

I. US nuclear forces

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As of January 2016, the United States maintained a stockpile of approximately 4500 nuclear warheads.¹ This included approximately 1930 deployed nuclear warheads, consisting of roughly 1750 strategic and 180 non-strategic warheads. In addition to this deployed arsenal, about 2570 warheads were held in reserve. Another roughly 2500 retired warheads were scheduled for dismantlement, for a total inventory of approximately 7000 warheads (see table 16.2).

To date, US implementation of the 2010 Russian–US Treaty on Measures for the Further Reduction and Limitation of Strategic Offensive Arms (New START Treaty) has focused on eliminating so-called ‘phantom weapons’, that is, weapons that are not actually used in nuclear operations but still carry equipment that makes them accountable under the treaty. As of 1 September 2015, the USA was counted as having 1538 strategic warheads attributed to 762 deployed missiles and bombers.² The total reduction since the treaty entered into force in February 2011 is 263 strategic warheads and 120 launchers. The implementation effort has now shifted to reducing the number of actual nuclear launchers, including denuclearizing 30 excess B-52H bombers, removing 40 intercontinental ballistic missile (ICBMs) from their silos and reducing the number of missile tubes on each nuclear-powered ballistic missile submarine (SSBN) from 24 to 20.

Nuclear modernization

Over the next decade, the United States plans to spend nearly \$350 billion on modernizing and maintaining its nuclear forces and the facilities that support them.³ This will include a new class of nuclear-powered SSBN; a new long-range bomber with nuclear capability, and a new air-launched cruise missile (ALCM); a next-generation land-based ICBM; a new nuclear-capable tactical fighter aircraft; complete full-scale production of one nuclear warhead (W76-1) and starting production of two others (B61-12 and W80-4);

¹ The US Department of Defense announced in May 2016 that its nuclear weapons stockpile included 4571 warheads as of 30 Sep. 2015. Since then a small number of warheads is thought to have been retired for an estimated stockpile of approximately 4500 warheads. US Department of Defense, *Stockpile Numbers: End of Fiscal Years 1962–2015*, DOD Open Government, [n.d.], accessed 25 May 2016, p. 1.

² US Department of State, Bureau of Arms Control, Verification and Compliance, ‘New START Treaty aggregate numbers of strategic offensive arms’, Fact Sheet, 1 Jan. 2016.

³ US Congressional Budget Office, *Projected Costs of US Nuclear Forces, 2015 to 2024* (US Congress: Washington, DC, Jan. 2015), p. 4.

Table 16.2. US nuclear forces, January 2016

Type	Designation	No. of launchers ^a	Year first deployed	Range (km) ^b	Warheads x yield	No. of warheads ^c
Strategic forces						3 736
<i>Bombers</i>		60/96 ^d				784 ^e
B-52H	Stratofortress	44/76	1961	16 000	20 x ALCM 5–150 kt ^f	528
B-2A	Spirit	16/20	1994	11 000	16 x B61-7, -11, B83-1 bombs ^g	256
<i>ICBMs</i>		440				840 ^h
LGM-30G	Minuteman III					
	Mk-12A	200	1979	13 000	1 x W78 335 kt	600
	Mk-21 SERV	240	2006	13 000	1 x W87 300 kt	24
<i>SSBNs/SLBMs</i>		264				2 112 ⁱ
UGM-133A	Trident II (D5) ^j					
	Mk-4	..	1992	>7 400	4 x W76-0 100 kt	628
	Mk-4A	..	2008	>7 400	4 x W76-1 100 kt	1 100
	Mk-5	..	1990	>7 400	4 x W88 475 kt	384
Non-strategic forces						500^k
F-15E	Strike Eagle	..	1988	3 840	5 x B61-3, -4, -10 ^l	200
F-16C/D	Falcon	..	1987	3 200 ^m	2 x B61-3, -4, -10	200
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 warheads						4 236ⁿ
Spares						264
Total stockpile						4 500
Retired awaiting dismantlement						2 500
Total inventory						7 000^o

.. = not available or not applicable; () = uncertain figure; ALCM = air-launched cruise missile; ICBM = intercontinental ballistic missile; kt = kiloton; SERV = security-enhanced re-entry vehicle; SLBM = submarine-launched ballistic missile; SLCM = sea-launched cruise missile; SSBN = nuclear-powered ballistic missile submarine.

^a Bombers have 2 numbers: the 1st figure is the number assigned to the nuclear mission; the 2nd figure is the total inventory.

^b 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.

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

^d Of the bombers, 76 B-52Hs and 18 B-2s are nuclear-capable, of which 44 B-52Hs and 16 B-2s are nuclear tasked under the war plans.

^e Of the bomber weapons, c. 300 (200 ALCMs and 100 bombs) are deployed at the bomber bases. The rest are in central storage.

^f The B-52H can also carry B61-7 and B83-1 gravity bombs but is currently configured to only deliver ALCMs.

^g The maximum yields of strategic bombs are B61-7 (360 kt), B61-11 (400 kt), B83-1 (1200 kt).

^h Of these warheads, 440 are deployed on missiles. The remaining warheads are in central storage.

ⁱ Of these warheads 1000 are deployed on the submarines. The rest are in central storage. Although each D5 missile was counted under New START as carrying 8 warheads, the US Navy has downloaded each missile to an average of 4–5 warheads.

^j Of the 14 SSBNs, at least 2 are normally undergoing overhaul at any given time. They are not assigned weapons.

^k Approximately 180 of the tactical bombs are deployed at bases in Europe. The remaining warheads are in central storage in the United States.

^l The yields of the tactical bombs range from 0.3 kt to 170 kt depending on type. The warhead in the B61-4, which will be used in the new B61-12, has four selective yields: 0.3 kt, 1.5 kt, 10 kt, and 50 kt. The B61-10 is in the inactive stockpile.

^m Most sources list 2400 km unrefuelled ferry range but Lockheed Martin lists 3200 km.

ⁿ Of these weapons, approximately 1930 are deployed on ballistic missiles, at bomber bases, and in Europe. The rest are in central storage.

^o In addition to these c. 7000 intact warheads, there are c. 20 000 plutonium pits stored at the Pantex Plant, Texas, and perhaps 4500 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 author's estimates.

modernizing nuclear command and control facilities; and building new nuclear weapon production and simulation facilities.

In addition to these programmes, the United States is planning significant redesigns of warheads for ballistic missiles. These modified warheads, known as interoperable warheads (IWs), are based on existing weapon designs but modified significantly by mixing warhead components from different types of warheads into designs that do not currently exist. The first such interoperable warhead, designated the IW-1, will use the nuclear explosives package from the W87 warhead and other components from the W78, and will be designed for delivery by the existing Mk21 (ICBM) and Mk5 (SLBM) reentry vehicles. Development work will start in 2020, with first delivery in 2030 and production continuing until 2040 at a cost of more than \$15 billion.⁴ The IW-2, which will combine the W87 and the W88 warheads, is scheduled to enter service in 2034 at a cost of more than \$17 billion. The IW-3 will be a modified W76-1 and cost more than \$18 billion.⁵ There is considerable uncertainty about how the US military will pay for all these nuclear modernization programmes.⁶

⁴ US Department of Energy (DOE), National Nuclear Security Administration, *Fiscal Year 2016 Stockpile Stewardship and Management Plan*, Report to Congress (DOE: Washington, DC, Mar. 2015), pp. 2–25.

⁵ US Department of Energy (note 4), pp. 8–17.

⁶ Harrison, T., *Defense Modernization Plan through the 2020s: Addressing the Bow Wave* (Center for Strategic and International Studies: Washington, DC, Jan. 2016).

Bombers

The US Air Force currently operates a fleet of 20 B-2 and 93 B-52H bombers. Of these, 18 B-2s and 76 B-52Hs are nuclear-capable. The New START Treaty counts 88 B-52Hs as nuclear-capable because installed equipment makes nearly all B-52Hs accountable under the treaty. Not all of these play a nuclear role. Of the 88 accountable bombers, only about 60 (16 B-2s and 44 B-52Hs) are thought to be assigned nuclear missions in the nuclear war plans.

The bombers are organized into nine bomb squadrons in five bomb wings at three bases: Minot Air Force Base (AFB) in North Dakota; Barksdale AFB in Louisiana; and Whiteman AFB in Missouri. Two new wings and three new squadrons have been added since 2012 using Air Reserve and Air National Guard personnel. The additions have not increased the number of nuclear bombers but enable the existing force to maintain a higher level of readiness.

Each B-2 can carry up to 16 nuclear bombs (B61-7, B61-11 and B83-1 gravity bombs), and each B-52H can carry up to 20 ALCMs (or AGM-86B). Nearly 850 nuclear weapons, including 528 ALCMs, are thought to be assigned to the bomber force.⁷ No more than 200–300 weapons are deployed at the bomber bases under normal circumstances. The remaining 550–650 weapons are kept in central storage at Kirtland AFB in New Mexico.

The Air Force has several long-term nuclear modernization programmes underway. In October 2015, the Air Force awarded a contract to the Northrop-Grumman Corporation to develop the next-generation long-range nuclear bomber.⁸ The new bomber, known as B-21, looks similar to the B-2 and will replace the B-52H and B-1B bombers during the 2030s and 2040s. The Air Force plans to buy at least 100 B-21s at a cost of at least \$60 billion, but there is still no public estimate for the expected total cost of the programme, which is likely to increase significantly.

To arm the B-21 and the B-2, the Air Force is developing a new guided nuclear gravity bomb known as the B61-12. The bomb will also be integrated on US and allied nuclear-capable combat aircraft (see below). The B61-12 programme is expected to cost approximately \$10 billion for an estimated 480 bombs. Delivery of the first B61-12 is planned for 2022.

The Air Force is also developing a new stealthy nuclear-armed cruise missile that will have greater range and accuracy than the existing ALCM (AGM-86B). The new missile, known as the LRSO (Long-Range Standoff missile), will be integrated on all three strategic bombers (B-2, B-52H and B-21), unlike the ALCM which is only delivered by the B-52H. Military

⁷ In addition, 47 ALCMs will be used as test-launch missiles until 2030, when the system is to be retired. Reif, K., 'Air Force wants 1,000 new cruise missiles', *Arms Control Today*, 7 May 2015.

⁸ US Air Force, Secretary of the Air Force Public Affairs, 'Air Force awards LRS-B contract', 27 Oct. 2015.

officials argue that the LRSO is needed to enable bombers to strike targets from outside modern and future air-defence systems, and to provide flexible strike options in regional scenarios.⁹ Development and production of the LRSO and its nuclear warhead are expected to cost around \$25 billion for 1000 missiles.¹⁰

US nuclear-capable bombers conducted several exercises and operations in 2015. In April, Exercise Polar Growl sent four B-52H bombers on a simulated strike mission over the North Pole and North Sea in support of the North Atlantic Treaty Organization (NATO). Exercise Constant Vigilance in May practised the entire bomber force's ability to load nuclear weapons and launch aircraft rapidly in a crisis.

Land-based ballistic missiles

According to New START data, as of 1 September 2015 the US Air Force deployed 441 operational Minuteman III ICBMs and held an additional 249 missiles in storage.¹¹ The Minute III force is deployed in underground silos at three air force bases: the 90th Missile Wing at F.E. Warren AFB in Colorado, Nebraska, and Wyoming; the 91st Missile Wing at Minot AFB in North Dakota; and the 341st Missile Wing at Malmstrom AFB in Montana. Each wing has 3 squadrons, each with 48 missiles controlled by 5 Launch Control Centres.

Under the New START Treaty the United States has chosen to reduce the ICBM force to 400 operationally deployed missiles by 2018. Rather than eliminating one of three squadrons from one base, the Air Force will spread the reduction across all three bases. The emptied silos will not be destroyed, however, but 'kept warm' and capable of reloading missiles if necessary. The US inventory will contain a total 454 deployed and non-deployed Minuteman III missiles in 2018.¹²

Each Minuteman III missile carries either the 335-kiloton W78 warhead or the 300-kt W87 warhead. The missiles equipped for the W87 warhead can only carry one warhead each. The missiles equipped for the W78 can carry up to three warheads, but they were downloaded (de-MIRVed) to single-warhead configuration in 2014. The offloaded warheads are in storage and the capability to re-MIRV the missiles is retained.

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

¹⁰ Of this total, 472 missiles will be used in test-launches over the 30-year lifetime of the LRSO. Reif (note 7).

¹¹ US Department of State (note 2).

¹² US Department of Defense, 'Report on plan to implement the nuclear force reductions, limitations, and verification and transparency measures contained in the New START Treaty specified in Section 1042 of the National Defense Authorization Act for Fiscal Year 2012', Apr. 2014, p. 3.

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 Air Force specified in January 2015 that the entire 'missile stack' (rockets, fuel, guidance and control system) should be replaced. The plan is to buy 642 missiles, of which 400 would be deployed and the remaining used for test-launches and as spares, at an estimated 30-year lifetime cost of \$62.3 billion.¹³ The new family of interoperable warheads (see above), on which design work is set to begin in 2020, will be deployed on the GBSD.¹⁴

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) SLBMs.¹⁵ Each SSBN is equipped with 24 missile tubes but in 2015 the US Navy began the process of reducing the number of tubes on each SSBN to 20. Under the New START Treaty the USA has chosen to reduce the number of SLBMs that can be deployed at any given time to no more than 240. The reduction will be completed in 2017.

Normally, 12 of the 14 SSBNs are considered operational, with the remaining 2 undergoing a refuelling overhaul at any given time. The New START aggregate data, however, shows that not all the remaining 12 submarines are fully loaded or operational. As of 1 September 2015, for example, only 236 SLBMs were counted as deployed (loaded in launch tubes), 52 fewer than the full capacity of 12 boats.¹⁶ Thus, 10 of the submarines at most were carrying all of their missiles at the time of the count, although some submarines might sometimes carry less than a full complement of missiles.

There are currently three versions of two basic warhead types deployed on the SLBMs: the 100-kiloton W76-0, the new 100-kt W76-1 and the 455-kt W88. The W76-1 is a refurbished version of the W76-0, with the same yield but new safety features. The Mk4A re-entry body that carries the W76-1 is equipped with a new arming, fusing and firing (AF&F) unit that improves the targeting efficiency of the weapon. Full-scale production of approximately 1600 W76-1s is underway at the Pantex Plant in Texas and scheduled to be completed in 2019.

The New START Treaty aggregate data does not specify warhead loading on deployed SSBNs. However, since each ICBM is known to carry only one warhead and each bomber counts as one warhead, it can be determined that the 236 SLBMs that were deployed as of 1 September 2015 carried 1012 war-

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

¹⁴ US Department of Energy (note 4).

¹⁵ Four other Ohio class submarines were converted to cruise missile and special forces platforms (SSGNs) in the mid-2000s and no longer carry nuclear weapons.

¹⁶ US Department of State (note 2).

heads. In practice the missiles probably carry three to six warheads, depending on the requirements of their particular role in the war plans.

The US Navy is well advanced with its development of the next-generation SSBN. The new submarine, which is known as the Ohio Replacement Submarine or SSBNX and expected to sail on its first patrol in 2031, will be equipped with 16 missile tubes rather than 24.¹⁷ A total of 12 SSBNs are planned, at an estimated total cost of \$98–103 billion, of which \$10–15 billion will be research and development.¹⁸ Initially the new SSBN will be armed with a life-extended version of the current Trident II SLBM (the D5LE) with a new guidance system designed for improved accuracy. Starting in 2017, the D5LE will also be fitted on to existing Ohio class submarines for the remainder of their service life (up to 2042).

Non-strategic nuclear weapons

The United States 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. Approximately 500 tactical B61 bombs of all versions remain in the stockpile.

A little over 180 of these (versions 3 and 4) are deployed at 6 bases in 5 European countries: Aviano, Italy; Büchel, Germany; Ghedi, Italy; Incirlik, Turkey; Kleine Brogel, Belgium; and Volkel, the Netherlands. Weapons deployed at Büchel, Ghedi, Kleine Brogel, Volkel and some of the weapons at Incirlik are intended for use by the host nation's aircraft. A small number of the remaining non-strategic weapons stored in the United States are for potential use by US fighter-bombers in support of allies outside Europe, including in the Middle East and north-east Asia.

In 2022 the US Air Force will start to replace tactical B61 bombs with the new B61-12 guided nuclear gravity bomb.¹⁹ 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 guided tail kit to increase its accuracy and give it some limited standoff capability. The B61-12, which also appears to have earth-penetration capability, will be a more effective weapon that can put at

¹⁷ For an overview of the SSBNX programme see O'Rourke, R., *Navy Ohio Replacement (SSBN[X]) Ballistic Missile Submarine Program: Background and Issues for Congress*, Congressional Research Service (CRS) Report for Congress R41129 (US Congress, CRS: Washington, DC, 18 Oct. 2012).

¹⁸ US Congressional Budget Office, *An Analysis of the Navy's Fiscal Year 2016 Shipbuilding Plan* (US Congress: Washington, DC, Oct. 2015), p. 25.

¹⁹ On NATO approval of the B61-12 modernization programme see 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*, GAO-11-387 (GAO: Washington, DC, May 2011), p. 13.

risk hardened targets unable to be destroyed by the B61-3 or B61-4.²⁰ It will also enable strike planners to select lower yields for existing targets in order to reduce collateral damage. The bomb will be integrated on the F-15E, F-16, F-35A and PA-200 Tornado fighter jets.

NATO's annual nuclear strike exercise, Steadfast Noon, was held at Büchel Air Base in Germany in October 2015. The exercise appeared to be intertwined with the Cold Igloo exercise, and included nuclear-capable aircraft from Belgium, Germany, Italy, Netherlands, Turkey and the USA. Aircraft from the Czech, Greek and Polish air forces provided non-nuclear support under the so-called SNOWCAT programme.²¹

²⁰ Kristensen, H. M. and McKinzie, M., 'Video shows earth-penetrating capability of the B61-12 nuclear bomb', Federation of American Scientists (FAS) Strategic Security Blog, 14 Jan. 2016.

²¹ SNOWCAT: Support of Nuclear Operations With Conventional Air Tactics (previously Support of Nuclear Operations With Conventional Attacks). See Kristensen, H. M., *NATO Nuclear Operations: Management, Escalation, Balance of Power*, Course on Nuclear Weapons Policy and Arms Control, James Martin Center for Nonproliferation Studies, Washington, D.C., 27 Oct. 2015, slide 3.