

I. US nuclear forces

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As of January 2017, the United States maintained a military stockpile of about 4000 nuclear warheads.¹ This represented a reduction of approximately 500 warheads compared with early 2016, as a result of a unilateral cut ordered by US President Barack Obama.² The active stockpile included approximately 1800 deployed nuclear warheads, consisting of nearly 1650 strategic and 150 non-strategic warheads. In addition, about 2200 warheads were held in reserve and another roughly 2800 retired warheads were awaiting dismantlement, giving a total inventory of approximately 6800 nuclear warheads (see table 11.2).

The USA has entered the final phase of implementing the 2010 Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START).³ As of January 2017 it was already below the treaty's numerical limits on deployed strategic nuclear warheads and deployed strategic missile launchers and heavy bombers that the parties are required to meet by February 2018.⁴

Nuclear modernization

The USA has begun the most ambitious modernization of its nuclear forces since the end of the cold war. Over the next decade the USA plans to start construction of a new class of nuclear-powered ballistic missile submarine (SSBN), introduce a new nuclear-capable strategic bomber, develop a long-range air-launched cruise missile (ALCM), design a next-generation intercontinental ballistic missile (ICBM), field a new nuclear-capable tactical combat aircraft and upgrade existing nuclear warheads and gravity bombs. There are also plans to modernize nuclear command, control, communication and early-warning systems and to refurbish US nuclear weapon laboratories and production facilities.

According to the US Congressional Budget Office (CBO), the total cost of modernizing the USA's nuclear forces and related infrastructure will be approximately \$400 billion over the 10-year period 2017–26—\$52 billion more than the CBO's previous estimate for the period 2015–24.⁵ Some analysts predict that the USA will spend approximately \$1 trillion by the mid-

¹ This section updates the more detailed discussion of US nuclear forces in *SIPRI Yearbook 2016*.

² White House, Office of the Press Secretary, 'The Prague agenda', Fact sheet, 11 Jan. 2017.

³ For a summary and other details of New Start see annex A, section III, in this volume.

⁴ On the implementation of New START see chapter 12, section I, in this volume.

⁵ US Congressional Budget Office, *Projected Costs of US Nuclear Forces, 2017 to 2026* (US Congress: Washington, DC, Feb. 2017).

Table 11.2. US nuclear forces, January 2017

| Type | Designation | No. of launchers | Year first deployed | Range (km) ^a | Warheads x yield | No. of warheads ^b |
|--------------------------------|------------------|---------------------|---------------------|-------------------------|---|------------------------------|
| Strategic forces | | | | | | 3 700 |
| <i>Bombers</i> | | 60/107 ^c | | | | 810 ^d |
| B-52H | Stratofortress | 44/87 | 1961 | 16 000 | 20 x ALCM 5–150 kt ^e | 528 |
| B-2A | Spirit | 16/20 | 1994 | 11 000 | 16 x B61-7, -11, B83-1 bombs ^f | 282 |
| <i>ICBMs</i> | | 400 ^g | | | | 970 ^h |
| LGM-30G | Minuteman III | | | | | |
| | Mk-12A | 180 | 1979 | 13 000 | 1-3 x W78 335 kt | 540 |
| | Mk-21 SERV | 220 | 2006 | 13 000 | 1 x W87 300 kt | 430 ⁱ |
| <i>SSBNs/SLBMs</i> | | 264 ^j | | | | 1 920 ^k |
| UGM-133A | Trident II (D5)j | | | | | |
| | Mk-4 | .. | 1992 | >7 400 | 1-8 x W76-0 100 kt | 321 |
| | Mk-4A | .. | 2008 | >7 400 | 1-8 x W76-1 100 kt | 1 215 |
| | Mk-5 | .. | 1990 | >7 400 | 1-8 x W88 475 kt | 384 |
| Non-strategic forces | | | | | | 300^l |
| F-15E | Strike Eagle | .. | 1988 | 3 840 | 5 x B61-3, -4, -10 ^m | 100 |
| F-16C/D | Falcon | .. | 1987 | 3 200 ⁿ | 2 x B61-3, -4, -10 | 100 |
| F-16MLU | Falcon (NATO) | .. | 1985 | 3 200 | 2 x B61-3, -4, -10 | 60 |
| PA-200 | Tornado (NATO) | .. | 1983 | 2 400 | 2 x B61-3, -4, -10 | 40 |
| Total stockpile | | | | | | 4 000^o |
| Retired awaiting dismantlement | | | | | | 2 800 |
| Total inventory | | | | | | 6 800^p |

.. = 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.

^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 aircraft bases.

^c Bombers have 2 numbers: the first is the number assigned to the nuclear mission; the second is the total inventory. By 2018 the Air Force plans to have 66 nuclear-capable bombers (20 B-2s and 46 B-52Hs) of which 60 will be deployed.

^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.

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

^f Strategic gravity bombs are only assigned to B-2 bombers. The maximum yields of strategic bombs are: B61-7 (360 kt), B61-11 (400 kt), B83-1 (1200 kt), but they also have lower yields. Once the B61-12 is deployed, all other gravity bombs will be retired.

^g There were 416 ICBMs deployed as of 1 Sep. 2016; 16 are being deactivated as part of a plan to reduce the force to 400 ICBMs under the New START Treaty.

^h Of these ICBM warheads, only 400 are deployed on the missiles. The remaining warheads are in central storage. Downloading of the Minuteman III was completed in June 2014 but the capability to re-MIRV (i.e. upload multiple independent re-entry vehicle technology) the 180 missiles with W78/Mk12A warheads if necessary has been retained.

ⁱ Another 110 W87s are possibly in long-term storage outside the stockpile for planned use in future so-called interoperable warheads.

^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 is being reduced to 240 by 2018.

^k Of these warheads, only about 900 are deployed on submarines; all the rest are in central storage. Although each D5 missile was counted under START as carrying 8 warheads and has been flight tested with 14, the US Navy has downloaded each missile to an average of 4–5 warheads. By now, 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.

^l Approximately 150 of the tactical bombs are deployed in Europe. The remaining bombs are in central storage in the United States. Once the B61-12 is deployed, all other B61 versions will be retired.

^m The maximum yields of tactical bombs are: B61-3 (170 kt), B61-4 (50 kt) and B61-10 (80 kt). All have selective lower yields. The B61-10 is in the inactive stockpile.

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 1800 are deployed on ballistic missiles, at bomber bases, and in Europe; all the rest are in central storage.

^p In addition to these intact warheads, there are c. 20 000 plutonium pits stored at the Pantex Plant, Texas, and perhaps 5000 uranium secondaries stored at the Y-12 facility at Oak Ridge, Tennessee.

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

2040s on maintaining the current arsenal, buying replacement systems and upgrading nuclear weapon infrastructure.⁶

Bombers

The US Air Force currently operates a fleet of 20 B-2 and 87 B-52H bombers. Of these, 20 B-2s and 54 B-52Hs were declared to be nuclear-capable as of 1 September 2016, although only 60 (16 B-2s and 44 B-52Hs) are thought to be assigned nuclear weapon delivery roles.⁷ The bombers are being equipped with new command and control systems to improve interconnectivity with other forces and the US National Command Authority.

The Air Force announced in September 2016 that its next-generation long-range strike bomber (LRS-B) will be called the B-21 Raider. This new dual-capable bomber, which appears to be very similar in design to the

⁶ Wolfsthal, J., Lewis, J. and Quint, M., *The Trillion Dollar Nuclear Triad* (Monterey Institute of International Studies, James Martin Center for Nonproliferation Studies: Monterey, CA, Jan. 2014), p. 4.

⁷ US Department of State, Bureau of Arms Control, Verification and Compliance, ‘New START Treaty aggregate numbers of strategic offensive arms’, Fact sheet, 1 Jan. 2017.

current B-2, will begin to enter service in the late 2020s and replace the B-52H and B-1B bombers. The Air Force has announced plans to buy at least 100 B-21s from Northrop Grumman in a deal worth up to \$80 billion.⁸

The Air Force is developing a new nuclear air-launched cruise missile, known as the LRSO (Long-Range Standoff missile), which will be integrated on three strategic bombers (B-2, B-52H and B-21). US defence officials argue that the LRSO is needed to enable bombers to strike targets from outside modern and future air-defence systems and provide flexible strike options in regional scenarios.⁹ However, some critics have argued that the standoff mission can be carried out using non-nuclear long-range cruise missiles such as the extended-range version of the Joint Air-to-Surface Standoff Missile (JASSM-ER).¹⁰

Land-based ballistic missiles

The US ICBM force has been reduced to 400 (or just above) Minuteman III missiles deployed in silos across three 'missile wings'.¹¹ The reduction to 400 missiles from the 450 missiles operated three years ago is part of the implementation of New START. The reduction is spread across all three ICBM bases. The 50 emptied silos are being kept in a state of readiness and capable of reloading the stored missiles if necessary.

The Minuteman III ICBMs have been extensively modernized over the past 15 years and additional enhancements are under way. This includes a new arming, fusing and firing (AF&F) component on the re-entry vehicles to improve their ability to destroy hardened targets. The Air Force plans to begin a Minuteman life-extension programme so that the missiles can remain in service until 2030.¹²

The Air Force has also 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. The plan is to buy 642 missiles, of which 400 would be deployed, 50 stored and the remaining used for test launches and as spares. The expected cost of developing and producing

⁸ Cooper, H., 'Northrop Grumman wins \$21.4 billion Pentagon contract', *New York Times*, 27 Oct. 2015.

⁹ For a review of official statements on the LRSO mission see Kristensen, H., 'LRSO: the nuclear cruise missile mission', FAS Strategic Security Blog, 20 Oct. 2015.

¹⁰ Kristensen, H., 'Forget LRSO: JASSM-ER can do the job', FAS Strategic Security Blog, 16 Dec. 2015.

¹¹ The New START aggregate data reported 416 deployed ICBMs as of 1 Sep. 2016 and an additional 270 missiles in storage. US Department of State (note 7). Since then, most or all of the 16 ICBMs in excess of the 400 missiles to be retained under New START have probably been deactivated.

¹² Wolf, A., *US Strategic Nuclear Forces: Background, Developments, and Issues*, Congressional Research Service (CRS) Report for Congress RL33360 (US Congress, CRS: Washington, DC, 10 Feb. 2017), pp. 13–15.

the GBSB is increasing and is now projected to be \$80–\$100 billion, up from \$62.3 billion two years ago.¹³

Three live test launches and several simulated launches of Minuteman III ICBMs were conducted in 2016. The first two test launches took place on 20 and 25 February; this marked the second time in a year that the Air Force test launched two ICBMs in one week.

Ballistic missile submarines

All of the US Navy's 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). Normally, 12 of the 14 submarines are considered operational, with 2 boats undergoing a refuelling overhaul at any given time. Pursuant to complying with New START's ceiling on deployed strategic warheads, the USA has chosen to reduce the number of missile launch tubes carried by the Ohio class SSBN from 24 to 20; about half of the SSBNs have been modified, and the rest will be so by late 2017.

Starting in 2017 the Trident II D5 SLBMs will be replaced with a life-extended version known as the D5LE. The new version is equipped with the Mk-6 guidance system, designed to improve its accuracy. 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. The D5LE will initially also arm the new Columbia class SSBN, the first of which is scheduled to start patrols in 2031.

The Navy has two basic warhead types for its SLBMs: the 475-kiloton W88 and the 100-kt W76. Each SLBM can carry up to eight warheads but normally carries fewer. The Navy does not disclose how many warheads it carries on the submarines but in practice each missile probably carries three to six warheads, depending on mission requirements.

In 2016 the US Navy test launched four Trident II (D5) SLBMs from two SSBNs: three in the Pacific and one in the Atlantic. The Atlantic test was the 160th successful flight test of the Trident II D5 since 1989.

Non-strategic nuclear weapons

The USA has one type of non-strategic weapon in its stockpile, the B61 gravity bomb. The weapon exists in three modifications: the B61-3, B61-4 and B61-10. Some 300 tactical B61 bombs of all versions remain in the stockpile. Approximately 150 of these (versions 3 and 4) 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;

¹³ Reif, K., 'Price tag rising for planned ICBMs', *Arms Control Today*, vol. 46, no. 8 (Oct. 2016).

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 2016.¹⁴ The remaining B61 bombs are stored in the USA for potential use by US fighter-bombers in support of allies outside Europe, including in north-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.¹⁵ The B61-12 will use the nuclear explosive package of the B61-4, which has a maximum yield of approximately 50 kt, but 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.¹⁶

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. Italy and the Netherlands have received the first of their F-35A combat aircraft, some of which will be designated for a nuclear delivery role. Belgium is considering whether to buy the F-35A and will probably do so if it intends to maintain a nuclear role. Germany does not currently have a plan to replace the PA-200 Tornado in its nuclear role but is expected to extend its service life into the 2020s.

Nuclear operations and exercises

In 2016 the USA carried out a number of exercises, training missions and foreign visits that collectively highlighted the central role of nuclear forces and operations in responding to regional deterrence challenges. In April US Strategic Command (STRATCOM) conducted the annual nuclear command and control exercise, Global Lightning 16, which included the rapid-launch

¹⁴ See e.g. Schlosser, E., 'The H-bombs in Turkey', *New Yorker*, 17 July 2016; and Barnes, J. E., 'Turkey closes airspace around US airbase following coup attempt', *Wall Street Journal*, 16 July 2016. On the coup attempt in Turkey see chapter 4, section III, in this volume.

¹⁵ On NATO approval of the B61-12 modernization programme see US Government Accountability Office (GAO), *Nuclear Weapons*, GAO-11-387 (GAO: Washington, DC, May 2011), p. 13.

¹⁶ For analyses of the military implications of the enhanced B61-12 see Kristensen, H. M., 'Video shows Earth penetration capability of B61-12 nuclear bomb', FAS Strategic Security Blog, 14 Jan. 2015; and Kristensen, H. M., 'B61 LEP: increasing NATO nuclear capability and precision low-yield strikes', FAS Strategic Security Blog, 15 June 2011.

of nuclear-capable strategic bombers.¹⁷ The exercise followed an unusually active period of nuclear missile testing by the US Air Force and Navy, during which three SLBMs, two ICBMs, and one ALCM were launched in a four-week period in February and March.¹⁸

In August 2016 STRATCOM carried out a heavy bomber exercise that was seen as a response to Russian military activities of concern to the USA and its allies. As part of Operation Polar Roar, six unarmed B-2 and B-52H bombers were sent on simulated strike missions over the North Pole, the North Sea, the Baltic Sea and the northern Pacific Ocean. The bomber operations followed a similar exercise in 2015, which had simulated nuclear strike operations in a way not seen since the late 1980s.¹⁹

There were also several highly visible visits by US strategic forces, such as the first port visit of an SSBN to Guam since the end of the cold war in an explicit display of the regional nuclear deterrence mission in the Pacific.²⁰ Also in the Pacific, US B-52H bombers were sent on overflights of South Korea and conducted overflights and bombing training in Australia.

¹⁷ The exercise was designed to assess joint operational readiness and to 'ensure the resilience, redundancy and survivability of US strategic deterrent forces'. US Strategic Command Public Affairs, 'USSTRATCOM, allies and partners conclude Global Lightning 16', Press release, 29 Apr. 2016.

¹⁸ US Strategic Command Public Affairs, 'Successful Trident II D5 missile test another demonstration of triad readiness', Press release, 21 Mar. 2016.

¹⁹ See Kristensen, H. M., 'Increasing nuclear bomber operations', FAS Strategic Security Blog, 25 Sep. 2016.

²⁰ US Strategic Command Public Affairs, 'USS Pennsylvania arrives in Guam for port visit', Press release, 13 Oct. 2016.