The United States is conducting a complete overhaul of all components of its nuclear triad, requiring three full decades of investment. This will cost, including current operations, at least $1 trillion. The new weapons and factories placed into service will last, i.e. generate nuclear threats (their purpose), until late in this century. US nuclear modernisation is already producing significant new nuclear capabilities with unknowable consequences, and significant additional new capabilities are planned and budgeted. No warhead retirements are occurring under New START and none are committed. Future dismantlements have been made contingent on construction of new factories and deployment of new weapons.

The modernisation programme-of-record has been dogged by delays, cancellations, downscaling, and cost overruns; its completion in an era of budgetary uncertainty and constraint is widely questioned. Modernisation competes with warhead dismantlement for scarce physical and financial resources in the production complex. There are deep concerns in government (including the military) and in civil society about nuclear weapons cost and relevance, but so far not one member of Congress publicly opposes maintaining a policy of “mutual assured destruction” (MAD) based on a triad of delivery systems with thousands of nuclear warheads.

Status of US nuclear forces

Warheads

As of 1 April 2015 the United States deployed 1,597 strategic warheads on 785 strategic delivery vehicles on or in 898 deployed and non-deployed launchers. In all the United States possesses at least 7,100 warheads including deployed strategic warheads, non-strategic warheads, operational warheads not deployed, and including a minimum of 2,340 intact but “retired” warheads. An unknown number of retired warheads are in “managed retirement” or “war reserve” status.

In addition the US stores more than 15,000 plutonium pits from dismantled nuclear weapons, thousands of which could be reused, as well as thousands of thermonuclear secondaries and millions of other parts. Warheads removed from deployed strategic stockpile to comply with New START are not being retired but rather transitioned to the maintained “hedge” stockpile, with the result that New START will not result in any significant change in the size of the active US stockpile until the late 2020s at the earliest. Current policy makes retirements contingent on successful completion of planned warhead modernisation and construction of new warhead production capacity.

Delivery systems

The US strategic “triad” consists of: 447 Minuteman III intercontinental ballistic missiles (ICBMs) carrying 447 warheads with the capacity for additional warheads to be uploaded; 14 Ohio-class submarines each with 24 launch tubes for Trident D5 submarine-launched ballistic missiles (SLBMs) carrying about 1,152 warheads with an upload capacity of more than that many warheads again; and 96 nuclear capable strategic bombers, 20 B2As and 76 B-52Hs. Of these heavy bombers, 60 (44 B-52Hs and 16 B-2As) have been assigned nuclear roles. Each heavy bomber is counted as one warhead under New START, although up to 20 warheads on cruise missiles can be deployed on a single B-52H and up to 16 nuclear gravity bombs can be carried on each B-2. The active US stockpile also includes about 500 non-strategic weapons, with about 180 deployed at NATO air bases in Europe for delivery by US F-15Es, F-16s, and host country F-16s and Tornado aircraft.

Fissile materials

The US has produced or acquired approximately 850 metric tons (MT) of highly-enriched uranium (HEU) and 112 MT of weapon-grade plutonium, of which 609 MT and 95 MT remain, respectively (current HEU stock is exclusive of HEU in spent naval reactor fuel).

Modernisation

The US government is officially committed to modernising or replacing all its nuclear bombs and warheads; all the submarines, missiles, and aircraft that carry them; its nuclear targeting, command, and control systems; and its laboratories and production plants that design, maintain, and manufacture warheads. US policy and budget documents all manifest an intent to keep thousands of nuclear weapons in service for most of this century, together with the capability to bring stored warheads back into service and to design and manufacture new warheads and delivery systems.

A nuclear weapon system consists of a nuclear explosive, a delivery system, a launch platform or air base, and the surveillance, intelligence, targeting, command, and control systems that enable nuclear use. All system components work together to produce the nuclear threat. Using this definition, the US is replacing and modernising all of its nuclear weapon systems. The result will be, in all US cases, new or renewed nuclear weapon systems with new military capabilities – even if some components, such as the nuclear explosive components in a warhead, change only a little.
Modernisation is continuous, underway, and is already incorporating new capabilities that expand potential nuclear target sets, increasing or making new threats. One example is the upgraded submarine-launched warhead, the W76-1, now a little more than halfway through production. The W76-1 is being equipped with an advanced fuze that enables, together with the increases in missile accuracy and range available from the D5 missile over the original C4 missile, targeting of Russian missile silos and other “hard” targets from ocean launches, a capability not present in the original W76-0.10

Another example is the proposed B61-12 gravity bomb now in advanced design and testing, which will have a precision-guidance tail fin system enabling 30-meter accuracy (down from the original 110-170 meters),11 allowing much lower nuclear yields, again expanding possible nuclear targets and increasing the “credibility” of the associated nuclear threats. In January 2014, US Air Force Chief of Staff, General Norton Schwartz, confirmed that the modernised B61 will have improved military capabilities to attack targets with greater accuracy and less radioactive fallout.12 Yet the 2010 US Nuclear Posture Review (NPR) pledged that nuclear weapon life extension programs “will not support new military missions or provide for new military capabilities.”13 The B61-12 violates the NPR pledge – as does the W76-1/Trident D5 combination and as would the W80-4 warhead on the proposed Long-Range Stand-Off (LRSO) stealth cruise missile as well.

The military characteristics of nuclear weapon systems are, in general, secret. Seemingly modest “improvements” in one aspect of a weapon (e.g. a new fuze with more accurate detonation placement) can combine with other “improvements” (increased stealth, forward basing, nearby-ocean launches, greater accuracy, or increased range) to create – intentionally or unintentionally – an entirely more threatening nuclear posture. Also, new and potentially destabilising threats cannot be analysed one weapon system at a time but must consider the entire military-political threat spectrum, including the capabilities of ballistic missile defenses, early warning systems, command and control, cyberwar, financial war, and conventional military offenses and defenses, all of which are evolving and changing in ways impossible to understand and predict. A stable “balance of terror” therefore cannot be assumed, especially given new geopolitical realities, one feature of which is unpredictability.

One certainty is that nuclear modernisation programmes will elicit compensatory responses from others. In the US, nuclear modernisation programmes require from one to three decades to complete; weapon service lives are in the 30 to 40 year range, expressive of great sunk costs, a political reality whether rational or not. For all these reasons, nuclear modernisation decisions will generate very long-lasting threats to the US and the world.

However, there is a great difference between modernisation aspirations on the one hand and practical accomplishment on the other. Virtually all the warhead and infrastructure modernisation projects in the Department of Energy (DOE) have experienced serious cost overruns and schedule delays that have selectively eroded support by congressional appropriators and the military, causing DOE to downscale, defer, or cancel several projects. Nuclear weapons programmes as a whole, including both DOE and the (larger) Department of Defense (DoD) programmes, face an approximate $10 billion/year shortfall starting in the early 2020s, roughly the total cost of modernisation across both DOE and DoD during this period and almost one third of nuclear weapons costs in all.14

More than just being limited by money shortfalls, modernisation programmes are also affected by persistent management problems in both DoD and DOE. One industry executive, expressing a common industry view, complained about “parts obsolescence, supply chain, employee recruitment and retention, funding and national program visibility.”15 DOE’s warhead programmes have been on the Government Accountability Office’s (GAO’s) “High Risk” list for waste, fraud, and abuse since the early 1980s.16

Production of upgraded warheads competes for space, staff, and budget with warhead dismantlement at the Pantex nuclear weapons factory in Texas. At one time, the applicable rule of thumb for planning was that one upgraded warhead consumes the Pantex resources necessary to dismantle approximately two warheads.17 It is a concrete metaphor for the peace and security consumed by modernisation.

Delivery systems

Submarines and SLBMs

The oldest of the 14 Ohio-class SSBNs is scheduled for retirement in 2027, a supposedly-firm date driven by reactor age and hull fatigue,18 with one retirement to follow in each subsequent year through 2039 as later-built SSBNs age out. The first of 12 SSBNX0s is expected to be deployed in 2031, with one subsequent boat entering service each year until 2042. This will give a minimum fleet size of 10 SSBNs from 2031 through 2040.

The SSBNX0, like the Ohio-class submarines it would replace, will carry Trident D5 missiles – 16 missiles each instead of the 24 on Ohio-class boats.19 The launch tubes are to be in Common Missile Compartments (CMCs), each with four missiles, which will also be used on the UK’s planned Vanguard- replacement SSBNs, which if built will also use D5 missiles. The UK Ministry of Defence is collaborating on the design of the CMC and so far has paid for most of design work.20

The D5 missiles are currently being upgraded for service through 2042 at a current steady annual cost of $1.2 billion, which in FY16 will buy 12 solid rocket motors, 35
Life Extension Program (LEP) kits, and other hardware. 21 In round numbers, D5 missiles cost $30 million each. 22 The Navy is very concerned about preserving the industrial base for large solid propellant rocket motors and can reasonably be expected to continue purchasing D5s for a long time both for its own use and for lease to the UK – should the UK continue to deploy SSBNs. Wolfsthal, Lewis, and Quint therefore use today’s annual cost as a reasonable estimate of future D5 and successor missile costs, a $36 billion total over 30 years. 23

The total estimated cost for the full multi-decade SSBN(X) procurement programme is speculative at this point but thought to lie in the vicinity of $100 billion – exclusive of missiles, warheads, deployment and other operational costs, DOE propulsion reactor development, and decommissioning. 24 Of that ballpark $100 billion, more than half will be spent – and more than half the boats purchased – before the first SSBN(X) goes into service in 2031. 25 For this reason, submarine-based nuclear modernisation costs, including warheads, will comprise more than half of all nuclear modernisation costs over the coming decade – $46 billion out of $79 billion. 26

Funding the SSBN(X) presents something of a crisis for the Navy’s ambitious plans to modernise and increase its overall fleet size, from 281 ships today to 306 ships by 2022. 27 Annual shipbuilding budgets have been about $16 billion for the past three decades. In a recent study, the Congressional Budget Office (CBO) estimates that the Navy’s current plans will cost an additional $5 billion annually, i.e. $21 billion each year; the $5 billion annual increment is about the expected cost of each SSBN(X) past the first one, not counting initial development. 28

According to CBO, under level extensions of the present $16 billion budget the best way to fulfill the Navy’s “forward deployment” goals (read: power projection) would be to purchase 25% fewer ships of all kinds than planned, including 2 fewer SSBN(X)s. The 30-year price tag with level funding would then be $483 billion, instead of the $621 billion that CBO estimates is really needed, i.e. $21 billion each year; the $5 billion annual increment is about the expected cost of each SSBN(X) past the first one, not counting initial development. 28

As a first step in solving these funding problems Congress last year created a new military account, called the “Sea-Based Deterrence Fund,” which remains to be filled with money.

The Navy has made clear on several occasions that the SSBN(X), which is slated to go into advance procurement in 2017 and full procurement in 2021, is its top priority – the plain meaning of which is that in the event of budget shortfalls and cost overruns it will protect the SSBN(X) over all other priorities. 29 It may have to do so. Whether the Navy is able to expand its annual shipbuilding budget, or move the SSBN(X) into the new “Sea-Based Deterrence Fund,” as well as how many SSBN(X)s are actually built, all remain to be seen.

Intercontinental ballistic missiles (ICBMs)

The US has 450 Minuteman III silos controlled by 45 launch centers in three Air Force bases spread across parts of Colorado, Wyoming, Nebraska, Montana, and North Dakota. Each base is the home of a missile wing of 150 silos with 15 launch centers, divided into three squadrons, each with 50 silos. The US plans to empty 50 of these silos and maintain them in “warm” standby while storing their missiles elsewhere to meet New START requirements by 2018.

Minuteman III missiles carry the 335 kt W78 and 300 kt W87 warheads, currently in a single warhead configuration. The US stores an estimated 490 W78 and W87 warheads, beyond the number deployed. There are more than enough of the more modern W87 warheads to arm all the Minuteman missiles, but not enough to do so while also providing a significant upload hedge. 30

Over the decade or so ending in 2012, the Air Force spent $7 billion replacing and upgrading nearly all components of these missiles, from the flight controls to the propellant in all three stages, to the guidance systems. According the Air Force they are “basically new missiles except for the shell.” The last of the life extension work, which extends the service life of these missiles to 2030, is slated for completion this year. 31 Fuzing systems for both the Mark 12A reentry vehicle (RV) (for the W78) and Mark 21 (for the W87) were part of this upgrade, with what implications for burst accuracy we do not know. 32 But by 2010, the upgraded missile already had “expanded targeting options, improved accuracy and survivability,” that is, significant new military characteristics. 33 Upgrades to the missile’s silo-based and above-ground launch infrastructure are now a very high Air Force priority. Further upgrades to the missile system itself are as well, in part to sustain the industrial base and in part to continuously upgrade the missile and prepare for what will follow it. 34

Given the already-extensive upgrades to the Minuteman system and its resulting capabilities, the Air Force fiscal year 2012 budget request contained no funds to even study a future ICBM. 35 The lack of such a study was however seen by Republicans as backtracking from a commitment made in 2010 to enable New START ratification. 36 The analysis of alternatives was subsequently funded in 2013 and completed in June of 2014. It examined options for sustaining ICBMs through 2075 that included incremental modernisation of the Minuteman III, an all-new ICBM, a rail-mobile ICBM, super-hardened silos, and an underground mobile missile moved from one silo to
another by a vast underground subway-like network of tunnels.\textsuperscript{37}

No final ICBM modernisation strategy has yet been announced, but the Air Force recently said its Minuteman follow-on system, now called the “Ground-Based Strategic Deterrent” (GBSD), is expected to cost $40-$60 billion and will be initially fielded in 2027. The Air Force is asking for a $75 million appropriation in FY 2016 for GBSD, rising to $325 million by FY 2020.\textsuperscript{38} Supposedly, still, “nothing is off the table” to build a “faster, better, smarter” ICBM system.\textsuperscript{39}

Another $287 million is included in the Air Force’s FY 2016 budget request for modernising the nuclear command, control, and communications (NC3) architecture, part of an estimated $52 billion tab for upgrading NC3 for all nuclear systems over the decade to come (see also below). The NC3 architecture includes a nationwide network of underground wiring dating back to the 1960s, outdated computer systems running in some cases on 5½” floppy disks, and other anachronisms. At times the Air Force describes the launch systems as antiquated and, it implies, dangerous. Despite whatever dangers there may be above and beyond the dangers of the system itself, the Air Force suggests that following existing budget law will prevent needed improvements to outdated US command and control systems.\textsuperscript{40}

Unlike bombers which can be recalled, and submarines that cannot be found in the sea and so need not be given an immediate order to launch, ground-based missiles can be destroyed by incoming missiles within a few minutes, creating institutional pressures to launch a nuclear attack almost instantly in the event of a perceived incoming attack. On 26 January 2015, retired General James Mattis, former commander of US Central Command, said during a hearing of the Senate Armed Services Committee that “the government should consider eliminating the land-based leg of the nuclear triad,” in part because it might reduce the risk of mistaken threats.\textsuperscript{41} As noted below, this is also the recommendation of General Cartwright, another former STRATCOM chief, Chuck Hagel, and other senior figures.

Heavy bombers

The Long-Range Strike Bomber (LRS-B) programme aims to augment and gradually replace the current US heavy bomber fleet, starting in the late 2020s, after first delivery in mid-decade and subsequent flight testing.\textsuperscript{42} The unclassified program began in 2012, but the short development path and low apparent R&D budget imply a longer and far more expensive “black” program.\textsuperscript{43} R&D costs for a new bomber are typically in the $20-45 billion range.\textsuperscript{44}

According to the Air Force, this bomber represents an essential component in its evolving joint portfolio of conventional and nuclear deep-strike capabilities.\textsuperscript{45} It is the conventional power projection and bombing role which is primary for the LRS-B; nuclear certification will come later and may “take some time.”\textsuperscript{46}

The existing US heavy bomber fleet consists of 76 B-52Hs, 61 B-1s (which are not nuclear-capable), and 20 B-2As.\textsuperscript{47} The B-52H first entered service in 1961, the first B-1 in 1986, and the first B-2A in 2003. Their average airframe ages are 50, 28, and 20 years, respectively. The Air Force has extended the operational life of the B-52 and B-1 to 2040 and that of the B-2 to 2058.\textsuperscript{48} All three bombers have been and still are being continuously upgraded and meticulously maintained, although there are also longevity challenges for each.

Importantly, these challenges are not strictly technical but are intertwined with issues of each airplane’s unique capabilities and vulnerabilities, its numbers (low, in the case of the B-2), its basing limitations, its operating cost (very high, in the case of the B-2), the evolution of munitions and defensive capabilities, its supplier base (limited, in every case), and the evolution of land and ship-born air defences.

Even at 50 or more years, the B-52 remains robust. “Every aspect of the aircraft – structurally, the capability to hold weapons and avionics, the power – has large margins in it,” according to Boeing’s B-52 manager.\textsuperscript{49} The B-52H is the Air Force’s only nuclear bomber capable of deploying long-range standoff weapons. The B-1, meanwhile, has the largest internal bomb capacity, but is not stealthy. The B-2 is the world’s only long-range stealth bomber.

There is a great deal of uncertainty, vagueness, and debate about what the missions of Air Force bombers actually are and will be, and therefore about the expected future relevance and role of each of its existing bombers as well as the proposed LRS-B. A significant and demanding part of the bomber mission is directed at “the Asia-Pacific region,” i.e. China, and requires “continuous bomber presence… [specifically] at Anderson Air Force Base, Guam – and corresponding displays of worldwide power projection missions by all three bombers.”\textsuperscript{50} But assuming it is possible, is it really necessary or even desirable, even from the most hawkish perspective, to attempt to overcome the most modern future air defences, e.g. those of nuclear-armed China, with bombers?

One of the questions raised about the LRS-B is whether a human crew is necessary for conventional bombing missions. While initially the LRS-B will be deployed as a “manned” aircraft, it could eventually be “optionally” manned, but never for nuclear missions.\textsuperscript{51} Other uncertainties delayed the LRS-B. Would it be better to focus on a less-expensive stand-off bomber capable of launching cruise missiles, which is a mission the B-52 can do today? If a bomber is too expensive to risk, as the B-2 is today and as the LRS-B will also be if it experiences cost overruns, will it be unusable against all but the most
helpless enemies? How many bombers are “needed,” and how many tons of bombs and stand-off munitions will “need” to be dropped on what targets, which will have what defenses? And what will it really cost? These and other questions have been asked pointedly at the highest levels in the military – especially, up to 2011 at least, by the then-Vice Chairman of the Joint Chiefs Gen. James Cartwright, who strongly opposed the LRS-B in favor of an inexpensive “truck” for delivering large quantities, if desired, of precision munitions – which describes, to our eye, the B-1 and B-52, for a long time to come. LRS-B got the go-ahead only after Cartwright was no longer able to stop it. The LRS-B under development is rumored to be about half as large as the B-2A, which has the smallest payload of the three existing heavy bombers, with two engines similar in size to the engine on the new F-35.

Since the B-52 the Air Force has had a poor record in bomber acquisition, the details of which are beyond this sketch. Will the LRS-B be any different? Experience suggests that it will be difficult to remain within the $550 million cost cap (exclusive of development costs) that was imposed by Secretary Gates when he finally approved the programme. The Air Force has already begun to backtrack on this: “No, of course it’s not going to be $550 million a copy, once you add in everything,” said Air Force deputy acquisition chief Lt. Gen. Charles Davis last year. A not-inconsiderable aspect of the LRS-B program is maintenance of the industrial and supplier base for combat aircraft. But with a starting cost of at least $550 million each, will there really be enough money and airplanes to accomplish this? In an attempt to mitigate this risk and to stretch out the cost, the Air Force proposes to buy a large number of LRS-Bs (80-100) over a relatively long period of time.

To deliver the first LRS-B by the mid-2020s, the Air Force is asking for $1.2 billion in FY 2016, rising to $3.79 billion by 2020. The full brunt of LRS-B acquisition begins concurrently with the SSBN(X), the F-35 Joint Strike Fighter, and a host of other Navy and Air Force acquisition programs, leading analysts like Todd Harrison at the Center for Strategic and Budgetary Assessment to conclude that there will simply not be enough money to buy it all.

The Congressional Budget Office estimates that in the 2020s nuclear modernisation, all in all, will cost more than nuclear operating and sustainment combined. The Air Force LRS-B is responsible for the second largest portion of this, behind the Navy’s SSBN(X), with the Air Force projected to spend $21 billion on new bombers over the next 10 years (vs. $19.2 billion for bomber operations and sustainment). A separate nuclear deterrence account for the Air Force, like that for the Navy, is under consideration, but a new account does not create new money.

Assuming the LRS-B were “necessary,” could it be delayed? The continued airworthiness of the three existing bombers, with their diverse capabilities and large combined numbers, is not in question. The nuclear mission of the B-2 and B-52 is not a significant factor in driving the new bomber at this time. The answer to whether the LRS-B can be delayed really depends on the urgency of the mission proposed for it – which has nothing to do with defense.

### Warheads

The programme-of-record for DOE warhead modernisation is described at length in the most recent DOE Stockpile Stewardship and Management Plan. DOE calls it the “3+2” plan because it would produce a single new gravity bomb to replace all others (the B61-12, to be replaced later by the B61-13), a new cruise missile warhead (the W80-4), and, eventually, three successive “interoperable” ballistic missile warheads, in the meantime pursuing life extension programmes (LEPs) to produce the W76-1 SLBM warhead and replace the fuze and high explosives in the W88 SLBM warhead (“Alteration 370”). LEPs for the W87 warhead and the B61-7 and B61-11 bombs have already been completed. As noted above, the 3+2 plan is unlikely to be realized and was widely considered “dead on arrival” as written when first proposed.

The 100 kt W76-1 provides significant and potentially destabilising new military capabilities to the ballistic missile submarine fleet, as noted above. About 3,030 W76 warheads were in the stockpile in 2007; an estimated 1,600 W76-1s will be produced from this inventory.

The B61-12 LEP will consolidate the roles of the existing B61-3, B61-4, B61-7, and B61-10 bombs with one new bomb, the B61-12, using the B61-4 nuclear explosive with selectable yields from 0.3 to 50 kilotons (kt). When the B61-12 is deployed, the B61-7, B61-11, and B83 strategic bombs will be placed in the hedge arsenal or retired, leaving just one type of gravity bomb. About 480 B61-12s are planned, giving a unit cost of at least $22 million per bomb, including the DoD-funded precision guided tail kit but not including unspecified DoD and DOE programme costs. The B61-12 is to be deliverable by the B-2, F-15E, F-16, and Tornado aircraft and later by the F-35A and Long Range Strike Bomber (LRSB).

Given the apparent failure of opposition to the B61-12 to date, it may be well to also focus on insuring the full retirement and dismantlement, and not just the storage, of the balance of the gravity bomb inventory.

The W88 Alt 370 programme, scheduled to begin as the W76-1 production run ends in 2020, will install a new arming, firing, and fuzing (AF&F) system to replace the original late-1980s AF&F and will also replace (“refresh”) the warhead’s conventional high explosive (CHE), allowing the upgraded 475 kt warhead to remain deployed through the late 2030s.

A senior official has described the Long-Range Stand-Off (LRSO) warhead as a “no-kidding new warhead.” A W80 warhead variant, dubbed “W80-4,” has been selected for...
this new delivery system.\textsuperscript{66} No new plutonium warhead core (“pit”) production is required for this warhead. W80 and W80-1 yields are selectable from 5 kt up to the 150-200 kt range.\textsuperscript{67}

In 2014, the first of the three proposed “ interoperable” warhead (IW) programs was delayed by five years, to 2030, reflecting the lack of any near-term need and poor military acceptance.\textsuperscript{68} IW-1 is to be based on the 300 kt W87. IW-1 would not require a pit production campaign to arm existing ICBMs with new “W87-like” warheads but would if an upload hedge for ICBMs is also desired, or if W88 warheads are also replaced as is currently planned in the late 2030s.\textsuperscript{69} Pit production costs (for operations, infrastructure upgrades, and waste management) are huge – in the $10+ billion range over the next two decades, and if attributed to IW-1 would roughly double its costs.

Meanwhile the future of the IW concept as a whole is now in doubt.\textsuperscript{70} Current plans entail separate new fuzing systems for the ICBM and SLBM component of IW-1 as well as separate production schedules. “IW-2” and “IW-3,” which are not slated to begin even as conceptual design programs until 2023 and 2030 respectively, are not fully described in any public documents and can be considered placeholders.\textsuperscript{71}

\section*{Economics}

Nuclear weapon costs occur in both the DOE and DoD budgets. The DOE budget request for fiscal year 2016 includes $8.847 billion for nuclear weapons activities, not including $283 million in related administrative costs. This is a proposed 10\% increase from 2015, an annual growth rate exceeded only twice in US history (1962 and 1982).\textsuperscript{72} It is higher in constant dollars than the last peak in nuclear warhead spending for development, testing, and production under President Reagan in 1985.\textsuperscript{73} Current budget projections entail continuous cost increases through 2040.\textsuperscript{74}

Over the past years there have been many reports and studies on the cost of the US nuclear programme and possible options for savings.\textsuperscript{75} In December 2013 the Congressional Budget Office (CBO) published an authoritative report assessing the projected costs of the US nuclear forces for the 2014–2023 timeframe, utilising long-term cost databases maintained by CBO and with full access to Department of Defense data.\textsuperscript{76} This study was updated in January 2015.\textsuperscript{77} According to CBO, maintaining and modernising the current US stockpile will cost $348 billion over the 2015–2024 decade, including about $79 billion for modernisation sensu stricta, exclusive of any abnormal cost overruns (which are in fact normal at DOE). Since most modernisation efforts are still in the initial phase, annual costs are expected to generally increase over the decade and continue to increase afterward.\textsuperscript{78}

CBO’s modernisation costs do not include all the weapon science programs and experimental facilities that underpin new warhead designs, or any portion of the operating costs of DOE warhead complex, little of which is needed for stockpile maintenance and surveillance exclusive of new production. CBO attributes only 25\% of the estimated cost of the new strategic bomber to its nuclear mission, 10\% of F-15E and F-16 costs, and no costs for the F-35, the most expensive weapon system in history, which will carry the B61-12 bomb.\textsuperscript{79} CBO also does not include in its modernisation figure any of the $52 billion it estimates will be spent over coming decade on nuclear command, control, and communications (NC3).\textsuperscript{80} CBO’s estimates thus understate the modernisation portion of total nuclear weapon costs.

CBO’s overall estimates are broadly consistent with a January 2014 independent study from the James Martin Center, which concluded that the total 30-year cost of the US stockpile (through 2042 in their study) would fall in the range of $1 trillion dollars, again assuming no unusual cost overruns.\textsuperscript{81} Neither the CBO nor the James Martin Center totals include the ongoing cleanup of the large, contaminated DOE warhead complex, some portion of which is necessary for continued operations.

Modernisation costs can be somewhat artificially divided into those for warheads proper, the so-called “life extension programs” (LEPs), DOE costs for modernising and maintaining the warhead factories and labs which produce them, DoD costs for delivery systems, and other DoD costs. DOE reports the total estimated cost for currently-proposed LEPs, not including facility costs and other supporting programmes and overhead, as follows.\textsuperscript{82}

DOE’s programme costs usually exceed the agency’s high-end estimates, often greatly. These are warhead and bomb costs only.

DOE’s total estimated nuclear weapon cost through 2040 is in the ballpark of $250 billion in constant 2015 dollars assuming 2\% inflation, or $300 billion if then-year dollars are simply summed. These totals include LEPs, operation and modernisation of production infrastructure, weapon science, and all other “Weapons Activities” costs but they do not include DOE administration.\textsuperscript{83} DOE administration of its nuclear weapons contractors has been running about $300 million per year.\textsuperscript{84}

The discussion and table below omit completed LEPs: the W87 (1999-2005) and the combined B61-7 and B61-11 LEP (2006-2009).\textsuperscript{85}

One of the main obstacles to US nuclear weapons modernisation plans may be the erosion of the ability of the US military-industrial complex to complete ever-more complex manufacturing and industrial projects. Work on a major plutonium facility on which more than $600 million already had been appropriated was postponed for at least five years after litigation halted incipient construction and
costs ballooned to more than ten times original estimates. After 13 years of work, the project was finally canceled, only to be replaced with a new multibillion-dollar plan with crucial details still “to be determined.” Eight different plans to replace and modernise production of plutonium pits in the US have failed over the past 25 years. Construction of a new Uranium Processing Facility (UPF) has been delayed more than a decade and its costs too have increased more than tenfold. The project has now been significantly down-scoped; its new design is still mostly under wraps. Robert Alvarez, a former senior DOE and now private analyst, describes the DOE warhead complex as being in a state of “incipient collapse.” Some current and former congressional and executive branch analysts and managers express similar concerns in private. Reasons cited typically include rampant mismanagement, runaway overhead and salaries, and other consequences of privatization, mal-investment, poor employee morale, unaccountable contract structures, internal and external deception, and loss of essential skills.

International law and doctrine

More than four decades after the United States signed and ratified the nuclear Non-Proliferation Treaty (NPT), it retains a nuclear arsenal large enough to end civilization, if not human life, in a few minutes. None of its bilateral reduction agreements with Russia fundamentally change the character or posture of nuclear weapon deployments, or the consequences should deterrence fail. Stockpile reductions, which began in 1968, are not disarmament, and in any case no further reductions are currently planned or being negotiated. There are strong disagreements between Russia and the US concerning compliance with the Intermediate Range Nuclear Forces (INF) Treaty.

The US has signed but not ratified the Comprehensive nuclear Test Ban Treaty (CTBT); ratification was rejected by the US Senate in 1999 even after a bargain was made to modernise its nuclear weapons infrastructure in exchange for ratification. The Obama administration has stated that CTBT ratification “remains a top priority for the United States” but there are no realistic near-term prospects for ratification. If the past is any guide, any attempt to obtain consent for ratification from the Senate, which has not occurred since 1999, is likely to be accompanied by new programmatic and funding commitments to the nuclear weapons establishment as was the case for New START, the ratification of which required a three-decade commitment to comprehensive force modernisation. There has been no technical need, or any expressed desire, for nuclear testing in or from the US warhead complex for almost 20 years. The negative consequences of nuclear testing for US security are very well-established throughout the foreign policy establishment. As a result there is no realistic prospect of resuming nuclear testing by the US. CTBT ratification by the US, or its continued absence, have no influence on US modernisation decisions or on US nuclear stockpile decisions generally.

At the conclusion of the 2000 NPT Review Conference, the US agreed that a no-backtracking “principle of irreversibility” applies to nuclear disarmament. Yet endless modernisation of the research laboratories and factories necessary to design and produce nuclear weapons is inherently incompatible with any “principle of irreversibility” in regard to disarmament. Doing so with the express intention of being able to re-arm, and to permanently hold open the potential to reconstitute large nuclear arsenals throughout the course of disarmament, also is inconsistent with an “unequivocal undertaking” to eliminate nuclear arsenals.

The US announced its withdrawal from the Anti-Ballistic Missile Treaty in 2001; continuing US development and deployment of ballistic missile “defence” systems is a serious impediment to further disarmament progress as well.

The US 2010 Nuclear Posture Review (NPR) states that the US will keep relying on its nuclear weapons as an important part of its national security and will also do this for the foreseeable future. On 19 June 2013 President Obama announced in Berlin that his administration would, together with its NATO allies, seek “bold reductions in US and Russian tactical nuclear weapons in Europe.” On
the same day, however, the US administration published a report on President Obama’s new guidance on the employment of nuclear weapons. Among other things, the report reaffirmed that “as long as nuclear weapons exist,” the United States will maintain a “safe, secure and effective arsenal for its protection and that of its allies.” At the third conference on the humanitarian impact of nuclear weapons, hosted by Austria in December 2014, the US representative stated that his government “does not support efforts to move to a nuclear weapons convention, a ban, or a fixed timetable for elimination of all nuclear weapons.”

Public discourse

Recent scholarship confirms that US public opinion is not at all correlated with the outcome of congressional policy debates. This is not a recent phenomenon, but recent trends in campaign finance law have certainly not improved the situation. Nuclear weapons policy, for example regarding modernisation, is among the most arcane topics in the national security field, itself the largely inaccessible “home turf” of what former congressional staffer Mike Loefgren has called the “Deep State”. For these reasons, among many others, it is no surprise that there is little public discussion or debate about US nuclear weapons policies.

What civil society discussion there is about US nuclear weapons policy is dominated by NGO specialists and skewed towards drumming up fear of nuclear weapons coming into the possession of non-nuclear weapon states or non-state actors, rather than pointing to the very real dangers posed by nuclear weapons held as central elements of national security policies in the hands of the world’s most powerful states. Despite this, there is also an undercurrent of concern and at times anger expressed in editorial pages and at times in Congress, directed more often at DOE than DoD, about nuclear weapon costs, federal and contractor competence, worker and public safety, and the relevance of the entire enterprise at its present scale to national security.

With minor exceptions, US NGO arms control and disarmament organisations, when presented in 2010 with the political necessity of a comprehensive commitment to modernising every part of the US nuclear stockpile, including delivery systems and supporting laboratories and production plants, in order to gain the 67 Senate votes necessary to ratify New START, chose to actively or passively support the full modernisation program. Loyalty to Democratic allies and to New START – despite the absence of significant disarmament requirements in the latter – were deemed more important than any concerns about modernisation. Modernisation commitments were by contrast taken very seriously by Republicans and the nuclear weapons lobby. Subsequent deviations from those promises have elicited very strong congressional responses, often bipartisan in the Senate, centered in the armed services committees. Post-New START efforts by NGOs to trim or postpone them have so far been largely ineffective, with the exceptions of the new plutonium and uranium production facilities, the first of which was delayed by litigation and subsequently canceled and the second, downsized under budget pressure.

US NGO critiques of modernisation are typically focused on degree. For example there is little objection to modernising the B61 tactical gravity bomb to some degree. The modernisation component that mainly has been considered objectionable in this case is the precision-guided tail kit, which very much changes the character and potential target set of the weapon. Simpler and cheaper upgrades would not however be as long-lived or offer the novel military characteristics desired, and at this point have been definitely rejected. There is almost no NGO objection to the scale and cost of the warhead complex as a whole, which in effect subsidizes each specific modernisation program with a much larger overhead that is tacitly accepted – again, with some exceptions – by US NGOs, blunting arguments raised about cost.

It is difficult to concisely summarize the chaotic currents of Congress, but those currents certainly do not run toward disarmament. Not one member of Congress publicly opposes a policy of nuclear “deterrence” and “mutual assured destruction” based on a triad of modernised or new delivery systems with thousands of nuclear warheads. In the United States, disarmament remains an abstract aspiration if not just a propaganda theme. The pursuit of global military dominance backed by constantly modernised nuclear weapons remains the concrete reality.

The proposed “Smarter Approach to Nuclear Expenditures (SANE) Act of 2015” (S.831), introduced by Senator Markey, two other liberal Democrats, and one independent liberal in the Senate on 23 March 2015, is illustrative of the state of the disarmament and modernisation debate in Congress. This is the fourth year that Senator Markey (formerly Representative Markey) and his House colleague Rep. Blumenauer have introduced versions of this legislation in the House and now also the Senate. It is supported by many of the largest US arms control NGOs as well many others.

Successive versions of the proposed SANE Act have attracted little serious legislative interest. The first version, in 2012 (H.R.3974, 112th Congress) had 48 (Democratic Party only) cosponsors (out of 435) but died in the House Armed Services Committee without a recorded vote. There was no companion senate bill. In 2013, the next version (H.R.1506, 113th Congress) had 41 (Democratic Party only) cosponsors, again with no companion senate bill and no recorded vote. In 2014 the SANE Act (S.2070 and H.R.4107, with the same text but called the “REIN-IN Act” in the House, 113th Congress) had 13 House cosponsors (Democratic Party only) and two Senate cosponsors, again with no recorded votes in either house.
This year’s SANE Act is similar to preceding years. It proposes to save $86 billion over 10 years from nuclear weapon modernisation programs by: immediately reducing the number of SSBNs operated by the Navy from 14 to 8 and delaying (but not canceling) the acquisition of the SSBN(X); delaying (but not canceling) development and purchase of a new Long Range Strike Bomber (LRSB); cancelling the F-35’s nuclear mission ($400 million only); reducing the scope of (but not canceling) the B61-12 LEP; delaying (but not canceling) development of a new ICBM; cancelling the proposed new cruise missile (LRSO); and cancelling the W78 LEP (meaning the warhead would be retired in about 2030) and the Uranium Processing Facility (UPF), without however providing for a safe uranium facility for dismantlement. None of the successive SANE acts have addressed the Cold-War-sized DOE laboratory complex, and none address stockpile size. The modernisation delays proposed would last until the end of the Act’s 10-year accounting period, after which the delayed work and its costs would reappear in amplified form. The costs of interrupting work now in progress, e.g. on SSBN(X) procurement, would be very substantial in both dollar and management terms. Thus the SANE Act “savings” of $86 billion would be substantially, though not wholly, eventually forfeited in the absence of further legislation.

The SANE Act, which has no legislative prospects in this or any foreseeable session of Congress, does not lay the groundwork for potential future bipartisan support. Nor does it address the unresolved issues of DOE accountability, which already attract considerable bipartisan interest. These defects notwithstanding, the lack of legislative interest in this bill is indicative of the wider atmosphere in Congress in which neither party has any visible interest in nuclear disarmament and only a little interest in second-guessing the executive branch’s modernisation decisions.

More broadly, the post-New-START search, on the part of US arms control NGOs and their congressional allies, for the elusive modernisation “sweet spot” has been unsuccessful, with the exception of plutonium and uranium facility plans. Rapidly rising tensions with Russia, consciously provoked by recent US actions, have all but doomed such efforts for the foreseeable future. As one long-time government analyst put it, “The fight against the B61-12 was lost on the streets of Kiev.”

Efforts to delay or rein in modernisation that remain within the mainstream nuclear “deterrence” paradigm of thousands of warheads of multiple types, delivered by a triad of delivery systems and including both extended deterrence and tactical nuclear weapons, all of which are supported by a large laboratory and production plant complex, can at best offer modest savings – so modest as to be hardly worth the candle. The budgetary savings available from a more modest B61 overhaul that would last only one decade instead of two and would not allow retirement of several other types of bombs, was not enough to motivate Congress to override military wishes. To save significant sums and to motivate new political alliances, more fundamental questions must be raised about nuclear deterrence policies than those being raised in Washington today. Small proposed policy adjustments will garner little attention.

The main loci of government concerns about modernisation overreach and programme accountability more generally
are the two appropriations committees, which must balance warhead budgets with others within a finite budget, the White House budget office, and finally the military itself, which as noted above has no identified source of funding for the increase in nuclear modernisation costs expected in the 2020s. The nuclear weapons share of overall military spending must double in the 2020s, from 2.6% to 5% or 6%, if all the planned nuclear modernisations are to proceed. Either the overall size of the military budget must grow, other military accounts must shrink, or some of both, for nuclear modernisation to proceed.

Budget conflicts over modernisation are already intense. DOE Secretary Moniz recently testified that the LRSO in particular could be delayed as other programmes already have been delayed, if existing, bipartisan-enacted, military budget caps are not to be loosened this year. Whether, and if so how, that budget law is changed, and not the merits of the LRSO, may well determine that program’s fate, despite the fact that as a new strategic nuclear weapon suitable for a stealthy first strike, and not countable under New START, there is a lot about this weapon to discuss.

Current majority party proposals to raise caps on military spending involve massive cuts to social programs. The future of US nuclear modernisation, and of US nuclear weapons generally, is likely to be decided by these and other budget tradeoffs as well as by the impact of unforeseen events arising outside and independent of the “ordinary” policy planning process.

Deep cuts are possible and have been considered. By early 2013, DoD, senior military officers, and all other relevant agencies had signed off on a classified decision directive that would allow negotiated cuts to the deployed strategic US stockpile of about one-third. With cuts to the hedge arsenal, an overall stockpile of 2,500 to 3,500 warheads was possible. A negotiated cut to 500 deployed strategic warheads was considered but rejected. For one reason or another that plan was not implemented, but its consensus logic very likely remains intact, classified though it be. Other recent proposals for still deeper cuts have been made, notably a detailed proposal by former Vice Chair of the Joint Chiefs and former STRATCOM Commander in Chief General James Cartwright, former Senator and now former Secretary of Defense Chuck Hagel, and other senior authors, which would in ten years lead to an arsenal of 900 total warheads, half of which would be deployed in a dyad of delivery systems, without ICBMs, and without tactical nuclear weapons. Whether, when, and how these proposals will inform future stockpile decisions remain to be seen.

Those contemplating the modernisation programme must ask, does nuclear modernisation really, as some say, “challenge the entire disarmament regime”? There is no disarmament regime. Modernisation challenges and hopefully dispels the myth that there is now, or will soon be, any “disarmament regime” in the US, or emerging from any US-led process. As former Obama White House nuclear czar Gary Samore recently put it, “Nuclear disarmament is not going to happen…It’s a fantasy. We need our weapons for our safety, and we’re not going to give them up.”
Notes:


95. Remarks by the President Obama at the Brandenburg Gate – Berlin, Germany, the White House Office of the Press Secretary, 19 June 2013, http://www.whitehouse.gov/the-press-office/2013/06/19/remarks-president-obama-brandenburg-germany.


97. Ibid.


105. Ibid.

106. Legislative history from the Library of Congress. Search by Congress (112th, 113th, or 114th) and bill number at http://thomas.loc.gov/home/Legislative-Data.php?sn=SS%e=114.


110. Senator Udall: “Do you worry the threat of sequestration might hurt our modernization …?” Moniz: “Absolutely. In fact DoD & DOE, for our different but complimentary responsibilities for nuclear security, have both said that sequestration caps will make it very, very difficult. Frankly, if the budget that we have requested in concert with the DoD and the Nuclear Weapons Council is reduced substantially, I think that there is no doubt that we will have to work with DoD to push out [into the future] military capabilities that they very much want. In fact, in this budget, we were able – the B61, we would try to probably hold that, but then the cruise missile for example would almost certainly have to get pushed out substantially, as we have already pushed out other parts of the stockpile refurbishment” DOE Secretary Ernest Moniz, Senate Appropriations Energy and Water Development Subcommittee, webcast, begins at 1:10:50, http://www aproppropriations. senate.gov/webcast/energy-water-development-subcommittee-hear-


112. A short list of these “known unknowns” might include the risks of: additional costly accidents, fissics, and shutdowns in the DOE warhead complex; financial and economic reversals that affect federal fiscal accounts; wars, environmental and public health calamities such as major droughts, epidemics, and earthquakes, as well as large-scale terrorist events with society-wide impacts, any or all of which could affect federal income and expense priorities (especially in the sensitive Energy and Water appropriations subcommittees); major cost overruns in military or nuclear weapons accounts; and a nuclear weapons ban that affects the perceived legitimacy, utility, and feasibility of contested nuclear weapons programs.


