuclear threat, combined with the sheer numerical difference between the United States and its adversaries, point to a poor score for the capacity of tactical nuclear weapons. However, while this *Index* can conclude that U.S. nuclear weapon capacity is likely inadequate, it stops short of assigning this category a score ranging from "very strong" to "very weak" as the rest of the categories in this chapter are rated.

The question that remains unanswered is how much more the United States needs to account for the drastic change in the Chinese nuclear threat, Russia's continuing expansion, and the potential rise of Iran as a nuclear power in a globally critical region. In addition to the inherent constraints on determining a baseline for nuclear weapons capacity, it would be hard to determine what an ideal force posture would look like in a three-party nuclear dynamic. For example, would the United States need to double its arsenal to deter two peers? Or would only limited additions to the stockpile or changes in U.S. posture or alert status suffice? Perhaps these questions can be answered in the future, but since China's strategic breakout was revealed to the public in 2021, there has been little time for the broader policy and academic community to analyze the three-party nuclear peer dynamic.

Even assigning a score for tactical weapon capacity would be difficult despite the evidence pointing to a deterrence gap. Some might argue that this gap weakens U.S. forces only slightly in this category because existing capabilities like the air-launched cruise missile and W76-2 would contribute to the deterrence of adversary tactical nuclear strikes. Others might argue that a lack of any nuclear weapons stationed in the Indo-Pacific to counter China's arsenal would warrant a score of "very weak." But without an identified number for how many tactical nuclear weapons the United States needs both to deter adversaries and to assure allies, making this assessment remains difficult.

As a result, this *Index* concludes that U.S. nuclear weapons capacity is likely not sufficient to face two nuclear peers at once but does not assign a score in this category. This may change in future editions.

U.S. Nuclear Weapons Assessment

In rating America's military services, this *Index* focuses on capacity, capability, and readiness. In assessing our nuclear forces, however, this *Index* focuses on several components of the existing nuclear weapons enterprise. This enterprise includes warheads; delivery systems; and the physical infrastructure that designs, manufactures, and maintains U.S. nuclear weapons. It also includes and must sustain the talent of people—the nuclear designers, engineers, manufacturing personnel, planners, maintainers, and operators who help to ensure a nuclear deterrent that is second to none—and additional elements like nuclear command and control; intelligence, surveillance, and reconnaissance; and aerial refueling, all of which also play a major role in conventional operations.

While many factors make such an assessment difficult, two stand out. First, there is a lack of detailed publicly available data about the readiness of nuclear forces, their capabilities, and the reliability of their weapons. Second, many components that comprise the nuclear enterprise are also involved in supporting conventional missions. For example, U.S. strategic bombers perform a significant conventional mission and do not fly airborne alert with nuclear weapons today as they did routinely during the 1960s. Thus, it is hard to assess whether any one piece of the nuclear enterprise is sufficiently funded, focused, and/or effective with regard to the nuclear mission.

With these difficulties in mind, this assessment considers seven factors that are deemed the most important elements of the nuclear weapons enterprise:

- Reliability of the current U.S. nuclear stockpile,
- Reliability of current U.S. delivery systems,
- Nuclear warhead modernization,
- Nuclear delivery systems modernization,
- Nuclear weapons complex,
- Personnel challenges within the national nuclear laboratories, and
- Allied assurance.

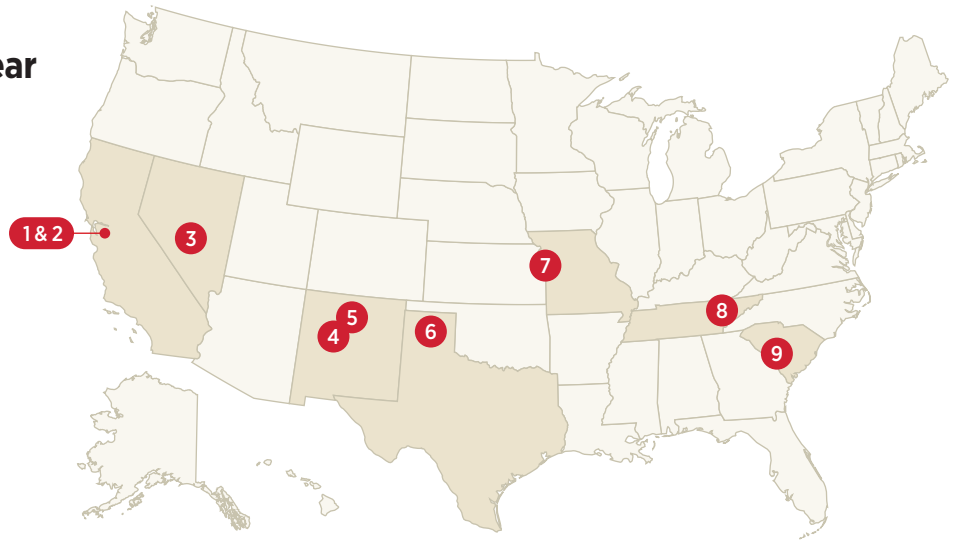
These factors are judged on a five-grade scale that ranges from "very strong" (defined as meeting U.S. national security requirements or having a sustainable, viable, and funded plan in place to do so) to "very weak" (defined as not meeting current security requirements and with no program in place to redress the shortfall). The other three possible scores are "strong," "marginal," and "weak."

Reliability of Current U.S. Nuclear Stockpile Score: Strong

U.S. warheads must be safe, secure, effective, and reliable. The Department of Defense defines

MAP 17

U.S. Nuclear Weapons Complex



1. **Lawrence Livermore National Laboratory**
   Livermore, CA
   Nuclear weapons R&D
2. **Sandia National Laboratories**
   Livermore, CA
   Nuclear weapons R&D and systems engineering
3. **Nevada National Security Site**
   Nye County, NV
   Subcritical experiments and test readiness
4. **Sandia National Laboratories**
   Albuquerque, NM
   Nuclear weapons R&D and systems engineering
5. **Los Alamos National Laboratory**
   Los Alamos, NM
   Nuclear weapons R&D and plutonium pit production
6. **Pantex Plant**
   Panhandle, TX
   Assembly of nuclear warheads
7. **Kansas City Plant**
   Kansas City, MO
   Production of non-nuclear components for nuclear warheads
8. **Y-12 National Security Complex**
   Oak Ridge, TN
   Manufacture of highly-enriched uranium parts for nuclear warheads
9. **Savannah River Site**
   Aiken, SC
   Pit production and tritium production

SOURCE: Heritage Foundation research.

heritage.org

reliability as "the probability that a weapon will perform in accordance with its design intent or military requirements."[46] Since the cessation of nuclear testing in 1992, reliability has been assessed and maintained through the NNSA's Stockpile Stewardship Program (SSP), which consists of an intensive warhead surveillance program; non-nuclear experiments (experiments that do not produce a nuclear yield); sophisticated calculations using high-performance computing; and related annual assessments and evaluations. America and its allies must have high confidence that U.S. nuclear warheads will perform as expected.

Over time, the number and diversity of nuclear weapons in the stockpile have decreased. The result is a smaller margin of error if all of one type are affected by a technical problem that might cause a weapon type or its delivery system to be decommissioned. Despite generating impressive amounts of knowledge about nuclear weapons physics and materials chemistry, the United States could find itself surprised by unanticipated long-term effects on a nuclear weapon's aging components. "The scientific foundation of assessments of the nuclear performance of US weapons is eroding as a result of the moratorium on nuclear testing," argue John

Hopkins, nuclear physicist and a former leader of the Los Alamos National Laboratory's nuclear weapons program, and David Sharp, former Laboratory Fellow and a guest scientist at the Los Alamos National Laboratory.[47]

The United States currently has the world's safest and most secure stockpile, but concerns about overseas storage sites, potential problems introduced by improper handling, or unanticipated effects of aging could compromise the integrity or reliability 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 without proper authorization. Some U.S. warheads have modern safety features that provide additional protection against accidental detonation; others do not.

Grade: Absent nuclear weapons testing, the national laboratories' assessment of weapons reliability, based on the full range of surveillance, scientific, and technical activities carried out in NNSA's Stockpile Stewardship Program, depends on the expert judgment of the laboratories' directors and the weapons scientists and engineers on their staffs. This judgment is based on experience, non-nuclear experimentation, and extensive modeling and simulation. It does not benefit from the objective data that could be obtained through direct nuclear testing, which was used in the past to diagnose and fix potential problems with nuclear warheads.

With or without nuclear testing, however, the United States maintains the world's most advanced Stockpile Stewardship Program and continues to make scientific and technical advances to help certify the stockpile. For example, NNSA is working on upgrades to the Enhanced Capabilities for Subcritical Experiments facility in Nevada (such as adding the capability to produce high-speed, high-fidelity X-ray images of subcritical experiments and to watch nuclear implosion) to improve our understanding of plutonium.[48] In addition, "[t]he Exascale Computing Initiative (ECI) will provide NNSA with next-generation simulation capabilities to support weapons design, science-based stockpile stewardship, and stockpile certification activities" and is on track "to meet its exascale system initial operation capability in FY 2023."[49]

Such advanced capabilities can help the NNSA to certify the stockpile more accurately and without testing, but according to Admiral Richard, confidence in the stockpile requires two other components in addition to the Stockpile Stewardship Program:

> [Y]ou have to have a flexible and modern stockpile, which means we need to move past life extensions, which we have been doing for 30 years, and move into refurbishments, which is where NNSA is about to go. And ...[y]ou have to have a modern, responsive, and resilient infrastructure, and we have delayed too long, in my opinion, giving NNSA the resources necessary to do that piece.[50]

To assess the reliability of the nuclear stockpile annually, each of the three nuclear weapons labs (the Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratory) reports its findings with respect to the safety, security, and reliability of the nation's nuclear warheads to the Secretaries of Energy and Defense, who then brief the President. Detailed classified reports are provided to Congress as well. The Commander of U.S. Strategic Command also assesses overall nuclear weapons system reliability, including the reliability of both warhead and delivery platforms.

In spite of concerns about aging warheads, according to the NNSA's Stockpile Stewardship and Management Plan (SSMP) for FY 2022:

> DOE/NNSA conducted surveillance activities for all weapon systems using data collection from flight tests, laboratory tests, and component evaluations to assess stockpile reliability without explosive nuclear testing, which culminated in completion of all annual assessment reports and generation of laboratory director letters to the President.[51]

Additionally, when asked in a congressional hearing whether she "agree[s] that there is not a current or foreseeable need for the United States to resume explosive nuclear testing that produces nuclear yields," Administrator Hruby testified, "Yes...I do. And I would just go further to say our entire Stockpile Stewardship Program is designed around the principal [sic] that we will make sure we understand weapons enough so that we do not have to test."[52]

Based on the results of the existing method used to certify the stockpile's effectiveness, we grade the

U.S. stockpile conditionally as "strong." This grade, however, will depend on whether support for an adequate stockpile, both in Congress and in the Administration, remains strong.

Reliability of Current U.S. Delivery Systems Score: Strong but Trending Toward Marginal or Weak

Reliability encompasses not only the warhead, but strategic delivery vehicles as well. For ICBMs, SLBMs, and air-launched cruise missiles (ALCMs), this requires a successful missile launch, including the separation of missile boost stages, performance of the missile guidance system, separation of the reentry vehicles from the missile post-boost vehicle, and accuracy of the final reentry vehicle in reaching its target.[53] It also entails the ability of weapons systems (cruise missiles, aircraft carrying bombs, and reentry vehicles) to penetrate adversary defensive systems and reach their targets.

The United States conducts flight tests of ICBMs and SLBMs every year to ensure the reliability of its delivery systems with high-fidelity "mock" warheads. Anything from faulty electrical wiring to booster separations could degrade the reliability and safety of the U.S. strategic deterrent. U.S. strategic long-range bombers also regularly conduct continental United States and intercontinental exercises and receive upgrades to sustain a demonstrated high level of combat readiness. The Air Force tested the AGM-86B ALCM, launched from the B-52H bomber, most recently in 2017.[54] The DOD must upgrade existing platforms and develop their replacement programs simultaneously, and diminished capabilities make this task more difficult.

Grade: In July 2018, the Air Force suffered its first unsuccessful ICBM test since 2011,[55] but it has conducted several successful tests since then, including a test in August 2020 that launched a missile armed with three reentry vehicles[56] and its most recent test, which was conducted in August 2021.[57] However, its May 2021 test was marred by a ground abort before launch, and this has provoked speculation about the reliability of the Minuteman III missile as it approaches its retirement, which is scheduled to begin in 2029.[58] Additionally, the DOD canceled a Minuteman III test scheduled for March 2022 (and then rescheduled to April 2022) "in a bid to lower nuclear tensions with Russia." As a result, as of the time this book was being prepared, the Air Force had not conducted any ICBM tests in 2022.[59] SLBM tests in 2021 were successful.[60]

To the extent that data from these tests are publicly available, they provide objective evidence of the delivery systems' reliability and send a message to U.S. allies and adversaries alike that U.S. systems work and that the U.S. nuclear deterrent is ready if needed. The aged systems, however, occasionally have reliability problems, as evidenced by the failed July 2018 and May 2020 Minuteman III launches. Moreover, canceling missile tests without rescheduling deprives the United States of an additional opportunity to confirm the system's reliability.

Although delivery systems are likely reliable enough today, the evidence indicates that this reliability could dwindle with aging. For instance, because of its obsolescence against Russian air defense systems, the B-52H bomber already no longer carries gravity bombs.[61] Despite the fact that the AGM-86B passed its most recent public test in 2017, General John Hyten has stated that because of its age, "it's a miracle that [the missile] can even fly" and that the current ALCMs "do meet the mission, but it is a challenge each and every day."[62] The five years that have passed since that last public test could only have exacerbated those problems. Admiral Richard has also stated that "I need a weapon that can fly and make it to the target. Minuteman-III is increasingly challenged in its ability to do that."[63]

The problem is made worse by advancing Russian and Chinese air and missile defenses. In addition to advanced air defense systems like the S-400, which contributed to the decision that the B-52H bomber should no longer carry gravity bombs, both Russia and China are placing a greater emphasis on long-range ballistic missile defense. Russia is modernizing its long-range interceptors—and has dozens more than the United States has—and China's missile defense capabilities, while mostly focused on regional threats, "appear to be developing towards countering long-range missiles."[64] As U.S. delivery systems increasingly approach obsolescence, adversary air and missile defense increasingly calls into question the ability of U.S. weapons to strike their targets.

Both adversary defenses and system aging will continue to affect delivery platform reliability until platforms are replaced, but as this book was being prepared, no publicly released data or statements from senior leaders had indicated that U.S. delivery

systems cannot currently meet mission requirements. Until that changes, this factor receives the grade of "strong." However, this grade will trend to "marginal" if not "weak" if modernization programs are not fully pursued and these aging systems are not replaced on time.

Nuclear Warhead Modernization
Score: Marginal

During the Cold War, the United States focused on designing and developing modern nuclear warheads to counter Soviet advances and modernization efforts and to leverage advances in our understanding of the physics, chemistry, and design of nuclear weapons. Today, the United States focuses on extending the life of its aging stockpile rather than on fielding modern warheads while trying to retain the skills and capabilities needed to design, develop, and produce such warheads. Relying only on sustaining the aging stockpile could increase the risk of failure caused both by aging components and by not exercising critical skills. It could signal to adversaries that the United States is less committed to nuclear deterrence.

Meanwhile, adversaries and current and future proliferants are not limited to updating Cold War designs and can seek designs outside of U.S. experiences. Other nations can maintain their levels of proficiency by developing new nuclear warheads.[65] As recently reported by the Department of State, "Russia has conducted nuclear weapons experiments that have created nuclear yield and are not consistent with the U.S. 'zero-yield' standard," and evidence points to China's potential lack of adherence to this standard as well.[66]

Fortunately, the NNSA has made noticeable improvements in this category in recent years. Since 2016, Congress has funded the Stockpile Responsiveness Program (SRP) to "exercise all capabilities required to conceptualize, study, design, develop, engineer, certify, produce, and deploy nuclear weapons."[67] Congress funded the SRP at $70 million in FY 2020 and FY 2021.[68] It provided only $50 million for the SRP for FY 2022, and the FY 2023 budget requests $68.7 million.[69] The SRP has demonstrated some important accomplishments in ensuring critical skills retention and has been met with enthusiasm by scientists at the national labs.

Ongoing work at the national labs to develop additional warheads will build on the success of the SRP in exercising these skills on modern warhead programs. Starting in FY 2021, Congress appropriated funding for the W93/Mark 7 warhead program, which will replace the W76-1 and W88 warheads carried by the Trident II D5 SLBMs.[70] The NNSA is also developing the W87-1 warhead for the Sentinel missile. Fielding modern weapons like the W93/Mark 7 would allow American engineers and scientists to improve previous designs and devise more effective ways to address evolving military requirements (for example, adaptability to emerging threats and the ability to hold hard and deeply buried targets at risk). Future warheads could remedy some ongoing aging concerns and thereby improve reliability while also enhancing the safety and security of American weapons.

The nuclear enterprise displayed improved flexibility when it produced the W76-2 warhead, a low-yield version of the W76 warhead that was designed to counter Russia's perception of an exploitable gap in the U.S. nuclear force posture, within a year. Congress fulfilled the budget request of $72 million for the W93/Mark 7 warhead program for FY 2022, and the FY 2023 budget requests $240.5 million to begin funding the program's second development phase.[71]

The ability to produce plutonium pits, which compose the core of all nuclear weapons, will be critical to warhead modernization efforts. The NNSA currently cannot produce plutonium pits at scale and is undergoing an effort to restore this capability with a statutory requirement to produce 80 pits per year by 2030. The W93/Mk 7, the W87-1, and likely future designs are planned to use these new pits.[72] Unfortunately, the NNSA announced last year that it would not be able to meet the 2030 deadline, and the new goal has shifted to somewhere between 2032 and 2035.[73]

Grade: Before the score for this category can move up to "strong," the NNSA, with support from Congress, will need to achieve enough progress with the W93/Mk 7 and W87-1 and minimize delays in pit production. Delays in pit production will require modern warheads to use older pits, which risks jeopardizing both the functioning of those systems and the credibility of the U.S. deterrent. The NNSA eventually will also need to begin programs for future land-based, sea-based, and air-delivered warheads, all of which currently remain notional, to succeed the current programs beyond 2030.[74]

Moreover, future assessments will need to examine whether the NNSA's current warhead

modernization effort is sufficient to address the increasing threat. For instance, despite Russian progress in hardening and deeply burying facilities to withstand strikes by current U.S. weapons, an earth-penetrating warhead is not part of the NNSA's warhead modernization plan.[75] The Biden Administration's proposal to cancel the plan to keep the B83 gravity bomb (currently the only warhead capable of striking hard and deeply buried targets) beyond its planned retirement could create a capability gap.[76]

For now, the score for this category remains at "marginal" but could trend toward "strong" in future years.

Nuclear Delivery Systems Modernization Score: Strong

All U.S. delivery systems were built during the Cold War and are overdue for replacement. The Obama Administration, in consultation with Congress, initiated a plan to replace current triad delivery systems within the constraints of New START. President Trump advanced this modernization program with bipartisan support from Congress. Under this modernization program:

- The Navy is fully funding the *Columbia*-class submarine to replace the *Ohio*-class submarine;
- The Air Force is funding the B-21 Raider Long-Range bomber, which will replace conventionally armed bombers before they become certified to replace nuclear-capable bombers, and the Long-Range Standoff weapon, which will replace the aging air-launched cruise missile;
- Existing Minuteman III ICBMs are expected to remain in service beyond the end of the decade, 50 years after their intended lifetime, and to be replaced by the Sentinel missile beginning in 2029;
- Existing Trident II D5 SLBMs have been life-extended to remain in service until 2042 through the end of the last *Ohio*-class submarine's lifetime; and
- The F-35 will replace the existing F-15E Dual Capable Aircraft that will carry the B61-12 gravity bomb.[77]

All of these programs have remained on track for the past few years, but they face high risks of delay. For instance, the U.S. Government Accountability Office (GAO) found risks in the Sentinel missile schedule related to "technology maturation," the complexity involved in operating Minuteman III missiles and Sentinel missiles concurrently during the transition period, "[l]imited schedule margin for testing," and the "aggressive pace of construction activities."[78] Moreover, these programs are entering a new phase of risk as they move from initial research and development to testing (the Sentinel's first flight test, for example, is planned for 2023) and then procurement.[79]

These scheduling risks are especially dangerous because years of deferred recapitalization have left modernization programs with no margin for delay. For instance, although the *Columbia*-class SSBN currently remains on schedule, the transition between the *Ohio* and the *Columbia* is so fragile that, according to Admiral Johnny Wolfe, "[d]elays to the Navy's SSBN modernization plan are not an option."[80]

The effects of failing to replace current systems before their planned retirement dates are significant. As systems like the Minuteman III, AGM 86-B, and *Ohio*-class submarines continue to age, they take on greater risks. Age degrades reliability by increasing the potential for systems to break down or fail to respond correctly. Any defects can have serious implications for U.S. deterrence and assurance. Should Sentinel fail to reach initial operating capability by 2029, the United States will be left with a less-capable—and therefore less credible—ICBM fleet, which will also begin to dip below 400 missiles as the Air Force continues to use missiles for annual testing. With respect to the Navy, the GAO has reported that the consequence of failing to deliver the first *Columbia*-class submarine on time would be a failure to meet STRATCOM's force-generation operational requirement, which means a weaker sea-based deterrent.[81]

Grade: U.S. nuclear platforms are in dire need of recapitalization. Plans for modernization of the nuclear triad are in place, and Congress and the services have largely sustained funding for these programs. Congress fully funded the FY 2022 budget requests for all modernization programs. GBSD was given the name "Sentinel" and as of April 2023 was expected to perform its "first flight test in the next 16 to 18 months."[82] The Air Force also awarded

Raytheon an engineering and manufacturing development contract in July 2021 for the LRSO, which also remains on schedule.[83] Despite these successes, however, the fragility of these programs keeps them at risk of technical or funding delays, including continuing resolutions.

This modernization plan will also likely not suffice to deter both Russia's and China's advancing nuclear forces at the same time. Growth in adversary forces has a direct impact on the required size of U.S. nuclear forces because U.S. forces must be able to target adversary nuclear weapons as part of the U.S. counterforce strategy. As a result, the United States will need to consider procuring more of these modern systems than originally planned. For example, the Program Executive Officer for Strategic Submarines recently stated that "[it] clearly makes sense to have more than 12 [*Columbia*-class SSBNs] to meet the current requirements."[84]

The United States will also need to consider acquiring additional capabilities to ensure that deterrence is tailored to the evolving Russian threat and the new Chinese threat. The SLCM-N, if it continues to receive funding from Congress, would begin to meet this challenge by providing the President with an option to respond more proportionally to—and therefore deter—an adversary's limited employment of nuclear weapons in a theater of conflict.

For now, replacing current systems remains the top priority, and based on the commitment to nuclear weapons modernization demonstrated by Congress and the Administration this year, this category again earns a grade of "strong." However, the score in future years will drop to "marginal" or "weak" if the United States fails to adjust its modernization program to account for the drastic change in threat. A failure to restore funding for the SLCM-N will contribute to such a drop in score.

Nuclear Weapons Complex Score: Marginal

Maintaining a reliable and effective nuclear stockpile depends in large part on the facilities where U.S. devices and components are developed, tested, and produced. These facilities constitute the foundation of our strategic arsenal and include the:

- Los Alamos National Laboratories (nuclear weapons research and development, or R&D, and plutonium pit production);
- Lawrence Livermore National Laboratories (nuclear weapons R&D);
- Sandia National Laboratory (nuclear weapons R&D and systems engineering);
- Nevada National Security Site (subcritical experiments, test readiness);
- Pantex Plant (assembly of nuclear warheads);
- Kansas City Plant (production of non-nuclear components for nuclear warheads);
- Savannah River Site (second site for pit production and tritium production); and
- Y-12 National Security Complex (manufacture of highly enriched uranium parts for nuclear warheads).

These complexes design, develop, test, and produce the weapons in the U.S. nuclear arsenal, and their maintenance is therefore of critical importance. As stated by NNSA Administrator Jill Hruby, "A resilient, flexible, and scalable infrastructure is the foundation of a modern nuclear security enterprise."[85] It contributes to deterrence by enabling the United States to adapt its nuclear arsenal to shifting requirements, signaling to adversaries that the United States can adjust its warhead capacity or capabilities when needed. 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 when they are needed.

The existing nuclear weapons complex, however, is not capable of producing some of the nuclear components needed to maintain and modernize the stockpile.[86] Significantly, the United States has not had a substantial plutonium pit production capability since 1993. The U.S. currently retains more than 5,000 old plutonium pits in strategic reserve in addition to pits for use in future LEPs, but uncertainties regarding the effect of aging on plutonium pits and how long the United States will be able to depend on them before replacement remain unresolved. In 2006, a JASON Group study of NNSA assessments of plutonium aging estimated that, depending on

pit type, the minimum pit life was in the range of 100 years.[87] A work program was recommended to address additional uncertainties in pit aging, but that did not reach fruition. In addition to the pits needed for modern warheads like the W87-1 and W93, numerous pits have been in the stockpile for decades—some for more than 50 years—and will need to be replaced.

Today, the production rate is too low to meet the need to replace aging pits. The United States has demonstrated an ability to produce about 10 plutonium pits a year at the Los Alamos PF-4 facility. If executed as planned, infrastructure modernization of PF-4, as mandated by statutory law, will boost that number to 30 by 2026. In April 2021, the NNSA reached the first critical milestone for pit production at the Los Alamos National Laboratory.[88] A second plutonium pit production facility is being planned to exploit the Mixed Oxide Fuel (MOX) facility that was being constructed at the Savannah River Site in South Carolina. Savannah River has a required production of no fewer than 50 pits per year by 2030 for an overall requirement of no fewer than 80 per year, but delays at the site are driving the delay in the NNSA's ability to produce 80 pits per year by 2030.

Aside from plutonium, the NNSA must maintain production of several other key materials and components that are used to build and maintain nuclear weapons. For instance, NNSA plans to increase the supply of tritium as demand increases. Because tritium is always decaying at a half-life of 12 years, delays in tritium production only increase the need to produce a timely replacement.[89] Other projects currently underway include a new lithium processing facility and the new Uranium Processing Facility at Y-12. So far, this facility is moving forward on schedule and cost.

Added to these considerations is the fact that the NNSA's facilities are old: About 60 percent of its 5,000 facilities are more than 40 years old, and more than half are in poor condition.[90] As a consequence, the NNSA had accumulated about $5.8 billion in deferred maintenance as of FY 2020. According to the FY 2022 SSMP, high deferred maintenance is a sign that infrastructure is in poor condition and in need of modernization.[91] Aging facilities have also become a safety hazard: In some buildings, for example, chunks of concrete have fallen from the ceiling.[92] Moreover, without modern and functioning NNSA facilities, the U.S. will gradually lose the ability to conduct the high-quality experiments that are needed to ensure the reliability of the stockpile without nuclear testing.

Finally, despite the self-imposed nuclear testing moratorium that the United States has had in place since 1992, a functioning nuclear weapons complex requires a low level of nuclear test readiness. "Test readiness" refers to a single test or a very short series of tests, not a sustained nuclear testing program, reestablishment of which would require significant additional resources. The NNSA is mandated, initially under President Bill Clinton's 1993 PDD-15, to maintain a capability to conduct a nuclear test within 24 to 36 months of a presidential decision to do so.[93] Whether this approach can assure that the United States has the timely ability to conduct yield-producing experiments to correct a flaw in one or more types of its nuclear weapons is open to question. The United States might need to test to assure certain weapon characteristics that only nuclear testing can validate, or to respond to another nation's nuclear weapons tests, or to communicate its unquestioned resolve.

However, the NNSA has been unable to achieve even this potentially inadequate goal. According to the FY 2018 SSMP, it would take 60 months to conduct "a test to develop a new capability."[94] And per the FY 2022 SSMP, "Assuring full compliance with domestic regulations, agreements, and laws related to worker and public safety and the environment, as well as international treaties would significantly extend the time required for execution of a nuclear test."[95] 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.[96] Test readiness has not been funded as a separate program since FY 2010 and is instead supported by the Stockpile Stewardship Program that exercises testing elements at the Nevada National Security Site and conducts subcritical nuclear laboratory experiments.[97]

Grade: Modernizing U.S. nuclear facilities is of critical importance because the NNSA's warhead modernization plans depend on the ability to produce certain components like plutonium pits. The importance of a functioning nuclear weapons complex has also increased as the threat posed by adversaries has worsened. Given the change to a three-party nuclear peer dynamic and both Russia's

and China's active nuclear production capabilities, the United States must maintain the ability to adapt its nuclear posture and hedge against an uncertain future.

On one hand, the United States maintains some of the world's most advanced nuclear facilities. Significant progress has been made over the past decade in getting funded plans in place to recapitalize plutonium pit production capacity and uranium component manufacturing in particular, as well as construction projects for new facilities.

On the other hand, the NNSA faces significant challenges. Some parts of the complex have not been modernized since the 1950s, and plans for long-term infrastructure recapitalization remain essential even as the NNSA embarks on an aggressive warhead life-extension effort. The weak state of U.S. test readiness is also of great concern. In a dynamic threat environment combined with an aging nuclear arsenal, the lack of this capability becomes riskier even as the NNSA improves its stockpile stewardship capabilities. Efforts to restore critical functions of the complex like pit production also face great technical challenges as well as the need to ensure stable funding. The recent shift in deadline for plutonium pit production at the Savannah River Site from 2030 to the 2032–2035 range is one example. After years of deferred modernization, any unexpected failure or disruption at a critical facility could significantly affect schedules for nuclear warhead modernization.[98]

Until demonstrable progress has been made toward completion of infrastructure modernization, the grade for this category will therefore remain at "marginal."

Personnel Challenges Within the National Nuclear Laboratories Score: Marginal but Trending Toward Strong

Combined with nuclear facilities, U.S. nuclear weapons scientists and engineers are critical to the health of the complex and the stockpile. In the words of NNSA Administrator Jill Hruby:

> The NNSA Federal workforce is critical to the success of the Nation's nuclear security enterprise. NNSA's expanding mission requirements and pressing modernization and recapitalization needs require recruiting, training, and retaining a skilled Federal workforce with the appropriate capabilities to meet mission requirements and deliver on our objectives.[99]

The ability to maintain and attract a high-quality workforce is critical to ensuring the future of the American nuclear deterrent, especially when a strong employment atmosphere adds to the challenge of hiring the best and brightest. Today's weapons designers and engineers are first-rate, but they also are aging and retiring, and their knowledge must be passed on to the next generation of experts. This means that young designers need meaningful and challenging warhead design and development programs to hone their skills. The NNSA and its weapons labs understand this problem and, with the support of Congress, are beginning to take the necessary steps to invest in the next generation.

The judgment of experienced nuclear scientists and engineers is critical to assessing the safety, security, effectiveness, and reliability of its nuclear deterrent. Without their experience, the nuclear weapons complex could not function. Few of today's remaining scientists or engineers at the NNSA weapons labs have had the experience of taking a warhead from initial concept to "clean sheet" design, engineering development, production, and fielding. The SRP is remedying some of these shortfalls by having its workforce exercise many of the nuclear weapon design and engineering skills that are needed. To continue this progress, SRP funding should be maintained if not increased.

The average age of the NNSA's enterprise-wide workforce had decreased slightly to 46 years as of the end of FY 2020, but more than a quarter of the workforce is now eligible for retirement.[100] Given the length of time required to train new hires, the long timelines of warhead production cycles, and the time it takes to transfer technical knowledge and skills, both recruiting and retaining needed talent remain challenging for the NNSA.[101]

Grade: In addition to employing world-class experts, the NNSA labs have had good success in attracting and retaining talent (for example, through improved college graduate recruitment efforts and NNSA Academic Programs).[102] As many scientists and engineers with practical nuclear weapon design and testing experience retire, continued annual assessments and certifications of nuclear warheads will rely increasingly on the judgments of people who have never tested or designed a nuclear weapon. Moreover:

> As NNSA mission scope increases, so does the demand for increased personnel to support new facilities and capabilities being brought on-line, and to support moving to 24/7 operations at many sites across the complex. These individuals are essential to minimizing unplanned outages and to supporting safe and secure operations, particularly in high hazard operations.[103]

Hazardous NNSA infrastructure and facilities can also be a hindrance to recruitment and retainment, so modernizing the nuclear weapons complex will be critical to these efforts.[104] Admiral Richard has emphasized the importance of investing in the workforce now: "If we lose those talent bases, you can't buy it back. It will take 5 to 10 years to either retrain and redevelop the people or rebuild the infrastructure."[105]

In light of these issues, the NNSA workforce earns a score of "marginal," but it will trend toward "strong" if these improvements continue.

Allied Assurance Score: Strong but at Risk of Weakening

The credibility of U.S. nuclear deterrence is one of the most important components of allied assurance. The United States extends nuclear assurances to more than 30 allies who have maintained the commitment to forgo nuclear programs of their own. If allies were to resort to building their own nuclear weapons because their confidence in U.S. extended deterrence had been degraded, the consequences for nonproliferation and stability could become dire.

In Europe, the United States can coordinate with France and the United Kingdom, which already have nuclear weapons. The United States also deploys B-61 nuclear gravity bombs in Europe as a visible manifestation of its commitment to its NATO allies and retains dual-capable aircraft that can deliver those gravity bombs. The United States provides nuclear assurances to Japan, South Korea, and Australia, all of which face increasingly aggressive nuclear-armed regional adversaries: China, Russia, and North Korea. Continued U.S. nuclear deterrence assurances are critical and must be perceived as credible. Both Japan and South Korea have the capability and basic know-how to build their own nuclear weapons quickly. A decision to do so would be a major setback for U.S. nonproliferation policies and could increase regional instability.

Grade: Not unlike deterrence, assurance is about allies' perceptions of the U.S. nuclear umbrella's credibility rather than what the United States perceives to be a credible extended deterrent. Any assessment of allied assurance will therefore be inherently subjective.

Based on public statements and the available data, U.S. allies do not appear to be doubting U.S. extended deterrence commitments to any serious degree or thinking of developing their own nuclear weapons. European members of NATO continue to express their commitment to and appreciation of NATO as a U.S.-led nuclear alliance even as they worry about the impact of Russia's growing non-strategic nuclear capabilities and nuclear saber-rattling over Ukraine.[106] Additionally, both NATO allies and Asian allies like Japan and South Korea have affirmed that the strategy outlined in the 2018 NPR supports extended deterrence.[107] Because the 2022 NPR has not yet been released publicly, allies have not publicly commented.

However, allied assurance faces increasing risks as the regional threats to U.S. allies grow in both Europe and the Indo-Pacific. In particular, as China continues to advance its capability to hold the U.S. homeland at risk with its strategic forces and to execute any nuclear strategy in the region, allies' assurance of the U.S. commitment to extend its nuclear umbrella in the region can become more fragile. While China has hundreds of nuclear-capable missiles in the region, the United States deploys none. Both South Korean and Japanese leaders have recently discussed with President Biden the need to ensure that extended deterrence remains strong in light of these threats.[108]

While official statements remain positive, unofficial sentiment could indicate concern about U.S. extended deterrence commitments. For example, former Japanese Prime Minister Shinzo Abe has called for Japan to consider hosting U.S. nuclear weapons,[109] and a senior Japanese ruling party lawmaker recently called for a national debate on the U.S. nuclear umbrella.[110] Additionally, significant percentages of South Koreans continue to express support for an indigenous nuclear weapons capability or nuclear-sharing agreement with the United States as they face increasing nuclear threats from both China and North Korea.[111]

The 2018 NPR had proposed and allies had expressed support for two supplements to existing capabilities—a low-yield SLBM warhead and a new nuclear sea-launched cruise missile—as important initiatives to strengthen allied assurance.[112] The low-yield SLBM warhead, deployed in 2020, is an important component of America's ability to deter regional aggression against its Asian and NATO allies. However, the Biden Administration has proposed canceling the SLCM-N, a capability that could be deployed directly to regional theaters of conflict to help assure our allies.[113] The Biden Administration had rejected a declaratory policy of "no first use" or "sole purpose," which would have made allies uneasy over U.S. extended deterrence commitments, but only after significant pressure from them.[114]

The score for allied assurance remains "strong," especially as the United States remains committed to modernizing its own nuclear deterrent and rejects calls to reduce its nuclear forces unilaterally, but is at risk of weakening. The increasing regional threats combined with the Biden Administration's consideration of a "no first use" policy and proposal to cancel SLCM-N could be creating concern about U.S. extended deterrence commitments. The United States will need to make concerted efforts to strengthen its commitments to extended deterrence to reflect the change in threat, both through its capabilities and by communicating resolve, if this score is to remain unchanged in future editions of this *Index*.

Overall U.S. Nuclear Weapons Capability Score: Strong but Trending Toward Marginal or Weak

The scoring for U.S. nuclear weapons must be considered in the context of a threat environment that is significantly more dangerous than it was in previous years. Until recently, U.S. nuclear forces needed to address one nuclear peer rather than two. Given the reassurances from senior leaders of the readiness and reliability of U.S. nuclear forces, as well as the strong bipartisan commitment to modernization of the entire nuclear enterprise, this year's chapter retains its grade of "strong," but only for now.

U.S. nuclear forces face many risks that without this continued commitment to a strong deterrent could warrant an eventual decline to an overall score of "marginal" or "weak. The reliability of current U.S. delivery systems and warheads is at risk as they continue to age and the threat continues to advance. The fragility of "just in time" replacement programs only exacerbates this risk. In fact, nearly all components of the nuclear enterprise are at a tipping point with respect to replacement or modernization and have no margin left for delays in schedule. Since every other military operation—and therefore overall national defense—relies on a strong nuclear deterrent, the United States cannot afford to fall short in fulfilling this imperative mission.

Additionally, future assessments will need to consider plans to adjust America's nuclear forces to account for the doubling of peer nuclear threats. While capacity was not assessed this year, it is clear that the change in threat warrants a reexamination of U.S. force posture and the adequacy of our current modernization plans.

Therefore, this portfolio retains its score of "strong," but failure to keep modernization programs on track while planning for a three-party nuclear peer dynamic could slowly lead to a decline in the strength of U.S. nuclear deterrence in future years.

U.S. Military Power: Nuclear

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Nuclear Stockpile				✓	
Delivery Platform Reliability				✓	
Warhead Modernization			✓		
Delivery Systems Modernization				✓	
Nuclear Weapons Complex			✓		
National Labs Talent			✓		
Allied Assurance				✓	
OVERALL				✓	

Endnotes

1. All of the past six confirmed Secretaries of Defense—including current Secretary of Defense Lloyd Austin—have affirmed U.S. nuclear deterrence as the department's number one mission.
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Missile Defense

Patty-Jane Geller

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

The Growing Missile Threat

Missiles remain a weapon of choice for adversaries who view them as cost-effective and symbols of power compared to other types of conventional weapons.[1] The number of states that possess missiles will continue to increase, as will the sophistication of these weapons, as modern technologies become cheaper and more widely available.

In 2022, North Korea intensified its missile testing efforts, conducting its first test of an intercontinental ballistic missile (ICBM) since 2017 in addition to tests of several shorter-range missiles and even a hypersonic missile capable of maneuvering during flight.[2] These tests allow Pyongyang to keep improving and adapting its missile program and by so doing add to an already formidable threat. North Korea also continues to advance its ability to overcome missile defenses, including those that protect the United States, with missiles that supposedly can carry multiple warheads and decoys.[3]

Iran continues to modernize and proliferate its regional missile systems. Its recent launches of solid-fuel rockets demonstrate that Iran has the ability to build and successfully launch sophisticated missiles, which implies in turn that it has or is developing the ability to advance to an ICBM capability.[4]

China and Russia, in addition to their vast ballistic missile inventories, are investing in new ground-launched, air-launched, and sea-launched cruise missiles that uniquely challenge the United States in different domains and are deploying new hypersonic glide vehicles.[5] China is rapidly building hundreds of new missiles, including modern ICBMs that can carry multiple warheads and theater-range missiles that can strike U.S. assets with precision.[6] Russia is developing entirely new capabilities, such as a nuclear-powered cruise missile, that are intended to avoid U.S. sensors and missile defenses. It has employed its Kinzhal hypersonic missile for the first time in Ukraine.[7] Russia's conventionally armed sea-launched and air-launched cruise missiles can strike strategic nodes within the U.S. homeland, even from Russian territory, and China is developing a long-range conventional strike capability of its own.[8]

The Strategic Role of Missile Defense

Missile defense plays a critical role both in deterring an attack and in mitigating the damage to U.S. forces, infrastructure, and population centers in the event deterrence fails. The ability to deter an attack depends on convincing the adversary that the attack will fail, that the cost of carrying out a successful attack is prohibitively high, or that the consequences will outweigh the perceived benefit of an attack. A U.S. missile defense system strengthens deterrence by offering a degree of protection to U.S. populations, military forces, and allies, making it harder for an adversary to threaten them with missiles. By raising the threshold for missile attack, missile defense can complicate an adversary's planning, remove the option for a "cheap shot" against the United States and its allies, and perhaps make the adversary think twice before launching an attack. By protecting key

U.S. assets, missile defense also mitigates an adversary's ability to intimidate or coerce the United States into making concessions.

Missile defense systems help to enable U.S. and allied conventional operations. During a regional conflict, adversaries could deny the United States the ability to conduct offensive operations by targeting U.S. and allied forward-deployed personnel or military assets. In addition, they might try to decouple the United States from defense of its allies by threatening to strike U.S. forces or the U.S. homeland if the United States intervenes in a regional conflict. Missile defenses can therefore strengthen the credibility of U.S. extended deterrence by making it easier for the U.S. military to introduce reinforcements that can move more freely through a region.

A missile defense system gives decision-makers more time to choose the most de-escalatory course of action. Without the ability to defend against an attack, U.S. authorities would be limited to an unappealing set of responses that could range from preemptive attacks to acceding to an enemy's demands or actions. By assuring some level of protection, robust missile defense systems would affect the dynamics of decision-making by removing the need to take immediate action. Missile defense can therefore be profoundly stabilizing.

Finally, missile defense minimizes damage if deterrence fails. A strong missile defense system would not only help to protect countless American lives; it would also help to keep U.S. forces available during a fight. During a campaign against China in the Indo-Pacific, for example, missile defenses deployed in the region could lower the loss rate for U.S. forces compared to the rate of replacement, thereby extending the war effort and giving U.S. forces more time to prevail.

The U.S. Missile Defense System

The U.S. missile defense system has three critical physical components:

- Sensors,
- Interceptors, and
- Command and control infrastructure that provides data from sensors to interceptors.

Of these, interceptors receive much of the public's attention because of their visible and kinetic nature. Components of missile defense systems can be classified based on the phase of flight during which intercept occurs, although some—for example, the command and control infrastructure or radars—can support intercepts in various phases of flight. Interceptors can shoot down an adversary ballistic missile in the boost, ascent, midcourse, or terminal phase of its flight. As cruise missiles and hypersonic glide vehicles continue to proliferate, the Missile Defense Agency (MDA) and the military services must therefore consider intercept in the boost, glide, or terminal phase of flight.

Another way to classify missile defense systems is by the range of an incoming missile (short-range, medium-range, intermediate-range, or intercontinental-range) that an interceptor is designed to shoot down. An interceptor's flight time determines both the time available to conduct an intercept and the optimal interceptor placement to improve intercept probability. With ICBMs, the United States has "30 minutes or less"[9] to detect the missile, track it, provide the information to the missile defense system, find the optimal firing solution, launch an interceptor, and shoot down the incoming missile, ideally with enough time to fire another interceptor if the first attempt fails. The time frame is shorter for intercepting short-range, medium-range, and intermediate-range ballistic missiles.

Finally, missile defense can be framed by the origin of interceptor launch. At present, U.S. interceptors are launched from the ground or from the sea. In the past, the United States explored possible ways to launch interceptors from the air or from space, but such efforts have been limited since the U.S. withdrawal from the Anti-Ballistic Missile Treaty in 2002.[10]

The current U.S. missile defense system is a result of investments made by successive U.S. Administrations. President Ronald Reagan envisioned the program—the Strategic Defense Initiative (SDI)—as a layered ballistic missile defense (BMD) system that would render nuclear missiles "impotent and obsolete."[11] These layers would have boost, ascent, midcourse, and terminal interceptors, including directed-energy interceptors, providing the United States with more than one opportunity to shoot down an incoming missile.

The United States stopped far short of this goal even though the SDI program generated tremendous technological advances and benefits.[12] Instead

MAP 18

U.S. Missile Defense Assets

GBI—Ground-based interceptors
GFC—Fire control center
GMD—Ground-based midcourse defense
IDT—In-Flight Interceptor Communications System (IFICS) Data Terminal
TPY-2—Transportable Radar Surveillance and Control Model 2
UEWR—Upgraded early warning radar

1. **Shemya, AK**
   - Cobra Dane radar
   - IDT
2. **Pearl Harbor, HI (base)**
   - Sea-based X-Band radar
3. **Clear, AK**
   - UEWR
4. **Ft. Greely, AK**
   - 40 GBIs
   - GMD
   - GFC
   - IDT
5. **Vandenberg AFB, CA**
   - 4 GBIs
   - 2 IDTs
6. **Beale AFB, CA**
   - UEWR
7. **Schriever AFB, CO**
   - GFC
8. **Ft. Drum, NY**
   - IDT
9. **Cape Cod, MA**
   - UEWR
10. **Thule, Greenland**
    - UEWR
11. **Fylingdales, UK**
    - UEWR
12. **Rota, Spain (base)**
    - Sea-based Aegis BMD SPY-1 radar
13. **Kurecik AFB, Turkey**
    - TPY-2 radar
14. **Israel**
    - TPY-2 radar
15. **CENTCOM-Middle East**
    - TPY-2 radar
16. **Shariki, Japan**
    - TPY-2 radar
17. **Kyogamisaki, Japan**
    - TPY-2 radar
18. **Outer space**
    - Defense support program satellites
    - Space-based infrared system satellites
    - Space-based kill assessment sensors

NOTE: Locations are approximate.

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of a comprehensive layered system, the United States has no boost-phase ballistic missile defense systems and no defense against the advanced ballistic missile threats from China or Russia. The volatility and inconsistency of priority and funding for missile defense by successive Administrations and Congresses—Administrations and Congresses controlled by *both* major political parties—have yielded a system that is limited both numerically and technologically and incapable of defending against more sophisticated or more numerous long-range missile attacks.

The National Missile Defense Act of 1999 made it U.S. policy to protect the homeland only from a "limited ballistic missile attack."[13] The National Defense Authorization Act (NDAA) for Fiscal Year 2017 dropped the word "limited" even as it continued to focus on ballistic missiles.[14] Then the 2020 NDAA made it a matter of policy to rely on nuclear deterrence to defend against "near-peer intercontinental missile threats" and focus on improving missile defense against "rogue states."[15] In the future, as technological trends progress and modern technologies become cheaper and more widely available, North Korean or Iranian ballistic missiles may rival—in sophistication if not in numbers—those of Russia or China. Consequently, the United States must remain aware of how such threats are evolving and be prepared to alter its missile defense posture accordingly.

In January 2019, the Trump Administration published its congressionally mandated Missile Defense Review (MDR), a statement of policy intended to guide the Administration's missile defense programs. The 2019 MDR addresses the dangerous threat environment that has evolved since the previous MDR in 2010 and recognizes that future missile defense systems must defend against cruise and hypersonic missiles in addition to ballistic missiles.[16] The Biden Administration completed its MDR in 2022 but has not yet released the document to the public.

For fiscal year (FY) 2023, the Biden Administration has requested $9.6 billion for the MDA,[17] a decrease from the $10.3 billion finally agreed upon for FY 2022.[18]

Interceptors

Interceptors are one major component of the U.S. missile defense system. Different types of interceptors that respond to different missile threats have been emphasized over the years, and the composition of today's U.S. missile defense reflects these choices.

While the United States is working to improve its ability to strike down cruise missiles and hypersonic glide vehicles, the primary mission of its fully operational missile defense systems today is to intercept ballistic missiles. Missile defense interceptors are designed to intercept ballistic missiles in three different phases of flight.

- **The boost phase** extends from the time a missile is launched from its platform until its engines stop thrusting.
- **The midcourse phase** is the longest and thus offers a unique opportunity to intercept an incoming threat and, depending on other circumstances like the trajectory of the incoming threat and quality of U.S. tracking data, a second shot if the first intercept attempt fails.
- **The terminal phase** is less than one minute long, occurring as the missile plummets through the atmosphere toward the target, and offers a very limited opportunity to intercept a ballistic missile threat.

Boost-Phase Interceptors. The United States currently has no capability to shoot down missiles in their boost phase. Technologically, boost-phase intercept is the most challenging option because of the very short time during which a missile is boosting, the missile's extraordinary rate of acceleration during this brief window of time, and the need to have the interceptor close to the launch site.[19] This phase, however, is also the most beneficial time to strike. A boosting ballistic missile is at its slowest speed compared to other phases; it is therefore not yet able to maneuver evasively and has not yet deployed decoys that complicate the targeting and intercept problem.

In the past, the United States pursued several boost-phase programs, including the Airborne Laser, the Network Centric Air Defense Element, the Kinetic Energy Interceptor, and the Air Launched Hit-to-Kill missile. Each of these programs was eventually cancelled because of technical, operational, or cost challenges, and the United States has not progressed significantly on any boost-phase program since then.

Midcourse-Phase Interceptors. Intercepting missiles in their midcourse phase offers more time for intercept and presents fewer technological challenges than intercept in the boost phase presents, but it also allows the missile time to deploy decoys and countermeasures that can complicate interception by confusing sensors and radars. The United States deploys two systems that can shoot down incoming missiles in the midcourse phase of flight:

- The Ground-Based Midcourse Defense (GMD) system and
- The Aegis defense system.

The Ground-Based Midcourse Defense system is the only operational system capable of shooting down a long-range ballistic missile headed for the U.S. homeland. It consists of 40 Ground-Based Interceptors (GBIs) at Fort Greeley, Alaska, and four at Vandenberg Air Force Base, California. A GBI consists of a multi-staged rocket booster and an Exoatmospheric Kill Vehicle (EKV), which intercepts the incoming missile with hit-to-kill technology. In September 2021, the MDA "demonstrated the capability to select a 2-stage or 3-stage burn of a Ground Based Interceptor (GBI) booster, which enables an earlier release of the kill vehicle to greatly expand the engagement area and time to counter the inbound threat."[20]

To increase the probability of an intercept, the United States has to shoot multiple interceptors at each incoming ballistic missile. At present, because its inventory of interceptors is limited, the United States can shoot down only a handful of ballistic missiles that have relatively unsophisticated countermeasures.

In 2017, Congress approved a White House request to increase the number of GBIs from 44 to 64 to keep up with the advancing ballistic missile threat, particularly from North Korea.[21] The MDA intended to produce a Redesigned Kill Vehicle (RKV) to top 20 additional GBIs that would fill the new silos, but this program was canceled in 2019 because of technological difficulties.[22] The MDA instead initiated the Next Generation Interceptor (NGI) program to build an entirely new interceptor that would add both capacity and capability to the GMD system. NGIs will begin to fill the 20 empty silos around 2028 and could eventually replace some or all of the existing 44 GBIs. Unlike the GBIs, the NGI will feature multiple kill vehicles, enabling a single NGI to shoot at multiple objects ejected from one incoming missile.[23]

Contracts to develop the NGI were awarded to Lockheed Martin and a Northrop Grumman–Raytheon team in March 2021.[24] The FY 2023 budget request includes $1.766 billion for NGI to support these two competing designs through Critical Design Review in FY 2025.[25]

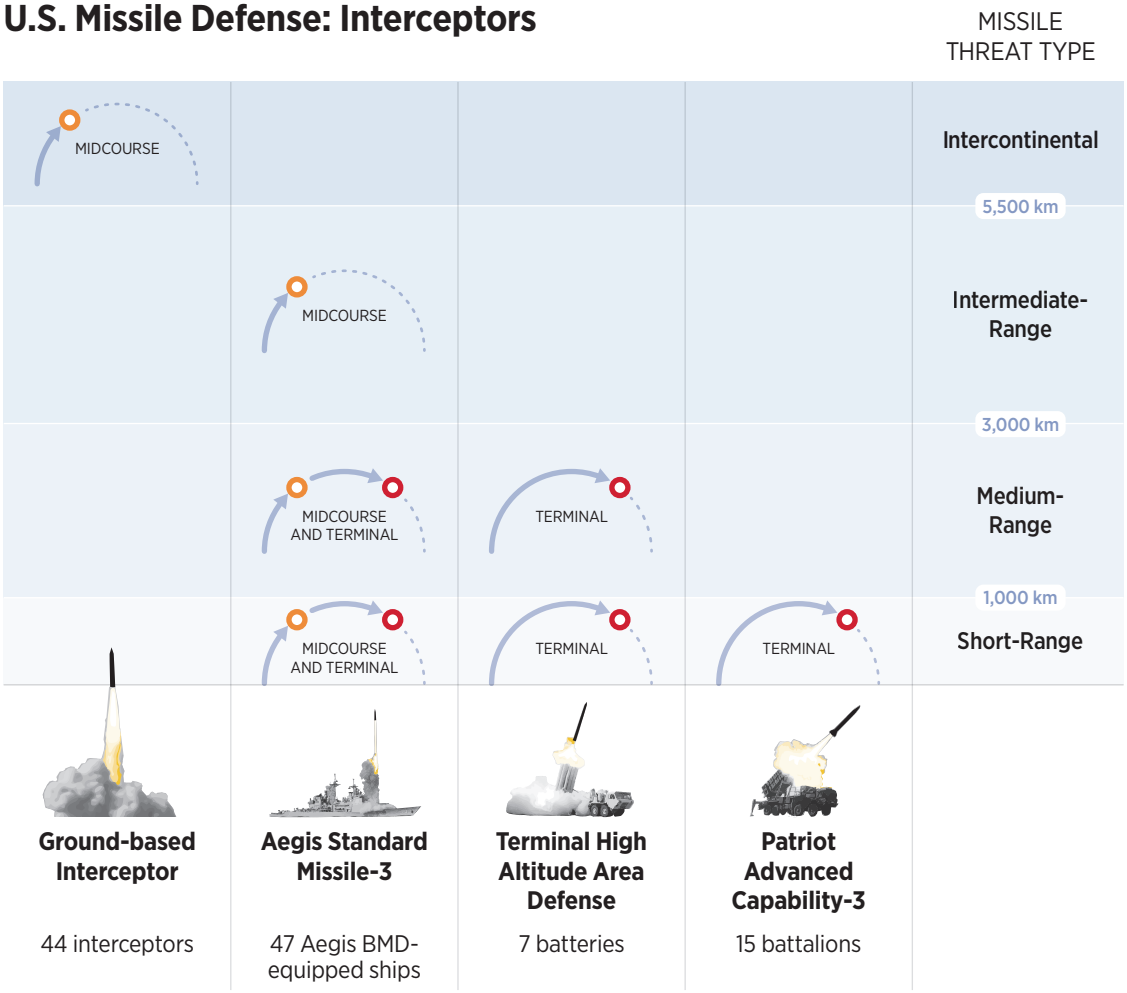
The Aegis defense system is a sea-based component of the U.S. missile defense system. It is designed to address the threat of short-range, medium-range (1,000–3,000 kilometers), and intermediate-range (3,000–5,500 kilometers) ballistic missiles. It utilizes different versions of the Standard Missile-3 (SM-3) and SM-6 depending on the threat and other considerations like ship location and quality of tracking data. The Aegis system also has capability against aerial threats and cruise missiles.[26] According to the FY 2023 budget submission, the number of BMD-capable Navy Aegis ships should increase to 50 by the end of FY 2023.[27] Japan also has several Aegis BMD-capable destroyers and cooperated with the United States to develop the latest SM-3 missile, the SM-3 Block IIA.[28]

The United States also deploys a land-based version of Aegis, called the Aegis Ashore system, in Romania, and another is nearing completion in Poland. Aegis Ashore sites relieve some of the stress on the naval fleet because BMD-capable cruisers and destroyers are multi-mission and are used for other purposes, such as wartime fleet operations and even anti-piracy operations. These Aegis Ashore sites help to protect U.S. allies and forces in Europe from the Iranian ballistic missile threat.

Aegis BMD will also play a significant role in the development of a missile defense system on the U.S. territory of Guam. Former Commander of U.S. Indo-Pacific Command (INDOPACOM) Admiral Philip Davidson has testified that "the most important action we can take to increase the joint force's lethality [in the region] is to introduce a 360-degree, persistent, air and missile defense capability on Guam (Guam Defense System (GDS))."[29] Current INDOPACOM Commander Admiral John Aquilino testified in March 2022 that "Guam's strategic importance is difficult to overstate" and emphasized "the importance of the island for sustaining the joint force as our main operating base and home to 130,000

FIGURE 5

U.S. Missile Defense: Interceptors



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Americans."[30] The FY 2023 budget request includes a total of $892 million to continue development of an architecture for Guam defense and to begin procurement of needed components, including SM-3, SM-6, and Aegis fire control components.[31]

In November 2020, the U.S. Navy and the MDA shot down an intercontinental-range ballistic missile using the SM-3 interceptor class Block IIA against an ICBM target.[32] The test, FTM-44, was the first step in a plan to use SM-3 Block IIAs as an "underlay" to the GMD system to defend the homeland, with GBIs taking the first shot at an incoming target and SM-3 interceptors taking a second shot if the GBIs miss.[33] The MDA had initially planned to test the SM-3 IIA against a more complicated ICBM as the next step. However, the budget request for FY

2023 eliminates funds to pursue the SM-3 IIA as a homeland underlay.[34]

Terminal-Phase Interceptors. The United States currently deploys three terminal-phase missile defense systems:

- Terminal High Altitude Area Defense (THAAD);
- The Patriot missile defense system; and
- Aegis BMD.

A THAAD battery can shoot down short-range and intermediate-range ballistic missiles inside and just outside of the atmosphere.[35] It consists of a launcher, interceptors, the Army Navy/Transportable Radar Surveillance and Control Model 2 (AN/TPY-2) radar, and fire control.[36] The system is transportable and rapidly deployable. THAAD batteries have been deployed to such countries as Japan, South Korea, Israel, and the United Arab Emirates (UAE), and the U.S. signed a deal in 2020 to deliver THAAD to Saudi Arabia.[37] THAAD was employed successfully to intercept missiles for the first time in the UAE in February 2022.[38]

Patriot is an air-defense and short-range ballistic missile defense system. A battery is comprised of a launcher, interceptors, AN/MPQ-53/65 radar, an engagement control station, and diesel-powered generator units. The Patriot family of missile defense interceptors has been upgraded over time, from the initial Patriot Advanced Capability-1 (PAC-1) deployed in Europe in 1988 to the PAC-3 configuration deployed around the world today. The most recent Patriot upgrade, the PAC-3 Missile Segment Enhancement, expands the lethal battlespace with an advanced solid rocket motor.[39] The system is transportable, and the United States currently deploys it in several theaters around the world.[40]

Assessment. Interceptor strength is difficult to assess because, while deploying more interceptors to increase capacity or defend more targets is always preferable, deploying more short-range to medium-range interceptors to unprotected locations or increasing interceptor capacity ad infinitum is simply not feasible. Congress provided funding in FY 2022 to procure additional SM-3 Block IIA, PAC-3, and THAAD interceptors.[41] The FY 2023 budget would continue this effort for PAC-3 interceptors and continue funding for the eighth THAAD battery, but it would reduce procurement for THAAD and SM-3 IIA interceptors.[42]

To increase the defended battlespace, the MDA is pursuing the Patriot Launch-on-Remote (THAAD) capability, which integrates the PAC-3 and THAAD systems by enabling a PAC-3 launch using a THAAD AN/TPY-2 radar. Launch-on-Remote is a significant capability that can increase the defended area by spreading out missiles.[43] After two failed tests for the capability in 2020, the MDA, in conjunction with the Army, conducted two successful tests early in 2022.[44] The Army plans to field this capability "across all Patriot battalions beginning in Fiscal Year 2023."[45]

Progress on building a Guam defense system has moved slowly compared to the urgency of the Chinese threat.[46] Even though this missile defense system first appeared on the INDOPACOM Unfunded Priorities List in 2019, the President requested and Congress first provided funding for the system only in FY 2022.[47] Even so, the $192 million that was appropriated fell far short of the $350 million requested by INDOPACOM for that year.[48] However, the FY 2023 budget request includes $892 million "for the Missile Defense Agency, the Army, and the Navy to develop and field missile defense capabilities" that would "augment the existing Terminal High Altitude Area Defense (THAAD) battery currently emplaced on the island...and bolster U.S. military posture in the Indo-Pacific region."[49]

The Commander of U.S. Northern Command (NORTHCOM), General Glen VanHerck, recently testified that "[w]hile current BMD capability and capacity is sufficient to defeat a limited ballistic missile attack from a rogue nation, North Korea's ongoing development of increasingly complex and capable strategic weapons requires the Next Generation Interceptor to be fielded on time or early."[50] The increasing capacity of North Korea's ballistic missiles to strike the U.S. homeland and North Korea's ability to deploy decoys cause concern that the rogue state may eventually be able to overwhelm the current GMD system.[51]

Following a delay in awarding the NGI contract, the program appears to be on track for an initial fielding in 2028 if not 2027.[52] NGI will add needed capacity and capability to the GMD system. In addition to accelerating the NGI program, the MDA and Congress continue to support a GMD service life extension program (SLEP) that is intended to

maintain the existing fleet through this decade and beyond 2030. Given that NGI will not replace the existing GBI fleet—at least not initially—it is critical that the existing interceptors can remain in service. The GMD system was largely built in the early 2000s, and many parts—including the GBI kill vehicles, boosters, and ground systems—are subject to degradation from aging. The SLEP, for instance, will include the delivery of five new boosters to ensure that the number of interceptors does not decrease, and it is essential that this effort to avoid a decrease in capacity continues.[53] The MDA will also need to consider additional NGI purchases after the initial 20 to begin replacing existing GBIs in the 2030s.

In 2019, to strengthen homeland missile defense after the RKV was canceled and before NGI comes online, the Trump Administration proposed the development of an underlay using SM-3 Block IIA and THAAD interceptors. General VanHerck agreed to the value of an underlay in 2021, stating that "an underlayer would give us additional capacity and capability" to address threats to the homeland.[54] The MDA had progressed toward this underlay after its successful test of the SM-3 IIA against an ICBM target in 2020, but the Department of Defense (DOD) had not articulated a concept of operations for employing the SM-3 Block IIA and THAAD for homeland defense, including where in the United States those systems could be deployed or how many would be required, as requested by Congress. The budget request for FY 2023 eliminates all funding for the layered homeland defense program.

While the MDA is investing both in the GMD SLEP and the NGI program to ensure defense of the homeland, forgoing a homeland underlay will deprive the homeland of added capacity against an uncertain North Korean threat. The utility of exploring the use of SM-3 and THAAD interceptors for ICBMs can also extend beyond an underlay for the continental United States, as they can work for other missions or defended assets like Hawaii, Alaska, and Guam as well. Using SM-3 and THAAD interceptors to defend against ICBMs could still be advantageous for the United States, but it would require a commitment to move quickly that neither the DOD nor Congress has demonstrated.

Currently, the only interceptor the United States has available to intercept hypersonic missiles is the SM-6.[55] To strengthen U.S. capability against maneuverable hypersonic missiles, the MDA is in the early stages of developing the Glide Phase Interceptor (GPI), which is designed to intercept regional hypersonic missiles in their glide phase of flight. In 2021, the MDA awarded Other Transaction Authority (OTA) agreements to Lockheed Martin, Northrop Grumman, and Raytheon to develop design concepts for the GPI.[56] For FY 2022, Congress added $39.9 million to the MDA's requested amount of $247.9 million for hypersonic defense,[57] and the FY 2023 budget request includes $225.5 million for the program.[58]

The Army's Indirect Fire Protection Capability Increment 2 (IFPC 2) program has been moving very slowly but has seen recent improvement. The IFPC 2 would defend against short-range rockets, artillery, and mortars as well as cruise missiles, against which the United States, as noted, lacks a sufficient defensive capability.[59] As a system, IFPC would fill the gap between short-range tactical air defense and ballistic missile defense like PAC-3 and THAAD.

In response to a congressional requirement that it field an interim cruise missile defense capability in response to the increasing cruise missile threat, the Army purchased two Iron Dome batteries manufactured by the Israeli company Rafael.[60] Despite prior concerns about integrating Iron Dome as part of an enduring IFPC solution, the Army is preparing the Iron Dome systems for operational deployment and integration into its future missile defense command and control system.[61] In 2021, the Army deployed Iron Dome to Guam and conducted a successful simulation to test the system.[62] However, no evidence indicates that Iron Dome will be integrated into the Guam defense system that is under development. In September 2021, the Army awarded a contract to Dynetics to develop its own enduring IFPC 2 system, which is scheduled to reach combat capability in FY 2023.[63]

Overall, the United States has multiple capable interceptors, but there is much room for improvement. The most important step for the near future will be on-time or early delivery of the NGI to ensure protection of the homeland from North Korea and to mitigate the growing threat from China.

Sensors

The sensor component of the U.S. missile defense system is distributed across the land, sea, and space domains and provides the United States and its allies with the earliest possible warning of a launch of

enemy missiles in addition to missile tracking and discrimination. These sensors can detect a missile launch, track a missile in flight, and even classify the type of projectile, its speed, and the target against which the missile has been directed. They relay this information to the command and control stations that operate interceptor systems like Aegis (primarily a sea-based system) or THAAD (a land-based system).

Land-Based. On land, the major sensor installations are the upgraded early warning radars (UEWRs), which are concentrated along the North Atlantic and Pacific corridors that present the most direct flight path for a missile aimed at the United States. They include the phased array early warning radars based in California, the United Kingdom, and Greenland that scan objects up to 3,000 miles away.[64] Two additional sites—one in Cape Cod, Massachusetts, and the other in Clear, Alaska—have been modernized for use in the layered ballistic missile defense system after facing delays.[65] These sensors focus on threats that can be detected in the missile's boost or launch phase when the release of exhaust gases creates a heat trail that is relatively easy for sensors to detect. A shorter-range (2,000-mile) radar called the Cobra Dane is based in Shemya, Alaska.[66]

The United States also deploys mobile land-based sensors called AN/TPY-2s. These sensors can be forward deployed for early threat detection or kept in terminal mode to provide tracking and fire control support for the THAAD interceptors.[67] Of the United States' 12 AN/TPY-2 systems, five are forward deployed with U.S. allies.[68] The United States plans to field a 13th AN/TPY-2 radar in FY 2025 for service with the eighth THAAD battery.[69] In cooperation with the Republic of Korea, the United States deploys a THAAD missile system accompanied by an AN/TPY-2 on the Korean Peninsula.

To fill a gap in missile discrimination capability for tracking North Korean missiles over the Pacific, the MDA is developing the Long Range Discrimination Radar (LRDR) in Northern Alaska to improve coverage in the northern Pacific. The LRDR utilizes the SPY-7 radar, which the MDA will also purchase for the Guam defense system.[70] The DOD had also identified the need to develop the Homeland Defense Radar–Hawaii (HDR–H) to fill a tracking and discrimination gap over Hawaii. The Trump Administration's FY 2021 budget request omitted funding for HDR–H because of budget constraints, as did the Biden Administration's request for FY 2022. In both years, Congress provided the funding needed to proceed with the radar, and in FY 2022, it mandated that future budget requests must include adequate funding to build and operate the HDR–H by 2028.[71] However, the FY 2023 budget request again excludes funding for the HDR–H.[72]

Sea-Based. There are two types of sea-based sensors. The first is the Sea-Based X-band (SBX) radar, which is mounted on an oil-drilling platform and can be relocated to different parts of the globe as threats evolve.[73] SBX is employed primarily in the Pacific. The second radar is the SPY-1 radar system, which is mounted on U.S. Navy vessels equipped with the Aegis Combat System and therefore is able to provide data that can be utilized for ballistic missile missions. The Navy is replacing all SPY-1 radars with the SPY-6 radar, which will have a greater detection range and other advanced capabilities.[74]

Space-Based. Finally, U.S. missile defense sensors operate in space. From the ultimate high ground, space-based sensors have the potential to detect and track missile launches from almost any location from boost to terminal phase, unlike ground-based radars that are limited in their tracking range.[75] The MDA, the U.S. Space Force, and the Space Development Agency (SDA) all control aspects of the space missile defense sensor system.

The oldest system that contributes to the missile defense mission is the Defense Support Program (DSP), a constellation of satellites that use infrared sensors to identify heat from booster and missile plumes to detect an initial launch. The DSP satellite system has gradually been replaced by the Space-Based Infrared Radar System (SBIRS) to improve the delivery of missile defense and battlefield intelligence.[76] For instance, SBIRS can scan a wide swath of territory while simultaneously tracking a specific target, making it a useful means for observing tactical, or short-range, ballistic missiles.[77]

The Space Force launched the sixth and final SBIRS satellite in August 2022.[78] The Air Force originally planned to launch eight SBIRS satellites, but because of congressional funding delays, it decided to end production of SBIRS early and move on to development of its replacement, the Next-Generation Overhead Persistent Infrared (Next-Gen OPIR) satellite, in 2017.[79] The seventh and eighth SBIRS satellites will be switched to Next-Gen OPIR satellites, the first of which is to be delivered "no later

than FY 2025."[80] The Next-Gen OPIR satellites are designed to be more survivable against cyber and electronic attacks.

The MDA also has developed and deployed Space-based Kill Assessment (SKA) sensors on commercial satellites.[81] SKA uses a network of infrared sensors to provide a hit and kill assessment of homeland defense intercepts. After several years of successful testing of SKA sensors in orbit, the FY 2023 budget supports integrating SKA into the homeland defense system.[82]

The United States is developing a system of satellites capable of providing global detection, tracking, and discrimination of any missile launch. Dating back as far as President Reagan's Strategic Defense Initiative, successive Administrations have called for a proliferated layer of sensing satellites in space to track the flight of any type of missile—not just ballistic—from birth to death. A layer of space-based sensors can be particularly useful in tracking hypersonic vehicles, which fly at lower altitudes than ballistic missiles and can maneuver during flight. The DSP and SBIRS systems were designed for ballistic missiles and can lose track of missiles flying at lower altitudes. Since many new threats are not flying on ballistic trajectories, Congress has been paying close attention to development of this space sensor layer.

Beginning in 2009, the MDA operated two Space Tracking and Surveillance System-Demonstrators (STSS-D) satellites in an effort to demonstrate this capability to track ballistic missiles that exit and reenter the Earth's atmosphere during the mid-course phase.[83] Data obtained by those demonstration satellites were used to provide risk reduction to support future space trackers. Both satellites were decommissioned in March 2022.[84] Today, the SDA, in conjunction with the MDA, is developing a space Tracking Layer of satellites proliferated in Low-Earth Orbit (LEO) as part of the SDA's National Defense Space Architecture. According to the SDA:

> Once fully operational, the SDA Tracking Layer will consist of a proliferated heterogeneous constellation of Wide Field of View (WFOV) space vehicles (SVs) that provide persistent global coverage and custody capability combined with the Missile Defense Agency (MDA) Hypersonic and Ballistic Tracking Space Sensor (HBTSS) Medium Field of View (MFOV) SVs that provide precision global access capability.[85]

Once deployed, the Tracking Layer will be able to detect, track, and discriminate among any types of missile launch throughout the entirety of the missile's flights, including both hypersonic glide vehicles and dimmer ballistic missile targets. The SDA is also exploring the ability of space sensors to provide fire control information directly to weapon platforms like THAAD or Aegis (as opposed to the data going through a ground station).

In FY 2022, Congress provided $256 million to the MDA for the HBTSS. In 2021, the MDA awarded contracts to Northrop Grumman and L3Harris to develop HBTSS prototypes, which are on track to launch in FY 2023. The budget request for FY 2023 includes $89.2 million for this effort.[86] Congress also added $550 million in FY 2022 for the SDA's tracking layer. The first eight satellites as part of Tranche 0 are projected to launch in 2023.[87] The SDA is also working to award a contract for Tranche 1 satellites to launch in 2025.[88]

Assessment. Senior defense leaders have stated repeatedly that deploying sensor satellites to space to track missiles from the high ground throughout their entire flight is the best way to advance sensor capability. According to Admiral Charles Richard, Commander of U.S. Strategic Command (STRATCOM):

> Future space-based sensors may be able to provide birth-to-death detection, tracking, and discrimination of hypersonic glide vehicle, cruise missile, and ballistic missile threats globally. These abilities cannot be fully achieved with the current or future terrestrial-based radar architecture due to the constraints of geography and characteristics of future missile threats.[89]

Initially, the space-based sensor program was plagued by insufficient funding requests and bureaucratic infighting over whether the SDA or the MDA would develop the HBTSS.[90] Since then, clear roles for the SDA and MDA have been defined, contracts for the HBTSS have been awarded, and the SDA's Tracking Layer has progressed steadily. A strong assessment of missile defense sensing capabilities will depend on progress made on the space-based sensor effort, especially in view of commanders' urgent need for improved missile tracking as well as the technological challenges associated with developing a sensor that can perform in LEO.[91]

Development of land-based sensors to fill the missile discrimination capability gap over the Pacific has progressed slowly. Development of the LRDR has been delayed by at least a year.[92] The HDR-H project continues to face an uncertain future: Congress provides appropriations for the program, but the DOD does not include it in its budget request despite explicit congressional direction to do so. This way of funding a program that was originally proposed to fill a discrimination gap over Hawaii is problematic, as the DOD and Congress have never resolved their differences over the need for this capability.

Improved sensor capabilities are also critical to addressing the cruise missile threat to the homeland. As noted previously, the United States has no dedicated missile defense system to counter this threat. Due to their low-trajectories, cruise missiles are more difficult to detect and track than are ballistic missiles. Russia's ability to strike key strategic nodes in the U.S. homeland from its own territory is of particular concern. To address the cruise missile threat, General VanHerck has emphasized improving domain awareness, because early identification of a threat allows for options like left-of-launch operations or diplomacy to avoid having to shoot down cruise missiles inside the U.S.[93]

The MDA included $11 million in the FY 2023 budget request (down from $14 million in FY 2022) to develop an architecture for cruise missile defense of the homeland. In 2021, General VanHerck requested funding for a new elevated sensor to help detect cruise missiles aimed at Washington, D.C.[94] The NORTHCOM unfunded priorities lists for both FY 2022 and FY 2023 include additional funding for a cruise missile defense homeland kill chain demonstration.[95] Developing a capability to detect, track, and eventually intercept a conventional cruise missile attack will be critical to denying adversaries the ability to hold the homeland at risk below the nuclear threshold.

The Next-Gen OPIR program appears to remain on schedule after early delays, and the FY 2023 budget request continues to fund the program. It also includes funding for several LEO and Medium Earth Orbit satellites to enhance missile warning capabilities.[96] The Army is also progressing quickly on development of the Lower-Tier Air and Missile Defense System radars that will provide 360-degree threat coverage for PAC-3 and other regional missile defense batteries; the current Patriot radar can scan only one-third of the sky at a time.[97]

The space-sensor project is now on track compared to previous years. It is important that land-based radar coverage moves forward to stabilize the future sensor architecture.

Command and Control

Command and control of the U.S. ballistic missile defense system requires bringing together data from U.S. sensors and radars and relaying those data to interceptor operators so that they can destroy incoming missiles directed against the U.S. and its allies. The operational hub of missile defense command and control is the Joint Functional Component Command for Integrated Missile Defense (JFCC IMD), a component of STRATCOM housed at Schriever Air Force Base, Colorado. JFCC IMD brings together Army, Navy, Marine Corps, Space, and Air Force personnel and is co-located with the MDA's Missile Defense Integration and Operation Center (MDIOC). This concentration of leadership from across the various agencies helps to streamline decision-making for those who command and operate the U.S. missile defense system.[98]

Command and control of the GMD system to defend the homeland utilizes the Ground-based Midcourse Defense Fire Control (GFC) system, which consists of a suite of hardware, software, and personnel located in Fort Greely, Alaska, and Vandenberg Air Force Base, California.[99] The system involves collecting data on missile movement from sensors and radars to inform the launch of GBIs.

Once a missile is launched, data from the U.S. global network of sensors and radars travel through secure satellite communications and ground-based redundant communications lines to the Command Launch Equipment (CLE) software that can task GBIs to fire at the incoming missile. Then, once the NORTHCOM Commander—who becomes the supported commander during GMD execution—in consultation with the President has determined the most effective response to a missile threat, the CLE fire response option is relayed to the appropriate GBIs in the field.[100] When the selected missiles have been fired, they maintain contact with In-Flight Interceptor Communications System (IFICS) Data Terminals (IDTs) to receive updated flight information that helps to guide them to their target.[101]

To prepare for and execute GMD operations, the NORTHCOM Commander can also utilize situational awareness data from the Command and Control, Battle Management and Communication (C2BMC) system. Through its software and network systems, C2BMC helps to process and integrate sensor information to provide a more complete picture of the battlespace.[102] The GMD Fire Control system acts as the primary decision aid for GMD execution, and the C2BMC system provides integrated battlefield awareness information before and during GMD operations.[103] It also provides information to other missile defense systems like THAAD and Patriot. Dozens of C2BMC workstations are distributed throughout the world at U.S. military bases.

C2BMC has undergone multiple technical upgrades (called spirals) since 2004 to bring more missile defense elements into the network. In 2019, the MDA completed an upgrade that will help to expand Aegis missile defense coverage by enabling Aegis Weapons Systems to engage on remote.

Regional missile defense systems like THAAD, PAC-3, and Aegis are equipped with their own individual fire control systems to control the launch of their interceptors. The C2BMC system can also provide tracking information to individual missile defense batteries from other regional sensors. Aegis BMD systems have onboard control governed by the Aegis Combat System, and they can provide their sensor data to the GMD system through C2BMC.[104]

C2BMC connects sensors and shooters around the world to a global network, but there is no comparable system to link sensors and shooters in a single region. The Army is developing the Integrated Air and Missile Defense (IAMD) Battle Command System (IBCS) to provide this capability. Once fielded, IBCS would connect all sensors and shooters in a region to a single fire control network.[105] Like IFPC, IBCS would also link defenses against smaller threats with ballistic missile defense.

Assessment. A strong global command and control system is critical to missile defense because linking information from sensors can increase domain awareness and the time available to engage a target, thereby improving the probability of intercept. In addition, according to General VanHerck, "[g]lobal all-domain awareness will generate a significant deterrent effect by making it clear that we can see potential aggressors wherever they are, which inherently casts doubt on their ability to achieve their objectives."[106] This concept is especially important in dealing with cruise missile threats to the homeland, against which the U.S. has no comprehensive interceptor capability.

Continuing to upgrade the C2BMC will remain critical to increasing the integration of missile defense elements across the world and therefore improving chances of intercept. For instance, it was revealed in 2021 that the MDA provided U.S. Indo-Pacific Command with a hypersonic missile defense capability, largely as a result of C2BMC improvements that allow sensors to see the threat sooner.[107] The MDA is nearing completion of another upgrade to incorporate the LRDR into C2BMC after a delay.[108] It also has linked C2BMC to the Army's IBCS, and the next round of upgrades will further integrate those systems as well as enhance the threat data provided to the GMD system.[109]

The United States will need a more advanced command and control capability as global missile threats shift to include cruise and hypersonic missiles in addition to ballistic missiles. The DOD is currently developing a Joint All Domain C2 (JADC2) system to integrate non-compatible sensors across all domains into a single network so that it can respond to the complex threat more efficiently. Missile defense command and control will strengthen as the services begin to field JADC2 capabilities.

In addition, NORTHCOM and the North American Aerospace Defense Command have conducted a series of Global Information Dominance Experiments (GIDE) that "provid[e] combatant commanders, intelligence and operations directors, and other participants at multiple sites with a shared, customizable, and near real-time data set" by collecting and integrating information from multiple sensors needed for decision-making and sending that information to commanders quickly.[110] Sensor information can tend to exist in stovepipes, and if it is not integrated, the result can be failure to detect a threat.[111] GIDE also uses artificial intelligence and machine learning cues to ensure that the commander receives a full data picture.[112]

IBCS will also provide an important improvement in regional missile defenses. The system will link all missile defense sensors and interceptors to one fire control center, as opposed to today's more stovepiped approach in which each unit operates its co-located sensor and launcher independently. By permitting air and missile defenses to function

as a joint kill web rather than as a linear kill chain, IBCS will be able to determine the best shooter to take down an incoming missile, in turn increasing the defended battlespace.

After an initial multi-year delay due to technical issues, the Army has awarded a production contract for IBCS to Northrop Grumman, and the program is now on its new schedule for full production by the end of 2022.[113] Advancements underway in missile defense command and control will become increasingly necessary to enable defense against the growing missile threat.

Conclusion

By successive choices of post–Cold War Administrations and Congresses, the United States does not have in place a comprehensive set of missile defense systems that would be capable of defending the homeland and allies from robust ballistic missile threats. U.S. efforts have focused on a limited architecture that protects the homeland and on deploying and advancing regional missile defense systems.

Although the United States has in place multiple types of capable interceptors, a vast sensor network, and a command and control system, many elements of the missile defense system need to be improved to defend against today's threat more efficiently. At the same time, the development of missile threats, both qualitative and quantitative, is outpacing the speed of missile defense research, development, and deployment to address those threats. Senior leaders continue to stress the importance of U.S. missile defense, but if the nation is to realize the strategic benefits that missile defense provides, Congress must ensure that the funding of critical programs like NGI, space sensors, and JADC2 is commensurate with that importance.

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Cyber Warfare and U.S. Cyber Command

James Di Pane

The world of cyber operations is notoriously secretive. Nevertheless, even a rudimentary understanding of the domain, the threats and opportunities associated with it, and the ability of the Department of Defense (DOD) to protect the U.S. from cyberattack and enable military operations against enemies is of the greatest importance. To supplement the concise overview of military cyber capabilities provided in this discussion, two essays, "National Defense and the Cyber Domain" and "The Reality of Cyber Conflict: Warfare in the Modern Age," from previous editions of the *Index of U.S. Military Strength* provide a wealth of information about the cyber domain and how it fits into the world of national defense.[1]

The vulnerability of allies and the private sector to cyberattacks can lead to complications for the military services that negatively affect the ability of the United States to sustain a war effort, thereby compromising our national security. But the need for cybersecurity goes beyond the Department of Defense alone. In the words of Kenneth P. Rapuano, former Assistant Secretary of Defense for Homeland Defense and Global Security:

> The increasingly provocative activities of key competitors, such as the NotPetya cyber operation conducted by Russia in February 2018, demonstrate how vulnerable the Department is to attacks against the many non-DoD-owned assets that are nevertheless critical to our ability to execute our missions. These assets include civilian ports, airfields, energy systems, and other critical infrastructure. Vulnerabilities in these areas will likely be targeted by our adversaries to disrupt military command and control, financial operations, the functioning of operationally critical contractors, logistics operations, and military power projection, all without ever targeting the comparatively well-protected DoD Information Network. Any large-scale disruption or degradation of national critical infrastructure represents a significant national security threat.
>
> To address these challenges, the DoD Cyber Strategy directs DoD to strengthen alliances and attract new partners to ensure that we are taking a whole-of-society approach and to enable better security and resilience of key assets....[2]

The use of cyber as a military tool to target enemy forces and capabilities falls into categories that are similar to those of other military operations. Cyber tools can be used in the form of conventional operations like the operations against the Islamic State that were used to disrupt command and control nodes and the group's ability to distribute propaganda.[3] In this type of campaign, cyber supplements other military capabilities as a way to target enemy forces.

Cyber also can take the form of special operations–type activity like the Stuxnet cyber operation against Iran, which could be compared to the U.S. Navy Seal raid to kill Osama Bin Laden.[4] In these operations, cyber is used to achieve targeted goals, sometimes in a covert way that, like special operations, falls below the threshold of traditional armed conflict.

In conventional operations, cyber is used to support forces and commanders by ensuring that they can operate uninhibited in cyberspace or by disrupting the enemy's ability to operate in order to achieve necessary objectives more effectively. In this way,

cyber is used to gain an advantage over an adversary in much the same way advantage is sought in the other domains[5] (for example, when naval forces restrict the enemy's ability to use the seas to achieve strategic ends).

Like naval power, cyber is an important means with which to maximize one's own access and effectiveness while restricting the opponent's access and effectiveness. However, it differs from other domains in a very important respect: In cyber operations, time and space are incredibly compressed. A cyber force can launch an attack from anywhere in the world and strike very quickly, whereas more traditional forces need time to move, are affected by terrain and weather, and must physically position themselves to launch attacks.

U.S. Cyber Command

U.S. Cyber Command (USCYBERCOM) is a capability-based Unified Combatant Command similar to U.S. Special Operations Command and is the military's primary organization for both offensive and defensive cyber activity. It is currently commanded by General Paul Nakasone, U.S. Army, who serves simultaneously as Director of the National Security Agency (NSA). The two organizations have a close cooperative relationship: The NSA and Cyber Command operate, respectively, under Title 50 and Title 10 of the U.S. Code, the sections that govern intelligence and military affairs.[6]

U.S. Cyber Command was founded in 2010 as a sub-unified command under U.S. Strategic Command. The Trump Administration elevated it to full Unified Combatant Command status in 2018, and it reached full operational capability in the same year.[7] Over the past approximately 12 years, Cyber Command has grown from a very small organization that was largely dependent on the NSA for personnel and resources into the much more robust and independent organization that exists today.

Missions

U.S. Cyber Command has a wide range of missions, from offensive and defensive operations to monitoring DOD networks and assisting with the defense of critical infrastructure. Its primary role is to ensure the DOD's ability to operate in a world that is increasingly dependent on cyber.

To this end, Cyber Command has three "enduring lines of operation":

- Provide mission assurance for the Department of Defense (DoD) by directing the operation and defense of the Department of Defense Information Networks (i.e. the DoDIN) and its key terrain and capabilities;
- Defeat strategic threats to the United States and its national interests; and
- Assist Combatant Commanders to achieve their missions in and through cyberspace.[8]

These "lines of operation" are critical to ensuring the success of the military enterprise and national defense, as any compromise in the ability to communicate or operate could jeopardize the full range of U.S. military activities.

A key part of these missions is the concept of "defending forward." As described in the 2018 DOD Cyber Strategy, "[t]his includes working with the private sector and our foreign allies and partners to contest cyber activity that could threaten Joint Force missions and to counter the exfiltration of sensitive DoD information."[9]

Defending forward means operating as close to the origins of the cyber threat as possible before it reaches critical networks in the U.S. with the goal of collecting threat intelligence or disrupting attacks. This is contrasted with passive defense, which involves monitoring within U.S. networks for intrusions. As noted, cyber compresses time and space in the battlespace by its very nature, and attacks can emanate from anywhere in the world with similar speed. U.S. forces must therefore engage adversaries in their networks and work to disrupt attacks in their early stages, because it is often too late once the networks have been compromised. U.S. Cyber Command physically deploys teams abroad to work alongside the cyber forces of partner nations to operate in selected networks.[10]

Cyber and the War in Ukraine

Russia's invasion of Ukraine is significant for cyber because it shows how cyber can be used in conjunction with conventional military assets. While it was largely overshadowed by other aspects of Russia's invasion like the movements of armor units and use of artillery, the Russians utilized cyber throughout as part of their overall war plan. This includes some notable operations that had effects beyond Ukraine. For example:

- The Russians targeted Viasat, an American satellite communications company that provided support to the Ukrainian military, with malware designed to erase its data before disabling it. The Russians did not limit the malware's scope, and it ended up affecting other ground satellite components, causing hundreds of thousands of people outside of Ukraine to lose electrical power and their connection to the Internet.[11]

- A cyberattack against the City Council of Odessa, a major Ukrainian port city situated on the Black Sea, was timed to coincide with a cruise missile attack that was meant to disrupt Ukraine's response to Russian forces attacking in the south.[12]

- Cyberattacks have also been launched against many parts of Ukraine's infrastructure and government and civilian networks, including hospitals.[13]

These actions show that cyber operations are not limited to the military forces of the combatants and, like World War II strategic bombing efforts, often extend to strike at infrastructure and areas of economic significance.

U.S. Cyber Command has provided analytic support and has sought additional ways to support Ukraine. It has deployed cyber teams to support both Ukraine and NATO allies, and those efforts have proved critical to protecting U.S. networks and critical infrastructure as well as those of NATO allies. Specifically, according to General Nakasone:

> U.S. Cyber Command (with NSA) has been integral to the nation's response to this crisis since Russian forces began deploying on Ukraine's borders last fall. We have provided intelligence on the building threat, helped to warn U.S. government and industry to tighten security within critical infrastructure sectors, enhanced resilience on the DODIN [Department of Defense Information Networks] (especially in Europe), accelerated efforts against criminal cyber enterprises and, together with interagency members, Allies, and partners, planned for a range of contingencies.[14]

Budget

Analyzing the budget for cybersecurity is difficult because of the degree of classification involved, but some data can be tracked with respect to USCYBERCOM and the broader Department of Defense. President Joseph Biden's FY 2023 budget includes $11.2 billion for "Cyberspace Activities."[15] This is $800 million more than the FY 2022 DOD budget request, which included $10.4 billion for cyberspace.[16]

General Nakasone testified in March 2021 that "USCYBERCOM's FY21 budget [was] roughly $605 million, which covers the headquarters staff and the Cyber National Mission Force," and that "27 different components shape the Department's overall Cyber Activities Budget, which averages about $10 billion a year."[17]

Capacity

The Cyber Mission Force (CMF) is the operational arm of U.S. Cyber Command, and CMF teams are distributed across various mission sets. In 2013, a force of 133 teams with 6,200 personnel was envisioned based on the mission requirements at that time. All 133 CMF teams reached full operational capability in 2018.[18]

These teams are distributed across functional areas. Specifically, there currently are:

- "13 National Mission Teams to defend the United States and its interests against cyber attacks";

- "68 Cyber Protection Teams to defend DoD networks and systems against rapidly evolving-threats and technologies in cyberspace";

- "27 Combat Mission Teams to provide support to Combatant Commands by generating integrated cyberspace effects in support of operational plans and contingency operations";

- "25 Support Teams to provide analytic and planning support to National Mission and Combat Mission teams"; and

- "14 new CMF Teams created in FY 2022 and FY 2023 to support the Combatant Commanders in Space Operations and for countering cyber influence."[19]

The teams are supported by four service components: Army Cyber Command (ARCYBER); Air Force Cyber Command (AFCYBER); Navy Fleet Cyber Command (FLTCYBER); and Marine Corps Forces Cyberspace Command (MARFORCYBER). These four commands, created at the same time that U.S. Cyber Command was created, provide the operational forces that make up the teams.

- ARCYBER supplies 41 teams to the CMF;[20]
- AFCYBER supplies 39 teams;[21]
- FLTCYBER supplies 40 teams, which reached full operational capability a year ahead of schedule in 2017;[22] and
- MARFORCYBER provides 13 teams.[23]

As of April 2022, according to General Nakasone, Cyber Command had "approximately 6,000 Service members, including National Guard and Reserve personnel on active duty," within its 133 teams" and was expecting to "grow by 14 teams over the next five years."[24]

Recruiting and retaining cyber talent is one of the key challenges for U.S. Cyber Command, which has invested in retention and incentive programs in an effort to keep the talent it cultivates. The high demand for cyber personnel in the private sector makes this a difficult challenge.

Capability

As noted at the outset of this discussion, the world of cyber operations is notoriously secretive, and much is classified. Thus, analyzing USCYBERCOM's capability as reflected in open-source (unclassified) literature is nearly impossible. However, the United States is viewed as one of the world's most capable cyber actors—an assessment that is based on its wide range of infrastructure and strategies and the advanced technologies that the U.S. is known to employ.[25]

Readiness

Because of the lack of open-source reporting, it is also nearly impossible to assess the readiness of America's cyber forces. The U.S. Government Accountability Office has identified some issues of training consistency in the past.[26] Standardizing and improving training is one of the main priorities for U.S. Cyber Command, along with retaining its talent, and both are critical to maintaining readiness.

Conclusion

Cyber is a key domain for the U.S. military. It also is increasingly important in the modern world generally. As seen in the various breaches and ransomware attacks that have come to light, cybersecurity for defense extends well beyond the Department of Defense. For the Joint Force, cyber supports military capabilities by ensuring that U.S. forces can operate in cyberspace without disruption, by making it difficult for enemies to conduct their own operations, and by conducting independent operations against targets as directed to achieve specified goals.

Within DOD, U.S. Cyber Command bears the primary responsibility for the full spectrum of military cyber operations. Having reached its authorized manning levels, USCYBERCOM has shifted its focus to training the force to ensure that it will be as capable as possible in helping to advance and protect the nation's interests.

Endnotes

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Conclusion: U.S. Military Power

The Active Component of the U.S. military is two-thirds the size it should be, operates equipment that is older than it should be, and is burdened by readiness levels that are more problematic than they should be. Some progress has been made, but it has been made at the expense of both capacity and modernization. Accordingly, this *Index* assesses:

- **The Army as "Marginal."** The Army's score remains "marginal" in the *2023 Index*. The Army has fully committed to modernizing its forces for great-power competition, but its programs are still in their development phase, and it will be a few years before they are ready for acquisition and fielding. In other words, the Army is aging faster than it is modernizing. It remains "weak" in capacity with 62 percent of the force it should have but has significantly increased the force's readiness, scoring the highest level of "very strong." However, with the Army pushing operational training down to the company level, below battalion and brigade, it is unclear how ready its brigades actually are or how effective they would be in combat. The Army has a better sense of what it needs for war against a peer, but funding uncertainties could threaten its ability to realize its goals.

- **The Navy as "Weak."** The Navy's overall score has dropped from "marginal" in the *2022 Index* to "weak" in the *2023 Index*. The technology gap between the Navy and its peer competitors is narrowing in favor of competitors, and the Navy's ships are aging faster than they are being replaced. Its fleet is too small relative to workload, and supporting shipyards are overwhelmed by the amount of repair work that is needed to make more ships available. The Navy is projected to have a fleet of 280 ships by 2037, which is smaller than the current force of 298 and well below the 400 needed to meet operational demands. Funding to improve any of these serious deficiencies remains problematic.

- **The Air Force as "Very Weak."** The USAF's score has been downgraded from "weak" in the *2022 Index* to "very weak" in the *2023 Index* due to the deepening of previously assessed issues related to aging aircraft and very poor pilot training and retention. The retirement of aircraft is outpacing the introduction of new aircraft, worsening the service's capacity problem. The shortage of pilots and the dangerously low levels of flying time for the pilots the service does have degrade the ability of the Air Force to generate the amount and quality of combat air power that would be needed to meet wartime requirements. Although it could eventually make its contribution to winning a single major regional contingency (MRC), the time needed to win that battle and the attendant rates of attrition would be much higher than they would be if the service had moved aggressively to increase high-end training and acquire the fifth-generation weapon systems required to dominate such a fight. The USAF would struggle greatly against a peer competitor.

- **The Marine Corps as "Strong."** The score for the Marine Corps was raised to "strong" from "marginal" in the *2022 Index*, and it remains "strong" in this edition for two reasons: (1) because the *2021 Index* lowered the threshold for capacity from 36 infantry battalions to 30 battalions in acknowledgment of the Corps' argument that it is a one-war force that also stands ready for a broad range of smaller crisis-response tasks and (2) because of the Corps'

U.S. Military Power: Army

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

U.S. Military Power: Navy

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

U.S. Military Power: Air Force

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

U.S. Military Power: Marine Corps

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

U.S. Military Power: Space

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

U.S. Military Power: Nuclear

	VERY WEAK	WEAK	MARGINAL	STRONG	VERY STRONG
Nuclear Stockpile				✓	
Delivery Platform Reliability				✓	
Warhead Modernization			✓		
Delivery Systems Modernization				✓	
Nuclear Weapons Complex			✓		
National Labs Talent			✓		
Allied Assurance				✓	
OVERALL				✓	

extraordinary, sustained efforts to modernize (which improves capability) and enhance its readiness during the assessed year. Of the five services, the Corps is the only one that has a compelling story for change, has a credible and practical plan for change, and is effectively implementing its plan to change. However, in the absence of additional funding in FY 2023, the Corps intends to reduce the number of its battalions even further from 22 to 21, and this reduction, if implemented, will limit the extent to which it can conduct distributed operations as it envisions and replace combat losses (thus limiting its ability to sustain operations). Though the service remains hampered by old equipment in some areas, it has nearly completed modernization of its entire aviation component, is making good progress in fielding a new amphibious combat vehicle, and is fast-tracking the acquisition of new anti-ship and anti-air weapons. Full realization of its redesign plan will require the acquisition of a new class of amphibious ships, for which the Corps needs support from the Navy.

- **The Space Force as "Weak."** The Space Force was formally established on December 20, 2019, as a result of an earlier proposal by President Trump and legislation passed by Congress. The *2021 Index* provided an overview of the new service, explaining its mission, capabilities, and challenges, but did not offer an assessment. With an additional year to gain more insight, the *2022 Index* scored the USSF as "weak" in all measured areas, not because of lack of expertise but because the capacity of the service falls far short of the demands being placed on it. The service has done quite well in transitioning missions from the other services without interruption in support, but it does not have enough assets to track and manage the explosive growth in commercial and competitor-country systems that are being placed into orbit. The majority of its platforms have exceeded their planned life spans, and modernization efforts to replace them are slow and incremental. The force also lacks defensive and offensive counter-space capabilities. Consequently, the U.S. Space Force retains its score of "weak" overall.

- **America's Nuclear Capability as "Strong."** The status of U.S. nuclear weapons must be considered in the context of a threat environment that is significantly more dangerous than it was in previous years. Until recently, U.S. nuclear forces needed to address one nuclear peer rather than two or more. Given senior leaders' reassurances about the readiness and reliability of U.S. nuclear forces, as well as the strong bipartisan commitment to modernization of the entire nuclear enterprise, America's nuclear capability retains the grade of "strong." The reliability

of current U.S. delivery systems and warheads is at risk as they continue to age and the threat continues to advance, and the fragility of "just in time" replacement programs only exacerbates this risk. In fact, nearly all components of the nuclear enterprise are at a tipping point with respect to replacement or modernization and have no margin left for delays in schedule. Future assessments will need to consider plans to adjust America's nuclear forces to account for the doubling of peer nuclear threats. While capacity was not assessed this year, it is clear that the change in threat warrants a reexamination of U.S. force posture and the adequacy of our current modernization plans. This portfolio retains its score of "strong," but failure to keep modernization programs on track while planning for a three-party (or more) nuclear peer dynamic could slowly lead to a decline in the strength of U.S. nuclear deterrence.

In the aggregate, the United States' military posture is rated "weak." The *2023 Index* concludes that the current U.S. military force is at significant risk of not being able to meet the demands of a single major regional conflict while also attending to various presence and engagement activities. It most likely would not be able to do more and is certainly ill-equipped to handle two nearly simultaneous MRCs—a situation that is made more difficult by the generally weak condition of key military allies. The downgrading of the Air Force from "weak" to "very weak," downgrading of the Navy from "marginal" to "weak," and a Space Force score of "weak" have led to the first downgrade of the overall score since the inception of the *Index*.

In general, the military services have continued to prioritize readiness and have seen improvement over the past few years, but modernization programs continue to suffer as the failure of resources to keep pace with inflation leads to cancelations, truncation, or delay. The services have normalized the reduction in size and number of military units, and the forces remain well below the level they need to meet the two-MRC benchmark.

Mounting U.S. federal debt and creeping inflation will pressure defense accounts further at a time when competitor countries like China and Russia are redoubling their efforts to expand and improve their military forces. If it continues on this trajectory, the U.S. risks falling very short in its ability to secure its core national interests.