Congressional Budget Office
Nonpartisan Analysis for the U.S. Congress

Projected Costs of U.S. Nuclear Forces, 2023 to 2032

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The Congressional Budget Office updates its projections of the 10-year costs of U.S. nuclear forces every two years. This report contains CBO's projections for the 2023–2032 period.

- 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) fiscal year 2023 budget requests, submitted in April 2022, would cost a total of $756 billion over the 2023–2032 period, or an average of just over $75 billion a year, CBO estimates.
- That total includes $305 billion for operation and sustainment of current and future nuclear forces and other supporting activities; $247 billion for modernization of strategic and tactical nuclear delivery systems and the weapons they carry; $108 billion for modernization of facilities and equipment for the nuclear weapons laboratory complex and for modernization of command, control, communications, and early-warning systems; and $96 billion for potential cost growth in excess of projected budgeted amounts.
- About two-thirds of those costs would be incurred by DoD, mainly for ballistic missile submarines and intercontinental ballistic missiles. DOE's costs would be primarily for nuclear weapons laboratories and supporting activities.
- CBO's current estimate of costs for the 2023–2032 period is 19 percent (or $122 billion) larger than its 2021 estimate of $634 billion, which covered the 2021–2030 period. Of that amount, $109 billion comes from differences in CBO's current and 2021 estimates of budgeted amounts for nuclear forces, and $13 billion comes from differences in the agency's estimates of additional costs based on historical cost growth.[1]
- About 55 percent (or $60 billion) of that $109 billion increase in budgeted amounts arises because the 10-year period covered by the current estimate begins and ends two years later than the period covered by the previous estimate. That $60 billion increase is made up of two components. First, the current estimate includes two later (and more expensive) years of development and production in nuclear modernization programs. When adjusted to remove the effects of inflation, that increased activity accounts for $34 billion of the $60 billion difference. The rest of the increase comes from inflation.
- About 45 percent (or $49 billion) of the $109 billion increase in budgeted amounts is projected to occur from 2023 to 2030—the span of years that overlap in the two estimates. Two factors account for most of that increase of about 10 percent in the costs projected for those years. First, the expected costs of the new intercontinental ballistic missile are larger, as are the costs to operate and sustain ballistic missile submarines. Second, DoD has new plans for modernizing its command, control, communications, and early-warning systems.

Background

Nuclear weapons have been an important component of U.S. national security since they were developed during World War II. During the Cold War, nuclear forces were central to U.S. defense policy, and a large arsenal

1. CBO's estimate of cost growth beyond budgeted amounts applies to the full 10-year period; the difference between the current and previous estimates cannot reliably be divided into overlapping and nonoverlapping years.

Notes: All years referred to are federal fiscal years, which run from October 1 to September 30 and are designated by the calendar year in which they end.
All costs are in nominal dollars. Numbers in the text, tables, and figure may not add up to totals because of rounding. In this report, "cost" refers to budget authority, the amount that would need to be appropriated to implement the Administration's plans.

was built. Since that time, nuclear forces have figured less prominently in defense policy than conventional forces have, and for several decades the United States did not develop and field new nuclear weapons or delivery systems, choosing instead to sustain or extend the life of existing ones. But the nation's current nuclear forces are reaching the end of their service life, and some delivery systems may not be capable of having their service life extended further.

U.S. nuclear forces consist of submarines that launch ballistic missiles (SSBNs), land-based intercontinental ballistic missiles (ICBMs), long-range bomber aircraft, shorter-range tactical aircraft carrying bombs, and the nuclear warheads that those delivery systems carry. Over the next two decades, essentially all those systems will have to be refurbished or replaced with new systems if the United States is to continue fielding those capabilities.

Over the coming years, the Congress will need to decide which nuclear forces the United States should field in the future and thus the extent to which the nation will continue to modernize those forces. The Biden Administration released its *Nuclear Posture Review* report in October 2022 describing the nuclear policies and forces it envisions.[2]

To help the Congress make decisions about U.S. nuclear forces, the National Defense Authorization Act for Fiscal Year 2013 (Public Law 112-239) requires CBO to estimate the 10-year costs of operating, maintaining, and modernizing those forces.[3] CBO has updated that estimate every two years, as required by the National Defense Authorization Act for Fiscal Year 2015 (P.L. 113-291). This report is the fifth update. In addition, in October 2017, CBO published an estimate of the 30-year costs of nuclear forces under existing plans and under various approaches for managing the costs of modernization.[4]

Projected Costs of Nuclear Forces Through 2032

Over the 2023–2032 period, the plans for nuclear forces specified in DoD's and DOE's 2023 budget requests (submitted to the Congress in April 2022) would cost a total of $756 billion, CBO estimates (see Table 1).[5] Of that amount, $660 billion would be needed to implement the plans as DoD and DOE have laid them out, CBO projects—provided that those plans did not change or experience any cost growth or schedule delays.

CBO's estimates for *individual* programs reflect the assumption that DoD's and DOE's plans will be executed successfully and on budget. In other words, those estimates do not incorporate any cost growth beyond the funding amounts planned by the two departments or any delays to program schedules. However, because programs often cost more than originally planned, CBO has incorporated cost growth into its *overall* estimate of the costs of nuclear forces. That growth amounts to $96 billion (the difference between the $660 billion cost for the plans as specified and the $756 billion total cost). That amount represents CBO's estimate of additional costs that would be incurred over the 2023–2032 period if the costs for nuclear programs exceeded planned amounts at roughly the same rates that costs for similar programs have grown in the past.

Those projections are not meant to predict DoD's and DOE's future budgets, because Administrations typically alter plans from year to year and programs often experience cost growth and schedule delays. Rather, the projections extend the cost estimates that underlie the agencies' 2023 budget submissions under the assumption that

2. Every Administration in the post–Cold War era, beginning with the Clinton Administration, has undertaken and published a nuclear posture review, which summarizes policies about nuclear weapons and the forces needed to execute those policies. For the full 2022 version of that report, see Department of Defense, *National Defense Strategy of the United States of America, Including the 2022 Nuclear Posture Review and the 2022 Missile Defense Review* (October 2022), www.defense.gov/National-Defense-Strategy.

3. Previous editions of the report are available at www.cbo.gov/about/products/major-recurring-reports#17. The most recent previous version is Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2021 to 2030* (May 2021), www.cbo.gov/publication/57130.

4. Congressional Budget Office, *Approaches for Managing the Costs of U.S. Nuclear Forces, 2017 to 2046* (October 2017), www.cbo.gov/publication/53211.

5. As directed by law, which requires CBO to estimate the costs of nuclear forces biannually in odd-numbered budget years, CBO's estimate is based on the plans contained in the 2023 budget submissions. The President's 2024 budget was released while this report was being prepared, but information in that submission was not used for these estimates. CBO's estimates are based on the plans in the 2023 budget requests from DoD and DOE, not on appropriated amounts. Although the Congress has appropriated funds for 2023, not enough details are known about how DoD and DOE will allocate those appropriations to each program and activity to directly compare those costs with the estimates in this report.

Table 1.

Projected Costs of Nuclear Forces, by Department and Function, 2023 to 2032

Billions of Dollars

	2023			Total, 2023–2032		
	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	11.4	1.2	12.7	172	16	188
Intercontinental ballistic missiles	6.4	0.9	7.3	103	16	118
Bombers	4.2	1.7	5.8	52	11	63
Other DoD nuclear activities[b]	1.6	n.a.	1.6	19	n.a.	19
Subtotal	23.6	3.8	27.5	346	43	389
Tactical nuclear delivery systems and weapons	0.6	0.4	1.0	5	2	6
Nuclear weapons laboratories and supporting activities						
Stockpile services	n.a.	1.1	1.1	n.a.	12	12
Facilities and infrastructure	n.a.	7.3	7.3	n.a.	79	79
Other stewardship and support activities[c]	n.a.	5.1	5.1	n.a.	57	57
Subtotal	n.a.	13.4	13.4	n.a.	148	148
Subtotal, Nuclear Delivery Systems and Weapons	24.2	17.7	41.9	351	192	543
Command, control, communications, and early-warning systems						
Command and control	1.5	n.a.	1.5	24	n.a.	24
Communications	2.7	n.a.	2.7	34	n.a.	34
Early-warning	6.3	n.a.	6.3	58	n.a.	58
Subtotal, Command, Control, Communications, and Early-Warning Systems	10.5	n.a.	10.5	117	n.a.	117
Total Budgeted Amounts for Nuclear Forces	**34.7**	**17.7**	**52.4**	**468**	**192**	**660**
CBO's Estimates of Additional Costs Based on Historical Cost Growth	n.a.	n.a.	n.a.	56	40	96
Total Estimated Cost of Nuclear Forces	**34.7**	**17.7**	**52.4**	**524**	**232**	**756**

Data source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy. See www.cbo.gov/publication/59054#data.

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, they are 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. For several programs, 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 $500 million in 2023 and $6 billion over the 2023–2032 period for federal salaries and expenses.

there is no change in the planned size and composition of nuclear forces or in the type, quantity, and schedule of weapons development programs.

The $660 billion would fund the following items:

- **Strategic Nuclear Delivery Systems and Weapons ($389 billion).** This category consists of 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, often referred to collectively as the strategic nuclear triad). It also includes DOE's funding for activities related to the warheads used by those systems and the nuclear reactors that power SSBNs. Almost half of the costs in this category would be for ballistic missile submarines.

- **Tactical Nuclear Delivery Systems and Weapons ($6 billion).** This category consists of 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. Costs in this category are less than those in CBO's 2021 estimate because the 2022 *Nuclear Posture Review* recommended canceling the new nuclear-armed sea-launched cruise missile that had been planned. The 2023 budget submission included no funding for that missile or for a warhead for that missile to carry.
- **DOE's Nuclear Weapons Laboratories and Their Supporting Activities ($148 billion).** This category consists of funding for activities at nuclear weapons laboratories and production facilities that are not directly attributable to a specific type of warhead but that are related to maintaining current and future stockpiles of nuclear weapons. Those activities include modernization of several facilities that produce specialized materials and components used in nuclear weapons.
- **DoD's Command, Control, Communications, and Early-Warning Systems ($117 billion).** This category consists of funding for the systems that allow operators to communicate with nuclear forces, issue commands that control their use, detect incoming attacks, and rule out false alarms. That funding would be used to operate and sustain those systems, as well as to modernize several of them.

Altogether, annual budgets for those programs (excluding the allowance for cost growth) would rise steadily from about $50 billion in 2023 to a peak of about $75 billion in 2031 before dropping slightly in 2032, CBO estimates.[6] DoD would incur about two-thirds of the costs.

Modernization Costs

About $247 billion of the $660 billion total cost over the 2023–2032 period would go toward modernizing nuclear weapons and delivery systems, CBO projects (see Figure 1).[7] All but $3 billion of that amount would be used to modernize the strategic nuclear triad; the rest would be used to modernize tactical nuclear weapons and delivery systems.[8] Dividing the $247 billion another way, DoD's programs for modernizing delivery systems would cost about $217 billion, and DOE's programs for refurbishing warheads and developing a reactor for the new SSBN would cost about $30 billion.

Not included in that $247 billion total is the cost of two other categories of modernization projects. One of those categories is DOE's facility modernization plans, which include several projects to refurbish or build new facilities for producing materials and components used in nuclear weapons. Those projects would cost about $49 billion over the 10-year period, in CBO's estimation. The second category of projects that is not part of the $247 billion is DoD's plans to modernize various command, control, communications, and early-warning systems. (Several of those projects have been introduced since CBO's 2021 estimate.) Those programs are projected to cost about $59 billion over the 2023–2032 period. In total, across the various categories, modernization costs would amount to $355 billion over the 2023–2032 period, CBO estimates.

The Share of Defense Funding Allocated to Nuclear Forces

As programs to modernize U.S. nuclear forces proceed, they will compete with other defense priorities for funding. To provide budgetary context to the Congress as it considers which programs to pursue, CBO has estimated two metrics that compare the costs of nuclear forces with the costs of other activities—namely, the fraction of total defense funding that is allocated to nuclear forces, and the fraction of DoD's acquisition funding that is allocated to nuclear forces.

Share of Total Defense Funding. Nuclear forces account for 7.5 percent of the total 10-year cost of the plans for national defense outlined in the President's 2023 budget submission, CBO estimates.[9] On an annual basis, that per-

6. For more details about annual costs, see the supplemental data posted with this report at www.cbo.gov/publication/59054.

7. The remaining $413 billion of the $660 billion total cost would fund operation, sustainment, and supporting activities for current and future nuclear forces, including modernization of equipment and facilities for nuclear weapons laboratories and for command, control, communications, and early-warning systems.

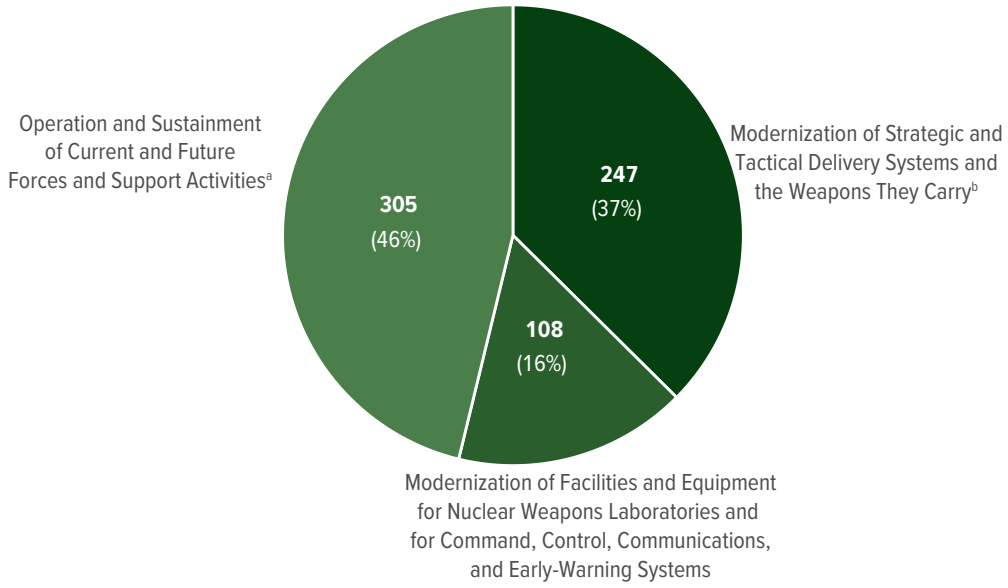
8. For more details about modernization costs for the strategic nuclear triad, by type of delivery system and by year, see the supplemental data posted with this report at www.cbo.gov/publication/59054.

9. That estimate is based on CBO's analysis of information in Office of Management and Budget, *Budget of the U.S. Government, Fiscal Year 2023: Analytical Perspectives* (April 2022), Table 25-1 (online only), https://tinyurl.com/w4huhwh6 (PDF). Nuclear forces would account for a smaller percentage of total defense costs in the last few years of the projection period if CBO's projection of DoD's total budget was used in the calculation. See Congressional Budget Office, *Long-Term Implications of the 2023 Future Years Defense Program* (January 2023), www.cbo.gov/publication/58579.

Figure 1.

Budgeted Amounts for Nuclear Forces, by Type of Activity, 2023 to 2032

Billions of Dollars



Data source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy. See www.cbo.gov/publication/59054#data.

DoD = Department of Defense; DOE = Department of Energy.

These budgeted amounts do not reflect independent estimates by CBO of the costs of U.S. nuclear forces. Instead, they are 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. For several programs, plans are still being formulated. In those cases, CBO based its estimate on historical costs of analogous programs.

a. The costs of support activities in this category include all costs of nuclear weapons laboratories except for costs allocated to modernization of specific warheads and costs allocated to modernization of facilities and equipment. Similarly, the category includes all costs of nuclear command, control, communications, and early-warning systems not allocated for modernization of those systems.

b. The costs of nuclear weapons in this category include only those costs allocated to modernization of nuclear warheads and bombs.

centage is projected to rise from about 6.5 percent in 2023 to a peak of about 8.5 percent in 2031 before dropping slightly in 2032. Those values are similar to CBO's estimates for the Administration's plans for the 2021–2030 period. By comparison, nuclear forces accounted for 3.6 percent of total defense funding in 2014 (the first year in the current series of CBO's estimates of the costs of those forces).

Share of DoD's Acquisition Funding. The development and procurement of nuclear weapons and delivery systems, driven by nuclear modernization programs, would constitute an increasing share of DoD's projected acquisition funding over most of the 2023–2032 period.[10] For DoD's programs, CBO projects that the costs of nuclear acquisition programs would represent just under 11 percent of DoD's total planned acquisition costs over the next decade as outlined in the 2023 budget submission.[11] That fraction would rise from about 8.5 percent in 2023 to just under 12 percent in 2031 before declining to

10. Acquisition funding for DoD's programs is the sum of the appropriations for procurement and for research, development, test, and evaluation. Planned DoD funding used in CBO's analysis, by appropriation title, is available in Office of Management and Budget, *Budget of the U.S. Government, Fiscal Year 2023: Analytical Perspectives* (April 2022), Table 25-1 (online only), https://tinyurl.com/w4huhwh6 (PDF).

11. That estimate is based on CBO's analysis of information in Office of Management and Budget, *Budget of the U.S. Government, Fiscal Year 2023: Analytical Perspectives* (April 2022), Table 25-1 (online only), https://tinyurl.com/w4huhwh6 (PDF). Acquisition costs for nuclear programs would account for a smaller percentage of DoD's total acquisition costs in the last few years of the projection period if CBO's projection of DoD's acquisition costs was used in the calculation. See Congressional Budget Office, *Long-Term Implications of the 2023 Future Years Defense Program* (January 2023), www.cbo.gov/publication/58579.

about 10.5 percent in 2032, in CBO's estimation. Many analysts have observed that competition for funding among acquisition programs will force DoD to make difficult choices about which programs to pursue and could jeopardize nuclear or other high-priority programs.[12]

Basis of CBO's Updated Estimates

CBO's estimate of total costs in this report consists of the costs of fielding, operating, maintaining, and modernizing U.S. nuclear forces. The agency prepared the report using the same approach that it used in its original 2013 report and subsequent updates, considering only costs that it identified as directly associated with the nuclear mission.[13] CBO's estimate thus does not include costs indirectly associated with nuclear forces, such as costs to clean up DOE's former production facilities, which some other analyses include. As with all projections of future costs, CBO's estimates come with substantial uncertainty.

Estimating Approach

For this update, CBO analyzed DoD's and DOE's 2023 budget requests 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 period by examining the departments' long-range plans for each program. For some systems (like new ICBMs, air-launched nuclear cruise missiles, and new engines for the B-52 bomber), DoD has published estimates of the total program cost.[14] For those systems, CBO projected costs beyond the five-year period in a manner consistent with those total cost estimates and DoD's planned production and fielding schedules.

For replacement systems that would be in development or initial production during the 2023–2032 period but that are not yet fully reflected in the departments' budgets, CBO estimated costs differently. In those cases, the agency reviewed actual costs for analogous systems that have already been built and the timelines that would be necessary to meet production and fielding schedules that are consistent with information in the 2023 budget requests.

To project personnel costs and the costs of operation and maintenance activities for most programs from 2028 to 2032, CBO began with the levels of operation and maintenance activities and the number of military personnel planned for 2027 (the final year of DoD's latest five-year plan) and projected that they would remain the same for the last five years of the period. In CBO's estimation, the costs to maintain those same activities and personnel would grow slightly faster than inflation, a projection that is based on DoD's past experience.

Some modernization programs that involve fielding new systems and retiring old ones will go through a transition period when fielded forces comprise a mix of both old and new systems. To estimate costs during that transition, CBO used a model for operation and sustainment costs that incorporates a projection that, for both the new and old systems, half of the costs would be fixed and half would be proportional to the number of each type of delivery system in the force.[15]

To arrive at an estimate of overall cost growth, CBO used two different approaches. For some major modernization programs, the agency used the independent cost estimates that it developed as part of its 2017 estimate of the 30-year costs of nuclear forces (updated for this report to address changes in programs when necessary) to estimate how much costs might rise above DoD's current projected budgets for those programs.[16] For all other programs and activities, CBO estimated cost growth for the four categories of DoD's costs (military personnel, operation and maintenance, procurement, and research and development) and for various types of activities for DOE's costs as

12. See, for example, Rebecca Hersman and Joseph Rodgers, *Nuclear Modernization Under Competing Pressures* (Center for Strategic and International Studies, February 2021), www.csis.org/analysis/nuclear-modernization-under-competing-pressures.

13. 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.

14. Bombers can be used both for nuclear and for conventional missions. To reflect their dual roles, CBO used only a percentage of the costs of bombers. More detail is given in the section on bombers' costs.

15. Sustainment refers to minor modifications and upgrades that keep defense systems current, such as updating communications systems to be compatible with new satellite communications capabilities, rather than routine maintenance. In this report, sustainment comprises all acquisition (that is, procurement and research, development, test, and evaluation funding, except for major life-extension efforts) associated with existing systems, as well as DOE's costs for sustaining the relevant warhead types and supporting naval reactors on current SSBNs.

16. For details about CBO's independent estimates, see Congressional Budget Office, *Approaches for Managing the Costs of U.S. Nuclear Forces, 2017 to 2046* (October 2017), Appendix A, www.cbo.gov/publication/53211.

a whole, rather than program by program, on the basis of experience with DoD's and DOE's programs.[17]

Excluded Costs

CBO's estimate does not include several categories of costs that are not directly related to developing and fielding nuclear forces over the next 10 years. For example, it does not include a prorated share of the military services' and DoD's overhead and support costs that are not specific to the nuclear mission—although such costs could change if DoD significantly altered the size of its nuclear forces.

CBO's estimate also does not include the costs of several related activities. For example, it excludes 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 those treaties); and the costs of developing and maintaining active defenses against other countries' nuclear weapons (primarily ballistic missiles).[18]

Sources of Uncertainty

CBO's estimates come with substantial uncertainty stemming mainly from two sources: Future plans are not yet fully determined for some programs; and estimates of the costs of developing, producing, and operating weapons systems are uncertain even when the plans are fully determined.

The indeterminacy of plans can lead to uncertainty in cost estimates in several ways. The largest source of uncertainty in the current 10-year estimate is attributable to unspecified production schedules for new programs. Several major modernization programs are scheduled to move into full-scale production during the 2023–2032 period, but the number of systems that will be produced each year has not yet been included in budget documentation for some of those programs. For other programs whose plans are less well defined, CBO has used known milestones for fielding the systems and developed production rates that would reflect the minimum rates needed to reach those milestones. DoD could choose to use higher production rates, which would increase the time available to address potential delays. In that case, the program's total production costs would not necessarily change, but the portion of those costs incurred within the 10-year period covered by this report could be larger.

The costs of operating new weapons systems as they are phased into the force can also involve uncertainty. During the current 10-year projection period, several modernization programs will begin to field new systems. For about a decade or more after those initial deployments, DoD will operate fleets comprising a mix of new and old systems. CBO has accounted for that situation by using the same simple model for estimating operation and sustainment costs that it used in estimating the costs of current forces.

Changes in Estimated Costs

CBO's current estimate of $756 billion in total costs for nuclear forces over the 2023–2032 period is $122 billion, or 19 percent, more than the agency's May 2021 estimate of $634 billion over the 2021–2030 period (see Table 2). The percentage increase for DoD is substantially larger than that for DOE: DoD's costs are projected to total $524 billion, or 29 percent more than CBO estimated in 2021, whereas DOE's costs are projected to total $232 billion, or 1 percent more than CBO estimated in 2021.

The $122 billion increase in costs has two components: The increase in CBO's estimates of budgeted costs for nuclear forces accounts for $109 billion, and the increase in CBO's estimates of potential cost growth accounts for $13 billion.

The $109 billion increase in budgeted costs is mainly in two categories. First, costs are projected to be substantially greater for nuclear delivery systems and weapons—particularly DoD's costs for SSBNs and ICBMs. (That category also includes costs for weapons laboratories and supporting activities.) Second, projected costs for command, control, communications, and early-warning systems have also increased substantially.

The higher estimates in this report do not necessarily signal an increase in programs' total lifetime costs. For example, 55 percent (or $60 billion) of the difference between CBO's current and 2021 estimates of budgeted amounts for nuclear forces is attributable to the fact that the current projections cover a 10-year period that starts and ends two years later than the period covered by the

17. 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), p. 18, www.cbo.gov/publication/44968.

18. For CBO's most recent estimate of the 10-year costs of missile defense, see Congressional Budget Office, *Costs of Implementing Recommendations of the 2019 Missile Defense Review* (January 2021), www.cbo.gov/publication/56949.

Table 2.

Differences in 10-Year Costs Between CBO's Current and Previous Projections of the Costs of Nuclear Forces

Billions of Dollars

	10-Year Costs		
	DoD	DOE	Total
CBO's Previous Projection			
Total Estimated Costs, 2021 to 2030	405	229	634
Difference in 10-Year Total (Current projection minus previous projection)[a]			
CBO's Projections of Budgeted Amounts for Nuclear Forces[b]			
Nuclear delivery systems and weapons			
Ballistic missile submarines	42	2	43
Intercontinental ballistic missiles	33	4	37
Bombers	11	-2	9
Other DoD strategic nuclear activities[c]	2	n.a.	2
Tactical nuclear delivery systems and weapons	-5	-6	-11
Nuclear weapons laboratories and supporting activities	n.a.	6	6
Command, control, communications, and early-warning systems	23	n.a.	23
Subtotal, CBO's Projections of Budgeted Amounts for Nuclear Forces	106	3	109
CBO's Estimates of Additional Costs Based on Historical Cost Growth	13	*	13
Total Difference	**119**	**3**	**122**
CBO's Current Projection			
Total Estimated Costs, 2023 to 2032	524	232	756

Data source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy. See www.cbo.gov/publication/59054#data.

DoD = Department of Defense; DOE = Department of Energy; n.a. = not applicable; * = less than $500 million.

a. A positive amount indicates that the current projection is greater than the previous one, which was published in Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2021 to 2030* (May 2021), www.cbo.gov/publication/57130.

b. These budgeted amounts do not reflect independent estimates by CBO of the costs of U.S. nuclear forces. Instead, they are 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. For several programs, plans are still being formulated. In those cases, CBO based its estimate on historical costs of analogous programs.

c. 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.

2021 estimate. In the previous report, estimated costs in 2021 and 2022 totaled $86 billion; those years drop out in this report, and estimated costs in the added years of 2031 and 2032 total $146 billion. Thus, in the current estimate, new programs are two years further along in their development or production phases—both of which tend to be characterized by higher annual costs in later stages. Those increased activities account for $34 billion of the $60 billion increase resulting from the differing 10-year periods; inflation accounts for the rest.

The other 45 percent (or about $49 billion) of the $109 billion difference between CBO's current and previous projections of budgeted amounts involves the eight years in which the projections overlap (see Box 1). Costs in those years are now projected to be about 10 percent higher than CBO previously projected.

- All of the increase during the years of overlap is for DoD. The largest contributions to that increase come from higher expected costs to develop and produce a new ICBM, higher operation and sustainment costs for SSBNs, and new programs for command, control, communications, and early-warning systems that had not been included in DoD's plans when CBO prepared its 2021 estimate.

Box 1.

Differences Between the Congressional Budget Office's Current and Previous Projections of the Costs of Nuclear Forces During the Years That Overlap

One of the goals of updating this report every two years is to assess the budgetary effects of changes in plans for U.S. nuclear forces, or in the execution of those plans, since the previous report was published. The most direct way to do that is to compare estimates only for the years that overlap, in this case 2023 through 2030 (see the table). That approach highlights the differences between sets of estimates that are the result of changes in plans. It does so by largely removing the effects of the natural ramp-up and ramp-down of activity typical of weapons development programs and the effects of economywide inflation in prices.

For the eight overlapping years, the projected budgets have risen by $49 billion. The cost categories with the largest differences in the projected budgets are land-based intercontinental ballistic missiles (a $22 billion, or 32 percent, increase) and submarines that launch ballistic missiles (an $18 billion, or 14 percent, increase). Smaller increases occurred in the categories for command, control, communications, and early-warning systems and for bombers. Conversely, costs in the tactical nuclear weapons category decreased by $10 billion, or 66 percent. Those comparisons were made under the assumption that plans would not change and that programs would not experience cost growth or schedule delays.

Differences in Costs for the Projections' Overlapping Years (2023 to 2030)

Billions of Dollars

	8-Year Costs		
	DoD	**DOE**	**Total**
CBO's Previous Projection			
Total Estimated Costs, 2023 to 2030	309	156	465
Difference in 8-Year Total (Current projection minus previous projection)[a]			
CBO's Projections of Budgeted Amounts for Nuclear Forces[b]			
Nuclear delivery systems and weapons			
Ballistic missile submarines	18	-1	18
Intercontinental ballistic missiles	21	1	22
Bombers	6	1	7
Other DoD strategic nuclear activities[c]	1	n.a.	1
Tactical nuclear delivery systems and weapons	-4	-5	-10
Nuclear weapons laboratories and supporting activities	n.a.	*	*
Command, control, communications, and early-warning systems	12	n.a.	12
Total Difference	**54**	**-5**	**49**
CBO's Current Projection			
Total Estimated Costs, 2023 to 2030	363	151	514

Data source: Congressional Budget Office, using data from the Department of Defense and the Department of Energy. See www.cbo.gov/publication/59054#data.

This table does not include CBO's estimate of cost growth beyond budgeted amounts. The estimate of cost growth applies to the full 10-year period, and the difference between the current and previous estimates cannot reliably be divided into the overlapping and nonoverlapping years.

DoD = Department of Defense; DOE = Department of Energy; n.a. = not applicable; * = less than $500 million.

a. A positive amount indicates that the current projection is greater than the previous one, which was published in Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2021 to 2030* (May 2021), www.cbo.gov/publication/57130.

b. These budgeted amounts do not reflect independent estimates by CBO of the costs of U.S. nuclear forces. Instead, they are 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. For several programs, plans are still being formulated. In those cases, CBO based its estimate on historical costs of analogous programs.

c. 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.

Box 2.

Status of the Sea-Launched Cruise Missile

In its 2018 *Nuclear Posture Review* report, the Trump Administration argued that new low-yield nuclear weapons (which have less explosive power) were required to strengthen deterrence against regional aggression.[1] To that end, two programs were initiated: a low-yield version of the W76 warhead that is carried by submarine-launched ballistic missiles, and a new nuclear-armed sea-launched cruise missile (SLCM-N). Alterations to the W76 warhead were undertaken and completed, and the low-yield W76-2 warhead is now fielded on ballistic missile submarines. Initial analysis of the design and operational concept for a new SLCM-N began in 2020. In its 2021 report on the costs of U.S. nuclear forces, the Congressional Budget Office estimated that design and production of a new SLCM-N and its warhead would cost about $10 billion over the 2021–2030 period.[2]

The Biden Administration canceled the new SLCM-N program in its 2022 *Nuclear Posture Review* report, saying that it was no longer necessary (given the availability of the W76-2) and that developing the SLCM-N was a lower budgetary priority than other ongoing nuclear modernization programs.[3] In its fiscal year 2023 budget submission, therefore, the Administration requested no funds for the SLCM-N or its warhead. Because CBO's current estimate of the costs of nuclear forces is based on that budget submission, CBO has not included any costs for the SLCM-N or its warhead in that estimate.

If CBO applied the same approach that it used in its 2021 estimate to the current projection period, the costs of the SLCM-N and its warhead would total about $10 billion over the 2023–2032 period, if the program began in 2024. That amount does not include any production costs after 2032, nor does it include any costs for integrating the weapons onto the ships or submarines that would carry them, or any additional weapons storage, security, or operations costs that would be incurred. Those excluded costs could be substantial.

The ultimate status of the SLCM-N is unclear. In the 2023 National Defense Authorization Act, the Congress authorized funds to continue research pertaining to both the SLCM-N and its warhead and mandated several studies regarding its cost and operational utility.

1. Department of Defense, *Nuclear Posture Review* (February 2018), https://go.usa.gov/xEcng.
2. Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2021 to 2030* (May 2021), www.cbo.gov/publication/57130.
3. Department of Defense, *National Defense Strategy of the United States of America, Including the 2022 Nuclear Posture Review and the 2022 Missile Defense Review* (October 2022), www.defense.gov/National-Defense-Strategy.

- The total costs for DOE during the years of overlap are about $5 billion *lower* than CBO had projected in its 2021 estimate. That decrease is primarily from the cancellation of the new sea-launched cruise missile and its associated warhead (see Box 2).

Along with the estimated increase of $109 billion in budgeted costs, an additional $13 billion of the total $122 billion increase occurs in CBO's estimate of cost growth beyond budgeted amounts. The estimate of cost growth applies to the full 10-year projection period, and the difference between the current and previous estimates cannot reliably be divided into overlapping and nonoverlapping years.

Nuclear Delivery Systems and Weapons

By CBO's estimate, the amounts needed to implement the plans for nuclear systems and weapons as DoD and DOE have laid them out in their 2023 budget submissions (provided that those plans did not change or experience any cost growth or schedule delays) would total $543 billion over the 2023–2032 period, $86 billion more than the $456 billion that CBO estimated in 2021 for the 2021–2030 period. Several factors account for that increase. Some major modernization programs are completing development and moving into full-rate production, and additional modernization efforts have been planned (particularly by DoD) that had not appeared in budget documentation as of 2021. In addition, plans and expected costs for some activities have become clearer or have changed since the departments' 2021 budget requests were made.

Ballistic Missile Submarines. Budgeted amounts for SSBNs would total $188 billion over 10 years, CBO projects (see Table 1 on page 3). That total is about $43 billion more than the 2021 estimate for the 2021–2030 period (see Table 2 on page 8). Nearly

all of that increase would be for DoD's SSBN-related programs, which are projected to cost $172 billion over the next decade, about $42 billion more than CBO's 2021 estimate.

That increase in 10-year costs mostly results from the shift in end dates from 2030 to 2032. Under the plans in DoD's 2023 budget request, the program for developing and producing a new SSBN will be well past the halfway point of procurement by 2032. As a result, during the next decade the program would spend more years near the peak of the construction effort, which extends to the mid-2030s. Other contributors to the increase include the following:

- Plans for the second phase of the effort to extend the life of the D5 submarine-launched ballistic missile (SLBM) to allow that missile to be used throughout the lifetime of Columbia class submarines begin earlier and ramp up more quickly than CBO had anticipated in its 2021 estimate.
- Operation costs for Ohio class submarines are higher in the 2023 budget submission than they were in the 2021 budget submission. CBO has extended that trend in its current projections, reflecting DoD's intention to operate some Ohio class submarines longer than had previously been planned.
- The Columbia class SSBN will have incurred two more years of operation and sustainment costs—as the first submarine prepares for its initial deployment in 2031—than were included in CBO's 2021 estimate.
- The Navy included two new programs in the 2023 budget that were not included in DoD's plans when CBO prepared its 2021 estimate. Those programs are for research and development pertaining to reentry vehicles (RVs) to protect SLBM warheads as they reenter the atmosphere.

DOE's share of the amounts budgeted for SSBNs would be $16 billion over 10 years, CBO projects, $2 billion more than the 2021 estimate. Two warhead programs, for the W93 and the Future Strategic Sea-Based Warhead, would be two years further along in their development, accounting for most of that increase in costs.

Intercontinental Ballistic Missiles. The amounts budgeted for ICBMs would total $118 billion over 10 years, CBO projects—about $103 billion for DoD and about $16 billion for DOE. That total is about $37 billion more than CBO's 2021 estimate for the 2021–2030 period; most of the increase ($33 billion) comes from DoD's share of the costs.

For DoD, the bulk of the $33 billion increase in CBO's estimate of ICBM costs over the projection period is for the Ground-Based Strategic Deterrent (GBSD) program, which includes development and fielding of the new ICBM (a $16 billion increase over the 2021 estimate) as well as refurbishment of the silos and elements of the command-and-control infrastructure (a $12 billion increase). The increase in the GBSD program is the result of both a higher overall cost for the program and a production schedule that would produce more missiles per year than CBO had anticipated in its last update.

DoD's latest estimate of total costs for the GBSD program (an estimate that includes years beyond those covered by this report) is $12 billion higher than its previous one. That higher overall program cost was reported in the Selected Acquisition Report for the GBSD in DoD's fiscal year 2023 budget. According to that report, the estimate of the total acquisition program cost (combining research, development, test, and evaluation, or RDT&E, missile procurement, and military construction funding) is $96 billion. By comparison, the program acquisition cost estimate in the fiscal year 2021 budget request, which was based on an independent cost estimate prepared by DoD's Cost Assessment and Program Evaluation office, was $85 billion.

The increase in procurement costs in CBO's current estimate (for the 2023–2032 period) relative to its 2021 estimate (for the 2021–2030 period) stems from two factors: more years in which missiles are being procured, and missiles that are being purchased in higher numbers during the early years of procurement. Procurement of production ICBMs (as opposed to construction of ICBMs for development and testing purposes) is slated to begin in 2026 in both estimates. Thus, CBO's 2021 estimate included five years of ICBM procurement, whereas this estimate includes seven years. Moreover, the fiscal year 2023 budget request calls for procuring 99 ICBMs over the 2026–2027 period, which is a steeper ramp-up in production than CBO assumed for its 2021 estimate, even though CBO used an eventual full production rate of 60 ICBMs per year in both its estimates. Combining those two effects, the current estimate includes the costs of procuring almost

400 new ICBMs (totaling $31 billion), about twice as many as were included in the agency's 2021 estimate (about 200, costing a total of $15 billion).

The other major factor contributing to the $33 billion increase in DoD's ICBM costs is a larger budget planned for the program to develop a new RV. That increase accounts for about $5 billion of the additional costs.

DOE's ICBM costs are projected to be about $4 billion higher over the next decade than CBO estimated in 2021. Almost all of that increase is from the two-year shift in projection periods. The largest contributor to that increase is the Future Strategic Land-Based Warhead program, which will be two years further along in its development.

Bombers. Under the plans in the departments' 2023 budget requests, the amounts allocated for the bomber portion of nuclear forces would total $63 billion over the 2023–2032 period, CBO projects, about $9 billion more than CBO's earlier estimate for the 2021–2030 period. Of that total, $52 billion would go to DoD ($11 billion more than CBO estimated in 2021), and $11 billion would go to DOE ($2 billion less than in CBO's 2021 estimate).[19]

About 90 percent of the increase in DoD's bomber costs is for the Long-Range Standoff (LRSO) weapon, a program that is developing a new nuclear-capable air-launched cruise missile. DoD's previous estimates for development and production of the LRSO weapon totaled around $10 billion, but the budget documents for fiscal year 2023 show total costs of $6 billion for RDT&E and $10 billion for procurement, summing to a total acquisition cost of about $16 billion for the program.[20]

The remainder of the increase in DoD's bomber costs comes from two additional years of production for the B-21 (from the two-year shift in the projection period).

For DOE, the decrease in projected costs is primarily from completion of the B61-12 life-extension program, which is slated for around 2026, and the ramping down of the W80-4 warhead program as it nears its planned completion around 2032.

Other DoD Strategic Nuclear Activities. This category comprises DoD's supporting activities for strategic nuclear forces that CBO could not associate with a particular weapon system. Costs for those activities would total $19 billion over 10 years, about $2 billion more than CBO's 2021 estimate, mainly because of small increases in the costs of several support programs.

Tactical Nuclear Delivery Systems and Weapons. CBO estimates that tactical nuclear capability would cost $6 billion over the next 10 years, about $11 billion less than CBO's 2021 estimate. Almost all of that decrease stems from the Administration's cancellation of the new sea-launched cruise missile and its associated warhead (see Box 2 on page 10).

Nuclear Weapons Laboratories and Supporting Activities. The amounts that DOE budgeted for its nuclear weapons laboratories and supporting activities would total $148 billion over the 2023–2032 period, CBO projects, $6 billion more than the 2021 estimate spanning the 2021–2030 period.[21] Essentially all of that increase results from the different time periods covered by the two estimates.

Command, Control, Communications, and Early-Warning Systems

The amounts budgeted by DoD for nuclear command, control, communications, and early-warning systems would total $117 billion over 10 years, CBO projects, about $23 billion more than the 2021 estimate. That cost increase is largely for several modernization programs that either are ramping up efforts or are included in the budget for the first time.

19. Bombers can be used for nuclear and for conventional missions. In these 10-year 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 nuclear-capable cruise missiles, by contrast, CBO attributes all costs to the nuclear mission. If the full cost of B-52 and B-21 bombers was included, the 10-year costs of bombers would increase to $137 billion (from $63 billion), and the total costs of nuclear forces, including projected cost growth, would be $840 billion from 2023 through 2032. The 25 percent scale factor for the nuclear mission was determined through discussions with operational personnel and on the basis of the Air Force's force structure. For more detail, see Congressional Budget Office, *Projected Costs of U.S. Nuclear Forces, 2014 to 2023* (December 2013), p. 18, www.cbo.gov/publication/44968.

20. For a discussion of estimated costs for the LRSO in 2018, see Mark Gunzinger, Carl Rehberg, and Gillian Evans, *Sustaining the U.S. Nuclear Deterrent: The LRSO and GBSD* (Center for Strategic and Budgetary Assessments, April 2018), pp. 33–35, https://tinyurl.com/5882uzrw.

21. That total does not include funding for sustaining and modernizing specific nuclear warheads. Those amounts are grouped with the delivery systems that carry them.

Programs that are ramping up efforts include replacement of the E-4B National Airborne Operations Center aircraft (on which senior civilian and military leaders can maintain communications with nuclear forces during a crisis); replacement of the E-6B Take Charge and Move Out aircraft (which relay communications to ballistic missile submarines and can also serve as an airborne command post for other nuclear forces); and replacement of the Advanced Extremely High Frequency communications satellites (which handle secure communications, including those for nuclear forces) with new satellites, the Evolved Strategic SATCOM system.

First-time programs include new satellite constellations for missile warning and missile tracking. Those programs will supplement the existing Space-Based Infrared System but will operate at lower orbital altitudes, specifically in medium-Earth orbit (from about 2,000 kilometers to 36,000 kilometers above the Earth's surface) and low-Earth orbit (from about 300 kilometers to about 2,000 kilometers above the surface).[22]

Additional Costs Based on Historical Cost Growth

Weapons programs frequently cost more than originally budgeted amounts. If nuclear programs exceeded planned amounts at roughly the same rates that costs for similar programs have grown in the past, they would cost an additional $96 billion over the next decade, $13 billion more than the cost growth CBO estimated in 2021. Nearly all of that increase is in DoD's share of the costs of nuclear forces. That is mainly because DoD's plans include increased funding for acquisition programs that would develop and field new systems—both for programs that have appeared in CBO's previous estimates and for new programs that appear for the first time in the current estimate. Historically, those types of efforts have been particularly susceptible to cost growth.

22. Missile warning satellites also provide tracking information that can be useful to missile defense systems, especially satellites that operate at low orbital altitudes. To account for their dual mission, CBO has included only half of the costs of the satellites in low-Earth orbit in its estimate of the costs of nuclear forces.

The Congressional Budget Office prepared this report as required by 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 prepared the report, with guidance from David Mosher and Edward G. Keating. David Arthur fact-checked the report.

Jeffrey Kling and Robert Sunshine reviewed the report. Christine Bogusz edited it, and R. L. Rebach created the graphics and prepared the text for publication. The report is available at www.cbo.gov/publication/59054.

CBO seeks feedback to make its work as useful as possible. Please send comments to communications@cbo.gov.

Phillip L. Swagel
Director