

I. US nuclear forces

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As of January 2019, the United States maintained a military stockpile of nearly 3800 nuclear warheads, roughly the same number as in January 2018.¹ The stockpile included approximately 1750 deployed nuclear warheads, consisting of about 1600 strategic and 150 non-strategic warheads. In addition, about 2050 warheads were held in reserve and around 2385 retired warheads were awaiting dismantlement, giving a total inventory of approximately 6185 nuclear warheads (see table 6.2).

The USA was in 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 660 deployed strategic launchers with 1393 warheads attributed to them.² The number of deployed warheads reported under New START differs from the estimate presented here because weapons deployed at bomber bases are not counted under the treaty.

The Nuclear Posture Review

The Nuclear Posture Review (NPR) published by the administration of US President Donald J. Trump in February 2018 was focused on the task of carrying forward the large-scale modernization programme started by the previous administration. However, the 2018 NPR differed from the previous administration's NPR from 2010 on several policy issues. The most significant change appeared to be a shift away from seeking to reduce the number and role of nuclear weapons: the 2018 NPR sets out plans to develop new nuclear weapons and modify others. It moves away from the 2010 NPR's goal of seeking to limit the role of nuclear weapons to the sole purpose of deterring nuclear attacks, and instead emphasizes 'expanding' US nuclear options to deter and, if deterrence fails, defeat both nuclear and 'non-nuclear strategic attacks'.³ Use of a nuclear weapon against non-nuclear attacks would be nuclear first use.

The 2018 NPR states that 'non-nuclear strategic attacks include, but are not limited to, attacks on the US, allied, or partner civilian population or

¹ Kristensen, H. M., 'Despite rhetoric, US stockpile continues to decline', FAS Strategic Security Blog, Federation of Atomic Scientists, 22 Mar. 2018.

² US Department of State, '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, in this volume. See also chapter 7, section II, in this volume.

³ US Department of Defense (DOD), *Nuclear Posture Review 2018* (DOD: Washington, DC, Feb. 2018), pp. 21, 38.

Table 6.2. US nuclear forces, January 2019

All figures are approximate and some are based on assessments by the author. Warhead totals and subtotals 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 forces						3 570
<i>Bombers</i>		60/107 ^c				850 ^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	>7 400	1-8 x W76-0 100 kt	46
	Mk-4A	..	2008	>7 400	1-8 x W76-1 100 kt	1 490
	Mk-4A	..	(2019)	>7 400	1-8 x W76-2 low kt	..
	Mk-5	..	1990	>7 400	1-8 x W88 455 kt	384
Non-strategic forces						230^l
F-15E	Strike Eagle	..	1988	3 840	5 x B61-3, -4 ^m	90
F-16C/D	Falcon	..	1987	3 200 ⁿ	2 x B61-3, -4	80
F-16MLU	Falcon (NATO)	..	1985	3 200	2 x B61-3, -4	30
PA-200	Tornado (NATO)	..	1983	2 400	2 x B61-3, -4	30
Total stockpile						3 800^o
Deployed warheads						1 750 ^p
Reserve warheads						2 050
Retired warheads awaiting dismantlement						2 385
Total inventory						6 185^q

.. = not available or not applicable; () = uncertain figure; 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. This estimate is lower than the author's assessment in *SIPRI Yearbook 2018* due to the retirement of some gravity bombs.

^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. 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 New START limit on deployed strategic missile launchers.

^k Of these warheads, only about 950 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 down-loaded each missile to an average of 4–5 warheads. All deployed W76 warheads are of the new W76-1 type. After completion of the W76-1 programme, all remaining W76-0s will be retired.

^l This estimate is based on a revision of the author's assessment of 200 in *SIPRI Yearbook 2018*. The author estimates that the stockpile of B61s is declining but at a slower pace than previously thought. Approximately 150 of the tactical bombs are thought to be deployed across six 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.

^m 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.

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

^o Of these weapons, approximately 1750 are deployed on ballistic missiles, at bomber bases in the USA and at six NATO airbases outside the USA; all the rest are in central storage.

^p The deployed warhead number in this table differs from the number declared under New START because the treaty attributes a fictive number to bombers and does not count weapons at bomber bases or cover non-strategic weapons.

^q 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, 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; 'Nuclear notebook', *Bulletin of the Atomic Scientists*, various issues; and author's estimates.

infrastructure, and attacks on US or allied nuclear forces, their command and control, or warning and attack assessment capabilities'.⁴ US nuclear capabilities will be postured to 'hedge against the potential rapid growth or emergence of nuclear and non-nuclear strategic threats, including chemical, biological, cyber, and large-scale conventional aggression'.⁵ According to the 2018 NPR, to achieve this aim, 'the United States will enhance the flexibility and range of its tailored deterrence options . . . Expanding flexible US nuclear

⁴ US Department of Defense (note 3), p. 21.

⁵ US Department of Defense (note 3), pp. 21, 38.

options now, to include low-yield options, is important for the preservation of credible deterrence against regional aggression'.⁶

If approved by the US Congress, the new tailored capabilities will include, in the short term, the modification of 'a small number' of warheads on the Trident II D5LE submarine-launched ballistic missile (SLBM) 'to ensure a prompt response option that is able to penetrate adversary defenses'.⁷ According to the 2018 NPR, this capability is necessary to 'help counter any mistaken perception of an exploitable "gap" in US regional deterrence capabilities'.⁸ The plan appears to be to modify some of the existing W76-1 100-kiloton two-stage thermonuclear warheads to single-stage warheads by shutting down the secondary to limit the yield to what the primary can produce, giving an estimated yield of 5–7 kt (see below).⁹

The NPR states that, in the longer term, the USA will also 'pursue a nuclear-armed' submarine-launched cruise missile (SLCM) to 'provide a needed non-strategic regional presence, an assured response capability' and a response—which is itself compliant with the 1987 Soviet–US Treaty on the Elimination of Intermediate-Range and Shorter-Range Missiles (INF Treaty)—'to Russia's continuing [INF] Treaty violation'.¹⁰ With regard to the new missile, the NPR states that the USA 'will immediately begin efforts to restore this capability by initiating a requirements study leading to an Analysis of Alternatives ... for the rapid development of a modern SLCM'.¹¹ According to the NPR, the 'US pursuit of a submarine-launched cruise missile may provide the necessary incentive for Russia to negotiate seriously a reduction of its non-strategic nuclear weapons, just as the prior Western deployment of intermediate-range nuclear forces in Europe led to the 1987 INF Treaty'.¹²

The NPR states that the above-mentioned short- and long-term capabilities will 'provide a more diverse set of characteristics greatly enhancing ... [the USA's] ability to tailor deterrence and assurance; expand the range of credible US options for responding to nuclear or non-nuclear strategic attack; and enhance deterrence by signaling to potential adversaries that their concepts of coercive, limited nuclear escalation offer no exploitable advantage'.¹³

The US nuclear arsenal already includes around 1000 gravity bombs and air-launched cruise missiles (ALCMs) with low-yield warhead options, but the NPR provides no evidence that existing capabilities are insufficient; it

⁶ US Department of Defense (note 3), pp. 38, 54.

⁷ US Department of Defense (note 3), p. 55.

⁸ US Department of Defense (note 3), p. 55.

⁹ Author's assessment based on private communication with US government officials.

¹⁰ US Department of Defense (note 3), p. 55.

¹¹ US Department of Defense (note 3), p. 55.

¹² US Department of Defense (note 3), p. 55. On the INF Treaty see chapter 7, section II, in this volume.

¹³ US Department of Defense (note 3), p. 55.

simply claims that new capabilities are needed.¹⁴ The US Navy had a nuclear SLCM (Tomahawk Land-Attack Cruise Missile, TLAM/N), but this missile was retired in 2011 because it was considered redundant.¹⁵ All other non-strategic nuclear weapons, except a limited number of gravity bombs for fighter-bombers (see below), have been retired because, notwithstanding Russia's large non-strategic nuclear weapons arsenal, the USA decided that there was no longer a military need for them. Russia's development of the ground-launched cruise missile (SSC-8 or 9M729) that the USA alleges is in violation of the INF Treaty began in 2008–10 when the US arsenal included a nuclear SLCM (i.e. the TLAM/N). It is therefore unclear why the USA now believes that the reintroduction of a nuclear SLCM would cause a change in Russian strategy. Moreover, US Strategic Command has already strengthened the USA's strategic bomber support of the North Atlantic Treaty Organization (NATO) to enhance deterrence in response to the perceived provocative and aggressive behaviour of Russia.¹⁶ Those bombers are equipped with the nuclear ALCM and will receive the new LRSO (Long-Range Standoff) missile, which will have essentially the same capabilities as the SLCM proposed by the NPR (see below).

Russia's decisions about the size and composition of its non-strategic nuclear arsenal appear to be driven by the USA's superiority in *conventional* forces and not by the US non-strategic nuclear arsenal or by weapons yield.¹⁷ Instead, pursuit of a new SLCM to 'provide a needed non-strategic regional presence' in Europe and Asia could—especially when combined with the parallel expansion of US long-range conventional strike capabilities—strengthen Russia's reliance on non-strategic nuclear weapons and potentially could even trigger Chinese interest in developing such a capability.

A new SLCM would also require the installation of nuclear-certified storage and launch-control equipment on the attack submarines that are assigned the new mission. Sea- and land-based personnel would need to be trained and certified to maintain and handle the weapons. These are complex and expensive logistical requirements that would place further strain on the US Navy's financial and operational resources. In addition, the reconstitution of a nuclear SLCM could spark discord with certain states. During the cold war era, visits to foreign ports by US nuclear-capable vessels regularly led to serious political disputes when the ports were in states that did not allow

¹⁴ Kristensen, H. M., 'The flawed push for new nuclear weapons capabilities', FAS Strategic Security Blog, Federation of American Scientists, 29 June 2017.

¹⁵ See e.g. Kristensen, H. M., 'W80-1 warhead selected for new nuclear cruise missile', FAS Strategic Security Blog, Federation of American Scientists, 10 Oct. 2014.

¹⁶ Kristensen, H. M., 'Increasing nuclear bombers operations', FAS Strategic Security Blog, Federation of American Scientists, 25 Sep. 2016.

¹⁷ Kristensen, H. M., 'Russian nuclear forces: Buildup or modernization?', Russia Matters, Belfer Center for Science and International Affairs, Harvard Kennedy School, 14 Sep. 2017.

nuclear weapons on their territory.¹⁸ In the case of New Zealand, for example, that country's long-standing policy of refusing entry to its ports of nuclear-capable vessels prompted significant strains in its diplomatic relations with the USA in the mid 1980s, which have only recently begun to be repaired.¹⁹

Nuclear modernization

The 2018 NPR confirmed that the Trump administration intends to continue, for the most part, with the nuclear weapon modernization programme instituted by the previous administration, some of which is already well under way. The programme aims to replace or upgrade all nuclear delivery systems. Specifically, it 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 ALCM (the above-mentioned LRSSO), a new intercontinental ballistic missile (Ground Based Strategic Deterrent, GBSD), and a new nuclear-capable tactical fighter-bomber aircraft (F-35A). The programme also aims to upgrade the command and control systems at the US Department of Defense, 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 2018 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 2017–26 period. 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.²⁰ 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.²¹ The NPR acknowledges that

¹⁸ For background on the international disputes over nuclear-capable ship visits during the cold war see Kristensen, H. K., *The Neither Confirm Nor Deny Policy: Nuclear Diplomacy at Work*, Working Paper (Federation of American Scientists: Washington, DC, Feb. 2006).

¹⁹ Robson, S., 'US Navy to return to New Zealand after 30-year rift over nukes', *Stars and Stripes*, 21 July 2016.

²⁰ US Congressional Budget Office, 'Projected costs of US nuclear forces, 2019 to 2028', Jan. 2019, p. 1.

²¹ See e.g. Reif, K., 'US nuclear modernization programs', Arms Control Association, Fact Sheet, updated Aug. 2018.

cost estimates of the modernization programme vary but states that the programme is ‘an affordable priority’ and emphasizes that the total cost is only a small portion of the overall defence budget.²² There is little doubt, however, that limited resources, competing nuclear and conventional modernization programmes, and the rapidly growing deficit will present significant challenges for the nuclear modernization programme.

Bombers

The US Air Force 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. The bombers are being equipped with new command and control systems to improve interconnectivity with other forces and the US National Command Authority.²³

The development of the next-generation long-range strike bomber, known as the B-21 Raider, is well under way. The B-21 will be capable of delivering B61-12 guided nuclear gravity bombs, which are currently in development, and LRSO cruise missiles (see below). It will also be capable of both manned and unmanned operations, although nuclear missions are thought to be manned.²⁴ The new bomber is scheduled to enter service in the mid 2020s.²⁵ The B-21 will replace the B-1 and B-2 bombers at Dyess Air Force Base (AFB) in Texas, Ellsworth AFB in South Dakota, and Whiteman AFB in Missouri.²⁶

To arm its bombers, the US Air Force is developing a controversial new nuclear ALCM—the LRSO—for deployment from 2030. US defence officials claim that the LRSO is needed to enable bombers to strike targets even when faced with advanced air defence systems and provide flexible strike options in regional scenarios. However, some critics argue that the standoff mission can be performed with non-nuclear long-range cruise missiles such as the extended-range version of the Joint Air-to-Surface Standoff Missile

²² US Department of Defense (note 3), pp. XI, 51–52.

²³ US Air Force, Presentation to the US House of Representatives Armed Services Committee, Strategic Forces Subcommittee, Subject: FY19 Posture for Department of Defense Nuclear Forces, Statement of Rand, R. (Gen.), Commander Air Force Global Strike Command, 22 Mar. 2018.

²⁴ US Department of Defense (DOD), Inspector General, *Audit of the Acquisition of the Long Range Strike-Bomber*, DODIG-2015-170 (DOD: Washington, DC, 8 Sep. 2015), pp. 2, 4, 6.

²⁵ 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 12 Oct. 2018), p. 10.

²⁶ US Air Force, Secretary of the Air Force Public Affairs, ‘Air force selects locations for B-21 aircraft’, 2 May 2018.

(JASSM-ER).²⁷ The US Air Force plans to acquire 1000 LRSO missiles, of which about half will be nuclear-armed and the rest used for test launches.²⁸

Land-based ballistic missiles

As of January 2019, the USA deployed 400 Minuteman III intercontinental ballistic missiles (ICBMs) in 450 silos across three missile wings. Fifty empty silos are kept in a state of readiness and can be reloaded with stored missiles if necessary.²⁹

Each Minuteman III ICBM is armed with one warhead: either a 335-kt W78/Mk12A or a 300-kt W87/Mk21. 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). It is estimated here that there are 800 warheads assigned to the ICBM force, of which 400 are deployed on the missiles.

The entire Minuteman III force completed a decade-long upgrade in 2015 to extend its life through the 2020s. Moreover, an upgrade is under way of the W87/Mk21 re-entry vehicle to a new fuze (arming, fuzing and firing unit).³⁰

The US Air Force has begun development of a next-generation ICBM, the above-mentioned GBSD, which is scheduled to begin replacing the Minuteman III in 2028. It plans to buy 642 missiles, of which 400 would be deployed, 50 stored and the rest used for test launches and as spares.³¹ The expected cost of developing and producing the GBSD is increasing, and in 2017 it was projected to be around \$100 billion, up from an initial projection of \$62.3 billion in 2015.³²

To arm the GBSD, the US Air Force and the NNSA previously planned to life-extend the W78 as part of a controversial Interoperable Warhead-I (IW-I) programme that would have combined ICBM and navy warheads. In August 2018, however, the US Nuclear Weapons Council (operated as a joint activity of the Department of Defense and the Department of Energy) cancelled the IW-I programme and renamed the W78 replacement programme as the W87-I

²⁷ For background and context on the LRSO see e.g. Kristensen, H. M., 'LRSO: The nuclear cruise missile mission', FAS Strategic Security Blog, Federation of American Scientists, 20 Oct. 2015; Kristensen, H. M., 'Forget LRSO: JASSM-ER can do the job', FAS Strategic Security Blog, Federation of American Scientists, 16 Dec. 2015; and Reif, K., 'Examining the flawed rationale for a new nuclear air-launched cruise missile', *Arms Control Today*, Issue Briefs, vol. 8, no. 2 (12 June 2016).

²⁸ US Air Force, Presentation to the US Senate Armed Services Committee, Strategic Forces Subcommittee, Subject: FY19 Posture for Department of Defense Nuclear Forces, Statement of Rand, R. (Gen.), Commander Air Force Global Strike Command, 11 Apr. 2018, p. 13.

²⁹ Air Force Technology, 'USAF removes last of 50 Minuteman III ICBMs and meets NST requirements', 3 July 2017.

³⁰ Padilla, M., 'Sandia on target for first Mk21 Fuze flight test in 2018', *Sandia Lab News*, vol. 70, no. 6 (16 Mar. 2018).

³¹ Reif, K., 'Air Force drafts plan for follow-on ICBM', *Arms Control Today*, 8 July 2015.

³² Reif, K., 'New ICBM replacement cost revealed', *Arms Control Today*, Mar. 2017.

to reflect that it will use a W87 plutonium pit with insensitive high explosives instead of the conventional high explosives used in the W78. The projected cost of the W87-1 programme is between \$8.9 billion and \$15.6 billion.³³

The US Air Force's Minuteman III flight-testing programme experienced several anomalies in 2018. The first occurred on 5 February when a test launch from Vandenberg AFB in California was cancelled.³⁴ A launch on 25 April was successful but on 30 July a Minuteman III was blown up shortly after launch.³⁵ A successful launch was carried out on 6 November.³⁶ The two successful flights flew mock warheads that impacted some 6760 kilometres away at the Ronald Reagan Ballistic Missile Defense Test Site in the Kwajalein Atoll in the Marshall Islands.

In addition to live Minuteman III launches, a simulated ICBM launch (Simulated Electronic Launch-Minuteman, SELM) was conducted at F. E. Warren AFB in Wyoming on 21–22 March that involved the use of the airborne launch control system on an E-6B Mercury aircraft to launch the missiles.³⁷ SELM tests are done every six months at one of the three ICBM bases on a rotational basis.

Ballistic missile submarines

The US Navy completed the reduction of missile launch tubes (from 24 to 20) on each of its Ohio class SSBNs in late 2017.³⁸ The reduction was necessary to meet the New START limit of no more than 700 deployed strategic launchers. Following the reductions, the navy's SSBN fleet can deploy up to 240 strategic missiles.

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—are armed with Trident II D5 SLBMs. Of the 14 SSBNs, 12 are normally considered to be operational and 2 are typically undergoing refuelling overhaul at any given time. 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.

³³ 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.

³⁴ Robbins, G., 'Tuesday night's Minuteman launch abruptly canceled', *San Diego Union-Tribune*, 6 Feb. 2018.

³⁵ The Defense Post, 'US Air Force tests Minuteman III intercontinental ballistic missile', 25 Apr. 2018; and Scully, J., 'Minuteman missile test launch from Vandenberg AFB ends in failure', *Noozhawk*, 31 July 2018.

³⁶ Jones, J. and Myles, D., US Air Force, 30th Space Wing Public Affairs, 'Minuteman III GT 228GM launches from Vandenberg', Defense Visual Information Distribution Service, 6 Nov. 2018.

³⁷ Wagner, A., 'Another SELM for the books', F. E. Warren Air Force Base, 29 Aug. 2018.

³⁸ US Navy officials, Private communication with author, 2018.

Since 2017, the navy has been replacing Trident II D5 SLBMs with an enhanced version known as the D5LE (LE for ‘life extended’). The first D5LEs were loaded on the *USS Maryland* (SSBN-738) in February 2017.³⁹ The D5LE is equipped with the new Mk-6 guidance system, designed to improve the SLBM’s effectiveness. The D5LE will arm Ohio class submarines 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 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 D5LE2.⁴⁰ The 2018 NPR states 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’.⁴¹

The Trident SLBMs carry two basic warhead types: either the 455-kt W88 or the 100-kt W76-1 (only a few of the older W76-0 version remain in the stockpile). The W76-1 is equipped with a new fuze that improves its targeting effectiveness. It is estimated here that around 1920 warheads are assigned to the SSBN fleet, of which about half are deployed on missiles. Each SLBM can carry up to eight warheads but normally carries fewer. The navy does not disclose how many warheads it carries on each submarine but, in practice, each missile carries an average of four to five warheads, depending on mission requirements. The New START data indicates that the SSBN fleet carried a total of 950 warheads as of September 2018.⁴²

As previously noted, pursuant to the 2018 NPR, the USA has begun development of a low-yield version of the W76 warhead (W76-2).⁴³ Production began in late 2018 and the warheads will be delivered to the navy by September 2019.⁴⁴ Although US war plans have long included limited strike options with a single SLBM or a small number of them, the addition of a low-yield W76-2 to the US arsenal to deter Russian use of low-yield tactical nuclear weapons (as explained by the 2018 NPR) indicates a new way of using strategic missiles in a tactical fashion.⁴⁵

The navy test launched two Trident II D5LE SLBMs from the *USS Nebraska* (SSBN-739) in the Pacific Ocean on 28 March 2018. The launches

³⁹ US Navy, US House of Representatives Armed Services Committee on Nuclear Forces, Strategic Forces Subcommittee, Statement of Benedict, T. (Vice Admiral), Director, Strategic Systems Programs, 25 May 2017.

⁴⁰ Peterson, J., ‘Navy strategic missile boss starting concept development for new missile’, *Seapower*, 24 May 2017.

⁴¹ US Department of Defense (note 3), p. 49.

⁴² US Department of State, ‘New START Treaty aggregate numbers of strategic offensive arms’, Fact Sheet, 1 Sep. 2018.

⁴³ US Department of Defense (note 3), p. 55.

⁴⁴ Leone, D., ‘NNSA has started building low-yield sub warhead’, *Nuclear Security & Deterrence Monitor*, vol. 23, no. 4 (25 Jan. 2019).

⁴⁵ US Department of Defense (note 3), p. 55.

formed part of the submarine's recertification for strategic patrols following a reactor refuelling overhaul.⁴⁶

Non-strategic nuclear weapons

The USA has one basic type of non-strategic weapon in its stockpile—the B61 gravity bomb. The weapon exists in two modifications: B61-3 and B61-4. A third modification (B61-10) was retired in September 2016.⁴⁷ There are an estimated 230 tactical B61 bombs left in the stockpile.⁴⁸

Approximately 150 of the bombs are thought to be deployed at six NATO airbases in five countries: Aviano and Ghedi, Italy; Büchel, Germany; Incirlik, Turkey; Kleine Brogel, Belgium; and Volkel, the Netherlands. The Belgian and Dutch air forces (using F-16 fighter-bombers) and German and Italian air forces (using PA-200 Tornado combat aircraft) are assigned nuclear strike missions with the US B61 bombs. Turkish F-16s are also thought to be nuclear-capable, but it is uncertain if the Turkish Air Force still serves a nuclear strike mission. In peacetime, the bombs are kept under the custodial control of US Air Force personnel. Concerns were raised about the security of the nuclear weapons at the Incirlik base during the failed coup attempt in Turkey in July 2016, and reports emerged in late 2017 suggesting that the weapons might have been 'quietly withdrawn'.⁴⁹ These reports have not been confirmed, and Incirlik is included in scheduled nuclear storage base upgrades for 2019.

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

NATO has approved a modernization of its nuclear posture in Europe through deployment, beginning in 2022–24, of the US B61-12 guided nuclear gravity bomb currently in development in the USA.⁵⁰ The B61-12 will use the nuclear explosive package of the B61-4, which has a maximum yield of approximately 50 kt, but will be equipped with a new tail kit to increase its accuracy and standoff capability. The B61-12 will be able to destroy hardened targets that could not be destroyed by the B61-3 or B61-4. It will also enable

⁴⁶ Lockheed Martin, 'Modernized Lockheed Martin Trident II D5 missile test certifies submarine for patrol', Press release, 28 Mar. 2018.

⁴⁷ 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, p. 1–13.

⁴⁸ This estimate is based on a revision of the author's assessment of 200 B61 bombs in *SIPRI Yearbook 2018*. The author estimates that the stockpile of B61s is declining but at a slower pace than previously thought.

⁴⁹ Hammond, J., 'The future of Incirlik Air Base', Real Clear Defense, 30 Nov. 2017.

⁵⁰ For an overview of the modernization of US and NATO non-strategic nuclear forces see Andreasen, S. et al., Nuclear Threat Initiative (NTI), *Building a Safe, Secure, and Credible NATO Nuclear Posture* (NTI: Washington, DC, Jan. 2018).

strike planners to select lower yields for existing targets, which would reduce collateral damage.⁵¹

Integration flight tests have begun of the B61-12 bombs on F-15E, F-16 and Tornado fighter-bombers.⁵² The B61-12 will also be integrated on the USA-built F-35A fighter-bomber, which is expected to be nuclear certified in 2024–26. Belgium, Italy, the Netherlands and Turkey have decided to acquire F-35A fighter-bombers, and it is assumed that some will later be designated with a nuclear delivery role.⁵³ In January 2019 Germany announced that it had decided not to acquire the F-35A and is considering whether to convert the Eurofighter or buy the F/A-18 to replace the PA-200 Tornado in the nuclear role once it becomes obsolete in the mid to late 2020s.⁵⁴

As previously noted, the 2018 NPR calls for the development of a nuclear SLCM—seven years after the USA retired the TLAM/N SLCM because it was considered redundant.⁵⁵ If the new SLCM is funded by the US Congress, it would probably be deployed on Virginia class attack submarines.

⁵¹ 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.

⁵² US Department of Energy, National Nuclear Security Administration, 'B61 life-extension program', Fact Sheet, Dec. 2018.

⁵³ Emmott, R., 'Belgium picks Lockheed's F-35 over Eurofighter on price', Reuters, 25 Oct. 2018.

⁵⁴ Shalal, A., 'Germany drops F-35 from fighter tender; Boeing F/A-18 and Eurofighter to battle on', Reuters, 31 Jan. 2019.

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