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Projected Costs of U.S. Nuclear Forces, 2017 to 2026

Nuclear weapons have been a cornerstone of U.S. national security since they were developed during World War II. In the Cold War, nuclear forces were central to U.S. defense policy, resulting in the buildup of a large arsenal. Since that time, nuclear forces have figured less prominently than conventional forces, and the United States has not built any new nuclear weapons or delivery systems for many years.

The nation's current nuclear forces are reaching the end of their service life. Those forces consist of submarines that launch ballistic missiles (SSBNs), land-based intercontinental ballistic missiles (ICBMs), long-range bomber aircraft, shorter-range tactical aircraft, and the nuclear weapons that those delivery systems carry. Over the next two decades, essentially all of those nuclear delivery systems and weapons would have to be refurbished or replaced with new systems to continue operating. Consequently, the Congress will need to make decisions about what nuclear forces the United States should field in the future and thus about the extent to which the nation will pursue nuclear modernization plans.

To help the Congress make those decisions, the National Defense Authorization Act for Fiscal Year 2013 required the Congressional Budget Office to estimate the 10-year costs to operate, maintain, and modernize U.S. nuclear forces. In response, CBO published *Projected Costs of U.S. Nuclear Forces, 2014 to 2023*.[1] The National Defense Authorization Act for Fiscal Year 2015 requires CBO to update its estimate of the cost of nuclear forces every two years. This report is the second such update.[2]

If carried out, the plans for nuclear forces delineated in the Department of Defense's (DoD's) and the Department of Energy's (DOE's) budget requests for fiscal year 2017 would cost a total of $400 billion over the 2017–2026 period, CBO estimates—an average of $40 billion a year. (In this analysis, "costs" refers to budget authority, the amount that would need to be appropriated to implement the plans.) The current 10-year total is 15 percent higher than CBO's most recent previous estimate of the 10-year costs of nuclear forces, $348 billion over the 2015–2024 period.[3]

Besides presenting an estimate of those costs, this report also describes the major differences between CBO's current estimate and its most recent previous estimate, which was published in January 2015. Most of the increase in the total estimated cost of nuclear forces reflects the fact that the current estimate spans a 10-year period that begins and ends two years later than the 2015 estimate and thus includes two later years of development in nuclear modernization programs. The development costs of weapon systems typically increase as a program

1. Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2014 to 2023* (December 2013), www.cbo.gov/publication/44968.

2. The first update was Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2015 to 2024* (January 2015), www.cbo.gov/publication/49870.

3. Like the other dollar amounts in this report, both the current and previous 10-year estimates are presented in nominal dollars, meaning that they include the effects of inflation.

Notes: Unless otherwise indicated, all years referred to in this report are federal fiscal years, which run from October 1 to September 30 and are designated by the calendar year in which they end. Numbers in the text and tables may not add up to totals because of rounding.

proceeds, which means that the current estimate replaces two lower-cost years with two higher-cost years.

The current estimate also includes the initial years of purchases in some programs that were not covered by the previous estimate, further raising costs in the 2017–2026 period relative to the 2015–2024 period. In addition, in the two years since CBO's earlier estimate, the modernization plans for some nuclear systems have become better defined, leading to higher cost projections for some programs and lower projections for others.

CBO's Projections of the Costs of U.S. Nuclear Forces Through 2026

Over the 2017–2026 period, the plans for nuclear forces specified in DoD's and DOE's 2017 budget requests would cost a total of $400 billion, CBO estimates (see Table 1). Of that amount, CBO projects that $344 billion would be allocated by the two departments as follows (excluding any cost growth beyond the planned funding levels):

- $189 billion for strategic nuclear delivery systems and weapons, which includes DoD's funding for strategic nuclear delivery systems (the three types of systems that can deliver long-range nuclear weapons—SSBNs, ICBMs, and long-range bombers), DOE's funding for activities related to the specific warheads used by those systems, and DOE's funding for the nuclear reactors that power SSBNs;

- $9 billion for tactical nuclear delivery systems and weapons, which includes DoD's funding for tactical aircraft that can deliver nuclear weapons over shorter ranges and DOE's funding for activities related to the warheads that those aircraft carry;

- $87 billion for DOE's nuclear weapons laboratories and their supporting activities, which consists of funding for activities at nuclear weapons laboratories and production facilities that are not attributable directly to a specific type of warhead but that are related to maintaining current and future stockpiles of nuclear weapons; and

- $58 billion for DoD's command, control, communications, and early-warning systems that allow operators to communicate with nuclear forces, issue commands that control their use, and detect incoming attacks or rule out false alarms.

Projected annual budgets for all of those programs together rise steadily over the next decade, CBO estimates, increasing by roughly 60 percent between 2017 and 2026.[4]

The remaining $56 billion of the $400 billion 10-year total represents CBO's estimate of additional costs that would be incurred over the 2017–2026 period if the costs for those nuclear programs exceeded planned amounts at roughly the same rates that costs for similar programs have grown in the past.

Nuclear forces account for roughly 6 percent of the total 10-year costs of the plans for national defense outlined last year in the departments' 2017 budget requests, CBO estimates.[5] On an annual basis, that percentage is projected to rise from 5 percent in 2017 to slightly less than 7 percent in 2026.

Besides the costs directly attributable to fielding nuclear forces, some published estimates of the total costs of nuclear weapons account for the costs of several related activities. Examples include the costs of addressing the nuclear legacy of the Cold War (such as dismantling retired nuclear weapons and cleaning up environmental contamination from past activities at nuclear facilities); the costs of reducing the threat from other countries' nuclear weapons (including U.S. efforts to halt proliferation, comply with arms control treaties, and verify other countries' compliance with treaties); and the costs of developing and maintaining active defenses against other countries' nuclear weapons (primarily ballistic missiles). CBO has not updated its 2013 estimate of those costs, so such costs are not included in this report.

4. For more details about annual costs, see the supplemental data posted with this report at www.cbo.gov/publication/52401.

5. The estimated costs of the most recent plans for national defense are based on CBO's analysis of information in Table 1-11 of Department of Defense, Office of the Under Secretary of Defense (Comptroller), *National Defense Budget Estimates for FY 2017* (March 2016), p. 18, http://tinyurl.com/hhvgdz7 (PDF, 10.5 MB).

Table 1.

Projected Costs of U.S. Nuclear Forces, by Department and Function

Billions of Dollars

	2017			Total, 2017–2026		
	DoD	DOE	Total	DoD	DOE	Total
CBO's Projections of Budgeted Amounts for Nuclear Forces[a]						
Nuclear delivery systems and weapons						
Strategic nuclear delivery systems and weapons						
Ballistic missile submarines	6.0	1.1	7.1	80	10	90
Intercontinental ballistic missiles	1.9	0.1	2.0	39	3	43
Bombers	2.4	0.6	3.0	34	9	43
Other nuclear activities[b]	1.2	n.a.	1.2	13	n.a.	13
Subtotal	11.5	1.8	13.3	167	22	189
Tactical nuclear delivery systems and weapons	0.4	0.4	0.8	6	3	9
Nuclear weapons laboratories and supporting activities						
Stockpile services	n.a.	1.5	1.5	n.a.	18	18
Facilities and infrastructure	n.a.	2.7	2.7	n.a.	32	32
Other stewardship and support activities[c]	n.a.	3.3	3.3	n.a.	37	37
Subtotal	n.a.	7.5	7.5	n.a.	87	87
Subtotal, Nuclear Delivery Systems and Weapons	11.9	9.7	21.6	174	112	286
Command, control, communications, and early-warning systems						
Command and control	1.3	n.a.	1.3	14	n.a.	14
Communications	2.4	n.a.	2.4	20	n.a.	20
Early warning	1.6	n.a.	1.6	24	n.a.	24
Subtotal, Command, Control, Communications, and Early-Warning Systems	5.3	n.a.	5.3	58	n.a.	58
Total Budgeted Amounts for Nuclear Forces	**17.2**	**9.7**	**26.8**	**232**	**112**	**344**
CBO's Estimates of Additional Costs Based on Historical Cost Growth	n.a.	n.a.	n.a.	35	21	56
Total Estimated Cost of Nuclear Forces	**17.2**	**9.7**	**26.8**	**267**	**134**	**400**

Source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy.

DoD = Department of Defense; DOE = Department of Energy; n.a. = not applicable.

a. These budgeted amounts do not reflect independent estimates by CBO of the costs of U.S. nuclear forces. Instead, this category is based on CBO's analysis of DoD's and DOE's budget proposals and accompanying documents, as well as on CBO's projections of those budget figures beyond the next five years under the assumption that programs proceed as described in budget documents. The category also includes several programs for which plans are still being formulated. In those cases, CBO based its estimate on historical costs of analogous programs.

b. This category includes nuclear-related research and operations support activities by DoD that CBO could not associate with a specific type of delivery system or weapon.

c. This category includes security forces, transportation of nuclear materials and weapons, and scientific research and high-performance computing to improve understanding of nuclear explosions. This category also includes $400 million in 2017 and $5 billion over the 2017–2026 period for federal salaries and expenses to support DOE's oversight of contractor-operated nuclear weapons laboratories and production facilities.

Basis of CBO's Updated Estimates

CBO's total estimate includes the costs to field, operate, maintain, and modernize U.S. nuclear forces. This update was prepared using the same approach as the original estimate and considers only those costs that CBO has identified as directly associated with the nuclear mission.[6] Unlike estimates by some other analysts, CBO's estimate does not include a prorated share of the services' and DoD's overhead and support costs that are not specific to the nuclear mission—although such costs could change if DoD made significant changes in the size of its nuclear forces.

For this update, CBO analyzed the 2017 budget requests of DoD and DOE and their associated justification documents, which include budgeted amounts planned for the next five years. To produce 10-year estimates, CBO identified the budget lines for programs related to nuclear forces and extended them beyond the five-year window by examining the departments' long-range plans for each program.

For replacement systems that are expected to begin development during the 2017–2026 period but that are not yet fully reflected in the departments' budgets (such as a new ICBM and a new cruise missile), CBO estimated costs by reviewing the actual costs for analogous systems that have already been built and the schedules that would be necessary to maintain inventories at the levels planned in the 2017 budget requests. Many of CBO's projections also drew on the agency's analyses for other reports.[7]

CBO used the levels of operation and maintenance activities and the number of military personnel planned for 2021 to project those costs for subsequent years. In keeping with DoD's historical experience, CBO projects that both of those types of spending will grow slightly faster than inflation.

CBO's estimates for individual programs reflect the assumption that DoD's and DOE's plans would be executed successfully and on budget. In other words, the estimates do not incorporate any cost growth beyond the funding levels planned by the two departments. However, because programs often cost more than originally planned, CBO also estimated cost growth beyond the projected budgeted amounts for the four cost categories as a whole (rather than program by program) on the basis of experience with DoD's and DOE's programs.[8]

Changes in Estimated Costs

The estimate of $400 billion in total costs for nuclear forces over the 2017–2026 period is $52 billion, or 15 percent, more than CBO's January 2015 estimate of $348 billion over the 2015–2024 period (see Table 2). The percentage increases differ for DoD and DOE: DoD's costs are projected to total $267 billion, about 18 percent more than the $227 billion that CBO estimated in 2015, whereas DOE's costs are projected to total $134 billion, about 11 percent more than the $121 billion that CBO estimated in 2015.

About three-quarters of the difference between CBO's current and 2015 estimates occurs because the current projections cover a 10-year period that starts and ends two years later than the 2015 estimate. Thus, in the latest estimate, new programs are two years further along in the process of ramping up development, and some are entering the production phase. Consequently, higher estimates in this report do not necessarily signal an increase in programs' total lifetime costs.

The other one-quarter of the difference between CBO's current and previous projections involves the eight years in which the projections overlap. Differences in estimates for those years stem from a number of factors:

- Some modernization plans, particularly for a new bomber, have become better defined since 2015;
- Some plans, particularly for ICBM modernization and the new cruise missile, have increased in scope or have been accelerated relative to 2015 plans; and

6. For more details about nuclear programs and CBO's approach to estimating costs, see Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2014 to 2023* (December 2013), www.cbo.gov/publication/44968.

7. Some cost projections, particularly for research and development and procurement, drew on analyses undertaken for Congressional Budget Office, *Long-Term Implications of the 2016 Future Years Defense Program* (January 2016), www.cbo.gov/publication/51050.

8. For more details about CBO's approach to estimating cost growth, see Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2014 to 2023* (December 2013), pp. 18–20, www.cbo.gov/publication/44968.

Table 2.

Differences Between CBO's 2017–2026 and 2015–2024 Estimates of the 10-Year Costs of U.S. Nuclear Forces

Billions of Dollars

	10-Year Costs		
	DoD	DOE	Total
	Total Estimated Costs in CBO's Earlier Estimate		
Total Estimated Costs, 2015–2024	227	121	348
	Difference in 10-Year Total (2017–2026 estimate minus 2015–2024 estimate)[a]		
CBO's Projections of Budgeted Amounts for Nuclear Forces[b]			
Nuclear delivery systems and weapons			
Ballistic missile submarines	5	2	8
Intercontinental ballistic missiles	16	1	16
Bombers	2	1	3
Nuclear weapons laboratories and supporting activities	n.a.	8	8
Other categories with smaller differences	4	-1	4
Command, control, communications, and early-warning systems	7	n.a.	7
CBO's Estimates of Additional Costs Based on Historical Cost Growth	7	*	7
Total Difference	**40**	**12**	**52**
	Total Estimated Costs in CBO's Current Estimate		
Total Estimated Costs, 2017–2026	267	134	400

Source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy.

DoD = Department of Defense; DOE = Department of Energy; n.a. = not applicable; * = between zero and $500 million.

a. A positive amount indicates that the current estimate is greater than the estimate published in Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2015 to 2024* (January 2015), www.cbo.gov/publication/49870.

b. These budgeted amounts do not reflect independent estimates by CBO of the costs of U.S. nuclear forces. Instead, this category is based on CBO's analysis of DoD's and DOE's budget proposals and accompanying documents, as well as on CBO's projections of those budget figures beyond the next five years under the assumption that programs proceed as described in budget documentation. The category also includes several programs for which plans are still being formulated. In those cases, CBO based its estimate on historical costs of analogous programs.

- Some new modernization programs, particularly for support functions, that were not included in previous budgets have begun to appear in departments' budgets.

The largest contributions to the $52 billion increase are costs for nuclear delivery systems and weapons (including weapons laboratories) as well as costs for command, control, communications, and early-warning systems. CBO's projection of potential cost growth over 10 years is also higher than it was in 2015.

Nuclear Delivery Systems and Weapons

By CBO's estimate, the amounts budgeted for nuclear delivery systems and weapons under DoD's and DOE's plans would total $286 billion over 10 years, $39 billion more than the $247 billion that CBO estimated in 2015. The main reason for that rise is that modernization plans are further along in development. In addition, plans have become clearer or have changed since the 2015 budget for all three segments of the strategic nuclear triad: SSBNs, ICBMs, and bombers.

Ballistic Missile Submarines. Budgeted amounts for SSBNs would total $90 billion over 10 years, CBO projects, about one-quarter of the total cost of nuclear forces and about $8 billion more than the 2015 estimate (see Table 2). Most of that total would be for DoD's SSBN programs, which are projected to cost $80 billion over the next decade, about $5 billion more than CBO's 2015 estimate.

Most of the increase in DoD's SSBN costs results from the fact that the current estimate extends through 2026 rather than 2024, as the previous estimate did. Under the plans in DoD's 2017 budget request, the program for developing a new SSBN will be through the design phase and well into production by 2026. In that year, the third new submarine is expected to be authorized, and the first two submarines would be under construction. However, some of the increase in CBO's estimate for SSBNs results from greater clarity about how DoD plans to distribute the costs of procuring each submarine over multiple years, which differs from the distribution that CBO used for its 2015 estimate.

DOE's share of the amounts budgeted for SSBNs would total $10 billion over 10 years, CBO projects, $2 billion more than the 2015 estimate. That increase stems primarily from larger budgets for the program to extend the life of W88 warheads, which has widened in scope to include replacement of the warheads' conventional high explosives. In addition, DOE's cost estimates for the program to develop interoperable warheads (IW-1 and IW-2) are higher in the department's 2017 budget than in its 2015 budget.[9]

Intercontinental Ballistic Missiles. The amounts budgeted for ICBMs would total $43 billion over 10 years, CBO projects, about $16 billion more than the 2015 estimate. Nearly all of the projected increase comes in DoD's share of those costs.

In early 2015, DoD announced that it would modernize ICBMs and related systems through a program called Ground-Based Strategic Deterrent (GBSD). The program involves designing and producing a new ICBM to replace the current Minuteman III missile, as well as refurbishing existing ICBM silos, infrastructure, and command-and-control systems. Fielding of the new missile is expected to begin in the mid-2020s, and CBO's estimate of the cost includes development and initial production. In its previous estimate for ICBMs, CBO assumed that existing missiles would be refurbished rather than replaced. The GBSD program is much larger in scope—and thus is expected to cost more—than the plans that CBO assumed for its 2015 estimate.

Furthermore, in August 2016, the GBSD program was approved for the first major step in the development process, known as Milestone A. Part of that approval was the adoption, for planning purposes, of a new cost estimate by DoD that was considerably higher than the GBSD estimate in DoD's 2017 budget documents. CBO's analysis of that new estimate forms the basis for its current projection of budgeted amounts for the GBSD program. In addition to that program, some of the increase in DoD's ICBM costs comes from a new effort to replace the helicopters used by security forces at ICBM bases.

DOE's ICBM costs are projected to be slightly higher over the next 10 years than CBO estimated in 2015. The main reason is that DOE's cost estimates for the IW-1 and IW-2 interoperable warheads are higher in the 2017 budget than in the 2015 budget.

Bombers. Under the plans in the departments' 2017 budget requests, the amounts budgeted for bombers would total $43 billion over 10 years, CBO projects, about $3 billion more than CBO's 2015 estimate. Of that total, $34 billion would go to DoD ($2 billion more than CBO estimated in 2015), and $9 billion would go to DOE ($1 billion more than CBO estimated in 2015).[10] In addition to the effects of an estimation period that is two years later, the difference between CBO's projections reflects an increase in the amount budgeted for the new cruise missile, called the Long-Range Standoff weapon, and its warhead. That increase results from a two-year acceleration in the schedule for those systems relative to the schedule on which CBO based its 2015 estimate.[11]

The program to develop a new bomber, called the B-21, also underwent some changes in the past two years. In October 2015, DoD awarded the contract to develop and

9. Each type of interoperable warhead is intended to follow a single design that will allow the warhead to be used on both ground-based and submarine-based ballistic missiles. In CBO's analysis, the costs of interoperable warheads are split evenly between the categories of SSBNs and ICBMs.

10. Bombers are used both for nuclear and for conventional missions. In its cost estimates, CBO attributes 25 percent of the costs of the B-52 bomber and the new B-21 bomber to the nuclear mission and 75 percent to the conventional mission. For the B-2 bomber and all nuclear weapons carried by bombers, in contrast, CBO attributes all costs to the nuclear mission.

11. The schedule for the Long-Range Standoff weapon and its warhead in the Obama Administration's 2015 budget included a three-year delay relative to earlier plans. The two-year acceleration relative to that schedule represents an attempt by DoD and DOE to partially reverse that delay.

build the B-21; the winning bid was lower than DoD had planned for in its budget documents. Nevertheless, CBO's current projection of the 10-year costs of the B-21 is virtually the same as its 2015 estimate because lower costs for the program as a whole are offset by the effect of having two later years in the estimation period. The B-21 is expected to enter service in the 2020s, and CBO's estimate includes the costs of development and initial production.

Nuclear Weapons Laboratories and Supporting Activities. Under DOE's plans, the amounts budgeted for the department's nuclear weapons laboratories and supporting activities would total $87 billion over 10 years, CBO projects, $8 billion more than CBO's 2015 estimate. Major contributors to that increase include larger budgets for support activities associated with strategic materials used in modernization programs (uranium, plutonium, and tritium) and plans for several new construction projects, such as a new facility to produce radiation-hardened electronics.

Command, Control, Communications, and Early-Warning Systems

The amounts budgeted for DoD's nuclear command, control, communications, and early-warning systems would total $58 billion over 10 years, CBO projects, about $7 billion more than the 2015 estimate. That increase stems mainly from several new modernization programs for command and control (including replacing the National Airborne Operations Center aircraft) and future improvements to the Space-Based Infrared System constellation of early-warning satellites. (The new plans for those satellites, referred to as Evolved SBIRS, are still being formulated, so the budget projections for them are particularly uncertain.)

Additional Costs Based on Historical Cost Growth

Weapons programs frequently cost more than originally budgeted. If costs for nuclear programs exceeded planned amounts at roughly the same rates that costs for similar programs have grown in the past, they would rise by an additional $56 billion over the next 10 years, $7 billion more than CBO estimated in 2015.

Almost all of the increase in CBO's estimate of potential cost growth involves DoD's share of the nuclear budget—specifically, the department's modernization programs. CBO's estimate of cost growth is based on DoD's experience with development programs for similar weapon systems and is applied as a percentage of budgeted costs. Thus, because CBO's projections of DoD's budgeted costs for programs to modernize nuclear systems have increased, the estimate of potential cost growth has also risen.

This Congressional Budget Office report was prepared in response to a requirement in the National Defense Authorization Act for Fiscal Year 2015. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

Michael Bennett of CBO's National Security Division prepared the report with guidance from David Mosher. Raymond Hall of the Budget Analysis Division collaborated on the cost estimates in this report with guidance from Sarah Jennings.

Jeffrey Kling and Robert Sunshine reviewed the report. Christian Howlett edited it, and Jorge Salazar prepared it for publication. An electronic version is available on CBO's website, www.cbo.gov/publication/52401.

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