I. United States nuclear forces

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As of January 2023 the United States maintained a military stockpile of approximately 3708 nuclear warheads, the same number as the previous year. Approximately 1770 of these—consisting of about 1670 strategic and roughly 100 non-strategic (tactical) warheads—were deployed on ballistic missiles and at bomber bases. In addition, about 1938 warheads were held in reserve and around 1536 retired warheads were awaiting dismantlement (184 fewer than the previous year's estimate), giving a total inventory of approximately 5244 nuclear warheads (see table 7.2).

The US stockpile is expected to continue to decline slightly over the next decade as nuclear modernization programmes consolidate some nuclear weapon types. Although the US Department of Energy indicated in early 2022 that the USA was currently 'on pace to completely dismantle the weapons that were retired at the end of [fiscal year (FY)] 2008 by the end of FY 2022', that schedule appears to have slipped.[1]

The estimates presented here are based on publicly available information regarding the US nuclear arsenal and assessments by the authors.[2] While in 2021 the USA briefly restored a policy of declassifying the size of its nuclear stockpile and the annual number of dismantled warheads, this practice was not repeated in 2022.[3]

In 2022 the USA remained in compliance with the final warhead limits prescribed by the 2010 Russian–US Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START), which places a cap on the numbers of US and Russian deployed strategic nuclear forces.[4] The most recent exchange of treaty data, from September 2022, lists the USA as having 1420 warheads attributed to 659 deployed ballistic missiles and heavy bombers.[5] Just as with Russia, many of the USA's strategic delivery systems carry fewer warheads than their maximum capacity in order to meet the limits of New START. If the USA chose to no longer comply with the treaty, or if the treaty were to expire without a follow-on agreement, the

[1] US Department of Energy (DOE), National Nuclear Security Administration (NNSA), *Fiscal Year 2022 Stockpile Stewardship and Management Plan*, Report to Congress (DOE: Washington, DC, Mar. 2022), pp. 2-15–2-16. US fiscal years end on 30 Sep. of the named year.

[2] Kristensen, H. M. and Korda, M., 'Estimating world nuclear forces: An overview and assessment of sources', SIPRI Commentary, 14 June 2021.

[3] US Department of State, 'Transparency in the US nuclear weapons stockpile', Fact sheet, 5 Oct. 2021.

[4] For a summary and other details of New START see annex A, section III, in this volume. On related developments in 2022 see chapter 8, section I, in this volume.

[5] US Department of State, Bureau of Arms Control, Verification and Compliance, 'New START Treaty aggregate numbers of strategic offensive arms', Fact sheet, 1 Sep. 2022. See also table 8.1 in chapter 8, section I, in this volume.

* The authors wish to thank Eliana Johns for contributing invaluable research to this publication.

Table 7.2. United States nuclear forces, January 2023

All figures are approximate and some are based on assessments by the authors.

Type	Designation	No. of launchers	Year first deployed	Range (km)[a]	Warheads x yield	No. of warheads[b]
Strategic nuclear forces		**746**				**3 508**[c]
Aircraft (bombers)		*107/66*[d]				*788*[e]
B-52H	Stratofortress	87/46	1961	16 000	20 x AGM-86B ALCMs 5–150 kt[f]	500[g]
B-2A	Spirit	20/20	1994	11 000	16 x B61-7, -11, B83-1 bombs[h]	288
Land-based missiles (ICBMs)		*400*				*800*[i]
LGM-30G Minuteman III						
	Mk12A	200	1979	13 000	1–3 x W78 335 kt	600[j]
	Mk21 SERV	200	2006	13 000	1 x W87-0 300 kt	200[k]
Sea-based missiles (SLBMs)		*14/280*[l]				*1 920*[m]
UGM-133A Trident II D5LE						
	Mk4	..	1992	>12 000	1–8 x W76-0 100 kt	–[n]
	Mk4A	..	2008	>12 000	1–8 x W76-1 90 kt	1 511
	Mk4A	..	2019	>12 000	1 x W76-2[o] 8 kt	25
	Mk5	..	1990	>12 000	1–8 x W88 455 kt	384
Non-strategic nuclear forces						**200**[p]
F-15E	Strike Eagle	..	1988	3 840	5 x B61-3, -4	80
F-16C/D	Falcon	..	1987	3 200[q]	2 x B61-3, -4	60
F-16MLU	Falcon[r]	..	1985	3 200	2 x B61-3, -4	30
PA-200	Tornado[r]	..	1983	2 400	2 x B61-3, -4	30
Total stockpile						**3 708**
Deployed warheads						1 770
Reserve warheads						1 938
Retired warheads awaiting dismantlement						**1 536**[s]
Total inventory						**5 244**[t]

.. = not available or not applicable; – = nil or a negligible value; ALCM = air-launched cruise missile; ICBM = intercontinental ballistic missile; kt = kiloton; SERV = security-enhanced re-entry vehicle; SLBM = submarine-launched ballistic missile.

[a] For aircraft, the listed range is for illustrative purposes only; actual mission range will vary according to flight profile, weapon payload and in-flight refuelling.

[b] These figures show the total number of warheads estimated to be assigned to nuclear-capable delivery systems. Only some of these warheads have been deployed on missiles and at airbases, as described in the notes below.

[c] Of these strategic warheads, *c.* 1670 were deployed on land- and sea-based ballistic missiles and at bomber bases. The remaining warheads were in central storage. This number differs from the number of deployed strategic warheads counted by the 2010 Russian–US Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START) because the treaty attributes 1 weapon to each deployed bomber, even though bombers do not carry weapons under normal circumstances. Additionally, the treaty does not count weapons stored at bomber bases and, at any given time, some nuclear-powered ballistic missile submarines (SSBNs) are not fully loaded with warheads and are thus not counted under the treaty.

[d] The first figure is the total number of bombers in the inventory; the second is the number of bombers that are counted as nuclear-capable under New START. The USA has declared that it will deploy no more than 60 nuclear bombers at any given time but normally only *c.* 50 are deployed, with the remaining aircraft in overhaul.

[e] Of the *c.* 788 bomber weapons, *c.* 300 (200 ALCMs and 100 bombs) were deployed at the bomber bases; all the rest were in central storage. Many of the gravity bombs are no longer fully active and are slated for retirement after deployment of the B61-12 is completed in the mid 2020s.

[f] The B-52H is no longer configured to carry nuclear gravity bombs.

[g] In 2006 the US Department of Defense decided to reduce the number of ALCMs to 528 missiles. Burg, R., Director of Strategic Security in the Air, Space and Information Operations, 'ICBMs, helicopters, cruise missiles, bombers and warheads', Statement before the US Senate, Armed Services Committee, Subcommittee on Strategic Forces, 28. Mar. 2007, p. 7. Since then, the number has probably decreased gradually to *c.* 500 as some missiles and warheads have probably been expended in destructive tests.

[h] Strategic gravity bombs are assigned to B-2A bombers only. The maximum yield of strategic bombs is 360 kt for the B61-7, 400 kt for the B61-11 and 1200 kt for the B83-1. However, all these bombs, except the B-11, have lower-yield options. Most B83-1s have been moved to the inactive stockpile and B-2As rarely exercise with the bomb.

[i] Of the 800 ICBM warheads, only 400 were deployed on the missiles. The remaining warheads were in central storage.

[j] Only 200 of these W78 warheads were deployed, as each ICBM has had its warhead load reduced to carry a single warhead; all of the remaining warheads were in central storage.

[k] SIPRI estimates that another 340 W87 warheads might be in long-term storage outside the stockpile for use in the W87-1 warhead programme to replace the W78.

[l] The first figure is the total number of SSBNs in the US fleet; the second is the maximum number of missiles that they can carry. However, although the 14 SSBNs can carry up to 280 missiles, 2 vessels are normally undergoing refuelling overhaul at any given time and are not assigned missiles. The remaining 12 SSBNs can carry up to 240 missiles, but 1–2 of these vessels are usually undergoing maintenance at any given time and may not be carrying missiles.

[m] Of the 1920 SLBM warheads, *c.* 970 were deployed on submarines as of Jan. 2023; all the rest were in central storage. Although each D5 missile was counted under the 1991 Strategic Arms Reduction Treaty (START I) as carrying 8 warheads and the missile was initially flight-tested with 14, the US Navy has reduced the warhead load of each missile to an average of 4–5 warheads. D5 missiles equipped with the new low-yield W76-2 are estimated to carry only 1 warhead each.

[n] It is assumed here that all W76-0 warheads have been replaced by the W76-1.

[o] According to US military officials, the new low-yield W76-2 warhead will normally be deployed on at least 2 of the SSBNs on patrol in the Atlantic and Pacific oceans.

[p] Of the 200 non-strategic bombs, *c.* 100 are thought to be deployed across 6 airbases in 5 North Atlantic Treaty Organization (NATO) member states (Belgium, Germany, Italy, the Netherlands and Türkiye), although the weapons remain in the custody of the US Air Force. The other *c.* 100 bombs were in central storage in the USA. Older B61 versions will be dismantled once the B61-12 is deployed. The maximum yields of non-strategic bombs are 170 kt for the B61-3 and 50 kt for the B61-4. All have selective lower yields. The B61-10 was retired in 2016.

[q] Most sources list an unrefuelled ferry range of 2400 kilometres, but Lockheed Martin, which produces the F-16, lists 3200 km.

[r] These dual-capable aircraft are operated at airbases outside the USA by other members of NATO.

[s] Up until 2018, the US government published the number of warheads dismantled each year, but the administration of President Donald J. Trump ended this practice. The administration of President Joe Biden temporarily restored transparency, but publication of the 2018, 2019 and 2020 data showed that far fewer warheads had been dismantled than assumed (e.g. only 184 in 2020). Nonetheless, dismantlement of the warheads has continued, leaving an estimated 1536 warheads in the dismantlement queue as of Jan. 2023.

[t] In addition to these intact warheads, more than 20 000 plutonium pits were stored at the Pantex Plant, Texas, and perhaps 4000 uranium secondaries were stored at the Y-12 facility at Oak Ridge, Tennessee.

Sources: US Department of Defense, various budget reports and plans, press releases and documents obtained under the Freedom of Information Act; US Department of Energy, various budget reports and plans; US Air Force, US Navy and US Department of Energy, personal communication with officials; *Bulletin of the Atomic Scientists*, 'Nuclear notebook', various issues; and authors' estimates.

USA (like Russia) could add reserve warheads to missiles and bombers and potentially double its number of deployed strategic nuclear weapons.

This section enumerates the USA's holdings of nuclear weapons, both strategic (including those delivered by air, land and sea) and non-strategic. Before doing so, it first outlines the role played by nuclear weapons in US military doctrine and describes the USA's warhead-production capacity.

The role of nuclear weapons in US military doctrine

In 2022 the administration of US President Joe Biden released its long-awaited Nuclear Posture Review (NPR), the principal document outlining US nuclear policy. The 2022 NPR affirmed three roles for US nuclear weapons: 'Deter strategic attacks; Assure Allies and partners; and Achieve US objectives if deterrence fails.'[6] The review states that 'The 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'; however, it does not elaborate on what specifically constitutes 'vital interests', nor does it define the phrase 'Allies and partners'.[7] In contrast to the language about expanding nuclear options against non-nuclear attacks in the 2018 NPR issued by the administration of President Donald J. Trump, the 2022 NPR appears to reduce the emphasis on this role.[8] Even so, the NPR acknowledges 'the range of non-nuclear capabilities being developed and fielded by competitors that could inflict strategic-level damage', and the USA retains a wide range of options against nuclear and non-nuclear attacks.[9]

The USA under the Biden administration continued to implement the large-scale nuclear weapon programmes initiated under the 2009–17 administration of President Barack Obama and accelerated and expanded by the 2017–21 Trump administration. These modernization programmes cover all three legs of the nuclear triad (see below). However, the 2022 NPR

[6] US Department of Defense (DOD), *2022 National Defense Strategy of the United States of America* (DOD: Washington, DC, Oct. 2022), p. 7.

[7] US Department of Defense (note 6), p. 9.

[8] US Department of Defense (note 6), p. 7; and US Department of Defense (DOD), *Nuclear Posture Review 2018* (DOD: Washington, DC, Feb. 2018). On the 2018 NPR see Kristensen, H. M., 'US nuclear forces', *SIPRI Yearbook 2019*.

[9] US Department of Defense (note 6), p. 9.

includes two major changes from the previous review: cancelling the sea-launched cruise missile (SLCM-N) proposed by the Trump administration and retiring the B83-1 gravity bomb.

The 2022 NPR concludes that the SLCM-N is no longer necessary given existing capabilities, uncertainty as to whether it would provide leverage to negotiate arms control limits on Russia's non-strategic nuclear weapons, and the estimated cost in the light of other nuclear modernization programmes and defence priorities.[10] At the end of 2022, however, the US Congress continued funding of limited research for the SLCM-N: the FY 2023 National Defense Authorization Act allocated US$25 million for this, in contradiction to the findings of the 2022 NPR.[11] If a new administration after 2024 decides to fully fund the programme, then the new missile could be deployed on attack submarines by the early 2030s. This would go against the US pledge from 1992 not to develop a nuclear sea-launched cruise missile and could potentially result in the first significant increase in the size of the US nuclear weapon stockpile since 1996.[12]

The Biden administration chose to continue the retirement of the B83-1 gravity bomb—the last nuclear weapon with a megaton-level yield in the US nuclear arsenal—which the Trump administration had put on hold. The 2022 NPR states that the B83-1 would be retired 'due to increasing limitations on its capabilities and rising maintenance costs'.[13] It also alludes to an eventual replacement weapon 'for improved defeat' of hard and deeply buried targets.[14]

Warhead production

Since the end of the cold war, the US nuclear weapon-production complex has relied on refurbishment of existing warhead types to maintain the nuclear arsenal. In 2018, however, the USA shifted to a much more ambitious plan focused on new warhead production, which depends heavily on the ability to produce new plutonium pits—the core of a nuclear weapon. Whereas production capacity in 2021 and 2022 was limited to around 10 plutonium pits per year, the National Nuclear Security Administration (NNSA) plans to produce

[10] US Department of Defense (note 6), p. 20. On the SLCM-N see US Office of the Under Secretary of Defense for Policy, *Strengthening Deterrence and Reducing Nuclear Risks*, part II, *The Sea-Launched Cruise Missile-Nuclear (SLCM-N)* (US Department of State, Office of the Under Secretary of State for Arms Control and International Security: Washington, DC, 23 July 2020), p. 3.

[11] US Senate, Committee on Armed Services, 'National Defense Authorization Act for Fiscal Year 2023: Report', 18 July 2022; and US House of Representatives, Committee on Armed Services, 'National Defense Authorization Act for Fiscal Year 2023: Report', 1 July 2022.

[12] Bush, G. W., US president, 'Address before a joint session of the Congress on the state of the union', 28 Jan. 1992.

[13] US Department of Defense (note 6), p. 20.

[14] US Department of Defense (note 6), p. 20.

up to 30 pits in 2026 and set an initial target of at least 80 pits per year by 2030 to meet the demands of the US nuclear modernization programmes.[15] In order to fulfil these objectives, the NNSA is modernizing its plutonium-processing facility (PF-4) at Los Alamos National Laboratory in New Mexico and creating a new plutonium-processing facility at the Savannah River Site in South Carolina.[16]

In February 2022 the NNSA confirmed what outside experts had long predicted—that the goal of producing up to 80 pits per year by 2030 would not be possible.[17] Hence, some of the nuclear weapon programmes described below will probably face delays or new delivery systems could be initially deployed with existing warheads.[18]

Strategic nuclear forces

US offensive strategic nuclear forces include heavy bombers, land-based intercontinental ballistic missiles (ICBMs) and nuclear-powered ballistic missile submarines (SSBNs). These forces, together known as the triad, changed little during 2022. SIPRI estimates that a total of 3508 nuclear warheads were assigned to the triad, of which an estimated 1670 warheads were deployed on ballistic missiles and at heavy bomber bases.

Aircraft and air-delivered weapons

As of January 2023 the US Air Force (USAF) operated a fleet of 152 heavy bombers: 45 B-1Bs, 20 B-2As and 87 B-52Hs. Of these, 66 (20 B-2As and 46 B-52Hs) were nuclear-capable and approximately 60 (18 B-2As and 42 B-52Hs) are assigned nuclear missions under US nuclear war plans. The B-2A can deliver gravity bombs (B61-7, B61-11 and B83-1) and the B-52H can deliver the AGM-86B/W80-1 nuclear air-launched cruise missile (ALCM). SIPRI estimates that approximately 788 warheads were assigned to strategic bombers, of which about 300 are deployed at bomber bases and ready for delivery on relatively short notice.[19] The USA is modernizing its nuclear

[15] US National Nuclear Security Administration (NNSA), 'Plutonium pit production', Fact sheet, Apr. 2019; and US Government Accountability Office (GAO), *Nuclear Weapons: NNSA Should Further Develop Cost, Schedule, and Risk Information for the W87-1 Warhead Program*, Report no. GAO-20-73 (GAO: Washington, DC, Sep. 2020), pp. 14–15.

[16] US Department of Energy (note 1), p. 8-7.

[17] Demarest, C., '80 pits by 2030 won't happen, NNSA boss reaffirms. But "acceleration" is in the works', *Aiken Standard*, 8 Feb. 2022. See also e.g. US Government Accountability Office (note 15), p. 5; Hunter, D. E. et al., 'Independent assessment of the two-site pit production decision: Executive summary', Institute for Defense Analyses (IDA) document no. NS D-10711, May 2019, p. 4; and Demarest, C., 'Plutonium pit production in SC might happen in 2035. The target was 2030', *Aiken Standard*, 12 June 2021.

[18] US Air Force (USAF), *Report on Development of Ground-Based Strategic Deterrent Weapon*, Report to eight congressional committees (USAF: [Washington, DC,] May 2020), p. 4.

[19] The reduction in bomber weapons compared with *SIPRI Yearbook 2022* is not the result of new cuts but of new stockpile numbers causing a reassessment of the estimate.

bomber force by upgrading nuclear command-and-control capabilities on existing bombers, developing improved nuclear weapons (the B61-12 gravity bomb and the new AGM-181 Long-Range Standoff Weapon, LRSO) and building a new heavy bomber (the B-21 Raider).

The first six B-21s are expected to enter service in 2027; the aircraft will gradually replace the B-1B and B-2 bombers.[20] It is expected that the USAF will procure at least 100 (possibly as many as 145) of the new bombers, with the latest service costs estimated at approximately $203 billion for the entire 30-year operational programme, at an estimated production cost of $550 million per aircraft.[21] As a result of these developments, the number of US bomber bases with nuclear capability is expected to increase from two in 2022 to five by the early 2030s.[22]

The B-21 appears to have a slightly reduced weapons load than the B-2. It will be capable of delivering two types of nuclear weapon: the B61-12 guided nuclear gravity bomb, which is also designed to be deliverable from shorter-range non-strategic aircraft (see below); and the AGM-181 LRSO ALCM, which is in development. The AGM-181 LRSO will replace the AGM-86B ALCM in the early 2030s and will carry the W80-4 nuclear warhead, a modified version of the W80-1 warhead that is used on the AGM-86B. In mid 2022 the NNSA announced that the schedule for the first production unit of the W80-4 had slipped to the end of FY 2027, instead of FY 2025 as originally planned. Production is scheduled to be completed in FY 2031.[23]

Land-based missiles

As of January 2023 the USA deployed 400 LGM-30G Minuteman III ICBMs in 400 silos across three missile wings.[24] Another 50 empty silos are kept in a state of readiness for reloading with stored missiles if necessary. SIPRI estimates that 800 warheads were assigned to the ICBM force, of which 400 were deployed on the missiles. Each Minuteman III ICBM is armed with either a 335-kiloton W78/Mk12A or a 300-kt W87-0/Mk21 warhead. Missiles carrying the W78 can be uploaded with up to two more warheads

[20] Tirpak, J. A., 'B-21 Raider first flight now postponed to 2023', *Air Force Magazine*, 20 May 2022; and US Air Force, 'B-21 bomber to be unveiled Dec. 2', 20 Oct. 2022.

[21] Capaccio, A., 'Under-wraps B-21 bomber is seen costing $203 billion into 2050s', Bloomberg, 17 Nov. 2021; and Tirpak, J. A., 'A new bomber vision', *Air Force Magazine*, 1 June 2020.

[22] Dawkins, J. C., Commander, 8th Air Force and Joint-Global Strike Operations Center, Barksdale Air Force Base, 'B21 General Dawkins intro', YouTube, 19 Mar. 2020, 01:35; and Kristensen, H. M., 'USAF plans to expand nuclear bomber bases', FAS Strategic Security Blog, Federation of American Scientists, 17 Nov. 2020.

[23] Leone, D., 'Two-year delay for first LRSO warhead, but NNSA says will still deliver on-time to Air Force', Defense Daily, 4 Aug. 2022.

[24] Willett, E., 'AF meets New START requirements', US Air Force Global Strike Command, Press release, 28 June 2017.

for a maximum of three multiple independently targetable re-entry vehicles (MIRVs). ICBMs with the W87-0 can only be loaded with one warhead.[25]

The USAF has scheduled its next-generation ICBM to begin replacing the Minuteman III in 2028, with full replacement by 2036, although delays to this schedule are expected.[26] Flight-testing of this new ICBM—the LGM-35A Sentinel—is expected to begin in 2023.[27] Each Sentinel will be able to carry up to two warheads, with the USAF planning to produce a significantly modified warhead based on the same design as the W87-0, known as the W87-1. The cost of the W87-1 warhead-modernization programme has been estimated at between $12.2 billion and $14.2 billion, but this excludes the considerable costs of producing the plutonium pits for the warhead.[28] After the NNSA completed a review of the W87-1 in 2021, the programme entered the development engineering phase in 2022, with anticipated completion of the first production unit in FY 2030.[29] However, production of the W87-1 in time to meet the Sentinel's planned deployment schedule depended on the NNSA's projected production rate of at least 80 plutonium pits per year by 2030 (see above). The NNSA's acknowledgement that this objective is unrealistic probably means that the Sentinel will initially be deployed with the existing W87-0 warheads.[30]

Sea-based missiles

The US Navy operates a fleet of 14 Ohio-class SSBNs, of which 12 are normally considered to be operational with the remaining 2 typically undergoing refuelling and overhaul at any given time. Eight of the SSBNs are based at Naval Base Kitsap in Washington state, on the Pacific Ocean, and six at Naval Submarine Base Kings Bay in Georgia, on the Atlantic. The most recent refuelling was completed in 2022, meaning that all 14 boats are now potentially deployable until 2027, when the first Ohio-class submarine is expected to retire.[31]

Each Ohio-class SSBN can carry up to 20 Trident II D5 submarine-launched ballistic missiles (SLBMs). To meet the New START limit on deployed launchers, 4 of the 24 initial missile tubes on each submarine were deactivated so that the 12 SSBNs that are usually operational can carry no

[25] On the warheads and yields see also Kristensen, H. M. and Korda, M., 'United States nuclear forces', *SIPRI Yearbook 2021*, p. 341.

[26] Richard, C. A., Commander, US Strategic Command, Statement before the US Senate, Armed Services Committee, 13 Feb. 2020, p. 9. On the Sentinel see also Kristensen and Korda (note 25), p. 341.

[27] 'LGM-35A Sentinel intercontinental ballistic missile, USA', Airforce Technology, 29 July 2022.

[28] US Department of Energy (note 1), p. 8-32.

[29] Sirota, S., 'NNSA completes requirements review of GBSD's W87-1 warhead', Inside Defense, 22 Apr. 2021; and US National Nuclear Security Administration (NNSA), 'W87-1 modification program', Jan. 2022.

[30] Demarest, '80 pits by 2030 won't happen' (note 17); and US Air Force (note 18).

[31] US Navy, Office of the Chief of Naval Operations, *Report to Congress on the Annual Long-Range Plan for Construction of Naval Vessels for Fiscal Year 2020* (US Navy: Washington, DC, Mar. 2019).

more than 240 missiles.[32] At any given time 8–10 SSBNs are normally at sea, of which 4–5 are on alert in their designated patrol areas and ready to fire their missiles within 15 minutes of receiving the launch order. The US SSBN fleet conducts about 30 deterrence patrols per year.[33]

The Trident II D5 SLBMs carry two basic warhead types: the 455-kt W88 and the W76. The latter exists in two versions: the 90-kt W76-1 and the low-yield W76-2.[34] The NNSA has begun modernizing the ageing W88 warhead, and the first production unit of the W88 Alt 370 was completed on 1 July 2021.[35] Mass production was expected to be authorized by the end of 2022, but appears to have been delayed.[36] Each SLBM can carry up to eight warheads but normally carries an average of four or five. SIPRI estimates that around 1920 warheads were assigned to the SSBN fleet as of January 2023, of which nearly 1000 were deployed on SLBMs.[37]

The newest warhead, the low-yield W76-2, was first deployed in late 2019 and has now been deployed on SSBNs in both the Atlantic and the Pacific.[38] It is a modification of the W76-1 and is estimated to have an explosive yield of 8 kt.[39] The 2022 NPR left open the possibility that the W76-2 warhead might be retired in the medium term as the F-35A combat aircraft and the LRSO are fielded over the coming decade.[40]

Since 2017 the US Navy has been replacing its Trident II D5 SLBMs with an enhanced version, known as the D5LE (LE for 'life extension'), which is equipped with the new Mk6 guidance system. The upgrade is scheduled for completion in 2024.[41] In 2022 the US Navy conducted four flight tests of the D5LE. It will arm Ohio-class SSBNs for the remainder of their service lives (up to 2042) and will also be deployed on the United Kingdom's Trident submarines (see section III). A new class of SSBN, the Columbia class, will initially be armed with D5LE SLBMs, but from 2039 these will

[32] US Navy Office of Information, 'Fleet ballistic missile submarines—SSBN', Fact file, 25 May 2021.

[33] See e.g. Kristensen, H., 'US SSBN patrols steady, but mysterious reduction in Pacific in 2017', FAS Strategic Security Blog, Federation of American Scientists, 24 May 2018.

[34] The older W76-0 version has been, or remains in the process of being, retired. On these warheads see also Kristensen and Korda (note 25), pp. 342–43.

[35] US National Nuclear Security Administration (NNSA), 'NNSA completes first production unit of W88 Alteration 370', 13 July 2021.

[36] Leone, D., 'Mass production of refurbished nuclear weapons could begin soon, NNSA says', Exchange Monitor, 15 Sep. 2022.

[37] US Department of State (note 5).

[38] Arkin, W. M. and Kristensen, H. M., 'US deploys new low-yield nuclear submarine warhead', FAS Strategic Security Blog, Federation of American Scientists, 29 Jan. 2020; and US Department of Defense, 'Statement on the fielding of the W76-2 low-yield submarine launched ballistic missile warhead', Press release, 4 Feb. 2020.

[39] US military officials, Private communication with authors, 2019–20.

[40] US Department of Defense (note 6), p. 20.

[41] Wolfe, J., Director of US Strategic Systems Programs, 'US nuclear weapons policy, programs, and strategy in review of the defense authorization request for fiscal year 2020 and the Future Years Defense Program', Statement before the US Senate, Armed Services Committee, Subcommittee on Strategic Forces, 1 May 2019, p. 4.

be replaced with an upgraded SLBM, the D5LE2.[42] The US Navy's FY 2022 budget submission estimated the procurement cost of the first Columbia-class SSBN—the USS *District of Columbia* (SSBN-826)—at approximately $15 billion, followed by a cost of $9.3 billion for the second boat.[43] The USS *District of Columbia* is scheduled to start patrols in 2031.[44]

To arm the D5LE2, the NNSA has begun early design development of a new nuclear warhead, known as the W93. This would be the first new warhead design developed by the USA since the end of the cold war. The W93 warhead will be housed in a new Mk7 re-entry body (aeroshell) that will also be deployed on the UK's new Dreadnought-class submarines (see section III). The W93 appears intended to initially supplement, rather than replace, the W76-1 and the W88. Another new warhead is planned to replace those warheads. The completion of the first production unit of the W93 is tentatively scheduled for 2034–36.[45]

Non-strategic nuclear forces

As of January 2023 the USA had one basic type of air-delivered non-strategic weapon in its stockpile—the B61 gravity bomb, which exists in two versions: the B61-3 and the B61-4.[46] There were an estimated 200 of these bombs in the stockpile.

SIPRI estimates that the USAF has deployed approximately 100 of the B61 bombs outside the USA for potential use by combat aircraft operated by members of the North Atlantic Treaty Organization (NATO), although the weapons remain in USAF custody. They are at six airbases in five NATO member states: Kleine Brogel in Belgium; Büchel in Germany; Aviano and Ghedi in Italy; Volkel in the Netherlands; and İncirlik in Türkiye.[47] The remaining (*c.* 100) B61 bombs are thought to be stored at Kirtland Air Force Base in New Mexico for potential use by US aircraft, possibly including

[42] Wolfe, J., Director of US Strategic Systems Programs, 'FY2021 budget request for nuclear forces and atomic energy defense activities', Statement before the US House of Representatives, Armed Services Committee, Subcommittee on Strategic Forces, 3 Mar. 2020, p. 5.

[43] O'Rourke, R., *Navy Columbia (SSBN-826) Class Ballistic Missile Submarine Program: Background and Issues for Congress*, Congressional Research Service (CRS) Report for Congress R41129 (US Congress, CRS: Washington, DC, 22 Feb. 2022), p. 9.

[44] Wolfe (note 41), p. 8.

[45] US Department of Energy (note 1), p. 2-10.

[46] A third version, the B61-10, was retired in Sep. 2016. US Department of Energy (DOE), National Nuclear Security Administration (NNSA), *Fiscal Year 2018 Stockpile Stewardship and Management Plan*, Report to Congress (DOE: Washington, DC, Nov. 2017), figures 1.1–1.7, p. 1-13.

[47] For detailed overviews of the dual-capable aircraft programmes of the USA and its NATO allies see Kristensen (note 8), pp. 299–300; and Andreasen, S. et al., *Building a Safe, Secure, and Credible NATO Nuclear Posture* (Nuclear Threat Initiative: Washington, DC, Jan. 2018).

in East Asia.[48] USA-based fighter wings for this mission include the 366th Fighter Wing at Mountain Home Air Force Base in Idaho.[49]

To replace all current versions of the B61 (including the non-strategic B61-3 and B61-4), the USA is producing the new B61-12 guided nuclear bomb. A guided tail-kit enables the B61-12 to hit targets more accurately, meaning that it can use lower yields and thus generate less radioactive fallout.[50] Full-scale production of the B61-12 began in late 2022 and is expected to be completed by 2026.[51] Once deployment to the bases outside the USA begins, the B61-3 and B61-4 bombs currently deployed at those bases will be returned to the USA and dismantled.

Operations to integrate the incoming B61-12 on seven types of aircraft operated by the USA or its NATO allies continued in 2022: the B-2A, the new B-21, the F-15E, the F-16C/D, the F-16MLU, the F-35A and the PA-200 (Tornado).[52] The F-35A will replace all Belgian, Dutch and US F-16s and German and Italian Tornado aircraft in the nuclear strike role.

[48] US Department of Defense, *Nuclear Posture Review 2018* (note 8), p. 48.

[49] Heflin, L., '53rd Wing WSEP incorporates NucWSEP, enhances readiness for real world operations', Press release, Air Combat Command, 9 Sep. 2021.

[50] Kristensen, H. M. and McKinzie, M., 'Video shows earth-penetrating capability of B61-12 nuclear bomb', FAS Strategic Security Blog, Federation of American Scientists, 14 Jan. 2016.

[51] Meub, K., 'B61-12 production begins', *Sandia LabNews*, Sandia National Laboratories, 11 Feb. 2022; and Defense Visual Information Distribution Service, 'F-35 dual-capable aircraft team meets goals ahead of schedule, earns prestigious award', F-35 Joint Program Office Public Affairs, 17 Feb. 2022.

[52] US Air Force (USAF), *Acquisition Annual Report Fiscal Year 2018: Cost-effective Modernization* (USAF: Washington, DC, [n.d.]), p. 24.