



**GLOBAL
ZERO**

A WORLD WITHOUT
NUCLEAR WEAPONS

**Global Zero Technical Report
Nuclear Weapons Cost Study | June 2011
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**WORLD SPENDING ON NUCLEAR WEAPONS
SURPASSES \$1 TRILLION PER DECADE**

Introduction

Building upon the two definitive studies of U.S. nuclear weapons spending (Brookings Institution’s [Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940](#) and Carnegie Endowment for International Peace’s [Nuclear Security Spending: Assessing Costs, Examining Priorities](#)), this report casts a wider net to capture the entire world’s spending on nuclear weapons programs.¹ The principal finding: a massive expenditure will be made over the next decade.

Chart 1: Total Military and Nuclear Weapons Spending 2010-2011

| | 2010 | | 2011 Est. | | |
|-----------------------|--------------------------|-----------------|-----------------|-----------|-----------|
| | Total Military Spending* | Nuclear Weapons | Nuclear Weapons | | |
| | | Core Cost | Full Cost | Core Cost | Full Cost |
| US | 687 | 30.9 | 55.6 | 34 | 61.3 |
| Russia | 53-86 | 6.8 | 9.7 | 9.8 | 14.8 |
| China | 129 | 5.7 | 6.8 | 6.4 | 7.6 |
| France | 61 | 4.6 | 5.9 | 4.7 | 6.0 |
| United Kingdom | 57 | 3.5 | 4.5 | 4.5 | 5.5 |
| India | 35 | 3.4 | 4.1 | 3.8 | 4.9 |
| Israel | 13 | 1.5 | 1.9 | 1.5 | 1.9 |
| Pakistan | 7.9 | .8 | 1.8 | 1.8 | 2.2 |
| N. Korea | 8.8 | .5 | .7 | .5 | .7 |
| Total: | 1052-1085 | 57.7 | 91.0 | 67 | 104.9 |

Note: Figures in billions of US dollars. Core costs refer to researching, developing, procuring, testing, operating, maintaining, and upgrading the nuclear arsenal (weapons and their delivery vehicles) and its key nuclear command-control-communications and early warning infrastructure; full costs add unpaid/deferred environmental and health costs, missile defenses assigned to defend against nuclear weapons, nuclear threat reduction and incident management. Not included are air defenses, anti-submarine warfare and nuclear-weapons related intelligence and surveillance expenses. Primary sources: SIPRI Military Expenditure Database; IISS Military Balance; CIA World Factbook, and other sources identified in the text of this report.

The 8.5 nuclear weapons countries (North Korea is half-way there) are passing a new milestone this year by collectively spending approximately one hundred billion dollars on their nuclear programs. This conservatively estimated expenditure represents about 9 percent of their total annual military spending.

¹ The first author was a member of the steering committee of both studies, and a co-author of the Brookings study (Stephen I. Schwartz, ed., [Atomic Audit: The Costs and Consequences of U.S. Nuclear Weapons Since 1940](#), Brookings, 1998; <http://www.brookings.edu/press/Books/1998/atomic.aspx>); Stephen I. Schwartz with Deepti Choubey, [Nuclear Security Spending: Assessing Costs, Examining Priorities](#), Carnegie Endowment for International Peace, 2009; http://carnegieendowment.org/files/nuclear_security_spending.pdf.

At this rate the nuclear-armed states will spend, conservatively estimated, at least one trillion dollars on nuclear weapons and their direct support systems over the next decade.² It will likely go significantly higher as numerous modernization programs underway are ramped up. It would go higher still if the true intentions of many non-nuclear weapons countries could be divined and their secret weapons programs added to the total.³

United States and Russia: No Post-Cold War Nuclear Peace Dividend

For the United States and Russia, spending will increase in spite of their recent ratification of the New START agreement and their continuing cuts in the overall size of their nuclear arsenals. Much of this upsurge stems from decisions by both nations to upgrade and replace aging nuclear production factories, missiles, submarines, and bombers.

Despite a shrinking arsenal (see Figure 1 below), the United States plans to increase its investment in nuclear weapons infrastructure by 21 percent, at a cost of \$85 billion over the next decade (see Figure 2 below), and to spend an additional \$100 billion on upgrading strategic nuclear forces during this period.⁴ A new factory to build plutonium pits and another to produce uranium for bombs will cost upwards of \$13 billion or more. \$10 billion will be spent on overhauling thousands of older nuclear bombs –the so-called life extension program. While continuing to rebuild its long-range land-based missiles, the United States will spend nearly \$1 billion this year and \$10 billion during the rest of the decade in long-lead investment for a new strategic submarine fleet whose ship-building cost for the 12 boats will exceed \$100 billion. The United States will then spend untold billions to operate the armada during its 50-year planned lifespan (2030 until 2080!).⁵

Using the cost accounting methodology applied to U.S. nuclear budgets by the aforementioned exhaustive studies, it is estimated that the U.S. core and full costs of its nuclear arsenal for 2011 are 34 and 61.3 billion dollars, respectively. (As noted earlier, core costs refer to research, developing, procuring, testing, operating, maintaining, and upgrading the nuclear arsenal and its key nuclear command-control-communications and early warning infrastructure; full costs add unpaid/deferred environmental and health costs, missile defenses assigned to defend against nuclear weapons, nuclear threat reduction and incident management. Not included in either cost categories are air defenses, anti-submarine warfare and nuclear-weapons related intelligence and surveillance expenses.) This represents largely inflationary growth over previous years. The extensive U.S. plans for modernization of its nuclear infrastructure and forces noted above will ensure that this budget growth continues on its upward trajectory.

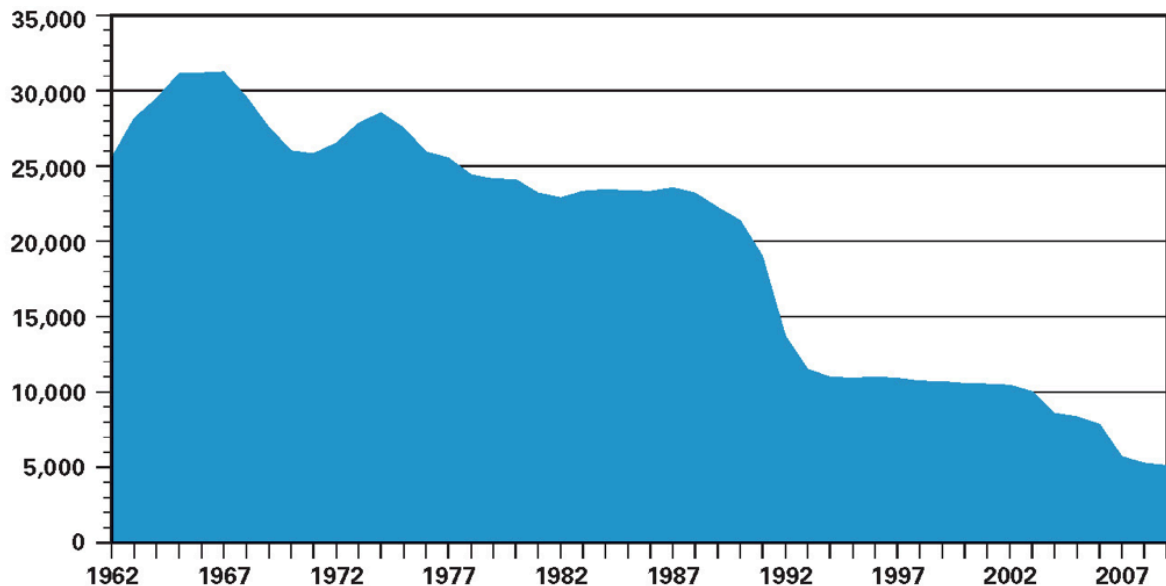
² As noted in the chart footnote, the trillion dollars per decade estimate does not count nuclear-related intelligence and surveillance expenditures, nor spending on dual-purpose programs such as air defenses and anti-submarine warfare designed to defend against both nuclear as well as conventional forces.

³ The estimate omits, for obvious methodological reasons, the secret spending of nuclear aspirants in the closet who may be investing vast sums in ostensible civilian nuclear facilities – reactors, plutonium re-processing and uranium enrichment facilities – with a view to switching their use to nuclear weapons production. For the same methodological reason, we cannot reliably identify the missiles, planes, and submarines that nuclear aspirants are procuring with a secret dual-use purpose of someday accommodating a nuclear payload.

⁴ Figures 1 and 2 below are extracted from “Nuclear Weapons Budget More Than Enough to Maintain Arsenal and Modernize Complex,” Arms Control Association, Vol. 1, No.41, Dec. 7, 2010; <http://www.armscontrol.org/issuebriefs/NuclearWeaponsBudget>.

⁵ Hans Kristensen, “The Nuclear Weapons Modernization Budget”, Feb. 17, 2011; <http://www.fas.org/blog/ssp/2011/02/nuclearbudget.php>.

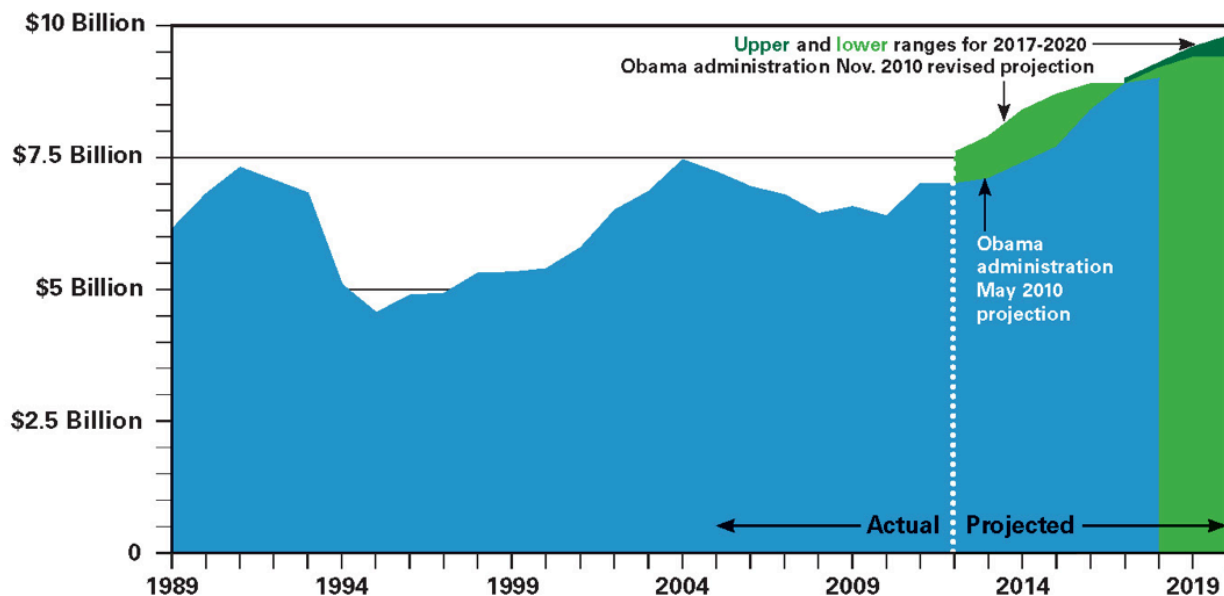
Figure 1: Total Number of Warheads in the United States Active Nuclear Arsenal from 1962-2009



Source: Department of Defense Fact Sheet "Increasing Intransparency in the U.S. Nuclear Weapons Stockpile" May 3, 2010.

Note: The "active" arsenal are those nuclear warheads that need to be maintained for deployment on delivery systems or for the strategic reserve. It does not include warheads that have been retired from service that are awaiting dismantlement.

Figure 2: Past, Current, and Proposed Spending for U.S. Nuclear Weapons Research, Development, Maintenance Activities by Fiscal Year, 1989-2020



Sources: Data for the years 1999-1996 are from Atomic Audit, by Stephan Schwartz et al, Brookings Institution Press, 1998, Data for fiscal years 1997-2011 are from the annual National Nuclear Security Administration Congressional Budget Requests. Projections for fiscal years 2012-2018 are from the May 13, 2010 White House Fact Sheet "The New START Treaty – Maintaining a Strong Nuclear Deterrent." The higher level projections for the years 2012-2020 are from the November 17, 2010 "Update to the National Defense Authorization Act of FY2010 Section 1251 Report – New START Treaty Framework and Nuclear Force Structure Plans."

Note: According to Atomic Audit, the Cold War annual average for the years 1948 to 1990 was \$5.1 billion for comparable nuclear weapons design, testing, production, and maintenance programs (now designated as the National Nuclear Security Administration "Total Weapons Activities" budget category).

Russia finds itself in a much deeper hole in terms of the obsolescence of its strategic nuclear forces. With the bulk of its geriatric arsenal reaching the end of its lifespan during the next five years, Russia is launching a veritable crash program to churn out a new generation of rockets and submarines to replace it. This is an urgent program to maintain rough parity with the United States. Russia has been retiring so many missile launchers that its total arsenal size has already fallen below the New Start treaty limits required to be met by 2018. To offset the decline, Russia recently announced a substantial boost in nuclear arms production spending over the next decade. Russia will spend \$70 billion on new strategic arms through 2020 – a fleet of new strategic submarines, silo- and mobile- land-based rockets, warhead production and maintenance by the Rosatom nuclear complex, and supporting command-control systems.⁶ This average annual spending of \$6.5 billion on new armaments represents 10 percent of Russia’s defense budget. Additional core costs for maintaining Russia’s thousands of tactical nuclear weapons and delivery vehicles, for building and deploying new early warning satellites, and other operational expenses for the strategic and tactical nuclear forces raise the total core cost in 2011 to \$9.8 billion. In addition, the associated costs of Russia’s nuclear-armed missile defense system ringing Moscow plus related missile defense research and development costs, plus environmental and health costs associated with nuclear weapons production and disposal are estimated to bring the total full cost to \$18.5 billion for 2011.⁷

A leading Russian nuclear expert describes this investment as an unwise attempt to replicate the Soviet strategic force structure. In his view, “... Russia will eventually find itself in the same situation as the Soviet Union did – with a pile of expensive hardware that is useless as far as the security of the country is concerned.”⁸

China: Patient Modernization Through 2050

China is well into a very long-term program of armed forces modernization (programmed to run through 2050!) that in the next decade will produce 5 new strategic submarines and an armada of long-range mobile rockets on land (growing its arsenal from 190 weapons today to upwards of 250-300 over the period).

Chinese spending on its military in general as well as its nuclear forces in particular is, however, very difficult to estimate with precision. China’s officially announced defense budget – \$92 billion for 2011 – excludes a wide range of military items typically included in Western nations’ defense budgets – items such as nuclear weapons and strategic rocket

⁶ <http://www.rg.ru/2011/02/24/pole-site.html>; personal communications with Russian nuclear experts; Pavel Podvig, “Russia to Spend \$70 billion on Strategic Forces by 2020” http://russianforces.org/blog/2011/02/russia_to_spend_70_billion_on.shtml;

⁷ We are conservatively estimating that the environmental and health costs constitute the bulk (\$5 billion) of these associated costs. We are carrying these costs at nearly \$10 billion for the United States, twice the Russian estimate, primarily because of the lower standards of environmental protection in Russia. As we noted in the earlier Brookings study, “... the near total lack of environmental concerns (as can be seen in the widespread practice of injecting high-level radioactive wastes directly into the ground or dumping fully fueled naval propulsion reactors at sea) ... reduced the cost of production but resulted in a potentially grave environmental legacy, which continues to have serious repercussions for the peoples of the former Soviet Union and, in the case of sea-based disposal, Norway.” *Atomic Audit*, op. cit., p. 612.

⁸ Pavel Podvig, “Russia to Spend \$70 billion on Strategic Forces by 2020” op.cit.

programs, according to an authoritative study.⁹ A host of other factors ranging from currency exchange issues to the difficulty of capturing the relative spending power of the Chinese military lead to significant discrepancies in the estimates.¹⁰ As a result, the U.S. Pentagon typically doubles the official Chinese estimate.

An authoritative source on worldwide military spending – the Stockholm International Peace Research Institute – estimates that China spent \$114 billion on defense in 2010.¹¹ Since China’s officially declared increase over 2010 is 13 percent, our report estimates that China will spend a total of \$129 billion on its military forces in 2011.

Chinese spending specifically on nuclear forces is even more opaque than the overall defense budget. The 2011 budget reportedly gives preferential treatment to the branch (Second Artillery) that operates the vast majority of nuclear-armed forces and all of the strategic nuclear missile forces.¹² According to a leading Indian analyst of nuclear weapons issues, Brigadier (ret.) Vijai K Nair, China’s budget for its nuclear weapons has been maintained constantly at 5 percent of overall defense expenditure in modern times, at least through 2004.¹³ This is only about one-half the typical average 10 percent level of the majority of countries. (In the early stage of China’s nuclear program it spent nearly 100 percent of its defense budget on nuclear programs, and similarly France spent as much as 30 percent of its total defense budget on its nuclear program in the early stage.) The steady program of modernization of China’s nuclear forces suggests a continuation of this pattern into the future with incremental growth in the nuclear budget in proportion to the steady increases in the overall defense budget. Based in part on Nair’s assessment, we conservatively estimate Chinese core nuclear cost at \$6.4 billion in 2011, and its full cost at \$7.6 billion. The latter probably understates the environmental and health costs incurred by China, but reflects the relatively lower environmental standards upheld by China.

France: Idling in a Discomfort Zone

France’s nuclear engine is idling for the foreseeable future with only modest modernization underway. While dedicating one of France’s fourth generation of strategic

⁹ Keith Crane et al., “Modernizing China’s Military: Opportunities and Constraints”, RAND Corporation, 2005.

¹⁰ A full explanation of these computational challenges lies beyond our scope. Two excellent reviews are Dennis Blasco, “An Analysis of China’s 2011 Defense Budget and Total Military Spending – The Great Unknown,” China Brief, Vol 11, Issue 4, March 10, 2011; http://www.jamestown.org/programs/chinabrief/single/?tx_ttnews%5Btt_news%5D=37631&cHash=45e8b93079c0a07f42ecd269d67cecf1; and Sean Chen and John Feffer, “China’s Military Spending: Soft Rise or Hard Threat?”, Asian Perspective, Vol 33, No. 4, 2009; <http://www.asianperspective.org/articles/v33n4-c.pdf>.

¹¹ Belinda Helmke, “China’s Military Spending”, The Diplomat, June 8, 2011; <http://the-diplomat.com/new-leaders-forum/2011/06/08/chinas-military-spending/>.

¹² “Chinese Defense Budget Boost Seen Aiding Nuclear Force”, Global Security Newswire, March 7, 2011; http://www.globalsecuritynewswire.org/gsn/nw_20110307_1314.php.

¹³ Brigadier Vijai K Nair, “China’s Nuclear Strategy and Its Implications For Asian Security”, China Brief, Vol 4, Issue 3, February 4, 2004; http://www.jamestown.org/single/?no_cache=1&tx_ttnews%5Btt_news%5D=26259. Nair’s estimate is repeated elsewhere in astute scholarly analyses, for instance James Rickard, “Sun Tzu, Nuclear Weapons and China’s Grand Strategy”, Strategic Insights, Vol. VII, Issue 3 (July 2008); <http://www.nps.edu/Academics/centers/ccc/publications/OnlineJournal/2008/Jul/rickardJul08.html>.

submarines in 2008 (named Le Terrible of the “Triumphant” class), President Sarkozy announced that France would continue drawing down the number of its nuclear warheads carried by airplanes, leaving a total arsenal of less than 300 weapons.¹⁴ France has also begun to work closely with the United Kingdom in the area of nuclear weapons stockpile maintenance using computer simulation, a collaboration that will mainly ease the pressure on the U.K. defense budget because the French Atomic Energy Commission facilities will conduct the simulation work and relieve the U.K. of building duplicate facilities.¹⁵ The French will charge for the service, however, thereby subsidizing a program whose annual cost exceeds one-half billion dollars.¹⁶

Although details of France’s nuclear budget are not publicly available, reliable aggregate figures have been provided by a leading French nuclear analyst, Bruno Tertrais. He disclosed that “. . . on average, France’s nuclear defense budget for 2003-2008 (in the five-year defense plan voted by Parliament in 2002) was planned to be 2.8 billion Euros (\$3.8 billion) per year. The 2007 nuclear defense budget includes 3.36 billion Euros (\$4.6 billion) for program authorizations, including 1.31 billion Euros (\$1.8 billion) for the Commissariat a` l’Energie Atomique (CEA), and 3.27 billion Euros (\$4.6 billion) for payment credits, including 1.26 billion Euros (\$1.7 billion) for the CEA.”¹⁷

There are downward pressures on France’s nuclear budget which, however, France has resisted on policy grounds.¹⁸ This report projects a steady rate of spending at around \$4.7 billion and \$6.0 billion in 2011 for core and full costs, respectively, reflecting only slight inflationary increases over 2010.

United Kingdom: Facing A Costly Decision on Modernization

The United Kingdom’s nuclear arsenal today consists of four aging Trident submarines whose operational running costs were projected to be \$3.4 billion in 2010-2011.¹⁹ During a debate on the Queen’s Speech on 26 May 2010 Foreign Secretary William Hague

¹⁴ Steven Erlanger, “France Adds Nuclear Sub and Vows to Cut Warheads”, *New York Times*, March 22, 2008; <http://www.nytimes.com/2008/03/22/world/europe/22france.html>.

¹⁵ James Blitz and Ben Hall, “UK and France in Talks Over Warheads”, *Financial Times*, October 7, 2010. The article says: “A deal to share the secrets of their nuclear programmes would boost powerfully defence collaboration between the countries and save money at a time when their [defence budgets are under stress](http://www.ft.com/cms/s/0/86783318-d252-11df-8fbc-00144feabdc0.html#ixzz1PF9Fr9wo),” - <http://www.ft.com/cms/s/0/86783318-d252-11df-8fbc-00144feabdc0.html#ixzz1PF9Fr9wo>.

¹⁶ Tertrais, Bruno. "The Last to Disarm? The Future of France’s Nuclear Weapons." *Nonproliferation Review* July 14.2 (2007): 251-73. James Martin Center for Nonproliferation Studies. 2007. Web. 28 Mar. 2011. <<http://cns.miis.edu/npr/pdfs/142tertrais.pdf>>

¹⁷ Ibid.

¹⁸ Tertrais assessed the situation as follows: “Given France’s appalling budget deficit, the French president elected in May 2007 will certainly be tempted to further reduce the defense expenditures, and the nuclear expense may be a target of choice. However, any significant reduction of that expense would imply critical political choices. A decision to cancel the fourth new-generation SSBN, for instance, would imply the termination of the current policy of permanence at sea of at least one SSBN. A decision to scale back the simulation program might encroach on France’s ability to independently maintain a viable deterrent for the foreseeable future, and a decision to terminate the airborne component of the nuclear deterrent would mean a significant loss of flexibility in planning and targeting.” Ibid.

¹⁹ <http://www.snp.org/node/13910>.

reiterated that the UK has no more than 160 operationally available warheads, and announced that the total number will not exceed 225.²⁰

A UK decision whether to buy a new set of four submarines to replace its aging Trident fleet, at an estimated cost of \$35-40 billion, must be made in 2016. A Ministry of Defense White Paper (December 2006) earlier recommended that a UK nuclear arsenal should be maintained and that a new submarine fleet should be built to extend this mission into the 2040s (later increased to the 2060s).²¹ The paper estimated the costs for this option at \$24-32 billion based on ship-building costs of up to \$22.4 billion, \$5 billion for refurbishing warheads, \$5 billion for infrastructure, and \$400 million to participate with the United States in the Trident D5 missile life extension program.

In 2011, Defense Minister Liam Fox stated that inflation (rather than cost growth) could drive the price of constructing the replacement fleet up to \$40 billion by the time the first submarines entered service in 2028 even without missiles, warheads or running costs.²²

Assuming the decision to proceed or cancel the program is made in 2016, the near future costs of the program would consist largely of the contracts let for the early design work. Defense Minister Fox recently announced the start of this phase at a cost of approximately \$5 billion.²³

In addition, very substantial costs for decommissioning submarines and nuclear reactors and other infrastructure will be incurred over the next decade and beyond. The “UK Ministry of Defence Consolidated Departmental Resource Accounts 2009-2010” presents the following information which largely falls into the environmental and health component of the full cost of the UK nuclear weapons program.²⁴

| UK MoD Consolidated Department Resource Accounts 2009-2010 (Nuclear Items) | |
|---|-----------------------|
| Item | Cost in GBP |
| Increase in nuclear and other decommissioning provisions | 436,792,000 |
| Nuclear decommissioning | 4,736,802,000 |
| Nuclear decommissioning after 2021 | 2,990,675,000 |
| Ministry of Defence’s nuclear liabilities | 9,343,264,000 |
| Nuclear risks and decontamination | 485,294,000 |
| Costs, including support services for submarines | 2,574,814,000 |
| Total | 20,567,641,000 |

²⁰ BBC, “UK to be “more open” about nuclear warhead levels”, http://news.bbc.co.uk/2/hi/uk_news/politics/8706600.stm.

²¹ The Future of the United Kingdom’s Nuclear Deterrent; <http://www.official-documents.gov.uk/document/cm69/6994/6994.asp>http://en.wikipedia.org/wiki/British_replacement_of_the_Trident_system.

²² Richard Norton-Taylor and Allegra Stratton, “New Trident fleet cost will Top 25 bn pnds”, Guardian, May 19, 2011; <http://www.guardian.co.uk/politics/2011/may/18/new-trident-fleet-funding>.

²³ “UK MoD Announces Plans for New Nuclear Deterrent”, Defense Talk, May 23, 2011; <http://www.defencetalk.com/uk-mod-announces-plans-for-new-nuclear-deterrent-34366/>.

²⁴ United Kingdom Ministry of Defence. www.mod.uk. July 2010. Web. 27 Mar. 2011. http://www.mod.uk/NR/rdonlyres/F10E990E-C296-48B1-9838-B3006C1F8DCB/0/mod_ra0910.pdf.

Based upon the figures given above for annual operating costs for the current strategic submarine fleet, new contracts for early design work on the replacement fleet, and the decommissioning and other costs identified in the table above, this report estimates the UK nuclear budget in 2011 at \$4.5 billion (core) and \$5.5 billion (full).

India and Pakistan: Nuclear Gang-Busters

In South Asia, an unprecedented nuclear build-up is underway and gaining momentum spurred by Pakistan's break-neck effort to double its already sizable arsenal over the next decade (rising from 125 weapons today to 250-350 over the next 5-10 years). India is playing serious catch-up with new land-based rockets and a new strategic submarine in its mix of delivery systems after a decade of sluggish growth (its current small arsenal of 25 weapons will increase to 100 over the next 5-10 years).

Pakistan has the fastest growing nuclear weapons program in the world, according to U.S. officials cited by a leading American nuclear expert, David Albright.²⁵ With 120-130 thousand people directly involved in its nuclear weapons production and nuclear-armed missile program,²⁶ Pakistan is completing construction on two new plutonium reactors (less than 100 miles from the scene of fighting between the Army and the Taliban) and building other infrastructure.²⁷

Pakistan does not officially reveal the cost of its secret nuclear program. In 2009, a credible assessment by an investigative journalist with expertise in the subject provided information on which we can calculate the overall nuclear program budget (weapons and missile delivery systems) to be approximately \$781 million – \$300 million for the Pakistan Atomic Energy Commission and \$481 million for the strategic missile delivery system.²⁸ This sum represents 10 percent of Pakistan's annual defense budget (\$7.9 billion)²⁹. Independently, an American expert on the Pakistani nuclear program suggested that Pakistan spends up to 10 percent of its defense budget on nuclear forces.³⁰ This report assumes that the current budget pressure on the Pakistani program is containing cost growth in 2011; core and full costs are estimated at \$800 million and \$2 billion, respectively. The health and

²⁵ David Albright, Paul Brannan, and Robert Kelley, "Pakistan Expanding Dera Ghazi Khan Nuclear Site: Time for U.S. to Call for Limits," *ISIS Imagery Brief*, Institute for Science and International Security, May 19, 2009; <http://www.isis-online.org/publications/southasia/PakistanExpandingCPC.pdf>.

²⁶ Ansar Abbasi, "Alarm bells ringing in security establishment", *Pakistan Herald*, May 24, 2011; <http://pakistanherald.com/Articles/Alarm-bells-ringing-in-security-establishment-2749>.

²⁷ Thom Shankar and David E. Sanger, "Pakistan Is Rapidly Adding Nuclear Arms, U.S. Says", *New York Times*, May 17, 2009; <http://www.nytimes.com/2009/05/18/world/asia/18nuke.html>.

²⁸ Ansar Abbasi, "Pak nuclear programme faces 35 pc cut", *The News*, May 1, 2009; <http://forum.pakistanidefence.com/index.php?showtopic=82307&mode=threaded&pid=1142305>.

²⁹ Ansar Abbasi, "Real figure of defense budget", *Pakistan Defense*, June 12, 2010; <http://www.defence.pk/forums/economy-development/61520-real-figure-defence-budget-675-bn.html>.

³⁰ Gregory S. Jones, "Pakistan's "Minimum Deterrent" Nuclear Force Requirements", in Henry D. Sokolski, editor, *Pakistan's Nuclear Future: Worries Beyond War*, Strategic Studies Institute, January, 2008; <http://StrategicStudiesInstitute.army.mil/>.

environmental consequences of Pakistan's recent expansion of its infrastructure constitute a significant cost which can be expected to grow rapidly as new plutonium factories come on line. Furthermore, core spending on the nuclear program is likely to grow significantly for the rest of the decade as Pakistan undertakes a rapid build-up, perhaps by two- or three-fold, of its arsenal.³¹

India's nuclear program is largely keyed to China's and to a lesser extent to Pakistan's, and both of India's nuclear rivals are expanding their arsenals sufficiently to stimulate India's program. India has always minimized the role of nuclear weapons in its national security strategy, and consequently was slow to acquire an arsenal and restrained in the size of the arsenal it built. The impetus to expand the arsenal is stronger today, however. India's modernization program already has considerable momentum yielding as much as a four-fold increase in the Indian arsenal over the next decade.

India, like Pakistan, keeps its nuclear budget under wraps. Very few details are publicly known about the program, and its cost is rarely discussed in public. One published estimate contends that the Indian program, very conservatively estimated, costs 0.5 percent of annual GDP.³² Using \$1.538 trillion dollars as the GDP of India, this would mean that India spends about \$7.7 billion on nuclear weapons at purchasing power parity exchange rates. This would represent 22 percent of India's overall defense budget, a proportion that exceeds Pakistan's ratio of nuclear to overall spending by a factor of two, and China's ratio by a factor of four.

This report assumes that India's nuclear spending does not exceed 10 percent of its overall military spending, a fraction in line with current Pakistani allocations. India's nuclear budget would thus be about \$3.8 for core costs, which is about 60 percent of China's nuclear budget. We estimate the full cost to be \$4.9 billion.

Israel and North Korea: Opaque Nuclear Programs and Budgets

These nations run their nuclear weapons programs under a thick veil of secrecy. Any estimates of their spending on these weapons are subject to wide margins of error. Their programs are certainly small enough, however, that inaccuracies in estimates would have negligible effect on the general conclusion that the nine nuclear weapons countries are spending approximately one trillion dollars per decade at minimum at the current levels of their spending.

The Israeli nuclear program has concentrated on acquiring a fleet of 5-6 submarines capable of firing nuclear-armed cruise missiles, and stationing 3 of them in the Persian Gulf to project a nuclear threat at Israel's current and only nuclear-capable adversary – Iran.³³ The

³¹ Andrew Bast, "Pakistan's Nuclear Surge", *Newsweek*, May 15, 2011; <http://www.newsweek.com/2011/05/15/fourth-nuclear-reactor-at-pakistan-s-khushab-site.html>.

³² C Rammanohar Reddy, "Indo-Pak Defense Spending", *South Asian Journal*, Jan-Mar 2004; http://www.southasianmedia.net/Magazine/Journal/indopak_defence.htm.

³³ Uzi Mahnaimi, "Israel stations nuclear missile subs off Iran", *The Times (Sunday Times)*, May 30, 2010; <http://www.timesonline.co.uk/tol/news/world/europe/article7140282.ece>; "Report: Israel to deploy nuclear-armed submarines off Iran coast", *Haaretz.com*; http://www.google.com/#sclient=psy&hl=en&rlz=1W1RNSN_en&source=hp&q=haaretz%20Israel%20to%20deploy

latest models of these boats and their weapons systems run into the billion-dollar range for each, though Germany has absorbed a substantial portion of the costs. Israel also possesses aircraft and land-based ballistic missiles capable of delivering its nuclear arsenal, whose size was estimated by the U.S. Pentagon to be about 80 weapons with only modest projected increases through 2020 (although Israel possesses enough fissile material to build up to 115-190 warheads).³⁴ We estimate the core and full cost of Israel's arsenal in 2011 to be \$1.5 billion and \$1.9 billion, respectively.

North Korea has conducted two nuclear tests and produced enough plutonium for up to a dozen fission bombs,³⁵ and is developing infrastructure to enrich uranium to build nuclear bombs. It does not yet possess the capability to deliver atomic bombs using long-range missiles, but this is clearly their delivery system of choice and an earnest effort is underway to develop this capability. The core and full cost of this program are estimated at \$500 and \$700 million, respectively. The former represents about 6 percent of North Korea's military spending (\$8.8 billion in 2009, the last available reliable estimate of total military spending, which represents about 33 percent of the country's national income spent on the military).³⁶

Conclusion: Upward Trending Nuclear Spending World-wide

The United States is moving into a phase of nuclear modernization that will entail greater spending on nuclear weapons than at any time since the Cold-War Reagan years, and much of the rest of the nuclear-armed world is undergoing similar upgrading of their arsenals at increasing cost. Conservatively estimated, the aggregate spending on nuclear weapons by the nine nuclear weapons countries over the next decade will exceed one trillion dollars.

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³⁴ Robert S. Norris and Hans M. Kristensen, "Global nuclear weapons inventories, 1945-2010," *Bulletin of the Atomic Scientists*, July/August 2010; <http://bos.sagepub.com/content/66/4/77>.

³⁵ Ibid.

³⁶ Reuters, "North Korea spends about a third of income on military: group", Jan 18, 2011; <http://ca.reuters.com/article/topNews/idCATRE70H1BW20110118>;