

## I. US nuclear forces

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As of January 2018, the United States maintained a military stockpile of about 3800 nuclear warheads, a reduction of nearly 200 warheads compared with the total in early 2017.<sup>1</sup> 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 2650 retired warheads were awaiting dismantlement, giving a total inventory of approximately 6450 nuclear warheads (see table 6.2). The reduction in warheads was due to the USA's implementation of its warhead life-extension programmes and continuing implementation of the 2010 Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START) during 2017.<sup>2</sup>

### Nuclear modernization

The USA has initiated a large-scale nuclear modernization programme (known as the 'program of record'), which aims to replace or upgrade (a) US land-, sea- and air-based nuclear delivery systems; (b) the command and control systems at the US Department of Defense; and (c) the nuclear warheads and their supporting infrastructure at the US Department of Energy's National Nuclear Security Administration.<sup>3</sup> According to an estimate published in February 2017 by the US Congressional Budget Office (CBO), modernizing and operating the US nuclear arsenal and the facilities that support it will cost around \$400 billion for the period 2017–26 (a 15 per cent increase on the CBO's estimate covering the period 2015–24).<sup>4</sup> The nuclear modernization (and maintenance) programme will continue well beyond 2026 and, based on the CBO's estimate, will cost \$1.2 trillion for the period 2017–46. Notably, although the CBO estimate accounts for inflation, other estimates forecast that the total cost will be closer to \$1.7 trillion.<sup>5</sup> The CBO estimates that the planned modernization would increase the total costs of US nuclear forces for 2017–46 by roughly 50 per cent when compared with

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

<sup>2</sup> For a summary and other details of New START see annex A, section III, in this volume. On the implementation of New START see chapter 7, section II, in this volume.

<sup>3</sup> Kristensen, H. M., 'US nuclear forces', *SIPRI Yearbook 2017*, pp. 413–15.

<sup>4</sup> US Congressional Budget Office, 'Projected costs of US nuclear forces, 2017 to 2026', Feb. 2017, p. 1.

<sup>5</sup> See e.g. Reif, K., 'US nuclear modernization programs', Arms Control Association, Fact Sheet, Mar. 2018.

**Table 6.2.** US nuclear forces, January 2018

Type	Designation	No. of launchers	Year first deployed	Range (km) <sup>a</sup>	Warheads x yield	No. of warheads <sup>b</sup>
<b>Strategic forces</b>						<b>3 600</b>
<i>Bombers</i>		60/107 <sup>c</sup>				880 <sup>d</sup>
B-52H	Stratofortress	44/87	1961	16 000	20 x ALCM 5–150 kt <sup>e</sup>	528
B-2A	Spirit	16/20	1994	11 000	16 x B61-7, -11, B83-1 bombs <sup>f</sup>	282
<i>ICBMs</i>		400				800 <sup>g</sup>
LGM-30G	Minuteman III					
	Mk-12A	200	1979	13 000	1-3 x W78 335 kt	600 <sup>h</sup>
	Mk-21 SERV	200	2006	13 000	1 x W87 300 kt	200 <sup>i</sup>
<i>SSBNs/SLBMs</i>		240 <sup>j</sup>				1 920 <sup>k</sup>
UGM-133A	Trident II (D5/D5LE)					
	Mk-4	..	1992	>7 400	1-8 x W76-0 100 kt	216
	Mk-4A	..	2008	>7 400	1-8 x W76-1 100 kt	1 320
	Mk-5	..	1990	>7 400	1-8 x W88 455 kt	384
<b>Non-strategic forces</b>						<b>200<sup>l</sup></b>
F-15E	Strike Eagle	..	1988	3 840	5 x B61-3, -4 <sup>m</sup>	70
F-16C/D	Falcon	..	1987	3 200 <sup>n</sup>	2 x B61-3, -4	70
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
<b>Total stockpile</b>						<b>3 800<sup>o</sup></b>
Deployed warheads						1 750
Reserve warheads						2 050
<b>Retired warheads awaiting dismantlement</b>						<b>2 650</b>
<b>Total inventory</b>						<b>6 450<sup>p</sup></b>

.. = not available or not applicable; ALCM = air-launched cruise missile; ICBM = inter-continental 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.

*Note:* The figures in the USA's New START Treaty declaration do not necessarily correspond to those contained in the table because of the treaty's counting rules.

<sup>a</sup> 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.

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

<sup>c</sup> Bombers have 2 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.

<sup>d</sup> Of the bomber weapons, c. 300 (200 ALCMs and 100 bombs) are deployed at the bomber bases; all the rest are in central storage. The total bomb inventory is listed as higher than in *SIPRI Yearbook 2017* to compensate for a recount of the ICBM warhead estimate, but many of the gravity bombs are no longer fully active and are slated for retirement after the B61-12 is fielded in 2020.

<sup>e</sup> The B-52H is no longer configured to carry nuclear gravity bombs.

<sup>f</sup> 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. Many B83-1s have been moved to the inactive stockpile. 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.

<sup>g</sup> Of these ICBM warheads, only 400 are deployed on the missiles. The remaining warheads are in central storage.

<sup>h</sup> Only 200 of these W78 warheads are deployed. The rest are in central storage.

<sup>i</sup> Another 340 W87s are possibly in long-term storage outside the stockpile for planned use in future so-called interoperable warheads.

<sup>j</sup> 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.

<sup>k</sup> Of these warheads, only about 900 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 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. Once production of the W76-1 is finished in 2019, all remaining W76-0s will be retired.

<sup>l</sup> Approximately 150 of the tactical bombs are deployed in Europe. The remaining bombs are in central storage in the USA. Once the B61-12 is deployed, all other B61 versions will be retired.

<sup>m</sup> The maximum yields of tactical bombs are as follows: B61-3 (170 kt) and B61-4 (50 kt). All have selective lower yields. The B61-10 was retired in 2016.

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

<sup>o</sup> Of these weapons, approximately 1750 are deployed on ballistic missiles, at bomber bases, and in Europe; all the rest are in central storage.

<sup>p</sup> 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 authors' estimates.

the costs of operating and sustaining only the forces that are already fielded.<sup>6</sup> It remains to be seen to what extent the US Congress will agree to fund these expensive projects (instead of building cheaper life-extended versions of existing designs) or whether it will decide to delay some of them.

## 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) were declared to be nuclear-capable as of 1 September 2017, although only 60 (18 B-2As and 42 B-52Hs) are thought to be assigned nuclear delivery

<sup>6</sup> US Congressional Budget Office (CBO), *Approaches for Managing the Costs of US Nuclear Forces, 2017 to 2046* (CBO: Washington, DC, Oct 2017), p. 1.

roles.<sup>7</sup> The bombers are being equipped with new command and control systems to improve interconnectivity with other forces and the US National Command Authority.<sup>8</sup>

The development of the next-generation long-range strike bomber, known as the B-21 Raider, is well under way. The B-21 is scheduled to enter service in the mid-2020s.<sup>9</sup>

To arm its bombers, the Air Force is developing a controversial new nuclear air-launched cruise missile, known as the LRSO (Long-Range Standoff missile), for deployment from 2030.<sup>10</sup> The Air Force plans to acquire 1000 missiles, of which about half will be nuclear-armed and the rest used for test launches. The weapon is intended for integration on the B-2A, the B-52H and the new B-21.<sup>11</sup>

### Land-based ballistic missiles

As part of its implementation of New START, in 2017 the USA completed the reduction of its intercontinental ballistic missile (ICBM) force from 450 to 400 deployed Minuteman III missiles, which are deployed in silos across three missile wings. Following the reduction, each of the three ICBM bases has 133–34 deployed missiles. The 50 emptied silos are being kept in a state of readiness and can be reloaded with stored missiles if necessary.

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). 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).<sup>12</sup>

<sup>7</sup> US Department of State, 'New START Treaty aggregate numbers of strategic offensive arms', Fact Sheet, 12 Jan. 2018.

<sup>8</sup> 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.

<sup>9</sup> Gertler, J., *Air Force B-21 Raider Long-Range Strike Bomber*, Congressional Research Service (CRS) Report for Congress R44463 (US Congress, CRS: Washington, DC, 7 June 2017).

<sup>10</sup> 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*, vol. 8, no. 2 (12 June 2016).

<sup>11</sup> US Air Force, 'USAF awards contracts for new nuclear missile to Lockheed, Raytheon', 23 Aug. 2017; Stone, M., 'US Air Force picks Raytheon, Lockheed for next-gen cruise missile', Reuters, 24 Aug. 2017; and Majumdar, D., 'B-52, B-2 and B-21 bombers are getting nuclear-tipped cruise missiles', *National Interest*, 24 Aug. 2017.

<sup>12</sup> Woolf, A. F., *US Strategic Nuclear Forces: Background, Developments, and Issues*, Congressional Research Service (CRS) Report for Congress RL33640 (US Congress, CRS: Washington, DC, 6 Mar. 2018), pp. 24–26.

The Air Force has begun development of a next-generation ICBM, known as the Ground Based Strategic Deterrent (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.<sup>13</sup> 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.<sup>14</sup>

The Air Force conducted four test launches of the Minuteman III in 2017. The tests took place on 8 February, 26 April, 3 May and 2 August.<sup>15</sup> All four missiles were launched from Vandenberg Air Force Base (AFB) in California with re-entry vehicle impact some 6760 kilometres away at the Ronald Reagan Ballistic Missile Defense Test Site in the Kwajalein Atoll in the Marshall Islands. Several simulated ICBM launches were also conducted in 2017, including one at F. E. Warren AFB in Wyoming that involved six missiles.<sup>16</sup>

### **Ballistic missile submarines**

In 2017 the US Navy completed the reduction of missile launch tubes (from 24 to 20) on each of its Ohio class nuclear-powered ballistic missile submarines (SSBNs). The reduction was necessary to meet the New START Treaty limit of no more than 700 deployed strategic launchers. Following the reductions, the navy's SSBN fleet can deploy up to 240 strategic missiles.<sup>17</sup>

All of the 14 Ohio class SSBNs, 8 of which are based in the Pacific and 6 in the Atlantic, carry Trident II (D5) submarine-launched ballistic missiles (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.

In 2017 the navy started replacing the Trident II (D5) SLBMs with an enhanced version known as the D5LE. The D5LE is equipped with the new Mk-6 guidance system, designed to improve the D5LE'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

<sup>13</sup> Reif, K., 'Air Force drafts plan for follow-on ICBM', *Arms Control Today*, 8 July 2015.

<sup>14</sup> Reif, K., 'New ICBM replacement cost revealed', *Arms Control Today*, Mar. 2017.

<sup>15</sup> US Air Force, Vandenberg Air Force Base, 30th Space Wing Public Affairs, 'Minuteman III launches from Vandenberg', 9 Feb. 2017; US Air Force, Global Strike Command, 'F. E. Warren tests Minuteman III missile with launch from Vandenberg', 26 Apr. 2017; US Air Force, Global Strike Command, 'Malmstrom tests Minuteman III missile with launch from Vandenberg', 3 May 2017; and US Air Force, Global Strike Command, 'F.E. Warren tests Minuteman III missile with launch from Vandenberg', 2 Aug. 2017.

<sup>16</sup> US Air Force, '90th MW provides unwavering nuclear deterrence', 13 Apr. 2017.

<sup>17</sup> Woolf (note 12).

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 in the early 2040s.<sup>18</sup>

The Trident SLBMs carry two basic warhead types: either the 455-kt W88 or the 100-kt W76. The navy has almost completed deployment of a life-extended version of the W76, known as W76-1. The W76-1 is equipped with a new fuze that improves its targeting effectiveness. 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 945 warheads as of September 2017.<sup>19</sup>

The navy test launched four Trident II (D5) SLBMs from one SSBN in 2017. As part of Follow-on Commander Evaluation Test number 53, the missiles were launched in the Pacific from the *USS Kentucky* (SSBN-737) over the course of three days.<sup>20</sup> The event marked the final test launch of the original Trident II (D5). All future Trident II test launches will be for the D5LE.

### Non-strategic nuclear weapons

The USA has one type of non-strategic weapon in its stockpile—the B61 gravity bomb. The weapon exists in two modifications: the B61-3 and B61-4. A third modification (B61-10) was retired in late 2016. There are an estimated 200 tactical B61 bombs in the US stockpile. Approximately 150 of these are deployed at six North Atlantic Treaty Organization (NATO) airbases in five European countries: Aviano and Ghedi, Italy; Büchel, Germany; Incirlik, Turkey; Kleine Brogel, Belgium; and Volkel, the Netherlands. The Belgian, Dutch and possibly Turkish air forces (using F-16 combat aircraft) and German and Italian air forces (using PA-200 Tornado combat aircraft) are assigned nuclear strike missions with the US B61 bombs. In peacetime, however, they 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’.<sup>21</sup> These reports have not been confirmed, and Incirlik is still included in scheduled nuclear storage base upgrades for 2019.<sup>22</sup>

<sup>18</sup> Woolf (note 12).

<sup>19</sup> US Department of State (note 7).

<sup>20</sup> Daniels, J. M., US Navy, Strategic Systems Programs Public Affairs, ‘FCET success: SSBN launches fleet ballistic missile’, NNS170216-21, 16 Feb. 2017.

<sup>21</sup> Hammond, J., ‘The future of Incirlik Air Base’, Real Clear Defense, 30 Nov. 2017.

<sup>22</sup> For background and context see Nuclear Threat Initiative (NTI), *Building a Safe, Secure, and Credible NATO Nuclear Posture* (NTI: Washington, DC, Jan. 2018).

The remaining 50 B61 bombs are stored in the (continental) USA for potential use by US fighter-bombers in support of allies outside Europe, including in East Asia and the Middle East.

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.<sup>23</sup> 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 strike planners to select lower yields for existing targets, which would reduce collateral damage.<sup>24</sup>

Integration flight tests have begun of the B61-12 bombs on F-15E, F-16 and Tornado combat aircraft. The B61-12 will also be integrated on the US-built F-35A combat aircraft, which is expected to be nuclear certified in 2024–26.<sup>25</sup> Italy and the Netherlands have received the first of their F-35A combat aircraft, some of which will later be designated for a nuclear delivery role.<sup>26</sup> Belgium is considering whether to buy the F-35A. Although in early 2018 the US State Department approved a possible sale of 34 F-35A aircraft, Belgium has not yet officially announced a decision to buy the F-35A.<sup>27</sup> Germany does not currently have a plan to replace the PA-200 Tornado in its nuclear role and is expected to extend its service life into the 2020s, despite the German Air Force's apparent preference for the F-35A.<sup>28</sup>

<sup>23</sup> US Government Accountability Office (GAO), *Nuclear Weapons: DOD and NNSA Need to Better Manage Scope of Future Refurbishments and Risks to Maintaining US Commitments to NATO*, Report to Congressional Requesters, GAO-11-387 (GAO: Washington, DC, May 2011), p. 13.

<sup>24</sup> For a description of the B61-12 and its implications see Kristensen, H. M., 'B61 LEP: increasing NATO nuclear capability and precision low-yield strikes', FAS Strategic Security Blog, Federation of American Scientists, 15 June 2011.

<sup>25</sup> Kristensen, H. M. and Norris, R. S., 'The B61 family of nuclear bombs', *Bulletin of the Atomic Scientists*, vol. 70, no. 3 (2014).

<sup>26</sup> Seligman, L., 'Dutch F-35s land in the Netherlands', *Defense News*, 23 May 2016; and Peruzzi, L., 'Italy receives first Cameri-assembled F-35A', *Flight Global*, 8 Dec. 2015.

<sup>27</sup> Defense Security Cooperation Agency, 'Belgium: F-35 Joint Strike Fighter Aircraft', News Release 17-80, 18 Jan. 2018.

<sup>28</sup> Reuters, "'F-35' für die Bundeswehr? Luftwaffe benennt Anforderungen an "Tornado": Nachfolger' [F-35' for the Bundeswehr? Air Force calls requirements on 'Tornado' successor], *Der Spiegel*, 8 Nov. 2017.