

I. US nuclear forces

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As of January 2020, the United States maintained a military stockpile of approximately 3800 nuclear warheads, roughly the same number as in January 2019. The stockpile included approximately 1750 deployed nuclear warheads, consisting of about 1600 strategic and 150 non-strategic (or tactical) warheads. In addition, about 2050 warheads were held in reserve and around 2000 retired warheads were awaiting dismantlement (385 fewer than the estimate for January 2019), giving a total inventory of approximately 5800 nuclear warheads (see table 10.2).

The USA reached compliance with the final warhead limits prescribed by the 2010 Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START) by the specified deadline of 5 February 2018, at which point it was reported to have 1393 deployed warheads attributed to 660 deployed strategic launchers—that is, deployed intercontinental ballistic missiles (ICBMs), deployed submarine-launched ballistic missiles (SLBMs) and deployed heavy bombers.¹ As of September 2019, the New START aggregate numbers showed the USA deploying 1376 warheads attributed to 668 deployed strategic launchers.² The number of deployed warheads reported under New START differs from the estimate presented here 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.

Nuclear modernization

In 2019 the administration of President Donald J. Trump continued to implement the 2018 Nuclear Posture Review (NPR).³ The NPR recommended maintaining the comprehensive nuclear weapon modernization programme decided by the previous administration but with several new nuclear weapons and an increase in the production of plutonium cores for nuclear weapons. Specifically, the NPR outlined plans to introduce a new class (Columbia) of nuclear-powered ballistic missile submarine (SSBN); a new nuclear-capable strategic bomber (B-21 Raider); a new long-range

¹ US Department of State, Office of the Spokesperson, 'Key facts about New START implementation', Fact Sheet, 5 Feb. 2018. For a summary and other details of New START see annex A, section III, and chapter 11, section I, in this volume.

² US Department of State, Bureau of Arms Control, Verification and Compliance, 'New START Treaty aggregate numbers of strategic offensive arms', Fact Sheet, 1 Sep. 2019.

³ US Department of Defense (DOD), *Nuclear Posture Review 2018* (DOD: Arlington, VA, Feb. 2018). For a summary and other details of the Nuclear Posture Review see Kristensen, H. M., 'US nuclear forces', *SIPRI Yearbook 2019*, pp. 289–94.

Table 10.2. US nuclear forces, January 2020

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

Type	Designation	No. of launchers	Year first deployed	Range (km) ^a	Warheads x yield	No. of warheads ^b
Strategic forces						3 570
<i>Bombers</i>		60/107 ^c				848 ^d
B-52H	Stratofortress	42/87	1961	16 000	20 x ALCMs 5–150 kt ^e	528
B-2A	Spirit	18/20	1994	11 000	16 x B61-7, -11, B83-1 bombs ^f	320
<i>ICBMs</i>		400				800 ^g
LGM-30G	Minuteman III					
	Mk-12A	200	1979	13 000	1–3 x W78 335 kt	600 ^h
	Mk-21 SERV	200	2006	13 000	1 x W87 300 kt	200 ⁱ
<i>SSBNs/SLBMs</i>		240 ^j				1 920 ^k
UGM-133A	Trident II (D5/D5LE)					
	Mk-4	..	1992	>12 000	1–8 x W76-0 100 kt	.. ^l
	Mk-4A	..	2008	>12 000	1–8 x W76-1 90 kt	1 511
	Mk-4A	..	2019	>12 000	1 x W76-2 8 kt	25 ^m
	Mk-5	..	1990	>12 000	1–8 x W88 455 kt	384
Non-strategic forces						230ⁿ
F-15E	Strike Eagle	..	1988	3 840	5 x B61-3, -4 ^o	80
F-16C/D	Falcon	..	1987	3 200 ^p	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^q
Deployed warheads						1 750 ^r
Reserve warheads						2 050
Retired warheads awaiting dismantlement^s						2 000
Total inventory						5 800^t

.. = not available or not applicable; 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; SSBN = nuclear-powered ballistic missile submarine.

^a Maximum unrefuelled range. All nuclear-equipped aircraft can be refuelled in the air. Actual mission range will vary according to flight profile and weapon loading.

^b The number shows the total number of warheads assigned to nuclear-capable delivery systems. Only some of these warheads are deployed on missiles and at aircraft bases.

^c Bombers have two numbers: the first is the number assigned to the nuclear mission; the second is the total inventory. The US Air Force has 66 nuclear-capable bombers (20 B-2As and 46 B-52Hs) of which no more than 60 will be deployed at any given time.

^d Of the 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 Strategic gravity bombs are only assigned to B-2A bombers. The maximum yields of strategic bombs are: B61-7 (360 kt), B61-11 (400 kt), B83-1 (1200 kt). However, they also have lower yields. Most B83-1s have been moved to the inactive stockpile and B-2As rarely exercise with the B83-1. The administration of President Barack Obama decided that the B83-1 would be retired once the

B61-12 was deployed, but the administration of President Donald J. Trump has indicated that it might retain the B83-1 for a longer period.

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

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

ⁱ Another 340 W87s are possibly in long-term storage outside the stockpile for planned use in the W78 replacement warhead (W87-1).

^j Of the 14 SSBNs, 2 are normally undergoing refuelling overhaul at any given time. They are not assigned weapons. Another 2 or more submarines may be undergoing maintenance at any given time and may not be carrying missiles. The number of deployable missiles has been reduced to 240 to meet the 2010 Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START) limit on deployed strategic missile launchers.

^k Of these warheads, only about 930 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 carry only 1 warhead.

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

^m 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.

ⁿ Approximately 150 of the 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 returned to the USA once the B61-12 is deployed.

^o The maximum yields of tactical bombs are: B61-3 (170 kt) and B61-4 (50 kt). All have selective lower yields. The B61-10 was retired in 2016.

^p Most sources list 2400 km unrefuelled ferry range but Lockheed Martin, which produces the F-16, lists 3200 km.

^q Of these weapons, approximately 1750 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.

^r 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.

^s Up until 2018, the US Government published the number of warheads dismantled each year, but the Trump administration ended this practice. Based on previous performance and the completion of the W76-1 life-extension programme, it is estimated here that approximately 385 retired warheads were dismantled during 2019.

^t In addition to these intact warheads, there are more than 20 000 plutonium pits stored at the Pantex Plant, Texas, and perhaps 4000 uranium secondaries 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.

air-launched cruise missile (ALCM), known as the long-range standoff weapon (LRSO); a new intercontinental ballistic missile (Ground Based Strategic Deterrent, GBSD); and a new nuclear-capable, tactical fighter-bomber (F-35A). The programme also aims to upgrade the command and control systems at the US Department of Defense (DOD), and the nuclear

warheads and their supporting infrastructure at the US Department of Energy's National Nuclear Security Administration (NNSA).

According to an estimate published in January 2019 by the US Congressional Budget Office (CBO), modernizing and operating the US nuclear arsenal and the facilities that support it will cost around \$494 billion for the period 2019–28, \$94 billion more than the CBO's 2017 estimate for the period 2017–26. The rise partly reflects the expected increase in costs based on the progression of the modernization programme as well as the 2018 NPR's addition of new nuclear weapons.⁴ The nuclear modernization (and maintenance) programme will continue well beyond 2028 and, based on the CBO's estimate, will cost \$1.2 trillion over the next three decades. Notably, although the CBO estimate accounts for inflation, other estimates forecast that the total cost will be closer to \$1.7 trillion.⁵ The NPR acknowledged that cost estimates of the modernization programme vary but stated that the programme is 'an affordable priority' and emphasized that the total cost represented only a small portion of the overall defence budget.⁶ There is little doubt, however, that limited resources, competing nuclear and conventional modernization programmes, and the rapidly growing federal budget deficit will present significant challenges for the nuclear modernization programme in the years ahead.

Bombers

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, although only 60 (18 B-2As and 42 B-52Hs) are thought to be assigned nuclear delivery roles. It is estimated here that there are nearly 850 warheads assigned to strategic bombers, of which about 300 are deployed at bomber bases.

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 satellite network used by the US president and military leadership to transmit launch orders and manage nuclear operations.⁷

The development of the next-generation long-range strike bomber, known as the B-21 Raider, is well under way with the first test aircraft under

⁴ US Congressional Budget Office, 'Projected costs of US nuclear forces, 2019 to 2028', Jan. 2019, p. 1.

⁵ See e.g. Reif, K., 'US nuclear modernization programs', Arms Control Association, Fact Sheet, updated Aug. 2018.

⁶ US Department of Defense (note 3), pp. XI, 51–52.

⁷ US Department of Defense (DOD), *Fiscal Year (FY) 2020 Budget Estimates, Air Force, Justification Book Volume 3a of 3: Research, Development, Test & Evaluation, Air Force, Vol-III Part 1* (DOD: Arlington, VA, Mar. 2019).

construction.⁸ The B-21 will be capable of delivering B61-12 guided nuclear gravity bombs, which are currently in development, and LRSO cruise missiles. The USAF plans to acquire 1000 LRSO missiles, of which about half will be nuclear armed and the rest used for spares and test launches.⁹ The new bomber is scheduled to enter service in the mid-2020s.¹⁰ 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.¹¹ The USAF plans to acquire at least 100 B-21s but the final order may be significantly higher.¹²

Land-based ballistic missiles

As of January 2020, the USA deployed 400 Minuteman III ICBMs in 450 silos across three missile wings. Fifty of the 450 silos are empty but kept in a state of readiness and can be reloaded with stored missiles if necessary.¹³

Each Minuteman III ICBM is armed with one warhead: either a 335-kiloton W78/Mk12A or a 300-kt W87/Mk21. Missiles carrying the W78 can be uploaded with up to two more warheads for a maximum of three multiple independently targetable re-entry vehicles (MIRVs). It is estimated here 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 above-mentioned GBSD, which is scheduled to begin replacing the Minuteman III in 2028 and achieve full operational capability in 2036.¹⁴ The plan is to buy 642 missiles, of which 400 would be deployed, 50 stored and the rest used for test launches and as spares.¹⁵ Development and production of the GBSD will go on well into the mid-2030s. The projected cost of the programme continues to increase. It rose from \$62.5 billion projected in 2015 to around \$100 billion in 2017.¹⁶ In 2019 the CBO estimated that the cost for the 10-year

⁸ US Air Force, Secretary of the Air Force Public Affairs, 'Acting SecAF Donovan announces B-21 manufacturing, testing locations', 16 Sep. 2019.

⁹ Rand, R. (Gen.), Commander, Air Force Global Strike Command, 'FY19 posture for Department of Defense nuclear forces', Presentation to the Strategic Forces Subcommittee, Armed Services Committee, US House of Representatives, 11 Apr. 2018, p. 13.

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

¹¹ US Air Force, Secretary of the Air Force Public Affairs, 'Air force selects locations for B-21 aircraft', 2 May 2018.

¹² Clark, C., 'More B-21s likely: B-1s to carry up to 8 hypersonic weapons', *Breaking Defense*, 17 Sep. 2019.

¹³ Air Force Technology, 'USAF removes last of 50 Minuteman III ICBMs and meets NST requirements', 3 July 2017.

¹⁴ Richard, C. A., Commander, US Strategic Command, Statement before the Committee on Armed Services, US Senate, 13 Feb. 2020, p. 9.

¹⁵ Reif, K., 'Air Force drafts plan for follow-on ICBM', *Arms Control Today*, 8 July 2015.

¹⁶ Reif, K., 'New ICBM replacement cost revealed', *Arms Control Today*, Mar. 2017.

period 2019–28 alone would be \$61 billion, \$18 billion higher than the 2017 estimate for 2017–26.¹⁷ In late 2019 the USAF confirmed that Northrop Grumman will produce the GBSD. The expectation is that the contract will be signed in the second half of 2020.¹⁸

The USAF is modernizing the nuclear warheads that will be used to arm the GBSD. These will also be used to arm the Minuteman III for the remainder of its service life. The W87/Mk21 warhead is being upgraded with a new fuze (arming, fuzing and firing unit). 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 that it will use a W87 plutonium pit with insensitive high explosives instead of the conventional high explosives used in the W78.¹⁹ The projected cost of the W87-1 programme is between \$10.6 billion and \$13.2 billion.²⁰

During 2019, the USAF Global Strike Command carried out four operational and developmental test launches of the Minuteman III ICBM weapon system. The missiles were launched from Vandenberg AFB in California with the payload impacting at the Ronald Reagan Ballistic Missile Defense Test Site in the Kwajalein Atoll in the Marshall Islands.²¹

Ballistic missile submarines

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 overhaul at any given time.

All of the 14 Ohio class SSBNs—8 of which are based at Naval Submarine Base Kitsap in Washington State and 6 at Naval Submarine Base Kings Bay in Georgia—can carry up to 20 Trident II D5 SLBMs. To meet the New START limit on deployed launchers, 4 missile tubes on each submarine have been deactivated so that the 12 deployable SSBNs can carry no more than 240 missiles.²²

¹⁷ US Congressional Budget Office (note 4), p. 9.

¹⁸ Erwin, S., 'Northrop Grumman wins competition to build future ICBM, by default', *Space News*, 14 Dec. 2019.

¹⁹ Padilla, M., 'Sandia on target for first Mk21 Fuze flight test in 2018', *Sandia Lab News*, 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.

²⁰ US Department of Energy, National Nuclear Security Administration (NNSA), *Fiscal Year 2020 Stockpile Stewardship and Management Plan*, Report to Congress (NNSA: Washington, DC, July 2019), pp. 8–41.

²¹ Murray, D., 'Air Force Global Strike Command year in review: 2019', US Air Force Global Strike Command Air Forces Strategic-Air, 3 Jan. 2020.

²² US Navy, 'Fleet ballistic missile submarines: SSBN', United States Navy Fact File, 29 Jan. 2019.

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.

Since 2017, the navy has been replacing its Trident II D5 SLBMs with an enhanced version known as the D5LE (LE for 'life extended'). Another 24 were deployed in 2018 (and possibly in 2019) and the upgrade is scheduled to be completed in 2024.²³ The D5LE is equipped with the new Mk-6 guidance system. The D5LE will arm Ohio class SSBNs for the remainder of their service lives (up to 2042) and will also be deployed on British Trident submarines (see section III). The D5LE will initially also arm the new Columbia class SSBN, the first of which—the *USS Columbia* (SSBN-826)—is scheduled to start patrols in 2031, but will eventually be replaced with a new SLBM, currently named the SWS (Strategic Weapon System) 534 or D5LE2.²⁴ The 2018 NPR stated that the navy 'will begin studies in 2020 to define a cost-effective, credible, and effective SLBM that . . . [can be deployed] throughout the service life of the COLUMBIA SSBN'.²⁵

The Trident SLBMs carry two basic warhead types: either the 455-kt W88 or the 90-kt W76-1 (the older W76-0 version has been, or remains in the process of being, retired). The W76-1 is equipped with a new fuze that improves its targeting effectiveness.²⁶ It is estimated here that around 1920 warheads are assigned to the SSBN fleet, of which about 930 are deployed on missiles.²⁷ Each SLBM can carry up to eight warheads but normally carries an average of four to five.

In late 2019 the navy started to deploy a new low-yield warhead on some of its SSBNs.²⁸ The new warhead is the W76-2, which is a modification of the W76-1 and is estimated to have an explosive yield of about 8 kt.²⁹ The 2018 NPR claimed that the warhead is needed to deter Russian first use of low-yield tactical nuclear weapons.³⁰ The first SSBN to deploy with the W76-2 was the *USS Tennessee* (SSBN-734), which left the Kings Bay base at the end of 2019 for a deterrent patrol in the Atlantic Ocean.³¹ According to US

²³ Wolfe, J., Director, Strategic Systems Programs, Statement before the Subcommittee on Strategic Forces, Armed Services Committee, US Senate, 23 Mar. 2019, p. 4.

²⁴ Peterson, J., 'Navy strategic missile boss starting concept development for new missile', *Seapower*, 24 May 2017.

²⁵ US Department of Defense (note 3), p. 49.

²⁶ 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.

²⁷ US Department of State (note 2).

²⁸ 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.

²⁹ US military officials, Private communications with the author, 2019–20.

³⁰ US Department of Defense (note 3), p. 55

³¹ Arkin and Kristensen (note 28); and US Department of Defense (note 28).

military officials, the W76-2 has also been deployed in the Pacific Ocean and it is believed that at least two of the SSBNs on patrol in each of these oceans will normally carry one or two D5 missiles, each with one W76-2.³²

Non-strategic nuclear weapons

The USA has one basic type of non-strategic (tactical) weapon in its stockpile—the B61 gravity bomb, which exists in two versions: B61-3 and B61-4.³³ An estimated 230 tactical B61 bombs remain in the stockpile.

Approximately 150 of the bombs are thought to be deployed for potential use by fighter-bomber aircraft at six North Atlantic Treaty Organization (NATO) airbases in five countries: Aviano and Ghedi, Italy; Büchel, Germany; Incirlik, Turkey; Kleine Brogel, Belgium; and Volkel, the Netherlands.³⁴ In 2019 the debate on whether the USA should continue to store nuclear weapons in Turkey intensified after incursions by Turkey into northern Syria, and there were reports that the US military was reviewing evacuation plans for the weapons.³⁵

The 80 other B61 bombs are stored at bases in the continental USA for potential use by US aircraft in support of allies outside Europe, including in East Asia.

The USA is close to completing the development of the B61-12 guided nuclear bomb, which will replace all existing versions of the B61. Delivery was scheduled to start in 2020 but production problems in 2019 caused delays and delivery is now expected to take place in late 2021.³⁶ 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.³⁷

Integration of the B61-12 on existing USAF and NATO aircraft continued in 2019. The USAF plans to integrate the B61-12 on seven types of aircraft: the B-2A, the B-21, the F-15E, the F-16C/D, the F-16 MLU, the F-35A and the PA-200 (Tornado).³⁸ To ensure that Germany can continue to participate in

³² US military officials, Private communications with the author, 2019–20.

³³ 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 Management Plan*, Report to Congress (NNSA: Washington, DC, Nov. 2017), figure 1-7, pp. 1-13.

³⁴ For a detailed overview of the dual-capable aircraft programmes of the USA and its NATO allies see Kristensen, H. M., 'US nuclear forces', *SIPRI Yearbook 2019*, pp. 299–300; and Andreasen, S. et al., Nuclear Threat Initiative (NTI), *Building a Safe, Secure, and Credible NATO Nuclear Posture* (NTI: Washington, DC, Jan. 2018).

³⁵ Sanger, D. E., 'Trump followed his gut on Syria. Calamity came fast', *New York Times*, 14 Oct. 2019.

³⁶ Gould, J. and Mehta, A., 'Nuclear gravity bomb and warhead upgrades face new delays', *Defense News*, 4 Sep. 2019.

³⁷ 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.

³⁸ US Air Force (USAF), *United States Air Force Acquisition, Annual Report, Fiscal Year 2018: Cost-effective Modernization* (USAF: Arlington, VA, [2019]), p. 24.

the NATO nuclear strike mission after it has completed the planned replacement of its Tornados with either Eurofighter or F/A-18 aircraft, some of the new aircraft would also need to undergo integration with the B61-12.³⁹

During 2019, the US Navy began an ‘analysis of alternatives’ study for the new nuclear-armed sea-launched cruise missile called for by the 2018 NPR.⁴⁰ The development of the weapon would mark a significant change in approach by the US Navy, which completely eliminated all non-strategic naval nuclear weapons after the end of the cold war.⁴¹ If funded by the US Congress, the new missile could be deployed on attack submarines or surface ships by the end of the 2020s and could potentially result in the first increase in the size of the US nuclear weapon stockpile since 1996.

³⁹ Shalal, A., ‘Germany drops F-35 from fighter tender; Boeing F/A-18 and Eurofighter to battle on’, *Reuters*, 31 Jan. 2019.

⁴⁰ Burgess, R. R., ‘Navy’s Trident missile director: Planning for sea-launched nuclear cruise missile set for 2019’, *Seapower*, 22 Mar. 2018. See also Kristensen, H. M., ‘US nuclear forces’, *SIPRI Yearbook 2019*, pp. 292–94.

⁴¹ Kristensen, H. M., ‘Declassified: US nuclear weapons at sea’, *FAS Strategic Security Blog*, Federation of American Scientists, 3 Feb. 2016.