

I. United States nuclear forces

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As of January 2021, the United States maintained a military stockpile of approximately 3800 nuclear warheads, roughly the same number as in January 2020. Approximately 1800 of these—consisting of about 1700 strategic and 100 non-strategic (or tactical) warheads—were deployed on aircraft, ballistic missiles and submarines. In addition, about 2000 warheads were held in reserve and around 1750 retired warheads were awaiting dismantlement (250 fewer than the estimate for 2020), giving a total inventory of approximately 5550 nuclear warheads (see table 10.2).

These estimates are based on publicly available information regarding the US nuclear arsenal. In 2010 the USA for the first time declassified the entire history of its nuclear weapon stockpile size, but since 2019 there has been a shift towards a lower level of transparency.¹ This was evidenced by the fact that in 2020, as had been the case in 2019, the US administration of President Donald J. Trump declined to declassify the number of nuclear weapons in the stockpile and the number of retired warheads that had been dismantled over the year.² The refusal, which was not explained, provided political cover for other nuclear-armed states to be less transparent and made an accurate independent assessment of the US nuclear arsenal significantly harder.

In 2020 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.³ The numbers of deployed warheads presented below differ from the numbers reported under New START because the treaty attributes one weapon to each deployed bomber—even though bombers do not carry weapons under normal circumstances—and does not count warheads stored at bomber bases.

The role of nuclear weapons in US military doctrine

According to the 2018 Nuclear Posture Review (NPR), ‘The United States would only consider the employment of nuclear weapons in extreme circumstances to defend the vital interests of the United States, its allies, and

¹ E.g. US Department of Defense, ‘Increasing transparency in the US nuclear weapons stockpile’, Fact sheet, 3 May 2010.

² Kristensen, H. M., ‘Trump administration again refuses to disclose nuclear stockpile size’, Federation of American Scientists (FAS) Strategic Security Blog, 3 Dec. 2020.

³ For a summary and other details of New START see annex A, section III, in this volume. On the negotiation of the renewal of New START see chapter 11, section I, in this volume.

Table 10.2. United States nuclear forces, January 2021

All figures are approximate and some are based on assessments by the authors. Totals for strategic and non-strategic forces are rounded to the nearest 5 warheads.

Type	Designation	No. of launchers	Year first deployed	Range (km) ^a	Warheads x yield	No. of warheads ^b
Strategic nuclear forces						3 570
<i>Aircraft (bombers)</i>		107/66 ^c				848 ^d
B-52H	Stratofortress	87/46	1961	16 000	20 x ALCMs	528 ^f
B-2A	Spirit	20/20	1994	11 000	16 x B61-7,-11, B83-1 bombs ^g	320
<i>Land-based missiles (ICBMs)</i>		400				800 ^h
LGM-30G	Minuteman III					
	Mk12A	200	1979	13 000	1-3 x W78	335 kt 600 ⁱ
	Mk21 SERV	200	2006	13 000	1 x W87	300 kt 200 ^j
<i>Sea-based missiles (SLBMs)</i>		14/280 ^k				1 920 ^l
UGM-133A	Trident II (D5/D5LE)					
	Mk4	..	1992	>12 000	1-8 x W76-0	100 kt - ^m
	Mk4A	..	2008	>12 000	1-8 x W76-1	90 kt 1 511
	Mk4A	..	2019	>12 000	1 x W76-2	8 kt 25 ⁿ
	Mk5	..	1990	>12 000	1-8 x W88	455 kt 384
Non-strategic nuclear forces						230^o
F-15E	Strike Eagle	..	1988	3 840	5 x B61-3, -4 ^p	80
F-16C/D	Falcon	..	1987	3 200 ^q	2 x B61-3, -4	70
F-16MLU	Falcon (NATO)	..	1985	3 200	2 x B61-3, -4	40
PA-200	Tornado (NATO)	..	1983	2 400	2 x B61-3, -4	40
Total stockpile						3 800^r
Deployed warheads						1 800 ^s
Reserve warheads						2 000
Retired warheads awaiting dismantlement^t						1 750
Total inventory						5 550^u

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

Note: The table lists the total number of warheads estimated to be available for the delivery systems. Only some of these are deployed and the strategic warheads do not necessarily correspond to the data-counting rules of the 2010 Russian-US Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START).

^a For aircraft, the listed range refers to the maximum unrefuelled range. All nuclear-equipped aircraft can be refuelled in the air. Actual mission range will vary according to flight profile, weapon loading and in-flight refuelling.

^b These numbers show the total number of warheads estimated to be assigned to nuclear-capable delivery systems. Only some of these warheads are deployed on missiles and at air bases.

^c The first figure is the total number of bombers in the inventory; the second is the number equipped for nuclear weapons. The USA has declared that it will deploy no more than 60 nuclear bombers at any time but normally only about 50 nuclear bombers are deployed, with the remaining aircraft in overhaul.

^d Of the c. 848 bomber weapons, c. 300 (200 ALCMs and 100 bombs) are deployed at the bomber bases; all the rest are in central storage. Many of the gravity bombs are no longer fully active and are slated for retirement after the B61-12 is fielded in the early 2020s.

^e The B-52H is no longer configured to carry nuclear gravity bombs.

^f In 2006 the Department of Defense decided to reduce the future ALCM fleet to 528 missiles. It is possible the inventory has been reduced slightly since then. Burg., R. (Maj. Gen.), 'ICBMs, helicopters, cruise missiles, bombers and warheads', Statement, US Senate, Armed Services Committee, Strategic Forces Subcommittee, 28. Mar. 2007, p. 7.

^g Strategic gravity bombs are only assigned to B-2A bombers. The maximum yields of strategic bombs are 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. The administration of President Barack Obama decided that the B83-1 would be retired once the B61-12 is deployed, but the 2018 Nuclear Posture Review indicates that the B83-1 might be retained for a longer period.

^h Of the 800 ICBM warheads, only 400 are deployed on the missiles. The remaining warheads are in central storage.

ⁱ Only 200 of these W78 warheads are deployed; all the rest are in central storage.

^j SIPRI estimates that another 340 W87 warheads might be in long-term storage outside the stockpile for use in the W78 replacement warhead (W87-1) programme.

^k The first figure is the total number of nuclear-powered ballistic missile submarines (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 or 2 of these vessels are usually undergoing maintenance at any given time and may not be carrying missiles. As of Sep. 2020, the New START aggregate data listed 11 SSBNs deployed with 220 SLBMs.

^l Of the 1920 SLBM warheads, just over 1000 are deployed on submarines; all the rest are in central storage. Although each D5 missile was counted under the 1991 Strategic Arms Reduction Treaty as carrying 8 warheads and the missile was initially flight tested with 14, the US Navy has downloaded 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.

^m It is assumed here that all W76-0 warheads have been replaced by the W76-1.

ⁿ 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.

^o Approximately 100 of the 230 tactical bombs are thought to be deployed across 6 NATO airbases outside the USA. The remaining bombs are in central storage in the USA. Older B61 versions will be dismantled once the B61-12 is deployed.

^p The maximum yields of tactical 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 km, but Lockheed Martin, which produces the F-16, lists 3200 km.

^r Of these 3800 weapons, approximately 1800 are deployed on ballistic missiles, at bomber bases in the USA and at 6 NATO airbases outside the USA; all the rest are in central storage.

^s The deployed warhead number in this table differs from the number declared under New START because the treaty attributes 1 warhead per deployed bomber—even though bombers do not carry warheads under normal circumstances—and does not count warheads stored at bomber bases.

^t 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. Based on previous performance and the completion of the W76-1 life-extension programme, SIPRI estimates that roughly 250 (but possibly more) retired warheads were dismantled during 2020.

⁴ In addition to these intact warheads, more than 20 000 plutonium pits are stored at the Pantex Plant, Texas, and perhaps 4000 uranium secondaries are 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 communications; *Bulletin of the Atomic Scientists*, 'Nuclear notebook', various issues; and author's estimates.

partners.⁴ The NPR further clarifies that the USA reserves the right to use nuclear weapons first in a conflict, and could use nuclear weapons in response to 'significant non-nuclear strategic attacks' on 'the US, allied, or partner civilian population or infrastructure, and attacks on US or allied nuclear forces, their command and control, or warning and attack assessment capabilities'.⁵

The USA continued to implement the 2018 NPR throughout 2020. This included a 25 per cent increase in funding in financial year 2021 for the US National Nuclear Security Administration (NNSA), which, among other things, oversees nuclear warhead research, development and acquisition programmes.⁶ The Trump administration continued to implement several large-scale nuclear weapon programmes initiated under the administration of President Barack Obama, including modernization programmes for all three legs of the nuclear triad. The Trump administration also continued to implement several of its own newer non-strategic nuclear weapon programmes. For example, in 2020 the USA completed the deployment of low-yield W76-2 nuclear warheads on its fleet of nuclear-powered ballistic missile submarines (SSBNs) in the Atlantic and Pacific oceans, and it made progress in its plans to field a new nuclear-armed sea-launched cruise missile (SLCM-N; see below).

The 2018 NPR's justification for the deployment of low-yield warheads and the development of the SLCM-N reflected important doctrinal changes in US nuclear planning. According to the NPR, the W76-2 is intended to provide the USA with a prompt low-yield capability aimed at deterring Russia from escalating to first use of non-strategic nuclear weapons, in the event that Russia perceived it was about to lose a conventional war.⁷ However, there is little publicly available evidence of such a shift in Russia's nuclear doc-

⁴ US Department of Defense (DOD), *Nuclear Posture Review 2018* (DOD: Arlington, VA, Feb. 2018), p. 21.

⁵ US Department of Defense (note 4), p. 21.

⁶ Woolf, A. F., *Energy and Water Development Appropriations: Nuclear Weapons Activities*, Congressional Research Service (CRS) Report for Congress R44442 (US Congress, CRS: Washington, DC, 22 Dec. 2020), p. i. The US financial year starts on 1 Oct. of the year before the named year and ends on 30 Sep. On US military expenditure see chapter 8, section I, in this volume.

⁷ US Department of Defense (note 4), pp. 8, 53–55.

trine.⁸ Both the W76-2 and SLCM-N are explicitly intended to restrengthen US non-strategic nuclear weapon operations, which had seemingly reduced in importance for the US military since the end of the cold war. Notably, a 2020 paper by the US Department of Defense (DOD) suggests that the SLCM-N will ‘provid[e] additional limited employment capabilities that an adversary will have to consider if contemplating the coercive use of nuclear weapons’, and the NPR states that the weapons ‘expand the range of credible US options for responding to nuclear or non-nuclear strategic attack’.⁹ However, a nuclear attack in response to non-nuclear strategic attacks would constitute first use of nuclear weapons—the very act that the NPR criticizes Russia for including in its presumed doctrine.

Based on the more aggressive nuclear posture set out by the NPR, at the end of 2020 the Trump administration disclosed plans to develop an entirely new nuclear warhead, known as the W93 (see below).¹⁰ This would be the first brand-new warhead developed by the USA since the end of the cold war. The W93 was part of a much broader nuclear weapon modernization plan presented in the NNSA’s Nuclear Weapons Stockpile and Management Plan, which doubled the number of new nuclear warhead programmes compared with the previous plan published in 2019.¹¹

Strategic nuclear forces

US offensive strategic nuclear forces include heavy bomber aircraft, land-based intercontinental ballistic missiles (ICBMs) and SSBNs. These forces, together known as the triad, changed little during 2020. SIPRI estimates that a total of 3570 nuclear warheads are assigned to the triad, of which an estimated 1700 warheads are deployed on missiles and at bomber bases.

⁸ Bruusgaard, K. V., ‘Here’s why US tactical nukes are a bad idea’, *National Interest*, 10 Dec. 2018; Oliker, O. and Baklitskiy, A., ‘The Nuclear Posture Review and Russian “de-escalation”: A dangerous solution to a nonexistent problem’, *War on the Rocks*, 20 Feb. 2018; and Oliker, O., ‘Russia’s nuclear doctrine: What we know, what we don’t, and what that means’, *Center for Strategic and International Studies (CSIS)*, May 2016.

⁹ 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; and US Department of Defense (note 4), p. xiii. For a summary and other details of the Nuclear Posture Review see Kristensen, H. M., ‘US nuclear forces’, *SIPRI Yearbook 2019*, pp. 289–94.

¹⁰ US Department of Energy, National Nuclear Security Administration (NNSA), *Fiscal Year 2021 Stockpile Stewardship and Management Plan—Biennial Plan Summary*, Report to Congress (NNSA: Washington, DC, Dec. 2020), pp. 2–6. See also Kristensen, H. M., ‘NNSA nuclear plan shows more weapons, increasing costs, less transparency’, *Federation of American Scientists (FAS) Strategic Security Blog*, 30 Dec. 2020.

¹¹ US Department of Energy (note 10).

Aircraft and air-delivered weapons

The US Air Force (USAF) currently operates a fleet of 169 heavy bombers: 62 B-1Bs, 20 B-2As and 87 B-52Hs. Of these, 66 (20 B-2As and 46 B-52Hs) are nuclear-capable. 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 almost 850 warheads are assigned to strategic bombers, of which about 300 are deployed at bomber bases and ready for delivery on relatively short notice.

Both the B-2As and B-52Hs are undergoing modernization intended to improve their ability to receive and transmit secure nuclear mission data. This includes the ability to communicate with the Advanced Extreme High Frequency (AEHF) satellite network used by the US president and military leadership to transmit launch orders and manage nuclear operations.¹²

The development of the next-generation long-range strike bomber, known as the B-21 Raider, is well under way and the first two test aircraft are being constructed.¹³ The B-21 will be capable of delivering two types of nuclear weapon: the B61-12 guided nuclear gravity bomb, which is nearing full-scale production and will also be deliverable from shorter-range non-strategic aircraft (see below); and the Long-Range Standoff Weapon (LRSO) ALCM, which is in development. The new bomber is scheduled to enter service in the mid 2020s.¹⁴ The B-21 will replace the B-1B and B-2A bombers at Dyess Air Force Base (AFB) in Texas, Ellsworth AFB in South Dakota, and Whiteman AFB in Missouri.¹⁵ The nuclear-capable B-21 will also replace non-nuclear B-1B bombers and entail ‘the reintroduction of nuclear mission requirements’.¹⁶ The number of US bomber bases with nuclear weapon storage capability is thus expected to increase from two as of January 2021 to five by the early 2030s.¹⁷ The USAF plans to acquire at least 100 (but possibly as many as 145) B-21 bombers by the mid 2030s.¹⁸ However, the final number will be determined by funding decisions made by the US Congress.

¹² US Department of Defense (DOD), *Fiscal Year (FY) 2021 Budget Estimates: Air Force: Justification Book*, vol. 3a, *Research, Development, Test & Evaluation, Air Force*, vol. III, part 1 (DOD: Arlington, VA, Feb. 2020), pp. 109–82, 203–21.

¹³ Tirpak, J., ‘Second B-21 under construction as bomber moves toward first flight’, *Air Force Magazine*, 15 Jan. 2021.

¹⁴ Gertler, J., *Air Force B-21 Raider Long-range Strike Bomber*, Congressional Research Service (CRS) Report for Congress R44463 (US Congress, CRS: Washington, DC, 13 Nov. 2019), p. 10.

¹⁵ US Air Force, Secretary of the Air Force Public Affairs, ‘Air force selects locations for B-21 aircraft’, 2 May 2018.

¹⁶ Dawkins, J. C., Commander, 8th Air Force and Joint-Global Strike Operations Center, Barksdale AFB, ‘B21 General Dawkins intro’, YouTube, 19 Mar. 2020, 01:35.

¹⁷ Kristensen, H. M., ‘USAF plans to expand nuclear bomber bases’, *Federation of American Scientists (FAS) Strategic Security Blog*, 17 Nov. 2020.

¹⁸ Tirpak, J., ‘A new bomber vision’, *Air Force Magazine*, 1 June 2020.

Land-based missiles

As of January 2021, the USA deployed 400 Minuteman III ICBMs in 450 silos across three missile wings. The 50 empty silos are kept in a state of readiness and can be reloaded with stored missiles if necessary.¹⁹

Each Minuteman III ICBM is armed with one warhead: either a 335-kiloton W78 or a 300-kt W87. The W78 warhead is carried in the Mk12A re-entry vehicle and the W87 is carried in the Mk21 re-entry vehicle. Missiles carrying the W78 can be upgraded with up to two more warheads for a maximum of three multiple independently targetable re-entry vehicles (MIRVs). SIPRI estimates that there are 800 warheads assigned to the ICBM force, of which 400 are deployed on the missiles.

The USAF has begun development of a next-generation ICBM, the Ground Based Strategic Deterrent (GBSD). It is scheduled to begin replacing the Minuteman III in 2028, with full replacement by 2036.²⁰ On 8 December 2020 the USAF awarded a \$13.3 billion engineering and manufacturing development contract to Northrop Grumman Corporation—the sole bidder for the GBSD contract. According to the USAF, the GBSD is a ‘modular design’ with ‘evolutionary warfighting effectiveness’ that will give the US ICBM force ‘increased accuracy, extended range and improved reliability’.²¹ It has not yet publicly provided a rationale for why these enhanced capabilities are needed for the ICBM mission.

The projected cost of the programme has continued to increase and the absence of competition in the bidding process for the contract may have eliminated any potential to make savings up front. The total projected cost rose from \$62.5 billion in 2015 to \$95.8 billion in 2020.²² For the 10-year period 2019–28 alone, the US Congressional Budget Office (CBO) in 2019 projected that the cost would be \$61 billion, \$18 billion higher than the 2017 estimate for 2017–26.²³ The cost is likely to increase further, which perhaps calls into question the decision not to extend the life of the existing Minuteman III.

The USAF is also modernizing the nuclear warheads that will be used to arm the GBSD. Initially, some of these will also be used to arm the current Minuteman III for the remainder of its service life. The W87/Mk21 is being

¹⁹ Willett, E., ‘AF meets New START requirements’, US Air Force Global Strike Command, 28 June 2017.

²⁰ Richard, C. A., Commander, US Strategic Command, Statement, US Senate, Armed Services Committee, 13 Feb. 2020, p. 9.

²¹ US Air Force, Secretary of the Air Force Public Affairs, ‘Department of the Air Force awards contract for new ICBM that enhances, strengthens US triad’, 8 Sep. 2020.

²² Reif, K., ‘New ICBM replacement cost revealed’, *Arms Control Today*, vol. 47, no. 2 (Mar. 2017); and Burns, R., ‘Pentagon estimates cost of new nuclear missiles at \$95.8B’, Associated Press, 20 Oct. 2020.

²³ Bennett, M., ‘Projected costs of US nuclear forces, 2019 to 2028’, US Congressional Budget Office, Jan. 2019, p. 9.

upgraded with a new arming, fusing and firing unit, and the W78/Mk12A will be replaced entirely. The replacement warhead was formerly known as the Interoperable Warhead 1 (IW1), but in 2018 it was given the designation W87-1 to reflect the fact that it will use a plutonium pit similar to that of the W87, with insensitive high explosives (IHE) instead of the conventional high explosives (CHE) used in the W78.²⁴ The projected cost of the W87-1 programme is between \$11.8 billion and \$15 billion, but this estimate does not include costs associated with production of plutonium pits for the W87-1.²⁵

Sea-based missiles

The US Navy operates a fleet of 14 Ohio-class SSBNs, of which 12 are normally considered to be operational and 2 are typically undergoing refuelling and overhaul at any given time. Eight of the SSBNs are based at Naval Base Kitsap in Washington state and six at Naval Submarine Base Kings Bay in Georgia.

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 deployable SSBNs can carry no more than 240 missiles.²⁶ Around 8 to 10 SSBNs are normally at sea, of which 4 or 5 are on alert in their designated patrol areas and ready to fire their missiles within 15 minutes of receiving the launch order.

The Trident II D5 SLBMs carry two basic warhead types. These are the 455-kt W88 and the W76, which exists in two versions: the 90-kt W76-1 and the low-yield W76-2.²⁷ The W88 warhead is carried in the Mk5 re-entry body (aershell); the W76-1 and W76-2 warheads each use the Mk4A re-entry body. The Mk4A is equipped with a new fuse that improves its damage effectiveness.²⁸ Each SLBM can carry up to eight warheads but normally carries an average of four to five. SIPRI estimates that around 1920 warheads are assigned to the SSBN fleet, of which about 1000 are currently deployed on missiles.²⁹

²⁴ Padilla, M., 'Sandia on target for first Mk21 Fuze flight test in 2018', *Sandia LabNews*, vol. 70, no. 6 (16 Mar. 2018); and US Department of Energy, National Nuclear Security Administration (NNSA), *W78 Replacement Program (W87-1): Cost Estimates and Use of Insensitive High Explosives*, Report to Congress (NNSA: Washington, DC, Dec. 2018), pp. III, 7.

²⁵ US Department of Energy (note 10), pp. 5–32, 5–33.

²⁶ US Navy Office of Information, 'Fleet ballistic missile submarines—SSBN', *America's Navy*, 29 Jan. 2019.

²⁷ The older W76-0 version has been, or remains in the process of being, retired.

²⁸ Kristensen, H. M., McKinzie, M. and Postol, T. A., 'How US nuclear forces modernization is undermining strategic stability: The burst-height compensating super-fuze', *Bulletin of the Atomic Scientists*, 1 Mar. 2017.

²⁹ US Department of State, Bureau of Arms Control, Verification and Compliance, 'New START Treaty aggregate numbers of strategic offensive arms', Fact sheet, 1 Dec. 2020.

The newest warhead, the low-yield W76-2, was first deployed in late 2019 onboard the USS *Tennessee* (SSBN-734) in the Atlantic Ocean and is now deployed on SSBNs in both the Atlantic and the Pacific.³⁰ It is a modification of the W76-1 and is estimated to have an explosive yield of about 8 kt.³¹ As noted above, the 2018 NPR claims that the warhead is needed to deter Russia from the first use of low-yield non-strategic nuclear weapons, even though the USA already has an estimated 1050 air-delivered weapons with low-yield options in its inventory.³²

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'). The upgrade is scheduled to be completed in 2024.³³ The D5LE is equipped with the new Mk6 guidance system. The D5LE will arm Ohio-class SSBNs for the remainder of their service lives (up to 2042) and will be deployed on the United Kingdom's Trident submarines (see section III). A new class of SSBN, the Columbia class, will initially also be armed with the D5LE, but these will eventually be replaced with an upgraded SLBM, the D5LE2, starting in 2039.³⁴ The first Columbia-class SSBN—the USS *Columbia* (SSBN-826)—is scheduled to start patrols in 2031.

To arm the D5LE2, the NNSA has begun early design development of a new nuclear warhead, known as the W93, to complement the W76 and W88 warheads. The W93 warhead will be housed in a new Mk7 re-entry body (aeroshell) that will also be delivered to the British Royal Navy. According to the DOD, the W93/Mk7 will be lighter than existing SLBM warheads, even though it will use IHE instead of CHE to increase safety. It will 'allow for more efficient targeting by expanding the footprint of targets the warhead can hit, thereby increasing targeting flexibility and efficiency', which will 'improve the SSBN force's ability to hold all targets in current plans at risk'.³⁵ Production is scheduled to begin in the mid 2030s.³⁶

³⁰ Arkin, W. M. and Kristensen, H. M., 'US deploys new low-yield nuclear submarine warhead', Federation of American Scientists (FAS) Strategic Security Blog, 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.

³¹ US military officials, Private communications with authors, 2019–20.

³² US Department of Defense (note 4), pp. 54–55; and Kristensen, H. M., 'The flawed push for new nuclear weapons capabilities', Federation of American Scientists (FAS) Strategic Security Blog, 29 June 2017. This estimate covers strategic and non-strategic weapons but does not include the B61-11, which has a single high-yield option.

³³ Wolfe, J., Director of US Strategic Systems Programs, Statement, US Senate, Armed Services Committee, Strategic Forces Subcommittee, 1 May. 2019, p. 4.

³⁴ Wolfe, J., Director of US Strategic Systems Programs, 'FY2021 budget request for nuclear forces and atomic energy defense activities', Statement, US House of Representatives, Armed Services Committee, Strategic Forces Subcommittee, 3 Mar. 2020, p. 5.

³⁵ US Department of Defense, 'W93/Mk7 Navy warhead: Developing modern capabilities to address current and future threats', May 2020, p. 2. Part of this document is available online.

³⁶ US Department of Defense (note 35), p. 2.

Non-strategic nuclear forces

US non-strategic (tactical) nuclear forces include nuclear bombs delivered by several types of short-range fighter-bomber aircraft, as well as potentially a future nuclear-armed SLCM.

Air force weapons

The USA currently has 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 B61-4.³⁷ An estimated 230 tactical B61 bombs remain in the stockpile.

SIPRI estimates that the USA deploys approximately 100 of the bombs for potential use by fighter-bomber aircraft at six airbases in five other member states of the North Atlantic Treaty Organization (NATO): Kleine Brogel in Belgium; Büchel in Germany; Aviano and Ghedi in Italy; Volkel in the Netherlands; and İncirlik in Turkey.³⁸ The remaining (c. 130) B61 bombs are thought to be stored at Kirtland AFB in New Mexico for potential use by US aircraft in support of allies outside Europe, including in East Asia.³⁹

The USA is close to completing the development of the B61-12 guided nuclear bomb, which will replace all existing versions of the B61 (both strategic and non-strategic). Delivery was scheduled to start in 2020 but production problems in 2019 caused delays; delivery is now expected to take place in 2022.⁴⁰ The new version is equipped with a guided tail kit that enables it to hit targets more accurately, meaning that it could be used with a lower yield and potentially produce less radioactive fallout.⁴¹

Operations to integrate the incoming B61-12 on existing USAF and NATO aircraft continued in 2020. The USAF plans to integrate the B61-12 on seven types of US- and allied-operated aircraft: 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).⁴² Germany plans to retire its Tornado aircraft by 2030. In 2020 the German Government stressed the need for Germany to continue to participate in the NATO nuclear strike mission and submitted a proposal to the national parliament

³⁷ A third version, the B61-10, was retired in Sep. 2016. US Department of Energy, National Nuclear Security Administration (NNSA), *Fiscal Year 2018 Stockpile Stewardship and Management Plan*, Report to Congress (NNSA: Washington, DC, Nov. 2017), figure 1-7, pp. 1–13.

³⁸ For a detailed overview of the dual-capable aircraft programmes of the USA and its NATO allies see Kristensen (note 9), pp. 299–300; and Andreasen, S. et al., *Building a Safe, Secure, and Credible NATO Nuclear Posture* (Nuclear Threat Initiative: Washington, DC, Jan. 2018).

³⁹ US Department of Defense (note 4), p. 48.

⁴⁰ Gould, J. and Mehta, A., 'Nuclear gravity bomb and warhead upgrades face new delays', *Defense News*, 4 Sep. 2019; and Trevithick, J., 'F-15E Strike Eagle first jet cleared to employ Air Force's new B61-12 nuclear bombs', *The Drive*, 8 June 2020.

⁴¹ Kristensen, H. M. and McKinzie, M., 'Video shows earth-penetrating capability of B61-12 nuclear bomb', *Federation of American Scientists (FAS) Strategic Security Blog*, 14 Jan. 2016.

⁴² US Air Force (USAF), *Acquisition Annual Report Fiscal Year 2018: Cost-effective Modernization* (USAF: Arlington, VA, [n.d.]), p. 24.

to acquire 30 F/A-18E combat aircraft from the USA specifically adapted for delivering the new B61-12 nuclear bomb.⁴³ The final decision to proceed with the acquisition lies with the parliament and is planned for 2022 or 2023.⁴⁴

Navy weapons

As noted above, the 2018 NPR established a requirement for a new nuclear-armed SLCM—the SLCM-N.⁴⁵ In 2019 the US Navy began an ‘analysis of alternatives’ study for the new weapon. Its Strategic Systems Programs office has been directed to complete the study in time for inclusion in the presidential budget request for financial year 2022.⁴⁶

The USA eliminated all non-strategic naval nuclear weapons after the end of the cold war. Completion of the SLCM-N would therefore mark a significant change in US Navy strategy.⁴⁷ If the administration of President Joe Biden continues the programme and the US Congress agrees to fund it, then the new missile could be deployed on attack submarines by the end of the 2020s. This could potentially result in the first increase in the size of the US nuclear weapon stockpile since 1996.

⁴³ German Federal Ministry of Defence, ‘Bundeswehr strebt Brückenlösung für Tornado-Nachfolge an’ [Bundeswehr strives for a bridge solution for the Tornado successor], 22 Apr. 2020; Wiegold, T., ‘Verteidigungsministerium will Boeings F-18 als Brückenlösung’ [Defense Ministry wants Boeing’s F-18 as a bridge solution], Augengeradeaus.net, 21 Apr. 2020; and Gebauer, M. and von Hammerstein, K., ‘Kramp-Karrenbauer sagt Washington Kauf von US-Kampffjets zu’ [Kramp-Karrenbauer promises Washington to buy US fighter jets], *Der Spiegel*, 19 Apr. 2020. On Germany’s proposed acquisition of F/A-18Es see chapter 9, section III, in this volume.

⁴⁴ German Federal Ministry of Defence (note 43).

⁴⁵ US Department of Defense (note 4), pp. 54–55.

⁴⁶ Wolfe (note 34), p. 8.

⁴⁷ Kristensen, H. M., ‘Declassified: US nuclear weapons at sea’, Federation of American Scientists (FAS) Strategic Security Blog, 3 Feb. 2016.